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ECONOMIC ANALYSIS OF THE EFFECTS OF MOTHER'S EDUCATION ON CHILD'S HEALTH AND THE DEMAND FOR HEALTH INPUTS

by

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I. INTRODUCTION

Increased attention has been given in recent years by economists to the subject of childrens' health. Some evidence suggests that health at early stages in the life cycle may have an important role in the determination of health at later stages as well as in the determination of intelligence, years of formal schooling completed, and earnings.

Given this evidence and the policy goal of improving the health of children, it is important to provide a theoretical and empirical framework that will explain the determinants of variation in childrens' health. Such an understanding of the sources of differences in health across children will provide a framework that will promote an efficient allocation of scarce resources by government policy makers by directing such policies towards the sources of such differences.

An important aspect of such a policy is the understanding of the factors that affect the demand for medical care services. Since appropriate pediatric care is one of the obvious ways of maintaining good health of children, policies that are aimed at improving childrens' health should include some elements directed at increasing the utilization of pediatric care. Examples of such policies are those that alter the costs of medical care, or the accessibility to medical care sources, or the quality of medical care. In particular, the quality of such services can be improved through regulations on certification, training programs, etc. The accessibility of pediatric care can be improved through increased neighborhood medical centers and increased number of physicians. The prices of medical care can be altered through programs like medicare, private insurance policies or a national health insurance program.

All three types of policies suggested above affect the full cost to the family of pediatric care by altering either the market price of medical care services or "quality" aspects of that care. For example, the higher quality of pediatrician services for a constant price translates to a lower full cost. Similarly, factors that affect the convenience of medical care, like waiting time at the source of medical care, travel time to that source, and travel costs, are cost components that have to be considered by policy makers. Policies directed at the demand for pediatric care will not be as effective if those implicit cost factors are not taken into consideration.

In addition, the demand for medical care is affected by socio-economic characteristics of the family. Factors like income, family size, and parents' education might affect the amount of medical care demanded and the ultimate health level of children.

One set of such socio-economic characteristics is the amount of human capital embodied in the members of the family. Human capital effects on childrens' health can be analyzed in the framework of the household production function. In this framework, medical services and health related goods that are purchased in the market do not enter directly into the family's utility function, but rather enter together with the time of the family's provider of child's health care, into the production function of the commodity "children's health." It is the latter commodity which enters into the utility function. Such household produced commodities are produced with a given level of technology in a manner that maximizes the family's utility function subject to budget and time constraints.

In this model, human capital is assumed to be an efficiency parameter that might affect both consumption and production patterns of a particular household produced commodity. It might affect consumption levels of commodities by reducing their marginal costs in a non-neutral way. If so, there will be substitution in consumption towards those commodities for which human capital has relatively large efficiency effects. Consumption patterns would change also if human capital is commodity neutral. Larger efficiency in production increases the real income and this would, in turn, have an increasing effect on the consumption of the various commodities. However, the consumption shares of these commodities generally will be altered as long as different commodities have different income elasticities.

Another way by which human capital can affect consumption patterns is through effects on the amount of resources available for the family during the life cycle. Human capital affects market productivity as well as non-market productivity, and this affects both money income and the wage rate of the family members. Differences in money income might affect consumption of non-market goods through the income effect, while the wage rate is a determinant of both the supply of hours to the labor market and the price of time inputs in the household production functions. An increased wage rate would alter the relative marginal costs of commodities and will lead to substitution away from relatively time intensive goods.

Human capital also has an effect on the technologies of production of non-market goods. Differences in the price of time inputs and in the marginal productivities of these inputs, might lead the family to alter the production technologies through substitution in production.

Thus, it is important to understand the interaction between human capital and different technologies, as well as the reasons for different levels of health consumption across different groups of the population, in order to formulate policies directed at improving the health of certain segments of the population.

Recent economic literature examines the subject of health, in general, and child's health, in particular, within the household production function framework. Grossman (1972) indicates that individuals choose the level of their health in a way that is done for any other consumption good. He argues that the level of health depends, among other things, on factors like education that affect the relative price of health and other commodities. This approach is applied to child's health as well. Among the studies that deal with this subject are those of Edwards and Grossman (1977), Goldman and Grossman (1975), Friedman and Leibowitz (1975), and Inman (1976).

Edwards and Grossman study the joint determination of children's health and cognitive development, and explore the interrelationship between physical health and their intellectual development.

Goldman and Grossman develop hedonic fee functions for the quality and quantity of physicians' services and use them to estimate demand functions for pediatric care. Their empirical results relate to physicians' characteristics, the effects of quality-adjusted price on the demand for quality and the relative importance of fixed costs of visits compared to the quality-adjusted price of a visit in determination of the number of pediatric visits.

Friedman and Leibowitz assume that mother's schooling is a positive correlate of efficiency in the production of childrens' health. They present a model in which parents transfer one form of human capital (health) and non-human capital to their children. They postulate diminishing marginal returns in the case of investment in human capital but not in the case of investment in financial capital. It follows that an increase in efficiency in the production of health would increase the quantity of pediatric care demanded. Empirically, they find that mother's schooling has a positive and significant effect on pediatric visits.

Inman assumes that the child's health production function has three direct inputs: curative pediatric visits, preventive pediatric visits and mother's own time input. He postulates that the relative productivities of these inputs depend on mother's schooling. This is supported by his findings in a sample of black children in Washington, D.C. He uses the incidence of acute ear, nose and throat conditions as a measure of health, and estimates demand curves for the three inputs. The findings show that an increase in the relative productivity of an input increases the quantity demanded of that input.

In my research, the mother is assumed to be the main provider of child health care in the family. My aim is to examine the role of mother's schooling in the production of childrens' health and in the demand for health inputs such as curative pediatric visits, preventive pediatric visits, and mother's own time input. Health production functions and input demand functions will be estimated in a special sample of New York City residents conducted by the New York City Department of Health (the Mindlin-Densen Survey). This is a longitudinal and cross-sectional survey of infants and preschool children covering twenty-one months in the period 1965-66.

Production functions will be estimated for a general measure of child's health, as well as for two different acute conditions (ENT and respitory conditions). By estimating production functions for various conditions, we will allow the effects of mother's schooling to differ by type of condition.

In addition, derived demand functions for curative pediatric visits, preventive pediatric visits, and the mother's own time input will be estimated. These estimates will enable us to explore the hypothesis that an increase in the relative productivity of an input due to schooling will increase the relative demand of that input. Mother's schooling will also enter directly into the demand estimates in order to get the direct partial effects of mother's schooling on the demand for the inputs for all three health measures.

The contribution of this paper is in two areas:

(A) It extends previous empirical work to three different measures of health (general health, ENT conditions and respitory conditions), and thus, it allows the effects of mother's schooling to differ by type of condition.

(B) The data that are used in this paper are longitudinal, and the health and input variables are measured over a period of a year. Similar studies used health measures that reflect the health state at a point in time (based on a physical examination). Goldman and Grossman (1975) used the same data but they included in their study only children with positive visits to private sources of medical care, while this paper includes children with no visits to public as well as private sources of medical care.

The research in this paper also goes beyond Goldman and Grossman's, by estimating health production functions and by examining the impact of relative input productivity variation on the demand for the health inputs.

II. THE THEORETICAL MODEL

Consider the following family's utility function:

$$U = u(h, z) \quad (1)$$

where:

h = child's health

z = a vector of other non-market commodities

and the following production function of child's health:

$$h = h(x_1, x_2, t; s) \quad (2)$$

where:

x_1 = curative visits to medical care source

x_2 = preventive visits to medical care source

t = mother's own time input in production of child's health.

s = mother's years of schooling.

The production function is assumed to be linear homogenous in x_1, x_2 and t.

The Budget Constraint

The family faces a budget constraint that includes earned and non-earned income, as follows:[1]

[1]Father's income is treated as an exogenous variable and is regarded as part of the non-earned income. It is assumed here that the only provider of child's health care in the family is the mother, and, thus, no subsitution between father's market activity and production of child's health exists.

$$Y = w \cdot t_w + V \qquad (3)$$

where:

Y = money income

w = mother's wage rate

t_w = time spent by mother in the market

V = non-earned income.

The family can purchase inputs in the market subject to the budget constraint that is given by equation (4):

$$Y = w \cdot t_w + V = \Sigma p_i x_i \qquad (4)$$

where:

p_i = price of a unit of market input x_i

The Time Constraint

The mother's time constraint is:

$$\Omega = t_w + \Sigma t_i \qquad (5)$$

where:

Ω = total time available for market and non-market activities

t_i = mother's time input in production of the i^{th} non-market commodity

The Full Income Constraint

By combining equations (4) and (5), we get the full income constraint:

$$R = w \cdot \Omega + V = \Sigma(p_i x_i + w t_i) \quad (6)$$

where:

R = full income.

This full income constraint represents the total amount of resources that the family can spend on market inputs (x_i's) and time inputs (t_i's).

<u>The Effect of Mother's Schooling on the Demand for Inputs</u>

Given the production function in equation (2), and assuming that schooling is factor neutral in h and also commodity neutral,[2] one can write the demand function for a given input (say x_1) as:

$$\ln x_1 = \eta_h \, d \ln R - e_{11} \, d \ln p_1 + e_{12} \, d \ln p_2 + e_{13} \, d \ln w + (\eta_h - 1) \, ds \quad (7)$$

---

[2]If schooling is factor neutral but has an impact on h production but not on z production eqaution (7) becomes:

$$\ln x_1 = \eta_h \, d \ln R - e_{11} \, d \ln p_1 + e_{12} \, d \ln p_2 + e_{13} \, d \ln w + (\xi_h - 1) \, ds$$

where:

ξ_h is the uncompensated price elasticity of x_1.

and

$$\frac{d \ln x_1}{ds} \gtrless 0 \quad \text{as} \quad \eta_h \gtrless 1 .$$

where:

e_{11} = price elasticity of x_1 with respect to p_1 (defined to be positive).

e_{12}, e_{13} = cross-price elasticity of x_1 with respect to p_2 and w, respectively

η_h = income elasticity of health

From (7) it follows that:

$$\frac{d \ln x_1}{ds} \gtrless 0 \quad \text{as} \quad \eta_h \gtrless 1 .$$

The demand for an input is expressed as a function of income and the prices of all inputs.

In order to allow for relative productivity effects of schooling on the demand for the health inputs, consider the following linear homogenous Cobb-Douglas production function:[3]

$$h = A x^{\alpha} t^{1-\alpha} \tag{9}$$

The marginal cost function can be written as:[4]

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[3]Because of the relatively small observed effects of medical care inputs on health outcomes, a function with a degree of homogeneity of less than one might be more appropriate to use, although the assumption of linear homogeneity should not reduce the generality of the discussion.

[4]For derivation of the marginal cost function, see Appendix A, equation (A-17).

$$\pi = \frac{1}{\alpha} A^{-1} p^{\alpha} w^{1-\alpha} (1 - \alpha)^{\alpha-1} \alpha^{1-\alpha} \tag{10}$$

where:

p = price of a unit of x

w = price of a unit of t.

By deriving the demand for x with respect to α one can write:[5]

$$\begin{aligned} \frac{\partial \ln x}{\partial \ln \alpha} &= \alpha\xi[\ln w - \ln p + \ln\alpha - \ln(1 - \alpha)] \\ &\quad - \alpha[\ln w - \ln p + \ln\alpha - \ln(1 - \alpha)] + 1 \end{aligned} \tag{11}$$

where:

ξ = price elasticity of x with respect to p.

The first term is the substitution effect in consumption that results from the change in marginal cost as x rises.[6] The second term is the change in x to produce a constant level of output as α rises, and the third term (+1) is the substitution in production between x and t. The effect of α on x is ambiguous since the first and second terms may be negative and their sum larger than 1. However, the ratio x/t would rise since the effect of a change in α on t will be identical in

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[5] For derivation, see Appendix A, equation (A-31).

[6] $\frac{\partial \ln \pi}{\partial \ln \alpha} = \alpha[\ln p - \ln w + \ln(1 - \alpha) - \ln\alpha]$. For derivation, see Appendix A, equation (A-22).

consumption and in the reduction to hold output constant and negative in substitution in production.

III. EMPIRICAL IMPLEMENTATION OF THE MODEL

A. Formulation of the Model

This chapter outlines the structure of the empirical estimation of the model. The empirical work includes estimations of health production functions and demand functions for the three health inputs. In addition, demand elasticities and health elasticities with respect to policy oriented variables are derived.

1. Production function estimations

Equation (9) can be written as:

$$\ln h = \ln A + \alpha \ln x + (1 - \alpha) \ln t \qquad (12)$$

By extending this formulation to a three input production function and releasing the homogeneity constraint, one can write:

$$\ln h = \ln A + \alpha \ln x_1 + \beta \ln x_2 + \gamma \ln t \qquad (13)$$

The assumption is that input productivities vary across mother's education levels. In order to obtain measures of input productivity, the sample was divided into three mother's education groups (no schooling or grade school, some high school and completed high school or college), and production functions of health were estimated for each mother's education subgroups. The regression coefficients of the inputs in the production functions estimations are then used as measures of the mean productivity of the inputs. The elasticities of these inputs, represented by the coefficients in equation (13), may vary for different measures of health. Therefore, three separate demand functions are estimated for each input, each one using the MP_i of each input in the respective health measure.

The structure of the health production functions is given by equation (14):

$$\ln h_{jk} = \ln A + \alpha_{jk} \ln x_1 + \beta_{jk} \ln x_2 + \gamma_{jk} \ln t \qquad (14)$$

j = health measure (j = 1,2,3)

k = mother's education group (k = 1,2,3)

In the estimations of the production functions [equation (14)], predicted values of curative visits are included as independent variables in their respective estimations, rather than the actual number of curative visits. This was done in order to reduce the problem of reverse causality between the health outputs (HEALTH, NOENT, NORES) and the corresponding curative visits inputs. Children with a larger number of sickness days are likely to have more curative visits. This positive and strong correlation, going from sickness days to curative visits, might reverse the expected positive effect of curative visits on the health output and yield strong negative effects for this input on the health output. In fact, multiple regression estimations, using the actual number of curative visits as an input measure, support this prediction. All the regression coefficients of visits in the production functions of health were negative and highly significant.

Equation (14) is therefore modified and the health production functions estimations are given by equation (15):[1]

[1]The production function estimations include also independent variables that hold constant child's age, race, income per capita and the child's health endowments

$$\ln h_{jk} = \ln A + \alpha_{jk} \ln x^*_{1j} + \beta_{jk} \ln x_2 + \gamma_{jk} \ln t \qquad (15)$$

where x^*_{1j} is the predicted value of curative visits for each health measure, given by the demand estimation in equation (16).

The three health measures are:

(a) A general health measure (HEALTH) that includes all illnesses, measured by the total number of restricted-activity days from all conditions.

(b) A measure of acute ear, nose, and throat (ENT) conditions, measured by the total number of restricted-activity days due to ENT conditions. ENT conditions in this data set include:

Growth on ear	Cold and teething
Middle ear infection	Swollen glands
Cold	Tonsillitis (acute)
Cold and fever	Acute pharyngitis (sore throat)

(c) A measure of acute respiratory (RES) conditions, measured by the total number of restricted-activity days due to respiratory conditions. RES conditions in this data include:

Chest cold	Acute bronchitis
Difficulty in breathing	Pneumonia
Cough	Respiratory infection
Croup	

The three mother's education groups are: (a) completed grade school or no schooling, (b) some high school, (c) completed high school or more.

2. Demand functions estimations

Four sets of demand functions were estimated to measure the direct effect of mother's schooling and the effects of the input elasticities on the demand for those health inputs.

(a) The direct effect of mother's education

The first set of demand estimations follows equation (7) and measures the direct effect of mother's schooling on the demand for health inputs. In this set "full cost" variables of the three inputs are used in the demand estimations of each input. Estimations are given here for the three inputs of the general health measure and for curative visits only in the production of ENT and RES health.[2]

The formulation of this set of demand estimations is given by equations (16) and (17):

For curative visits (x_1) :

$$x_{1j} = f_{1j} (\Pi_1, \Pi_2, \Pi_3, Y, S, M) \tag{16}$$

j = health measure (j = 1, 2, 3)

and for preventive visits (x_2) and mother's time (t):

$$x_{ij} = f_{ij} (\Pi_1, \Pi_2, \Pi_3, Y, S, M) \tag{17}$$

i = input (i = 2, 3)

j = health measure (j = 1, 2, 3)

[2]See later discussion on page 38 on the deletion of demand estimations for preventive visits and mother's time input for ENT and RES conditions.

where:

Π_i = full cost of a unit of i^{th} input[3] (i = 1, 2, 3)

Y = family's annual income

S = mother's years of schooling

M = vector of other variables[4]

Note that the structural model given by equations (15), (16), and (17) is a recursive system. If the disturbance terms in each equation were mutually independent, consistent estimates of the parameters of each equation could be obtained by ordinary least squares. The production function, however, is estimated by two-stages least-squares with the number of curative visits treated as an endogenous variable. This procedure is adopted because I assume that the error term in the production function is positively correlated with the error term in the demand function for curative visits. That is, I assume that the health endowment measures in the production function reduce, but do not eliminate the correlation between the error terms in the demand and production functions.

(b) The effects of input elasticities

The second set of demand estimations, measures the effect of the input elasticities of the inputs on their demand. The structure of these demand estimations is given in equation (18):

---

[3]The "full cost" variables were interacted in the regression estimations with the labor force participation of the health provider (mother) to account for differences in the value of time of working and nonworking mothers.

[4]These variables that are held constant in the demand estimations are child's age, family size, race, and two health endowment measures.

$$x_{ij} = f_{ij} (\Pi_1, \Pi_2, \Pi_3, Y, \alpha^*_{ij}, M) \qquad (18)$$

i = input (i = 1,2,3)

j = health output (j = 1,2,3)

where α^*_{ij} is the input elasticity of a given input for a given condition. The values of the regression coefficients in the production functions of the i^{th} input for the j^{th} health condition were assigned to each child according to his or her membership in the k^{th} mother's education group, as values of the input elasticities per given input/health measure.[5]

The third demand estimation measures the effect of the relative input elasticity of a pair of inputs on their relative demand. This estimation was done for preventive and curative visits for the general health measure only, and the estimation is of the following form:[6]

$$x_2/x_1 = f (\Pi_1, \Pi_2, \Pi_3, Y, \alpha^*_2/\alpha^*_1, M) \; . \qquad (19)$$

---

[5]With respect to the input elasticities of curative visits,an implicit assumption is made here that the extent of reverse causality bias is independent of the level of mother's education. If mothers with higher levels of education exhibit more responsiveness to the occurance of an illness this would reflect a higher effect of the dependent variable on the independent variable for higher education levels, and the productivity measures will be mother education biased, underestimating the relative productivity of higher education mothers.

[6]In this demand estimation the sample includes children with a positive number of curative visits only.

This formulation is the same as measuring the effects of α_1^* and α_2^* on each input holding the quantity of the other input constant. By ignoring the other variables and using natural logs one can write (19) as:

$$\ln x_2 = \ln \beta_0 + \beta_1 \ln \alpha_2^* - \beta_2 \ln \alpha_1^* + \beta_3 \ln x_1 \qquad (20)$$

$$\beta_1 = \beta_2$$

and similarly for $\ln x_1$:

$$\ln x_1 = \ln \gamma_0 + \gamma_1 \ln \alpha_1^* - \gamma_2 \ln \alpha_2^* + \gamma_3 \ln x_2 \qquad (21)$$

$$\gamma_1 = \gamma_2$$

The fourth set of demand estimations is a modification of the second set. The "full cost" variables are replaced by separate cost components to measure their separate effects in the demand functions. This is done for curative and preventive visits and the form of estimation is:

$$x_{ij} = f_{ij} (P_i, C_i, \Pi_k, \Pi_3, Y, \alpha_{ij}^*, M)$$

i = input ($i = 1,2$)

j = health measure ($j = 1, 2, 3$)

k = input ($k = 1,2$) $k \neq i$

where:

P_i = physicians fee for i^{th} unit of service

C_i = vector of other cost components.

The estimation method applied to all the demand estimations is ordinary least square regressions.

3. Estimation of demand and health elasticities

In order to arrive at some policy related conclusions, input demand elasticities (Table 17) and health elasticities (Table 18), with respect to income and cost variables, were computed for the general health measure.

The demand elasticities are computed at the sample means.

The health elasticities are computed as follows:

$$E_{hv_{ij}} = (E_{hx_{jk}}) \cdot (E_{x_j v_i})$$

where:

$E_{hv_{ij}}$ = Health elasticity with respect to i^{th} independent variable

$E_{hx_{jk}}$ = Health elasticity with respect to j^{th} input in the k^{th} mother's education group. (These elasticities are taken directly from the production functions, Tables 2-4.)

$E_{x_j v_i}$ = Demand elasticity of the j^{th} input with respect to the i^{th} independent variable.

B. The Data

The data source used in this work is the Mindlin-Densen (MD) study titled "Medical Care of the Infants and Preschool Children." This is a special sample of New York City residents and was conducted by the New York City Department of Health. This is a longitudinal and cross-sectional survey of infants and preschool children covering twenty-one months in the period 1965-66. It contains a variety of health indexes, including mother's evaluation of children's health, number and type of acute and chronic conditions, and number of restricted-activity days due to illness per condition. Also included are data on number of contacts per condition with a source of medical care, number of check ups, and socioeconomic characteristics of the family.

The sample can be classified by age of child (infants under one and preschoolers ages one to five). This paper will examine only the preschool children, and an examination of the infants, along the same lines of this paper will be done in future work.

The children in the sample are classified into two groups, study and control.

Mothers of the preschool children in the study group were interviewed repeatedly on a bimonthly basis for one year, while mothers of preschoolers in the control group were interviewed only once. Since the health measures and inputs in this work are aggregated on an annual basis, the control group children were excluded from the empirical work. The sample consists of two contiguous health districts in the Bronx, New York City--Mott Haven and Westchester. The sample was chosen by ringing doorbells in an area probability sample in each district and choosing randomly only one preschool child per family for the survey.[7]

For the sample size of the preschool children see Table 1. Of the possible 455 study children in the sample, only 407 are included in the

[7]For a more complete description of the sample, see Mindlin and Densen (1969, 1971); Mindlin (1970); Mindlin and Lobach (1971); Goldman (1975) and Goldman and Grossman (1975).

TABLE 1

Sample Size of Preschool Children in the Mindlin-Densen Study[a]

	Mott-Haven	Westchester	Total
Study	212	243	455
Control	539	494	1,033
Total	751	737	1,488

[a]The sample size of infants in the Mindlin-Densen study is 2,052 children (486 in the study group and 1,566 in the control group).

empirical work below. The remaining 48 observations were deleted because of missing information.

IV. SPECIFICATION AND ESTIMATION OF THE HEALTH PRODUCTION FUNCTIONS

A. Specification of the Production Functions

The production functions are estimated in the following forms[1] [k refers to mother's education class (k = 1, 2, 3)].

For the general health measure:

$$\ln HEALTH_k = \alpha_{0k} + \alpha_{1k} \ln PVISITS + \alpha_{2k} \ln PREVENT + \alpha_{3k} \ln MTIME + \alpha_{4k} \ln HEALTH1 + \alpha_{5k} PFHEALTH + \alpha_{6k} \ln INCPC + \alpha_{7k} \ln AGE + \alpha_{8k} WHITE$$

For the ENT conditions:

$$\ln NOENT_k = \beta_{0k} + \beta_{1k} \ln PENTVIS + \beta_{2k} \ln PREVENT + \beta_{3k} \ln MTIME + \beta_{4k} \ln NOENT1 + \beta_{5k} PFHEALTH + \beta_{6k} \ln INCPC + \beta_{7k} \ln AGE + \beta_{8k} WHITE$$

---

[1]In addition, production functions that include the three inputs interacted with mother's schooling were estimated. The form of these estimations for HEALTH (and similarly for NOENT and NORES) is:

$$H = \beta_0 + \sum_{i=1}^{3} \sum_{j=1}^{3} \beta_{ij} x_{ij} + \beta_{10} HEALTH1 + \beta_{11} PFHEALTH + \beta_{12} INCPC + \beta_{13} AGE + \beta_{14} WHITE$$

where:

$x_{ij} = (ED_i) \cdot (x_j)$

ED_i = Dummy variable equal to 1 if mother is a member of the i^{th} education group and 0 otherwise (i = 1, 2, 3)

x_j = Inputs (j = 1, 2, 3)

For the regression results, see Tables C-1 to C-3.

and for RES conditions:

$$\ln \text{NORES}_k = \gamma_{0k} + \gamma_{1k} \ln \text{PRESVIS} + \gamma_{2k} \ln \text{PREVENT} + \gamma_{3k} \ln \text{MTIME} + \gamma_{4k} \ln \text{NORES1} + \gamma_{5k} \text{PFHEALTH} + \gamma_{6k} \text{INCPC} + \gamma_{7k} \ln \text{AGE} + \gamma_{8k} \text{WHITE}$$

The variables in the production functions are defined as follows:

1. Health measures

(a) HEALTH: A positive measure of general health, equal to -(SICK) where SICK is the sum of the number of restricted-activity days due to each possible condition, during the last ten months of the interview year. This measure sums up restricted-activity days for time-overlapping conditions and is not equal, therefore, to the number of restricted-activity days out of $\frac{10}{12}$ (365) days.

This variable might overestimate the state of sickness of children with multiple time-overlapping conditions since it assumes a linear relationship between condition-overlapping illness days and the state of health of the child, but on the other hand it allows for the number of conditions and their duration, a fact that would have been ignored if the variable measured only the number of restricted-activity days out of $\frac{10}{12}$ (365).

Since HEALTH is a variable that assumes negative values, ln HEALTH is defined as -(ln SICK).

(b) HEALTH1: A positive measure of child's health endowment, equal to -(SICK1) where SICK1 is the sum of the number of restricted-activity days due to each possible condition during the first two months of the interview year. As in the case of SICK, this measure sums up illness days from time-overlapping conditions.

Since HEALTH1 is a variable that assumes negative values, ln HEALTH1 is defined as -(ln SICK1).

(c) PFHEALTH: A dummy variable that measures child's health as evaluated by his parents at the time of the first interview. The variable is equal to 1 if parents evaluate their child's health as poor or fair and equal to 0 if they evaluate it as good or excellent.

(d) NOENT: A positive measure of ENT health, equal to -(ENT) where ENT is the total number of restricted-activity days due to ENT conditions, during the last ten months of the interview year. Since ENT is a variable that assumed negative values, ln NOENT = -(ln ENT).

(e) NOENT1: A positive measure of ENT health endowment, equal to -(ENT1) where ENT1 is equal to the number of restricted-activity days due to ENT conditions, during the first two months of the interview year.

Since NOENT1 is a variable that assumes negative values, ln NOENT1 is defined as -(ln ENT1).

(f) NORES: A positive measure of respiratory health, equal to -(RES) where RES is the total number of restricted-activity days due to respiratory conditions, during the last ten months of the interview year.

Since NORES is a variable that assumes negative values, ln NORES is defined as -(ln RES).

(g) NORES1: A positive measure of respiratory health endowment, equal to -(RES1) where RES1 is the number of restricted-activity days due to respiratory conditions, during the first two months of the interview year.

Since NORES1 is a variable that assumes negative values, ln NORES1 is defined as -(ln RES1).

2. Health inputs

(a) PVISITS:[2] Predicted number of curative contacts with a medical care source, for all conditions, in the last ten months of the interview year.

(b) PENTVIS[2]: Predicted number of curative contacts with a medical care source, for ENT conditions, in the last ten months of the interview year.

(c) PRESVIS[2]: Predicted number of curative contacts with a medical care source, for respiratory conditions, in the last ten months of the interview year.

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[2]For the instrumental variables that are used in the prediction of PVISITS, PENTVIS and PRESVIS, and for their estimated values, see Tables 7-9, respectively.

(d) PREVENT: Total number of check-ups child has had during the last ten months of the interview year.

(e) MTIME: The amount of time spent by mother with study child, measured in hours. This variable is equal to: [7300 - 2433 - HRWORK - (SICKTRIP + SICKWAIT) · (VISITS) · (1/60) - (CHECTRIP + CHECWAIT) · (PREVENT) · (1/60)]N

where:

7300 = Total number of hours in ten months.

2433 = Total number of hours spent on other than children-related activities, in ten months (eight hours per day).

HRWORK = Total number of hours worked by mother during the last ten months of the interview year.

SICKTRIP = Usual length of a trip to a medical care source for a curative visit (measured in minutes).

SICKWAIT = Usual length of waiting time at the medical care source for a curative visit (measured in minutes).

VISITS = Total number of curative contacts with a medical care source during the last ten months of the interview year. These contacts include office, clinic, health center, home emergency and other unspecified contacts (not including telephone contacts).

CHECTRIP = Length of a trip to the usual source of preventive care (measured in minutes).

CHECWAIT = Length of waiting time at the usual source of preventive care (measured in minutes).

N = Number of children in the family.

3. Socioeconomic variables

(a) INCPC: Annual per capita income, where annual total income (INCOME) is continuous family's annual income computed by assigning midpoints to the following intervals, $500 to the lowest interval and $17,500 to the highest interval. The closed income intervals are:

$1,000 -	$1,999
2,000 -	2,999
3,000 -	3,999
4,000 -	4,999
5,000 -	5,999
6,000 -	6,999
8,000 -	9,999
10,000 -	14,999

(b) AGE: Age of child (in months).

(c) WHITE: A dummy race variable = 1 if child is white
= 0 otherwise.

B. Estimation of the Production Functions

The estimation results of the production functions are given in Tables 2-4.[3]

In spite of the fact that predicted values of curative visits, rather than the actual number of such visits were used as independent variables, some of the regression coefficients of these variables are negative[4] but none is significant at the .05 level. These results, however, are superior to the results obtained by applying the ordinary least squares method to estimate the production functions, a method that yielded negative and highly significant coefficients for curative visits for all three mother's education groups in the three health measures.

PREVENT has a positive effect for all the three health measures in the highest education group, a positive effect in the middle education group for HEALTH and NORES and negative in all three production functions for the low education group. One possible explanation for the later result is that the low education subclass has more reverse

[3] In the estimations of the production functions, the sample was divided into three mother's education groups. Because of the relatively small sample size (n = 407), the number of observations in the subsamples is small (especially in the lowest mother's education group where the number of observations is 94). The number of observations per subsample could have been increased by subdividing the sample into only two mother's education groups, but this was not done in order to increase the variation in the marginal productivity elasticity variables that assume the values of the input coefficients from the production function estimations. Although 94 is a relatively small number of observations for multiple regression analysis, it is statistically sufficient to get significant results.

[4] A summary of the regression coefficients of the three inputs in the production functions (including the coefficients of predicted curative visits) is given in Table

causality even with preventive care since the distinction between preventive care and curative care may not always be clear to them.

MTIME has a negative sign in most of the production functions (the sign is positive only for the middle education groups in the production functions of HEALTH and NOENT and for the lowest education group in the production function of NOENT). These results can be explained partially by the fact that there are only two major sources of variation in this variable. Although MTIME varies by the number of curative and preventive visits and the travel and waiting time per visit, the most important sources of variation are the number of hours worked by mother and the number of children in the family. This low level of variation in MTIME might have a reduced effect on the regression coefficients and the significance of this variable downwards. It is assumed here that the low variation effect on the regression coefficients is the same across mother's education groups, for a given condition, and under this assumption, the regression coefficients of MTIME can be used as productivity measures in the demand estimations.

The health endowment measures (HEALTH1, NOENT1, and NORES1) are positive, as expected, and highly significant.

PFHEALTH enters the production functions as a measure of relative low health endowment, as evaluated by parents at the beginning of the interview year. Although this variable is expected to have a negative sign in the production functions, there might be a rationale for this variable to have a positive sign. A positive sign might reflect, in part, the increased efforts by parents who evaluate their children's health as relatively inferior, to improve their child's health. Such efforts might include better quality physicians, a more efficient use of time input, better nutrition, etc. In addition, a positive sign of PFHEALTH might be a reflection of the fact that parents of healthier children might have higher standards of evaluation of their child's health. PFHEALTH has a positive effect only in the production functions of HEALTH for the lowest education group, and of NOENT for the lowest and highest mother's education group. It has a negative effect in all the other production functions.

An income variable (INCPC) was entered to the production functions as a measure of environmental factors and other inputs in the production of health (housing and nutrition, for example) that were not entered directly into the estimations. The expected sign of LINCPC is positive, although in some of the production functions the estimated coefficient is negative.

Child's age is expected to have a positive effect in the production functions of health, as acute conditions that are negatively correlated with age are more likely to occur in children with poor health. In two HEALTH production functions, AGE has a positive effect but it has a negative sign in the lowest mother education group. Taking all three mother education together (n = 407), the effect of AGE in the production function of HEALTH is positive. AGE has also a positive effect in two NOENT and two NORES production functions, as NOENT and NORES are measures of acute conditions.

WHITE has a positive effect in all the production functions of HEALTH and NOENT, but negative in those of NORES. The positive effect can be explained by differences in living conditions between white and non-white children in the sample, as the proportion of white children living in Westchester is larger than the proportion of white children living in Mott-Haven. Mott-Haven is an urban slum whereas Westchester is a middle class community.

TABLE 2
Two Stage Least Squares Estimations of HEALTH Production Functions, by Mother's Education
Dependent Variable: LHEALTH[a]

Mother's Education Group / Independent Variable	Grade School		Some High School		Completed High School or College	
	Regression Coefficient	t-Ratio	Regression Coefficient	t-Ratio	Regression Coefficient	t-Ratio
LPVISITS[a]	-.259	(-0.42)	.501	(1.22)	.095	(0.18)
LPREVENT[a]	-.225	(-0.52)	.511	(1.67)	.304	(1.13)
LMTIME	.104	(0.18)	.226	(1.53)	-.217	(-0.91)
LHEALTH1[a]	.701	(4.54)	.954	(8.39)	.610	(5.63)
PFHEALTH	.676	(0.82)	-.614	(-0.92)	-.083	(-0.08)
LINCPC	.086	(0.15)	-.827	(-2.30)	-.406	(-0.89)
LAGE	-.358	(-0.63)	.325	(0.82)	.124	(0.33)
WHITE	1.228	(1.47)	.494	(1.01)	.032	(0.07)
CONSTANT	-.828		2.175		3.507	
n	94		125		188	

[a]Zero values for these variables were set to .5 to allow for the computations of the natural logs.

TABLE 3

Two Stage Least Squares Estimations of ENT Health Production Functions, by Mother's Education
Dependent Variable: LNOENT[a]

Mother's Education Group / Independent Variable	Grade School		Some High School		Completed High School or College	
	Regression Coefficient	t-Ratio	Regression Coefficient	t-Ratio	Regression Coefficient	t-Ratio
LPENTVIS[a]	-.522	(-1.27)	.091	(0.29)	-.156	(-0.73)
LPREVENT[a]	-.026	(-0.09)	-.039	(-0.22)	.105	(1.03)
LMTIME	-.341	(-1.01)	.087	(1.06)	-.084	(-0.93)
LNOENT1[a]	.128	(1.20)	.188	(2.25)	.045	(0.93)
PFHEALTH	.789	(1.78)	-.811	(-2.22)	.511	(1.37)
LINCPC	.410	(1.17)	-.643	(-2.98)	-.123	(-0.89)
LAGE	-.005	(-0.00)	.058	(0.20)	.023	(0.14)
WHITE	.260	(0.55)	.128	(0.50)	.104	(0.71)
CONSTANT	-.296		3.987		1.729	
n	94		125		188	

[a]Zero values for these variables were set to .5 to allow for the computations of the natural logs.

TABLE 4

Two Stage Least Squares Estimations of RES Health Production Functions, by Mother's Education
Dependent Variable: LNORES[a]

Mother' Education Group / Independent Variable	Grade School		Some High School		Completed High School or College	
	Regression Coefficient	t-Ratio	Regression Coefficient	t-Ratio	Regression Coefficient	t-Ratio
LPRESVIS[a]	.108	(1.91)	.009	(0.13)	-.006	(-0.08)
LPREVENT[a]	-.098	(-0.64)	.107	(1.09)	.031	(0.47)
LMTIME	-.154	(-0.84)	-.030	(-0.65)	-.050	(-0.83)
LNORES1[a]	.171	(2.17)	.237	(3.47)	.072	(1.26)
PFHEALTH	-.172	(-0.83)	-.347	(-1.76)	-.715	(-2.81)
LINCPC	.404	(2.09)	.009	(0.08)	-.088	(-1.00)
LAGE	.080	(0.46)	.210	(1.82)	-.108	(-1.23)
WHITE	-.092	(-0.37)	-.254	(-1.75)	-.175	(-0.00)
CONSTANT	-1.058		.039		1.997	
n	94		125		188	

[a]Zero values for these variables were set to .5 to allow for the computations of the natural logs.

V. SPECIFICATION AND ESTIMATION OF THE DEMAND FUNCTIONS FOR HEALTH INPUTS

From the production functions estimations for health, it is possible to present production technologies of mothers with different levels of education for different health measures. The simple correlations between mother's years of schooling (MEDUCAT) and the marginal productivity elasticities of the three inputs, for the three health measures are given in Table 5.

TABLE 5

Simple Correlation Coefficients Between MEDUCAT and Input Elasticities by Different Conditions

Input \ Health Measure	HEALTH	NOENT	NORES
Curative Visits	.38	.53	-.89
PREVENT	.65	.77	.56
MTIME	-.67	.53	.75

These correlation coefficients suggest that mother's education level affects the health production technologies, and those technologies differ across conditions. It seems that mother's education is a strong positive correlate with the marginal productivity measure of PREVENT for all three health measures, a positive correlate with the productivity measure of curative visits for HEALTH and NOENT and a positive correlate with mother's time productivity for NOENT and NORES.

In the following demand function estimations, the estimations of PREVENT and MTIME for ENT and RES conditions should be regarded as suggestive only, since these two inputs are general in nature and an attempt to explain the demand for them based on variables derived from individual conditions may be misleading. Moreover, the price variables for these inputs are general and not condition-specific, and might not reflect the true cost associated with a given condition. It is true, however, that the efficiency of a given input (PREVENT and MTIME) in the production function of a specific health output should affect the demand for those inputs, but such measured effects might not represent the true effects in the absence of the effects of the efficiency of these inputs in other conditions. For these reasons, in the first set of demand function estimations, estimations of PREVENT and MTIME were not included. However, estimations of the effects of the efficiency of these variables on their demand were included and are given in Tables 10-16.

Four sets of demand functions are estimated as follows:

(a) A set of demand functions that measure the direct effect of mother's schooling on the demand for inputs (Tables 7-9). The inputs studied here are curative visits for all three conditions, and PREVENT and MTIME for the general health measure (HEALTH) only. (See above discussion on the deletion of estimations of PREVENT and MTIME for separate conditions.)

(b) A set of demand functions that measure the effects of the input elasticities on their demand (Tables 10-12). In these estimations, the "full cost" variables of curative and preventive visits enter here as independent variables.

(c) A relative demand estimation to measure the effect of relative changes in the input elasticities of two inputs on their relative demand. This demand estimation is given for two inputs (VISITS and PREVENT) for the HEALTH measure only (Table 13).

(d) A set of demand functions that measure the effects of the separate cost components on the demand for the inputs (Tables 14-16). In this set, the cost components of direct visit fee, travel time cost and direct travel costs enter the demand estimations of curative visits and preventive visits, respectively.

The variables used in the demand equations, and were not defined before, are:

LFVCOST and LFVCOST: Total direct and indirect costs of a curative visit to the usual source of medical care for working mothers and non-working mothers, respectively (measured in dollars). LFVCOST assumes a value of 0 if mother does not work and is equal to:

[VISITFEE + (SICKTRIP + SICKWAIT) * (WAGE) * (1/60) + VTRACOST] * LFPR if mother works.

NLFVCOST assumes a value of 0 if mother works and is equal to:

[VISITFEE + (SICKTRIP + SICKWAIT) * (WAGE) * (1/60) + VTRACOST] * NLFPR if mother does not work.

Where: VISITFEE: Physician's fee per curative visit to the usual source of medical care (measured in dollars).

WAGE: Continuous actual hourly wage rate used to measure the actual hourly wage for working mothers and the potential hourly wage rate for non-working mothers.

In the absence of a wage variable in the data set, the wage variable used here is derived from Fuchs's calculations of hourly wage rates of women ages twenty to thirty four by race and years of formal schooling completed.[1] Since Fuchs's computed national averages, an adjustment was made for this particular sample, to allow for differences between the national averages and the wages in the sample population. The adjustment was done by using the ratio of the average wage in Standard Metropolitan Statistical Areas with population of 1,000,000 or more, to the national average wage rate, for each race-education group.

VTRACOST: Travel costs to the usual source of curative care (measured in dollars).

LFPR: A dummy variable = 1 if mother works
= 0 if otherwise.

NLFPR: A dummy variable = 1 if mother does not work
= 0 otherwise.

[1]Victor R. Fuchs, Differentials in Hourly Earnings by Region and City Size (1959), NBER, 1967.

LFVTRIP and
NLFVTRIP: A measure of travel time cost of a curative visit to usual source of medical care for working mothers and non-working mothers, respectively (measured in dollars).

LFVTRIP assumes a value of 0 for non-working mothers and is equal to:

(SICKTRIP) * (1/60) * (WAGE) * (LFPR) for working mothers.

NLFVTRIP assumes a value of 0 for working mothers and is equal to:

(SICKTRIP) * (1/60) * (WAGE) * (NLFPR) for non-working mothers.

LFPCOST and
NLFPCOST: Total direct and indirect costs of a preventive visit to the usual source of medical care for working and non-working mothers, respectively (measured in dollars).

LFPCOST assumes a value of 0 if mother does not work and is equal to:

[CHECKFEE + (CHECTRIP + CHECWAIT) * (WAGE) * (1/60) + CTRACOST] * LFPR if mother works.

NLFPCOST assumes a value of 0 if mother works and is equal to:

[CHECKFEE + (CHECTRIP + CHECWAIT) * (WAGE) * (1/60) + CTRACOST] * NLFPR if mother does not work.

Where: CHECKFEE: Physician's charge per preventive visit to the usual source of preventive care (measured in dollars).

LFPTRIP and NLFPTRIP: A measure of travel time cost of a preventive visit to usual source of medical care for working mothers and non-working mothers, respectively (measured in dollars).

LFPTRIP assumes a value of 0 for non-working mothers and is equal to:

(CHECTRIP) * (1/60) * (WAGE) * (LFPR) for working mothers.

NLFPTRIP assumes a value of 0 for working mothers and is equal to:

(CHECTRIP) * (1/60) * (WAGE) * (NLFPR) for non-working mothers.

LFWAGE and NLFWAGE: A measure of the value of mother's time for working mothers and non-working mothers respectively. LFWAGE is equal to: WAGE * LFPR for working mothers and 0 for non-working mothers. NLFWAGE is equal to WAGE * NLFPR for non-working mothers and 0 for working mothers.

FAMSIZE: No. of members of the family. This variable includes the parents and children who live in the household.

MEDUCAT: Mother's education measured by the number of completed schooling years, coded as follows:

0 - No Schooling

3 - Some Grade School

6 - Completed Grade School

9 - Some High School

12 - Completed High School

14 - Some College

16 - Completed College or More.

MPCURE, MPCENT, MPCRES: Input elasticity (by assignment) of curative visits in the production of HEALTH, NOENT and NORES, respectively.

MPPREV, MPPENT, MPPRES: Input elasticity (by assignment) of preventive visits in the production of HEALTH, NOENT and NORES, respectively.

MPTIME, MPTENT, MPTRES: Input elasticity (by assignment) of MTIME in the production of HEALTH, NOENT and NORES, respectively.

The values of the input elasticities assigned to each input are given in Table 6.

RATIOPV: The ratio of preventive visits to curative visits in the last 10 months of the interview year.

MPPMPC: The ratio of input elasticities of preventive and curative visits (equal to MPPREV/MPCURE)

In the first set of demand functions estimations (Tables 7-9), MEDUCAT entered as an independent variable to measure the partial quantative effects of mother's schooling on the demand for the inputs. MEDUCAT has a negative effect on the demand for curative visits for HEALTH and NORES measures, and a positive for NOENT. A negative sign for MEDUCAT in the demand function may reflect a larger efficiency in production that is associated with mother's schooling, although the expected sign of MEDUCAT in the demand function is ambiguous (see equations (7) and (8) in Chapter II. In the case of HEALTH, MEDUCAT is positively correlated with the marginal productivity of curative visits (.38, see Table 5), and this accounts for the negative effect of MEDUCAT in the demand function of curative visits. The effect of MEDUCAT on PREVENT and MTIME is positive.

TABLE 6

Input Elasticities of Health Inputs by Health Measure and Mother's Education

Mother's Education Group \ Health Measure/Input	HEALTH			NOENT			NORES		
	VISITS	PREVENT	MTIME	ENTVIS	PREVENT	MTIME	RESVIS	PREVENT	MTIME
Grade School	-.259	-.225	.104	-.522	-.026	-.341	.108	-.098	-.154
Some High School	.501	.511	.226	.091	-.039	.087	.009	.107	-.030
Completed High School or College	.095	.304	-.217	-.156	.105	-.084	-.006	.031	-.050

In the demand for VISITS (equation (1) in Table 7), the effect of LFVCOST is negative, as expected, and significant at the .10 level. NLFVCOST, that is the cost variable for non-working mothers, is positive (expected sign is negative). The cross-price effects of preventive visits (LFPCOST and NLFPCOST), have a positive sign, as expected. The wage variables (LFWAGE and NLFWAGE), have negative effects. These negative effects may reflect the complementary relationship between mother's time input and curative visits. The income effect is positive, as expected, and highly significant. Both health endowment measures (HEALTH1 and PFHEALTH) have the expected sign. HEALTH1 that is a measure of relatively good health endowment, has a negative effect on VISITS, and PFHEALTH that is a measure of relatively low health, has a positive and significant effect on VISITS.

AGE has a negative effect on curative visits, and significant at the .05 level. These results agree with some previous studies. Friedman and Leibowitz (1975) explain the negative effect of AGE as reflecting the diminishing returns to pediatric care as childrens' age goes up. According to Grossman (1972), the negative effect of AGE in the demand function for pediatric care may be a result of a reduction in the rate of depreciation on health capital at early stages in the life cycle. These hypotheses are also supported by findings in Goldman and Grossman (1975).

FAMSIZE has a negative, and significant, effect at the .10 level, on VISITS. A larger family size (and for this purpose, the number of children in the family), raises the shadow price of child's health (Becker and Lewis, 1973). Using child's health as a measure of child's quality, health output and the demand for its inputs should be negatively related to family size.

WHITE has a positive and non-significant effect on VISITS.

In the demand estimation of ENTVIS, only the signs of two independent variables differ from their signs in the demand estimation of VISITS (LFPCOST and NLFPCOST that are negative).

In the demand estimation of RESVIS, NLFPCOST has the expected sign (negative) but LFPCOST is positive. NLFPCOST and the two wage variables (LFWAGE and NLFWAGE) have positive cross-price effects. However, it should be noted again, that the price variables in the demand estimations for individual conditions, are general and not condition-specific. In addition, AGE has a positive but small effect (β = .00004) and not significant (t = 0). All the other variables have the same sign as in the demand for VISITS.

In the demand function for PREVENT (Equation (2) in Table 7), the effects of LFPCOST and NLFPCOST are negative, as expected, and these effects are significant at .10 level for NLFPCOST and close to .10 for LFPCOST. The cross-price effects with respect to curative visits (LFVCOST and NLFVCOST) are positive, as expected, and statistically significant for NLFVCOST. The effects of LFWAGE and NLFWAGE on PREVENT are negative, reflecting possibly the complementary relationship between mother's time and preventive visits, the same way these variables were explained in the demand function for curative visits. INCOME has a positive and significant effect on PREVENT. The health endowment measure (HEALTH1) has a small effect (β = .0004) and PFHEALTH has a positive effect, a result of the fact that mothers that evaluate their child's health as relatively poor will increase the amount of preventive

TABLE 7

Ordinary Least Squares Estimations of Demand for HEALTH Inputs
(n = 407)

Independent Variable \ Dependent Variable	VISITS		PREVENT		MTIME	
	Regression Coefficient	t ratio	Regression Coefficient	t ratio	Regression Coefficient	t ratio
LFVCOST	-.601	(-1.52)	.051	(0.91)	-18.353	(-0.40)
NLFVCOST	.030	(0.20)	.034	(1.59)	-27.540	(-1.58)
LFPCOST	.319	(0.67)	-.084	(-1.23)	-108.315	(-1.93)
NLFPCOST	.150	(0.82)	-.040	(-1.54)	50.844	(2.37)
LFWAGE	-.554	(-0.19)	-.250	(-0.60)	-300.124	(-0.87)
NLFWAGE	-1.090	(-0.42)	-.190	(-0.51)	-417.698	(-1.35)
INCOME (000)	.404	(2.76)	.029	(1.37)	9.010	(0.52)
HEALTH1	-.008	(-1.19)	.0004	(0.37)	.697	(0.84)
PFHEALTH	3.952	(3.26)	.069	(0.40)	96.160	(0.68)
AGE	-.037	(-1.76)	-.007	(-2.27)	-7.155	(-2.93)
FAMSIZE	-.365	(-1.44)	-.093	(-2.57)	-592.797	(-19.92)
WHITE	.952	(0.82)	.049	(0.30)	13.047	(0.09)
MEDUCAT	-.004	(-0.00)	.059	(1.64)	33.802	(1.15)
CONSTANT	5.394		1.536		5,594.077	
R^2	0.09		0.09		0.56	
F	2.89		3.13		38.09	

Table 8

Ordinary Least Squares Estimation
of Demand for ENT Curative Visits
Dependent Variable: ENTVIS
(n = 407)

Independent Variable	Regression Coefficient	t ratio
LFVCOST	-.012	(-.014)
NLFVCOST	.011	(0.32)
LFPCOST	-.047	(-0.43)
NLFPCOST	-.021	(-0.50)
LFWAGE	-1.940	(-2.89)
NLFWAGE	-1.961	(-3.25)
INCOME(000)	.050	(1.48)
NOENT1	-.014	(-1.71)
PFHEALTH	.600	(2.13)
AGE	-.014	(-2.84)
FAMSIZE	-.005	(-0.09)
WHITE	.558	(2.09)
MEDUCAT	.120	(2.10)
CONSTANT	2.978	
R^2	0.08	
F	2.74	

TABLE 9

Ordinary Least Squares Estimation
of Demand for RES Curative Visits
Dependent Variable: RESVIS
(n = 407)

Independent Variable	Regression Coefficient	t ratio
LFVCOST	.013	(0.38)
NLFVCOST	-.013	(-0.99)
LFPCOST	.026	(0.63)
NLFPCOST	-.010	(-0.64)
LFWAGE	.054	(0.21)
NLFWAGE	.285	(1.22)
INCOME (000)	.002	(0.14)
NORES1	-.020	(-3.90)
PFHEALTH	.300	(2.82)
AGE	.000	(0.00)
FAMSIZE	-.006	(-0.27)
WHITE	.009	(0.09)
MEDUCAT	-.006	(-0.26)
CONSTANT	-.174	
R^2	0.07	
F	2.15	

care given to the child. AGE and FAMSIZE have negative and highly significant effects on PREVENT. This is consistent with the results for these two variables in the demand estimation of VISITS. WHITE has a positive and non-significant effect on PREVENT.

In the demand estimation of MTIME (Equation (3) in Table 7), the wage effect is negative, as expected, for both working and non-working mothers. However, the regression coefficient of LFWAGE is smaller in absolute value than the effect of NLFWAGE (-300.1 compared to -410.7). This is not consistent with the expectation that changes in the wage rate of a working mother will have larger effects on the amount of time spent with child than would have changes in the potential wage rate of non-working mothers. The regression coefficient of NLFWAGE is significant at the .10 level while the coefficient of LFWAGE is not. INCOME has a positive effect on MTIME, HEALTH1 has a positive and PFHEALTH has also a positive effect as mothers that evaluate their child's health as poor or fair will spend more time with the child. AGE and FAMSIZE have negative and significant effects on MTIME, and this is consistent with the findings in the demand for curative and preventive visits.

In the second set of demand estimations (Tables 10-12) measures of the marginal productivities of the inputs were included in their respective demand estimation.

The signs of the independent variables in this set of demand estimations are generally the same as in the first set that includes MEDUCAT as an independent variable. Only LFWAGE, NLFWAGE in the estimation of PREVENT, and WHITE in the estimation of PREVENT and MTIME, have different signs compared to the first set.

Table 10

Ordinary Least Squares Estimations of Demand for HEALTH Inputs
(n = 407)

Independent Variable \ Dependent Variable	VISITS		PREVENT		MTIME	
	Regression Coefficient	t ratio	Regression Coefficient	t ratio	Regression Coefficient	t ratio
LFVCOST	-.595	(-1.51)	.052	(0.93)	-18.100	(-0.39)
NLFVCOST	.025	(0.17)	.037	(1.75)	-26.605	(-1.53)
LFPCOST	.335	(0.70)	-.075	(-1.10)	-103.268	(-1.85)
NLFPCOST	.152	(0.83)	-.040	(-1.52)	49.810	(2.32)
LFWAGE	-.155	(-0.08)	.243	(0.79)	-85.229	(-0.35)
NLFWAGE	-.610	(-0.41)	.325	(1.38)	-187.185	(-1.11)
INCOME(000)	.394	(2.70)	.033	(1.57)	7.795	(0.45)
HEALTH1	-.009	(-1.21)	.0003	(0.27)	.681	(0.82)
PFHEALTH	3.968	(3.29)	.047	(0.27)	98.456	(0.69)
AGE	-.037	(-1.77)	-.007	(-2.27)	-7.147	(-2.93)
FAMSIZE	-.360	(-1.42)	-.093	(-8.16)	-591.479	(-19.88)
WHITE	.799	(0.76)	-.071	(-0.46)	-50.643	(-0.41)
MPCURE	-1.211	(-0.85)	-	-	-	-
MPPREV	-	-	.021	(0.09)	-	-
MPTIME	-	-	-	-	-340.179	(-1.37)
CONSTANT	4.857		1.264		5,566.943	
R^2	0.09		0.09		0.56	
F	2.95		2.91		38.19	

TABLE 11

Ordinary Least Squares Estimations of Demand for ENT Inputs
(n = 407)

Independent Variable \ Dependent Variable	ENTVIS		PREVENT		MTIME	
	Regression Coefficient	t ratio	Regression Coefficient	t ratio	Regression Coefficient	t ratio
LFVCOST	-.007	(-0.08)	.051	(0.90)	-16.372	(-0.35)
NLFVCOST	.017	(0.49)	.037	(1.75)	-28.381	(-1.63)
LFPCOST	-.024	(-0.22)	-.076	(-1.11)	-100.633	(-1.80)
NLFPCOST	-.019	(-0.45)	-.041	(-1.56)	53.166	(2.48)
LFWAGE	-.792	(-1.63)	.191	(0.64)	78.945	(0.32)
NLFWAGE	-.740	(-2.05)	.263	(1.23)	-3.248	(-0.00)
INCOME(000)	.056	(1.67)	.031	(1.46)	10.157	(0.59)
NOENT1	-.014	(-1.67)	-.002	(-0.38)	6.583	(1.59)
PFHEALTH	.560	(1.98)	.041	(0.23)	116.509	(0.81)
AGE	-.014	(-2.85)	-.007	(-2.23)	-7.524	(-3.08)
FAMSIZE	-.005	(-0.09)	-.091	(-2.51)	-591.555	(-19.97)
WHITE	.263	(1.07)	-.061	(-0.41)	-83.266	(-0.67)
MPCENT	-.334	(-0.76)	-	-	-	-
MPPENT	-	-	.685	(0.74)	-	-
MPTENT	-	-	-	-	-304.716	(-0.95)
CONSTANT	2.157		1.323		5,262.310	
R^2	0.07		0.09		0.56	
F	2.42		2.96		38.34	

TABLE 12

Ordinary Least Squares Estimations of Demand for RES Inputs
(n = 407)

Independent Variable \ Dependent Variable	RESVIS Regression Coefficient	RESVIS t ratio	PREVENT Regression Coefficient	PREVENT t ratio	MTIME Regression Coefficient	MTIME t ratio
LFVCOST	.014	(0.40)	.055	(0.98)	-15.611	(-0.34)
NLFVCOST	-.013	(-1.03)	.037	(1.76)	-25.588	(-1.47)
LFPCOST	.027	(0.64)	-.081	(-1.19)	-106.248	(-1.89)
NLFPCOST	-.010	(-0.63)	-.040	(-1.53)	51.891	(2.41)
LFWAGE	.068	(0.33)	.303	(1.00)	99.818	(0.38)
NLFWAGE	.304	(1.79)	.379	(1.66)	-8.534	(-0.04)
INCOME(000)	.002	(0.14)	.032	(1.55)	11.283	(0.66)
NORES1	-.020	(-3.91)	-.011	(-1.36)	-7.954	(-1.16)
PFHEALTH	.299	(2.81)	.039	(0.23)	68.559	(0.48)
AGE	.000	(0.00)	-.006	(-2.17)	-6.977	(-2.85)
FAMSIZE	-.006	(-0.27)	-.088	(-2.43)	-587.647	(-19.73)
WHITE	.005	(0.04)	-.071	(-0.47)	-72.606	(-0.57)
MPCRES	.661	(0.60)	-	-	-	-
MPPRES	-	-	-.017	(-0.00)	-	-
MPTRES	-	-	-	-	-739.579	(-0.61)
CONSTANT	-.273		1.120		5,142.956	
R^2	0.07		0.09		0.56	
F	2.17		3.06		38.04	

The input elasticity of curative visits is positive only for RES conditions, and the input elasticity of PREVENT is positive only for HEALTH and NOENT, although it has also a positive sign in RES conditions in the last set of demand estimations (see equation (2) in Table 16). The effect of the input elasticity of time is negative for all the three health measures. The negative signs of MPCURE and MPCENT may be explained partially by the bias in the values assigned to those variables, as discussed above. This possible bias underestimates the input elasticity of higher education mothers. Given the positive correlation between MEDUCAT and curative visits for the general health measure (simple correlation = .033), such a bias reduces the correlation between MPCURE and VISITS and affects the sign of MPCURE downwards in the demand estimation of VISITS.

The negative signs of the input elasticities in the demand functions are not inconsistent tough with the theoretical model, according to which the effect of the input elasticity is positive on the ratio of the inputs but ambiguous on the absolute amount of the input.

In order to measure the effect of the input elasticity of a given input on the input ratio, a relative demand function was estimated using only two inputs (PREVENT and VISITS) for the general health measure only.

The sample includes only children with a positive number of curative visits (n=295) in order to allow the creation of a relative measure of inputs.

The regression results are given in Table 13. The effect of MPPMPC on RATIOPV is positive, as expected from the theoretical model, although the coefficient is not significantly different from zero. The ratio of the input elasticities is used as the independent variable rather

TABLE 13

Ordinary Least Squares Estimation of Relative Demand for Inputs
Dependent Variable: RATIOPV
(n = 295)

Independent Variable	Regression Coefficient	t ratio
LFVCOST	.033	(0.51)
NLFVCOST	.0001	(0.00)
LFPCOST	-.031	(-0.43)
NLFPCOST	-.027	(-1.21)
LFWAGE	.159	(0.48)
NLFWAGE	.198	(1.02)
INCOME (000)	.000	(0.16)
HEALTH1	-.000	(-0.03)
PFHEALTH	-.033	(-0.22)
AGE	-.001	(-0.52)
FAMSIZE	.001	(0.03)
WHITE	.103	(0.81)
MPPMPC	.021	(0.40)
CONSTANT	.265	
R^2	0.03	
F	0.61	

than the input elasticity of preventive visits only in order to keep the input elasticity of curative visits constant and in order to simultaneously measure the effect of MPCURE on the input ratio, since the regression equation in Table (13) can be written as follows:

$$\ln RATIOPV = a_o + a_1 \ln MPPREV + \ln MPCURE + \sum_{i=3}^{n} a_i \ln x_i$$

A positive sign for MPPMPC in such a specification would mean that MPPREV has a positive effect on the ratio PREVENT?VISITS while MPCURE has a positive effect on VISITS?PREVENT, where in each case the input elasticity of the other input is held constant.

The price variables of VISITS (LFVCOST and NLFVCOST) are positive, as expected, and the price variables of PREVENT (LFPCOST and NLFPCOST) are negative, also as expected. PFHEALTH is expected to have a negative sign as the ratio of curative visits to preventive visits is likely to be higher for children with relatively low health (regression coefficient of PFHEALTH is -.033). Healthl is likely to have a positive sign although its predicted sign may be ambiguous depending upon the relative effect of HEALTHL on PREVENT and VISITS which is expected to be negative in both cases. (The regression coefficient of HEALTHL is negative and very small, -.00003). The signs of the other variables, LFWAGE,NLFWAGE,INCOME, AGE,FAMSIZE and WHITE can not be predicted intuitively, since they affect both PREVENT and VISITS in the same direction and their signs depend on the relative effects of these variables on the two inputs.

In the last set of demand estimations (Tables 14-16), the separate cost components of curative and preventive visits were entered directly into their respective demand functions. The signs of all the variables (except for NLFWAGE in the VISITS equation and FAMSIZE in the ENTVIS equation) are the same as in the second set of demand estimations (Tables 10-12). The separate cost components (VISITFEE, VTRACOST, LFVTRIP and NLFVTRIP for curative visits, and CHECKFEE, CTRACOST, LFPTRIP and NLFPTRIP for preventive visits) are expected to be negative. VISITFEE and CHECKFEE are negative for all three conditions (except for VISITFEE for the ENT conditions). The travel cost variables (VTRACOST and CTRACOST) don't have the expected sign. The time cost variables of a trip to a source of curative care (LFVTRIP , NLFVTRIP) have negative signs for all conditions, and the same is true for the time cost variables of a trip to a source of preventive care (LFPTRIP and NLFPTRIP).

Estimation of demand and health elasticities

The estimates of demand elasticities of the three health inputs with respect to income and cost variables are given in Table 17. The price elasticities are low in absolute value supporting previous findings.[1] The travel time cost elasticities for non-working mothers

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[1]See, for example, Inman, Robert P. "The Family Provision of Children's Health: An Economic Analysis" and Newhouse, Joseph P. and Phelps, Charles E. "New Estimates of Medical Care Services" In The Role of Health Insurance in the Health Services Sector, edited by Richard Rosett. New York: Columbia University Press for the National Bureau of Economic Research, 1976.

TABLE 14

Ordinary Least Squares Estimations of Demand for HEALTH Inputs
(n = 407)

Dependent Variable / Independent Variable	VISITS		PREVENT	
	Regression Coefficient	t ratio	Regression Coefficient	t ratio
LFVCOST	-	-	.045	(0.78)
NLFVCOST	-	-	.038	(1.80)
VISITFEE	-.182	(-1.25)	-	-
VTRACOST	.686	(1.54)	-	-
LFVTRIP	-2.325	(-0.89)	-	-
NLFVTRIP	-2.164	(-1.98)	-	-
LFPCOST	.133	(0.25)	-	-
NLFPCOST	.166	(0.91)	-	-
CHECKFEE	-	-	-.061	(-1.61)
CTRACOST	-	-	.198	(1.23)
LFPTRIP	-	-	-.433	(-0.77)
NLFPTRIP	-	-	-.199	(-0.75)
LFWAGE	-.308	(-0.13)	.299	(0.86)
NLFWAGE	.405	(0.27)	.351	(1.40)
INCOME(000)	.404	(2.74)	.033	(1.59)
HEALTH1	-.008	(-1.16)	.0003	(0.30)
PFHEALTH	4.005	(3.33)	.047	(0.27)
AGE	-.040	(-1.95)	-.007	(-2.39)
FAMSIZE	-.336	(-1.31)	-.094	(-2.59)
WHITE	.819	(0.77)	-.070	(-0.46)
MPCURE	-1.385	(-0.98)	-	-
MPPREV	-	-	.026	(0.11)
CONSTANT	4.617		1.229	
R^2	0.10		0.09	
F	2.88		2.67	

TABLE 15

Ordinary Least Squares Estimations of Demand for ENT Inputs
(n = 407)

Independent Variable \ Dependent Variable	ENTVIS Regression Coefficient	ENTVIS t ratio	PREVENT Regression Coefficient	PREVENT t ratio
LFVCOST	-	-	.043	(0.76)
NLFVCOST	-	-	.038	(1.79)
VISITFEE	.013	(0.39)	-	-
VTRACOST	.076	(0.74)	-	-
LFVTRIP	-.901	(-1.50)	-	-
NLFVTRIP	-.670	(-2.66)	-	-
LFPCOST	-.114	(-0.93)	-	-
NLFPCOST	-.021	(-0.50)	-	-
CHECKFEE	-	-	-.062	(-1.63)
CTRACOST	-	-	.195	(1.22)
LFPTRIP	-	-	-.420	(-0.75)
NLFPTRIP	-	-	-.197	(-0.75)
LFWAGE	-.287	(-0.51)	.248	(0.73)
NLFWAGE	-.488	(-1.35)	.293	(1.27)
INCOME(000)	.045	(1.32)	.032	(1.49)
NOENT1	-.015	(-1.84)	-.002	(-0.36)
PFHEALTH	.540	(1.93)	.040	(0.23)
AGE	-.014	(-2.99)	-.007	(-2.35)
FAMSIZE	.019	(0.32)	-.092	(-2.54)
WHITE	.181	(0.74)	-.062	(-0.41)
MPCENT	-.336	(-0.77)	-	-
MPPENT	-	-	.662	(0.71)
CONSTANT	2.087		1.280	
R^2	0.10		0.09	
F	2.75		2.70	

TABLE 16

Ordinary Least Squares Estimations of Demand for RES Inputs
(n = 407)

Independent Variable \ Dependent Variable	RESVIS		PREVENT	
	Regression Coefficient	t ratio	Regression Coefficient	t ratio
LFVCOST	-	-	.047	(0.82)
NLFVCOST	-	-	.038	(1.81)
VISITFEE	-.019	(-1.50)	-	-
VTRACOST	.005	(0.12)	-	-
LFVTRIP	-.134	(-0.58)	-	-
NLFVTRIP	-.016	(-0.16)	-	-
LFPCOST	.017	(0.36)	-	-
NLFPCOST	-.009	(-0.54)	-	-
CHECKFEE	-	-	-.062	(-1.65)
CTRACOST	-	-	.203	(1.27)
LFPTRIP	-	-	-.445	(-0.80)
NLFPTRIP	-	-	-.203	(-0.77)
LFWAGE	.203	(0.84)	.354	(1.03)
NLFWAGE	.288	(1.67)	.408	(1.67)
INCOME(000)	.003	(0.24)	.033	(1.58)
NORES1	-.020	(-3.78)	-.011	(-1.38)
PFHEALTH	.302	(2.83)	.039	(0.23)
AGE	.0003	(0.11)	-.007	(-2.28)
FAMSIZE	-.010	(-0.42)	-.089	(-2.46)
WHITE	.011	(0.11)	-.069	(-0.46)
MPCRES	.654	(0.59)	-	-
MPPRES	-	-	-.003	(-0.00)
CONSTANT	-.251		1.079	
R^2	0.07			
F	1.96			

are relatively higher (-.21 for curative visits and -.10 for preventive visits). This results also support Inman's findings with respect to time cost, although his estimates are based on all components of time costs taken together.

The estimates of the health elasticities with respect to income and cost variables are given in Table 18. The health elasticities with respect to income, include only the indirect effect of income on health through the three inputs and not the direct effect of income on health through other inputs (like nutrition, housing, etc.) for which income enters directly into the production function, to account for these additional inputs. Therefore, the health elasticities with respect to income, in Table 18, are partial and limited to the effects of curative visits, preventive care and mother's time only.

A comparison between the health elasticities with respect to the various cost variables for curative and preventive care reveals a difference across mother's education groups. For these two inputs, the health elasticities are larger for lower mother's education groups, in respect to all cost variables. Such a comparison is important in considering policies directed towards improving the general health of different segments of the population. Given these results, a reduction in the price of medical care, through insurance programs or subsidies that effect the unit price of medical care, will lead to larger improvements for lower education groups. Although the total effect of income on health is not given here, some policy related implications can be drawn as to the relative effects of prices and income across mother's education groups. The income effect on health (via curative visits) is larger for higher education groups while the price effect of such medical care is higher for lower education groups. These are relevant results for determining the type of programs directed at increasing the amount of medical care. If it is true that the health elasticity with respect to income (taking all the partial effects of income into account) is larger for higher education groups (as is the case for the partial effect of income on health through curative visits), then programs to improve the health of lower education (and lower income) children would be more effective if they affect the prices of medical care rather than the income level. This is only an assumption, since such income elasticities are not given, although one might add that it makes intuitive sense since lower income families might have high income elasticities for other essential goods.

TABLE 17

Demand Elasticities with Respect to Income and Prices[a]
(HEALTH measure)

Policy Aspect / Variable \ Input	VISITS	PREVENT	MTIME
Income[a]	.50[c]	.15[c]	.02
Insurance[b]			
VISITFEE	-.14	-	-
CHECKFEE	-	-.11[c]	-
Access to medical care[b]			
LFVTRIP	-.03	-	-
NLFVTRIP	-.21[c]	-	-
LFPTRIP	-	-.02	-
NLFPTRIP	-	-.10	-
VTRACOST	.07[d]	-	-
CTRACOST	-	.08[d]	-
Family's decision variables[a]			
LFVCOST	-.07[c]	-	-
NLFVCOST	.03[d]	-	-
LFPCOST	-	-.02[c]	-
NLFPCOST	-	-.12[c]	-
LFWAGE	-	-	-.01
NLFWAGE	-	-	-.13[c]

[a]The estimates are based on the regression coefficients given in Table 10.

[b]The estimates are based on the regression coefficients given in Table 14.

[c]Coefficient significant at the .10 level in the demand estimation.

[d]Coefficient has "wrong" sign in the demand estimation.

TABLE 18

Health Elasticities with Respect to Income and Prices
(HEALTH measure)

Variable \ Input/Mother's Education	VISITS				PREVENT				MTIME			
	Total	ED1[a]	ED2	ED3	Total	ED1[a]	ED2	ED3	Total	ED1	ED2	ED3[a]
Income	.043		.251	.048	.033		.077	.046	.001	.002	.005	
Insurance												
VISITFEE	-.012		-.071	-.013	-		-	-	-	-	-	
CHECKFEE	-		-	-	-.024		-.056	-.033	-	-	-	
Access to medical care												
LFVTRIP	-.003		-.015	-.003	-		-	-	-	-	-	
NLFVTRIP	-.018		-.105	-.020	-		-	-	-	-	-	
LFPTRIP	-		-	-	-.004		-.010	-.006	-	-	-	
NLFPTRIP	-		-	-	-.022		-.051	-.030	-	-	-	
VTRACOST[b]	.006		.035	.007	-		-	-	-	-	-	
CTRACOST[b]	-		-	-	.018		.041	.024	-	-	-	
Family's decision variables												
LFVCOST	-.006		-.035	-.007	-		-	-	-	-	-	
NLFVCOST[b]	.003		.015	.003								
LFPCOST	-		-	-	-.004		-.010	-.006	-	-	-	
NLFPCOST	-		-	-	-.026		-.061	-.036	-	-	-	
LFWAGE	-		-	-	-		-	-	-.001	-.001	-.002	
NLFWAGE	-		-	-	-		-	-	-.007	-.014	-.029	

ED1, ED2, ED3 = Mother's education Group: Grade School, Some High School, Completed High School or College, respectively.

[a] Coefficient has a negative sign in the production function.

[b] Coefficient has "wrong" sign in the demand function.

VI. CONCLUSIONS

The basic points that were examined in this paper are:

(a) The direct effects of mother's schooling on the demand for health inputs (curative visits, preventive visits and mother's own time input) for three health measures (general health, ENT conditions and respitory conditions).

(b) The effects of the input elasticities of the health inputs on their demand and on the input ratios.

(c) Demand and health elasticities with respect to income and prices.

It is not assumed a priori that mother's schooling is a *positive* correlate with efficiency in all inputs. The observed correlations between schooling and input elasticities are used as predictors as to the effect of mother's schooling on the demand for inputs. Mother's education is found to be a positive correlate with the input elasticity of curative visits for HEALTH and NOENT and with the input elasticity of preventive visits for HEALTH, and it is likely, although not necessary (depending on the nature of schooling as an efficiency parameter) to get a negative effect for schooling on the demand for those inputs. (It is negative only in the demand for VISITS). Mother's schooling is negatively correlated with the input elasticity of time for the general health measure, and with the input elasticity of curative visits for NORES. The sign of mother's schooling in the demand function of time is positive but its sign in the demand function for respitory curative visits is negative. But, as has been stated before, these results are consistent with the theoretical predictions given by equation (7) in Chapter II. Conclusions about the effects of input elasticities on the input demand are ambiguous although the regression results show a positive (but not significant) effect on PREVENT for all three measures. This ambiguous result agrees with the theoretical model, although intuitively it would seem that these effects should be positive. However, the effect of the input elasticity of an input is positive on the ratio of that input to others, as discussed in Chapter 2. The relative demand estimations in Table 13 support this prediction although with no statistical power.

Demand and health elasticities were computed in order to allow for comparisons across inputs and mother's education groups. A comparison of the health elasticities across mother's education groups, reveals that lower education groups (that includes children with relatively lower health), increase their children's health by more than higher education groups, as a result of reduced prices of medical care. Although income elasticities that include the total effect of income were not computed by different education groups, it is reasonable to assume that those elasticities are higher for higher education groups (such results are obtained for the health elasticities of income via curative visits). If in fact this is true, then those differences should have an important role in determining alternative programs to raise the health level of children so that these programs will achieve the desired results with high efficiency of resources allocation.

APPENDIX A

Mathematical Derivation of the Marginal Cost and Demand Functions

A. Derivation of the Marginal Cost Function of a Cobb-Douglass Production Function

Given the following Cobb-Douglass production function:

$$h = A\, x^{\alpha}\, t^{\beta} \qquad \text{(A-1)}$$

the total cost function would be:

$$C = px + wt \qquad \text{(A-2)}$$

where:

x = input purchased in the market

t = time input

p = price of a unit of x

w = wage rate

The first order condition of cost minimization is:

$$\frac{mp_x}{mp_t} = \frac{p}{w} \qquad \text{(A-3)}$$

The marginal products of x and t are:

$$mp_x = A\, \alpha x^{\alpha-1}\, t^{\beta} \qquad \text{(A-4)}$$

$$mp_t = A\, \beta x^{\alpha}\, t^{\beta-1} \qquad \text{(A-5)}$$

By dividing (A-4) by (A-5), we get:

$$\frac{mp_x}{mp_t} = \frac{\alpha A\ x^{\alpha-1}\ t^{\beta}}{\beta A\ x^{\alpha}\ t^{\beta-1}} = \frac{\alpha}{\beta}\ \frac{t}{x} \qquad \text{(A-6)}$$

From (A-3) and (A-6) we get:

$$\frac{p}{w} = \frac{\alpha}{\beta}\ \frac{t}{x} \qquad \text{(A-7)}$$

or:

$$t = \frac{p}{w} \cdot \frac{\beta}{\alpha} \cdot x \qquad \text{(A-8)}$$

Substitute (A-8) into (A-2) to get:

$$\begin{aligned} C &= px + w(\frac{p}{w} \cdot \frac{\beta}{\alpha} \cdot x) = px + px\ \frac{\beta}{\alpha} \\ &= px\ (1 + \frac{\beta}{\alpha}) = px\ (\frac{\alpha + \beta}{\alpha}) \end{aligned} \qquad \text{(A-9)}$$

Substitute (A-8) into (A-1) to get:

$$\begin{aligned} h &= A\ x^{\alpha}(\frac{p}{w} \cdot \frac{\beta}{\alpha} \cdot x)^{\beta} = A\ x^{\alpha}\ x^{\beta}\ (\frac{p}{w})^{\beta}\ (\frac{\beta}{\alpha})^{\beta} \\ &= A\ x^{\alpha+\beta}\ (\frac{p}{w})^{\beta}\ (\frac{\beta}{\alpha})^{\beta} \end{aligned} \qquad \text{(A-10)}$$

Solve (A-10) for $x^{\alpha+\beta}$ to get:

$$x^{\alpha+\beta} = h\ A^{-1}\ (\frac{p}{w})^{-\beta}\ (\frac{\beta}{\alpha})^{-\beta} \qquad \text{(A-11)}$$

Solve (A-11) for x to get:

$$x = h^{\frac{1}{\alpha+\beta}} A^{-\frac{1}{\alpha+\beta}} \left(\frac{p}{w}\right)^{-\frac{\beta}{\alpha+\beta}} \left(\frac{\beta}{\alpha}\right)^{-\frac{\beta}{\alpha+\beta}}$$

$$= h^{\frac{1}{\alpha+\beta}} A^{-\frac{1}{\alpha+\beta}} p^{-\frac{\beta}{\alpha+\beta}} w^{\frac{\beta}{\alpha+\beta}} \beta^{-\frac{\beta}{\alpha+\beta}} \alpha^{\frac{\beta}{\alpha+\beta}} \qquad \text{(A-12)}$$

Substitute (A-12) into (A-9) to get:

$$C = \left(\frac{\alpha+\beta}{\alpha}\right) p h^{\frac{1}{\alpha+\beta}} A^{-\frac{1}{\alpha+\beta}} p^{-\frac{\beta}{\alpha+\beta}} w^{\frac{\beta}{\alpha+\beta}} \beta^{-\frac{\beta}{\alpha+\beta}} \alpha^{\frac{\beta}{\alpha+\beta}}$$

$$= \left(\frac{\alpha+\beta}{\alpha}\right) h^{\frac{1}{\alpha+\beta}} A^{-\frac{1}{\alpha+\beta}} p^{\frac{\alpha}{\alpha+\beta}} w^{\frac{\beta}{\alpha+\beta}} \beta^{-\frac{\beta}{\alpha+\beta}} \alpha^{\frac{\beta}{\alpha+\beta}} \qquad \text{(A-13)}$$

From (A-13), one can derive the marginal cost as follows:

$$\pi = \left(\frac{1}{\alpha+\beta}\right) \left(\frac{\alpha+\beta}{\alpha}\right) h^{\frac{1}{\alpha+\beta} - 1} A^{-\frac{1}{\alpha+\beta}} p^{\frac{\alpha}{\alpha+\beta}} w^{\frac{\beta}{\alpha+\beta}} \beta^{-\frac{\beta}{\alpha+\beta}} \alpha^{\frac{\beta}{\alpha+\beta}} \qquad \text{(A-14)}$$

or:

$$\pi = \frac{1}{\alpha} h^{\frac{1-\alpha-\beta}{\alpha+\beta}} A^{-\frac{1}{\alpha+\beta}} p^{\frac{\alpha}{+}} w^{\frac{\beta}{\alpha+\beta}} \beta^{-\frac{\beta}{\alpha+\beta}} \alpha^{\frac{\beta}{\alpha+\beta}} \qquad \text{(A-15)}$$

or:

$$\pi = \frac{1}{\alpha} h^{\frac{1-\phi}{\phi}} A^{-\frac{1}{\phi}} p^{\frac{\alpha}{\phi}} w^{\frac{\beta}{\phi}} \beta^{-\frac{\beta}{\phi}} \alpha^{\frac{\beta}{\phi}} \qquad \text{(A-16)}$$

where: $\phi = \alpha + \beta$

if $\alpha + \beta = 1$, (A-16) reduces to:

$$\pi = \frac{1}{\alpha} A^{-1} p^{\alpha} w^{1-\alpha} (1-\alpha)^{\alpha-1} \alpha^{1-\alpha}$$

B. <u>Derivation of the Demand Function</u>

Given the following production function:

$$h = A x^{\alpha} t^{1-\alpha} \qquad \text{(A-18)}$$

and the marginal cost function [from (A-17)]:

$$\pi = \frac{1}{\alpha} A^{-1} p^{\alpha} w^{1-\alpha} (1-\alpha)^{\alpha-1} \alpha^{1-\alpha} \qquad \text{(A-19)}$$

$$\ln \pi = -\alpha \ln \alpha - \ln A + \alpha \ln p + (1-\alpha) \ln w + (\alpha-1) \ln (1-\alpha) \qquad \text{(A-20)}$$

$$\frac{\partial \ln \pi}{\partial \alpha} = \ln p - \ln w - \ln \alpha - \frac{\alpha}{\alpha} \frac{d[(1-\alpha) \ln (1-\alpha)]}{d\alpha}$$

$$= \ln p - \ln w - \ln \alpha - 1 - \ln(1-\alpha) + (\frac{\alpha-1}{1-\alpha})$$

$$= \ln p - \ln w - \ln \alpha - 1 - \ln (1-\alpha) - 1$$

$$= \ln p - \ln w + \ln (1-\alpha) - \ln \alpha \qquad \text{(A-21)}$$

$$\frac{\partial \ln \pi}{\partial \ln \alpha} = \alpha[\ln p - \ln w + \ln (1-\alpha) - \ln \alpha] \qquad \text{(A-22)}$$

The demand function for h is:

$$\ln h = \eta \ln R + \xi \ln \pi \qquad \text{(A-23)}$$

By substituting (A-20) for $\ln \pi$, we get:

$$\ln h = \eta \ln R + \xi \ln A - \xi \alpha \ln p - \xi(1-\alpha) \ln w + \xi[\alpha \ln \alpha + (1-\alpha) \ln (1-\alpha)] \tag{A-24}$$

$$\ln x = \ln h - \ln A - (1-\alpha) \ln p + (1-\alpha) \ln w + (1-\alpha) [\ln \alpha - \ln (1-\alpha)] \tag{A-25}$$

or:

$$\ln x = \eta \ln R + (\xi-1) \ln A - [\xi \alpha + 1 - \alpha] \ln p + (1-\alpha)(1-\xi) \ln w + (1-\alpha) [\ln \alpha - \ln (1-\alpha)] + \xi[\alpha \ln \alpha + (1-\alpha) \ln (1-\alpha)] \tag{A-26}$$

$$\frac{\partial \ln x}{\partial \alpha} = -(\xi-1) \ln p - (1-\xi) \ln w + \xi \frac{d[\alpha \ln \alpha + (1-\alpha) \ln (1-\alpha)]}{d\alpha} + \frac{d[(1-\alpha) [\ln \alpha - \ln (1-\alpha)]}{d\alpha} \tag{A-27}$$

$$\frac{\partial \ln x}{\partial \alpha} = (1-\xi)(\ln p - \ln w) + \xi[\ln \alpha - \ln (1-\alpha)] + \ln (1-\alpha) - \ln \alpha + \frac{1}{\alpha} \tag{A-28}$$

$$\frac{\partial \ln x}{\partial \alpha} = (1-\xi) [(\ln p - \ln w) + \ln (1-\alpha) - \ln \alpha) + \frac{1}{\alpha} \tag{A-29}$$

$$\frac{\partial \ln x}{\partial \ln \alpha} = (\alpha - \alpha\,\xi)\ [(\ln p - \ln w) + \ln (1-\alpha) - \ln \alpha] + 1 \qquad \text{(A-30)}$$

$$\frac{\partial \ln x}{\partial \ln \alpha} = \alpha\,\xi[\ln w - \ln p + \ln \alpha - \ln (1-\alpha)]$$
$$- \alpha[\ln w - \ln p + \ln \alpha - \ln (1-\alpha)] + 1 \qquad \text{(A-31)}$$

APPENDIX B

Means and Standard Deviations of Variables in Regression Estimations

TABLE B-1

Means and Standard Deviations of Variables in the Production Functions by Education Groups[a]

Variable	Unit	Grade School or No School (n = 94)		Some High School (n = 125)		Completed High School or College (n = 188)	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Health Variables							
HEALTH	Days	-98.894	154.397	-79.400	118.854	-54.910	89.576
HEALTH1	"	-40.872	55.483	-41.432	51.447	-38.271	49.322
NOENT	"	-4.745	12.829	-4.280	16.916	-.926	3.183
NOENT1	"	-5.064	10.573	-5.568	10.257	-5.234	10.477
NORES	"	-1.255	7.572	-.840	5.717	-.553	3.938
NORES1	"	-2.766	9.612	-1.424	6.299	-.840	3.517
PFHEALTH		.234	.426	.136	.344	.032	.176
Health Inputs							
PVISITS		4.060	2.196	4.030	2.425	4.646	1.837
PENTVIS		1.171	.586	.852	.444	.922	.385
PRESVIS		.145	.227	.166	.160	.153	.113
PREVENT		.957	.867	1.168	1.014	1.388	1.139
MTIME	Hours	1,876.332	1,144.309	2,068.318	1,263.315	2,392.782	1,245.921
Socioeconomic Variables							
INCPC	Dollars	817.661	476.024	1,041.035	680.774	1,595.605	771.445
AGE	Months	42.962	16.857	41.578	17.725	42.394	18.156
WHITE		.223	.419	.384	.488	.686	.465

[a]In the production functions estimations, all the variables except PFHEALTH and WHITE were used in their natural log form.

TABLE B-2

Means and Standard Deviations of Variables
in the Demand Functions
(n = 407)

Variable	Unit	Mean	Standard Deviation
Health Variables			
HEALTH1	Days	-39.843	51.344
NOENT1	"	-5.297	10.409
NORES1	"	-1.464	6.289
PFHEALTH		.111	.314
Health Inputs			
VISITS		4.332	7.369
ENTVIS		.951	1.690
RESVIS		.165	.643
PREVENT		1.221	1.055
MTIME	Hours	2,179.381	1,243.940
RATIOPV		.548	.743
Input Elasticities			
MPCURE		.138	.279
MPCENT		-.165	.223
MPCRES		.025	.046
MPPREV		.245	.273
MPPENT		.031	.069
MPPRES		.025	.075
MPTIME		-.007	.200
MPTENT		-.091	.156
MPTRES		-.068	.048
MPPMPC		2.074	1.115

(continued)

TABLE B-2 (concluded)

Variable	Unit	Mean	Standard Deviation
Prices			
LFVCOST	Dollars	.540	1.785
NLFVCOST	"	4.686	3.206
VISITFEE	"	3.397	2.797
LFVTRIP	"	.061	.244
NLFVTRIP	"	.428	.374
VTRACOST	"	.417	.827
LFPCOST	"	.382	1.333
NLFPCOST	"	3.774	2.689
CHECKFEE	"	2.128	1.904
LFPTRIP	"	.061	.205
NLFPTRIP	"	.593	.390
CTRACOST	"	.512	.435
WAGE	"	1.636	.382
LFWAGE	"	.171	.513
NLFWAGE	"	1.465	.621
Socioeconomic Variables			
INCOME	Dollars	5,482.801	2,982.246
MEDUCAT	Years	9.523	3.383
AGE	Months	42.275	17.696
FAMSIZE		4.759	1.524
WHITE		.487	.500
LFPR		.106	.308

APPENDIX C

Additional Results[1]

The regressions given in Tables 2-4 estimate health production functions using the dependent variables and the health inputs in their natural log form. This was done in order to obtain input elasticities to be used later in the demand estimations. This procedure required the assignment of positive values to variables whose actual values were zero in order to allow for the computation of the regressions.[2] The assignment of positive values may have biased the regression results and reduced the statistical significance of the coefficients. In addition, the estimations were done separately for three education sub-groups, reducing the sample size in each estimation and further contributing to the reduction in the statistical power of the estimations.

Because of these two reasons, alternative health production functions were estimated using education-interacted inputs as independent variables.[3] The estimations (Tables C1-C3) are given for all three health measures and are based on the pooled sample.

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[1]The additional results include alternative estimations of production functions. The inputs coefficients from these estimations were not used, however, as measures of productivity in demand estimations, a procedure that has been used based on the estimations given by Tables 2-4.

[2]Values of 0.5 were assigned to variables with zero values.

[3]The education-interacted inputs are defined and discussed in footnote 1 to Chapter IV. In this case, as in the estimations given in Tables 2-4, predicted curative visits were used rather than the actual number of such visits.

TABLE C-1

Two Stage Least Square Estimation of HEALTH Production Function
(with education interactions)
Dependent Variable: HEALTH
(n = 407)

Independent Variable	Regression Coefficient	t ratio
ED1VIS	-1.128	(-0.15)
ED2VIS	-2.182	(-0.33)
ED3VIS	6.250	(0.97)
ED1PREV	.166	(0.00)
ED2PREV	17.658	(2.06)
ED3PREV	4.143	(0.60)
ED1TIME	-.009	(-0.94)
ED2TIME	-.009	(-1.29)
ED3TIME	-.009	(-1.39)
HEALTH1	1.130	(9.94)
PFHEALTH	-10.025	(-0.33)
INCPC	-.008	(-0.64)
AGE	-.190	(-0.51)
WHITE	10.028	(0.68)
CONSTANT	-12.325	

TABLE C-2

Two Stage Least Squares Estimation of ENT Health Production Function
(with education interactions)
Dependent Variable: NOENT
(n = 407)

Independent Variable	Regression Coefficient	t ratio
ED1ENTV	-2.769	(-1.36)
ED2ENTV	-9.259	(-3.09)
ED3ENTV	-.976	(-0.40)
ED1ENTP	-.553	(-0.44)
ED2ENTP	.938	(0.98)
ED3ENTP	.050	(0.07)
ED1ENTT	-.001	(-0.90)
ED2ENTT	.0001	(0.14)
ED3ENTT	-.000	(-0.44)
NOENT1	.212	(3.58)
PFHEALTH	.465	(0.20)
INCPC	-.001	(-1.29)
AGE	-.027	(-0.64)
WHITE	1.571	(1.21)
CONSTANT	4.198	

TABLE C-3

Two Stage Least Squares Estimation of RES Health Production Function (with education interactions) Dependent Variable: NORES (n = 407)

Independent Variable	Regression Coefficient	t ratio
ED1RESV	-5.271	(-0.92)
ED2RESV	1.353	(0.25)
ED3RESV	-4.738	(-1.02)
ED1RESP	-.578	(-0.95)
ED2RESP	.538	(1.20)
ED3RESP	.239	(0.66)
ED1REST	.000	(0.84)
ED2REST	-.001	(-2.13)
ED3REST	-.000	(-0.17)
NORES1	.077	(0.73)
PFHEALTH	-1.913	(-1.19)
INCPC	-.000	(-0.37)
AGE	.006	(0.40)
WHITE	-.283	(-0.42)
CONSTANT	.197	

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