Ben Gurion University of the Negev

Health & Welfare Economics and Administration

THE INTERRELATIONSHIP BETWEEN PARENTS' INVESTMENT IN CHILDREN'S HEALTH AND EDUCATION: THEORETICAL AND EMPIRICAL NOTES

Dov Chernichovsky

Working Paper 82-1 82-1 - נייר עבודה

March 1982

Table of Contents

THE INTERRELATIONSHIP BETWEEN PARENTS' INVESTMENT IN CHILDREN'S HEALTH AND EDUCATION: THEORETICAL AND EMPIRICAL NOTES

Dov Chernichovsky

Ben Gurion University, Israel

I. Introduction

The effect of child health and mortality on parents' desire to have children has been extensively discussed in demographic and related economic literature, such as, for example, O'Hara 1970. Little or no theoretical or quantitative information is available about how parents' incentive to educate their children may relate to children's health, particularly in developing areas where even primary education is not universal and children's health is still precarious.

This short paper deals with the effect of child health on parents' desire to allocate resources toward the education of their children. The paper consists of two parts. In the first, which is theoretical, some elements of the economic theory of uncertainty are applied to the subject. It is posited that the higher children's health status, the greater is the parents' desire to educate their offspring. Furthermore, parents who wish to have better educated children will also attempt to provide better health care for them. In the second, empirical part, these hypotheses are tested

by applying regression analysis to household survey data of a village in India.

II. Investment in Children: A Theoretical Note

For analytical purposes, we assume that parents make decisions concerning their children in a two-period "Fisherian" framework. During the first period parents give birth to, raise, and educate their offspring while subject to a variety of biological and economic constraints. During the second period, parents expect to benefit, both psychologically and otherwise from their grown children.[1]

Formally, we express the parents' expected utility function by

$$U = EU(C_1, C_2, S) \tag{1}$$

where C_1 and C_2 are two deterministic consumption flows corresponding to the first and second periods. S is a stochastic parameter denoting the services children are expected to render to their parents during the second period. Parents are assumed to be risk averse and to have decreasing temporal risk aversion with respect to S.[2] These assumptions imply that between any two situtations which bring about a particular change in expected benefits from

---

1 For relevant discussions, see Willis (1973), Neher (1971), and Chernichovsky (1982).

2 This follows the definition of risk by M. Rothchild and J.H. Stiglitz (1970:226) that an asset y is more risky than x -- both having the same expected value -- if EU (x) > EU (y).

children, or in the value of S, the situation bringing about a higher corresponding change in variance of S is least desired. Alternatively, parents should be willing to sacrifice resources for the sake of obtaining a higher degree of certainty concerning their expectations from their children.[1]

The distribution of benefits from children, or of S, is assumed to be determined by three parameters; the number of children parents have, N, each child's probability of reaching maturity, P_j (j = 1...N) and the anticipated benefits from each surviving child, Q_j, which are considered to be a direct and positive function of the child's level of education.[2]

The parameters C_1, C_2 and S are assumed to exhaust parents' lifetime wealth and parents are assumed to behave in such a way as to maximize their expected utility. Parents will thus determine the levels of the three parameters by equating the marginal expected utilities per unit of expenditure, in terms, for example, of C_1.

---

1 A. Sandmo (1970), J. Dreze and F. Modgliani (1972) of the class of utility functions satisfying this assumption, the quadratic one, with respect to S, is ruled out because that particular function may imply increasing risk aversion with respect to wealth. This implication is not regarded as too realistic. See J.W. Pratt (1964).

2 Education is defined here in the broad sense. It may include, in addition to formal education, non formal education such as home and farm on-the-job training as well as instillment of ethical values in children. Q can also be increased by other assets; this case, however, is not considered explicitly in the discussion because these assets are not embodied in children and the parents do not stand to lose them with child mortality. For a discussion of investment in child "quality" or human capital vs. other investment opportunities, see W. Bush (1973).

If parents assign a priori equal survival probabilities to each of their children, $P_i = P_j = P$, parents who have N children will expect the number of survivors (SR) to be

$$E(SR) = NP. \tag{2}$$

The variance of that number is

$$VAR\ (SR) = NP\ (1 - P), \tag{3}$$

as VAR (P) = P(1 - P).[1] Consequently, the level of expected services from children is

$$E(S) = QPN \tag{4}$$

and the corresponding variance is

$$VAR\ (S) = Q^2NP\ (1 - P). \tag{5}$$

---

[1] In the more general case when $P_i \neq P_j$ and survival probabilities are interdependent;

$$E\ (SR) = \bar{P}N$$

where $$\bar{P} = \frac{1}{N} P_i$$

and $$VAR\ (SR) = \sum_1^N P_i\ (1 - P_i) + \sum_{j \neq i} \sum_{i \neq j} COV\ (SR_i, SR_j)$$

When children's survival probabilities are interdependent, in any given household, we can assume COV (SR_i, SR_j) > 0.

The discussion concentrates now on the optimal composition of S which parents can affect through fertility behavior and investment in children's education with children's health as given, in the special case; and investment in child health as well as in the general case. Parents can thus affect the distribution of S by changing P and Q -- when $N \geq 1$ -- and by changing N; thereby parents determine the expected level of benefits from children as well as the risk involved in obtaining these benefits.

The behavioral implications concerning the composition of S are based on the differential effects each of the three arguments has on S. Differentiating expressions (4) and (5) with respect of each parameter indicates the particular effects N, P, and Q have on the distribution of expected services from children. An increase in either N, by fertility behavior, or in Q, by investment in education, leads to an increase both of the mean and the variance of S. However, an increase in Q brings about an increase in the variance of expected benefits that is more than proportionate compared with the increase in the expected benefits, while an increase in N brings about equiproportional changes in the mean and the variance.[1] Hence, an increment in expected benefits through more children is less risky than through better education to given number of children. This argument is consistent with the intuition suggesting that for any given survival probability, the expected real loss to parents is higher when a few children are better educated than when parents have more but less educated children.[2] This loss is even higher

---

1 See mathematical annex. The ratio between the mean and the variance does not change in the case of a change in N. It falls when Q is increased. Note, however, that the discussion does not necessarily imply a Mean-Variance analysis. We just assume that parents remain indifferent to prospects which increase the mean and the variance by the same factor.

2 The popular equivalent of this notion is the risk associated with putting "all the eggs in one basket".

when parents have more than one child, and the children's probabilities or survival are interdependent (when COV (SR_j, SR_i) > 0). It is noteworthy that the particular risk associated with higher levels of education falls as survival probabilities rise.

The more general case entails the possibility that in addition to their ability to affect N and Q parents can also influence P. The effect on increasing a child's probability to survive by enhancing his health increases the expected value of S and reduces its variance, whenever $P \geq 5$.[1] This particular effect is compounded when the health of one child affects that of his siblings, as would be the case of contagious diseases. Thus, investment in child health, or a decrease in child mortality probabilities, has a unique effect on the expected benefits from children.

Optimal behavior, which implies obtaining as much expected utility as possible from expenditures of C_1 on all prospects, requires the marginal expected utility from any of the parameters comprising S per unit of costs, or C_1 forgone, to be equal. This means that the shadow prices $\left(-\frac{dj}{dC_1} = \Pi_j;\ j = N,P,Q \right)$ of the prospects must differ because an increase in

---

[1] See annex, Section 3. The assumption of an endowed $P \geq 0.5$ is realistic. Bounds on the probabilities of the parents in India, for example, to benefit from children can be established based on the following assumptions: (a) fathers' prime fertility years are between 20-35 years of age; (b) a parent (father) expects to start benefiting from children at about age 45; (c) a child (son) is out of school at age 15. Assuming that their probabilities to survive are independent, the joint probability of the father reaching age 45 (from 20) and the elder son reaching 25 is .6396. For having a child at age 35, the joint probability of the son reaching 15 and the father age 50 is .6205. The joint probabilities of at least one of the parents surviving with the child are even higher. These probabilities are computed according to life tables for males from Saxesna (1971).

E(S) through Q coincides with a smaller increment in expected utility than the same increase in E(S) through N or P. That is, raising E(S) through Q must carry a lower shadow price than does an increase through N or P. Following this argument, the relationship among the prices should be:

$$\Pi_Q < \Pi_N < \Pi_P . \tag{6}$$

Namely, the marginal costs of each prospect in terms of C_1 must correspond to the marginal gain in expected utility.[1]

This ranking of shadow prices (given ratios that do not imply a corner solution) implies that the parents combine linearly investments in health and education as two complementary prospects. That is,

$$\Pi_N = \alpha \Pi_Q + (1 - \alpha) \Pi_N \tag{7}$$

where α is the share of a given gain in E(S) attributed to Q. Thus, at the intensive margins -- per child -- parents will invest in both forms of human capital up to the point where the gain in expected utility is equal to that of having an additional child. This implies first that investment in health and education are complementary and second that investment in a child's health and education continues up to the equality point in relationship (7) which defines optimal investment in human capital per child.

Hence, in areas of high child mortality, especially where contagious diseases affect mortality, one can expect parents to be reluctant to educate

---

[1] Technically, this is required to avoid a so-called corner solution.

their children. Rather, parents will opt for a given level of expected benefits from their children through higher fertility rates. On the other hand, as the probability of child survival increases, we can expect that parents will lower fertility and opt for more education for each child. This proposition differs from most others dealing with "child quality".[1]

This framework is also useful when discussing effects of parents' income or wealth on investment in children's health and education. Employing the realistic assumption of decreasing risk-aversion with respect to wealth along with the proposition that education is the relatively "risky" asset in our "portfolio", one can hypothesize that relatively wealthier parents may opt for relatively riskier investments. All other things being equal, they will invest more than lower income parents will in their children's education.

III. The Effect of Child Mortality on Schooling: An Empirical Note

The data for this discussion were obtained from a cross-sectional household survey carried out during 1967-68 in the village of Ankodia, in the Indian state of Gujarat (Patel 1970). Between the 161 village households on which economic and demographic data were gathered, 324 children between the ages 6 and 14, the compulsory schooling ages in India, were reported. As children in this village attended school irregularly, these

---

[1] See Willis (1973), Becker (1973) and DeTray (1973).

data provided the opportunity to test the hypothesis that child mortality, used here as a proxy for child's health status, has a negative effect on parents' willingness to educate their children.

An index defining the household's investment in children's schooling was developed on the basis of children's age and sex distribution with the village's age and sex specific schooling norms (Chernichovsky, 1977).[1] This index was used as a dependent variable in a linear regression estimated by ordinary least squares. The parents' attitude toward child mortality was approximated by the ratio of the number of children who had died in the family to the number ever born. This ratio was used as an independent variable along with household income, parents' education, and father's occupation, civil servant or otherwise. The estimated coefficients are reported in Table 1.

Table 1. Regression Coefficients,
Household Education Index as a Dependent Variable
(t statistics in parentheses)

Constant	Household Income (In Rupees)	Father's Schooling (Yrs.)	Mother Literate (=1)	Father Civil Servant (=1)	Ratio of Children who died to No. born	R^2	F
0.81902	0.00003 (2.796)	0.04932 (2.242)	0.22637 (2.094)	0.54790 (3.755)	-0.49033 (-2.118)	0.28	13.49

[1] The index defines a household's investment in children's education as the ratio between the actual level of schooling of school-age children, and the predicted level given children's age and sex distribution that is based on the community's schooling experience.

When controlling for household income, parents' education, and the father being a civil servant, the household's child mortality ratio has a stastically significant negative effect on the parents' investment in their children's primary schooling. Hence, within socioeconomic strata identified by variables that presumably determine school-related abilities and tastes for schooling, households that experienced more child mortality appear to provide less education for their living children. Unfortunately, we cannot determine whether the measured effect of mortality on schooling is only behavioral as postulated here; poor health leads to a lack of concentration, absenteeism and dropping out, and thus may affect schooling in some other ways than through parents' motivation. However, the fact that the household's socioeconomic characteristics are controlled for and that we account for the effect of children who died on the schooling of those surviving, lends more weight to the major hypothesis postulated in this paper.

The income coefficient is also of interest in the context of this discussion. One cannot refute the hypothesis that wealthier parents, ceteris paribus, are less risk averse than less wealthy parents, and therefore invest more in their children's education, although they may incur a higher loss in case of child death.

In summary, the theoretical and empirical notes comprising this paper suggest that while controlling for other factors, improvements in children's health status which thereby enhance parents' attitudes toward their children's chances of reaching maturity, may offer another means of increasing the demand for schooling.

Mathematical Annex

The following statistics are used according to the definitions in the text.

$$E(S) = QPN \tag{1}$$

$$VAR(S) = Q^2NP\ (1-P) \tag{2}$$

$$MV(S) = \frac{E(S)}{VAR\ (S)} = \frac{1}{Q(1-P)}$$

I. A change in the number of children, N, has the following effects:

$$\frac{\partial E(S)}{\partial N} = QP > 0 \tag{3}$$

$$\frac{\partial VAR(S)}{\partial N} = Q^2P\ (1-P) > 0 \tag{4}$$

$$\frac{\partial MV(S)}{\partial N} = 0$$

II. A change in child "quality", or a child's education, Q, has the following effects:

$$\frac{\partial E(S)}{\partial Q} = PN > 0 \tag{5}$$

$$\frac{\partial VAR(S)}{\partial Q} = 2QNP\ (1-P) > 0 \tag{6}$$

$$\frac{\partial MV(S)}{\partial Q} = -\frac{1}{Q^2(1-P)} < 0$$

III. A change in P:

$$\frac{\partial E(S)}{\partial P} = QN > 0 \tag{7}$$

$$\frac{\partial VAR(S)}{\partial P} = Q^2\ N(1-2P) \quad \begin{cases} >0 \\ =0 \\ <0 \end{cases} \quad \text{if} \quad \begin{cases} P < 0.5 \\ P = 0 \\ P > 0.5 \end{cases} \tag{8}$$

$$\frac{\partial MV(S)}{\partial P} = \frac{1}{[Q(1-P)]^2} > 0 \tag{9}$$

References

Becker, Gary S., and Lewis, H. Gregg. "On the Interaction Between the Quality and Quantity of Children." Journal of Political Economy 81, Part 2 (March-April 1973): 279-288.

Bush, Winston C. "The Economic Analysis of Fertility: Two Extensions." Virginia Polytechnic, 1973. (Mimeographed).

Chernichovsky, Dov. "Fertility Behavior in Developing Economies - An Investment Approach." In J. Simon and P. Lindert, Research in Population Economics vol. 4. JAI Press, Inc., 1982, forthcoming.

Chernichovsky, Dov. "Indexing Household Investment in Formal Education of School-Age Children." World Bank mimeo, 1977.

DeTray, Dennis N. "Child Quality and Demand for Children." Journal of Political Economy 81, Part 2 (March-April 1973): 70-95.

Dreze, Jacques H., and Modigliani, Franco. "Consumption Decisions Under Uncertainty." Journal of Economic Theory 5 (1972): 308-335.

Neher, Philip A. "Peasants, Procreation and Pensions." American Economic Review 61 (June 1971): 380-389.

O'Hara, Donald J. Changes in Mortality Levels and Family Decisions Regarding Children. R-914-RF. Santa Monica, California: RAND Corporation, September 1970.

Patel, R.M. Ankodia, Change in Economic Life in a Tobacco Village. Vallabh Vidhanagar, India: Sardar Patel University, 1970.

Pratt, John W. "Risk Aversion in the Small and in the Large." Econometrica 32 (1964): 122-136.

Rothchild, Michael, and Stiglitz, Joseph H. "Increasing Risk I: Definition." Journal of Economic Theory 2 (1970): 225-243.

Sandmo, A. "The Effect of Uncertainty on Savings Decisions." Review of Economic Studies 37 (July 1970): 353-360.

Saxena, O.B. India, Population in Transition. New Delhi: Commercial Publication Bureau, 1971.

Willis, Robert J. "A New Approach to Economic Theory of Fertility Behavior." Journal of Political Economy 81, Part 2 (March-April 1973): 14-64.

תקציר בעברית - Abstract in Hebrew

העבודה דנה בקשר בין מצב בריאותם של ילדים והנכונות של הורים להשקיע בחינוך הילדים בעקר בארצות מתפתחות, שם תמותת ילדים גבוהה יחסית וחינוך, גם יסודי, אינו מובן מאליו.

העבודה מיישמת מסגרת דיון כלכלית להוכיח שבריאות הילד היא "נכס" מועדף במובן שהיא מבטיחה להורים כל הוצאה אחרת על ילדיהם. ההשערות הנגזרות מהדיון הן:

א. כאשר שעורי תמותת ילדים גבוהים יחסית, הורים ייטו ללדת יותר ילדים אך להשקיע פחות בחינוכם;

ב. כל רצון להשקיע יותר בחינוכו של הילד יהיה סימולטנית ברצון להשקיע יותר בהבטחת בריאותו.

ההשערות נבדקו ע"י שמוש בנתונים מהודו והעסקת רגרסיה רבת משתנים. מהדיון האקונומטרי מתקבל שכאשר מחזיקים קבועים את רמת ההכנסה של המשפחה, השכלת ההורים ותעסוקת האב, היחס של מספר ילדים שמתו במשפחה לאלה שנולדו הוא בעל השפעה שלילית על רמת ההשכלה שהורים מקנים לילדיהם. דיון זה תומך, איפוא, בהשערה שתמותת ילדים גבוהה יותר מובילה לרצון להשקיע פחות בחינוך, כאשר כל הדברים האחרים שווים.

מבחינת קביעת מדיניות גורסת העבודה שהבטחת (מערכת שירותי) בריאות לילדים היא תנאי מוקדם להקמת מוסדות לחינוכם. אלטרנטיבית, ניתן לעודד חינוך על ידי השקעה בבריאות.

List of Health & Welfare Economics & Administration Working Papers

The Interrelationship Between Parents' Investment in Children's Health and Education: Theoretical and Empirical Notes.	Dov Chernichovsky	82-1