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The Family Provision of Children's Health: An Economic Analysis

1. INTRODUCTION

The healthiness of children can be a major source of consumption and investment benefits for a society. In the U.S., for example, we spend nearly $1 billion annually on pediatric services and publicly allocate $800 million yearly (1970) for predominantly children-directed health care.[1] In this paper my purpose is to propose and to statistically test a model of the family as a provider-protector of the health of its children. Since our society is interested in protecting and enhancing the state of health of our children, and since the family is the primary social unit for child care, analysis such as that

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presented here becomes indispensable for sound social policy. The results developed below are offered as a beginning step toward a policy model of children's health.

Section 2 is a brief outline of a concept of "healthiness" for statistical and policy analysis and contains a description of a model of the demand for health care wherein the effects on healthiness of health care activities (e.g., doctor visits, good nutrition, rest) are uncertain. The model yields a demand for health care activities with the usual price and income specifications plus a relationship between quantities consumed and the means and variances of the effects of health activities on healthiness.

In Section 3 this model of the demand for health care activities is applied to the family's decisions to buy preventive and curative doctor service and to allocate parents' time for the protection of children's health. "Production functions" of the family's provision of children's health are specified, and models of the demand for child health care by working and nonworking mothers are presented.

In Section 4 there are econometric estimates of the health care production and demand models proposed in Section 3 for one major class of childhood diseases—ear, nose, and throat (ENT) infections. The production model shows that parents' time and doctor visits do have, on average, a positive effect on children's health but that the final outcome is extremely uncertain. The relationship of the health care technology to mother's education and the source of physician services (public or private) is explored. Estimation of the demand model provides price and income elasticities as well as a test of the uncertainty model of Section 2.

Section 4 contains a few *tentative* policy conclusions. National health insurance with shallow coverage, as well as most policies operating through the economic variables of prices and income, appear to have only minor positive effects on children's ENT health. Changes in medical technology, parent health knowledge, and the patterns of adult-child interaction appear to be more promising avenues for improved children's health.

2. HEALTH CARE DEMAND WHEN OUTCOMES ARE UNCERTAIN

Unlike many consumption activities in which consumers know exactly what they are getting for their dollars, the consumption of health-related services can be extremely uncertain. We rarely know what the exact effects of a doctor visit, a night's rest, or a "well-balanced" meal will be on our physical healthiness. At best we have expectations and a sense of the range of possible results. This section outlines a consumer model of health care demand that incorporates these uncertain effects on health of health care consumption activities. The model forms the basis for our empirical analysis of the family's provision for children's health.

The individual (or family) is assumed to derive satisfaction from three basic sets of consumption goods—non-health-related consumer goods (denoted by the vector y), health-related consumer goods (x), and a vector of *measurable* attributes of *physical* healthiness (A).[2] The new element here is the formal inclusion of physical healthiness into the consumer's allocation problem.[3]

The elements of the vector of health attributes (A) are cardinal measures of (physical) health-related human characteristics.[4] Height, weight, body temperature, blood pressure, white blood count, serum protein level, eye acuity, and hearing range are all candidates for membership in A. In addition to such continuous measures of the body's physical state, the health-attribute vector may also include elements whose values are 0 or 1 to signify the absence or presence of qualitative characteristics. The 0, 1 elements of A might measure the presence or absence of such characteristics as inguinal hernia, stenoused (narrowed) cardiac value, or a fractured femur. Clearly, some configurations of the elements of A will be preferable to others.

The consumer has control over some, perhaps most, of the elements of A through his consumption of health-related goods and services (x). In a certain world, the level (or presence) of an attribute, A_t, will be a function of the initial level of health attributes (A_0) and the current consumption of x:

$$A_t = f_t(x, A_0) \tag{1}$$

where $\partial A_t/\partial x_i > 0$ and $\partial A_t/\partial x_i < 0$, respectively, define "health-enhancing" and "health-reducing" goods and services.

In an uncertain world, however, the selection of x will not be sufficient to define A unmistakably. First, independent of A_0 and of the chosen levels x, the individual may be exposed to random, health-related incidents that will alter A_t. These exogenous influences on healthiness—accidents over which the individual has no control—are represented here by the continuous random variable, $\tilde{u}_t$.[5] There is a second source of uncertainty, however, which is at least equally important, the uncertainty regarding the health consequences of changes in any specific health-related good or service. Even knowing A_0, x, and $\tilde{u}$, the consumer often cannot predict perfectly the marginal health effectiveness of changes in x_i ($i = 1 \ldots N$). Indeed, medical science may not even know the exact marginal impact of each input. These uncertain input effects can be represented by a vector of continuous random variables, $\tilde{v}_t$, whose typical element is $\tilde{v}_{it}$. The random variables $\tilde{v}_{it}$($i = 1 \ldots N$; $t = 1 \ldots T$) represent the technological uncertainty of using health care inputs x_i($i = 1 \ldots N$) to affect attributes A_t($t = 1 \ldots T$). Given such uncertainty, the health attribute production function must be generalized to:

(1a) $$\tilde{A}_t = f_t(x, A_0, \tilde{u}_t, \tilde{v}_t)$$

Here, A_t itself is a random variable whose distribution, conditional on x and past attributes A_0, is defined by $f(\cdot)$ and the distributions of $\tilde{u}_t$ and the $\tilde{v}_{it}$'s.[6]

The consumer's allocation behavior can now be characterized by the selection of a vector x and a vector y that maximize expected utility, where health attributes, $\tilde{A}$, are random variables conditional on x. The commodities in y are assumed to affect satisfaction directly and with certainty. The health-related goods—in addition to their (uncertain) effects on A—may also generate direct and certain consumer satisfaction. For example, food, cigarettes, and exercise can provide direct consumption benefits. Doctor visits can be a source of comfort and emotional support; hospitals often provide very attractive "hotel" services. Health-related goods (x) play a dual role. Expected utility therefore assumes the general form:

(2) $$V = \int \ldots \int U[\,y, x, \tilde{A}(x)] \cdot f(A_1 \ldots A_T) \cdot dA_1 \ldots dA_T$$

Consumers are assumed to purchase x and y so as to maximize V subject to constraints on their time and income.

Assuming that V is a continuous concave function, that the income and time constraints are linear, and that the distributions of $\tilde{u}_t$ and $\tilde{v}_{it}$ are independent and members of the class of two parameter distributions, a vector of health care demand functions of the form:

(3) $$x_i = \phi_i(p_x, p_y, I \,|\, \mu_1 \ldots \mu_T, \sigma^2_{\tilde{u}_1} \ldots \sigma^2_{\tilde{u}_T}; \beta_{11} \ldots \beta_{NT}, \sigma^2_{\tilde{v}_{11}} \ldots \sigma^2_{\tilde{v}_{NT}}; A_0)$$

can be specified, where p_x is the vector of prices (including a wage as the price of leisure) for x, p_y is the vector of prices for y, I is exogenous income, and A_0 is the vector of initial attribute levels. The parameters μ_t and $\sigma^2_{\tilde{u}_t}$ define the "location"(e.g., mean) and the "spread" (e.g., variance), respectively, for the distributions of

$\tilde{u}_t$; β_{it} and $\sigma^2_{v_{it}}$ define the location and spread of the distribution of $\tilde{v}_{it}$.[7]

Given the vectors μ, σ^2_u, β, and σ^2_v, the demand schedules in (3) display the usual Slutsky properties with respect to exogenous shifts in prices and income. No general *a priori* predictions about the demand effects of changes in the elements of μ, σ^2_u, β, or σ^2_v, are possible, however.[8] The effect on health care consumption of changes in an uncertain health care technology is an empirical issue. Sections 3 and 4 provide one set of answers in the context of the family's provision for its children's health.

3. THE FAMILY'S PROVISION FOR ITS CHILDREN'S HEALTH: A MODEL SPECIFICATION

The model developed here, and formally tested in Section 4, is an application to children's health of the demand analysis presented in Section 2. Specifically, the model is an attempt to structure the family's decisions to spend income and parents' time on three child health-related goods and services—curative care ("illness-motivated") doctor visits, preventive care ("check-up") doctor visits, and parents' time with children.

The focus of the model is on the mother. She is assumed to be the decision-maker for and the family's provider of child health services. It is her scarce time that is used in raising the child and her preferences define the family's choices for child health care. She is assumed to be predominantly interested in her and her family's direct consumption benefits of having healthy children.[9]

Four facts of the family's environment will be taken as given when the mother decides on the level and mix of child health care activities—(1) the level of health insurance coverage, (2) the family's usual provider of doctor care, (3) the mother's work status, and (4) the number of children in the family. Each of the four factors may, of course, influence the level of doctor visits and parents' time with children (we will test for this), but the factors themselves are assumed to be unaffected by changes in the consumption of the three health care commodities. I will discuss the validity and implication of these assumptions when the statistical results are reported in Section 4.

The model will be tested against data from a National Academy of Science, Institute of Medicine, survey of Washington, D.C., families. The survey includes detailed information on children's utilization of health care facilities, family socioeconomic information, and, important for this study, the results of a thorough ear, nose, and throat examination by an independent NAS team of physicians.[10] The sample is composed predominantly of black children between the ages of six months and twelve years from lower- and middle-income families (see the Data Appendix).

The analysis will be developed in two steps. First, a health attribute production function corresponding to (1a) will be specified (Part A, below) and estimated for children's ear, nose, and throat diseases (Part A, Section 4). Next, the results of the production function model will be integrated into our demand equation specifications (Part B, below) and these demand equations will be estimated (Part B, Section 4). The demand results will offer a first test of the health care demand specification presented in Equation (3) of Section 2.

A.

The health attribute production function specified here is for children's ear, nose, and throat infections. Table 1 summarizes the prevalence rates for the major ENT diseases in the NAS sample population. Approximately 11 per cent of the children were found

TABLE 1 Prevalence of ENT Diseases in NAS Children Survey

	Prevalence
Ear Infections	
Acute Serous Otitis Media	.0603
Acute Suppurative Otitis Media	.0145
Acute External Otitis Media	.0052
Nose Infections	
Acute Nasopharyngitis (common cold) plus Acute Rhinitis	
Throat Infections	
Acute Tonsillitis	.0017
Acute Pharyngitis (sore throat)	.0005
Total	.1077

to be suffering from some ENT disease, the major source of illness being ear infections. This study will concentrate on two aspects of this disease pattern—(1) a "clean bill" of ENT health with no diagnosed ENT infections at the time of medical examination (denoted by NOSICK), and (2) the absence of diagnosed inner ear infection (denoted by NOEARINF).[11] In both cases the dependent health attribute is specified as a dichotomous sick (0) or not sick (1) variable. In effect we are trying to explain the probability that a child from the sample will have an ENT disease.

The functional form chosen for the NOSICK and NOEARINF attribute models is the logit specification, which can be written as:

$$(4) \qquad ln\left(\frac{p_t}{1-p_t}\right) = lnA_0 + \sum_i \tilde{v}_{it} \cdot x_t + \tilde{u}_t$$

where p_t is the child's probability of NOSICK or NOEARINF, A_0 is a measure of the child's initial health state, x_t is the child's consumption of health care commodities, and the $\tilde{v}_{it}$'s and $\tilde{u}_t$ are random coefficients reflecting the uncertainty of the health care process. In the work that follows, $\tilde{v}_{it}$ is assumed to be normally distributed with mean β_{it} and variance $\sigma^2_{\tilde{v}_{it}}$ whereas $\tilde{u}_t$ is assumed to be normally distributed with mean 0 and variance $\sigma^2_{\tilde{u}_t}$.[12]

The child's initial health state, A_0, is summarized by three variables. The presence (EARSCAR = 1) or absence (EARSCAR = 0) of significant scarring of the tympanic membrane describes the child's history of inner ear infections. A history of three or more colds a year (COLDHIST = 1, otherwise 0) is also used to measure a susceptibility to ENT infections. In addition, the age of the child (AGE) is included in our health attribute model. Previous epidemiological studies have shown that older children are less susceptible to inner ear infections.[13]

The health care goods that are assumed to influence a child's chances of ENT infections are the number of preventive doctor visits (DOCPRV) in the past year, the number of curative doctor visits (DOCCUR) *for ENT infections* in the past six months, and the average number of hours per day one or both parents spend with the child in play or conversation (PARTIME/N).[14] Family income per person (INCPC) is used as a single measure of the quality of the family's *material* environment. Unlike studies of adult healthiness, in which income and health are simultaneously determined, it is reasonable to assume for this study of children's ENT health that there is only the one direction of causation—from income to health.

DOCPRV, DOCCUR, PARTIME/N, and INCPC are expected to enhance health and therefore are positively related to the child's probability of NOSICK and NOEARINF. EARSCAR and COLDHIST should be negatively related and the child's AGE positively related to the probability of the healthy state.

The two fundamental premises of the health care production-demand model of Section 2 were (1) that the effects of health inputs on health outputs will differ across inputs and be uncertain, and (2) that consumers will adjust their consumption in response to perceived changes in this health technology.

It is hypothesized here that the average effects of health inputs (DOCPRV, DOCCUR, PARTIME/N) on health outputs (NOSICK, NOEARINF) and the variability of these effects will depend on the education of the mother and the professional source of health care. There is some sociological evidence to suggest that more highly educated parents follow a physician's advice more closely and are more likely to know the warning signals of illness than are parents with less education.[15] For both reasons we anticipate the average effect (β_{it}) of care to rise and the uncertainty ($\sigma^2_{v_{it}}$) to fall as the mother's education rises.

The provider of medical services may also influence β and σ^2_v. The doctor's role is not only to diagnose illness and dispense office care but to educate patients and encourage good curative and preventive health practices. The provider format that permits continued personal physican care is more likely to succeed in this education-encouragement task. All else equal, patients receiving care from solo private physicians or small-group practitioners may therefore face higher β's and lower σ^2_v's than patients receiving care from public clinics or outpatient services.

To test for the differential effects of education and provider type on the means and variances of health care inputs, our health attribute production functions will be estimated for four subsamples of the NAS survey population: (1) a low education (mother's education less than eight years)-public (clinic and outpatient) provider sample, (2) a high school education (mother's education nine–twelve years)-public provider sample, (3) a high school education-private (solo and group) provider sample, and (4) a college-private provider sample.

In Section 4, Part A, I will present and discuss estimates of the production function of children's ENT health.

B.

The mother's allocation problem, as characterized in Section 2, is to spend family income and parents' time on non-health goods and

DOCCUR, DOCPRV, and PARTIME in order to maximize family satisfaction, of which the uncertain ENT health of the children forms an integral part. The basic demand specification for the three health goods is given by (3) and elaborated by the following extensions.

Income and Prices

The demand model tested here distinguishes between working and nonworking mothers, and separate demand systems will be estimated for each. Both mothers face income and time constraints, but the specification of the two constraints for the two types of mothers differs and this difference generates testably distinct demand models.

Both working and nonworking mothers are limited to 24-hour days, 365 days a year. Their scarce time can be allocated to activities without the children (t_L), time with the children (PARTIME), time invested in providing doctor visits for the children (t_v), and, for the working mother, time on the job (t_w). The time required for doctor visits (t_v) is defined by the number of visits multiplied by the time cost per visit (TIMCOST). The time cost per visit equals the travel time to and from the physician plus waiting time at the office or clinic.[16] As I have assumed that the family's source of physician care is predetermined, TIMCOST is exogenous in this analysis and plays the role of a parameter in the household's consumption technology—t_v = TIMCOST*(DOCPRV + DOCCUR). The yearly time constraint is therefore:

(5) $$T = t_L + \text{PARTIME} + \text{TIMCOST}^*(\text{DOCPRV} + \text{DOCCUR}) + t_w$$

where $t_w > 0$ for working mothers and $t_w = 0$ for nonworking mothers. Assuming mother needs eight hours a day to herself for personal health and sanity, $T = 16^*365 = 5{,}840$ hours.

The income constraint (INC) facing the working and nonworking mother is defined by the level of husband's earnings (h, assumed exogenous) plus family nonwork income (z, also exogenous). For the working wife there is an additional source of income equal to working time (t_w) times her (exogenously set) hourly wage (WIFWAGE).[17] Thus, the yearly income constraint is given by:

(6) $$\text{INC} = h + z + \text{WIFWAGE}^* t_w$$

where again $t_w > 0$ for working mothers and $t_w = 0$ for nonworking mothers.

The purchase of non-health-related goods and services (y) costs

p_y per bundle, whereas a preventive or curative doctor visit costs a doctor's fee per visit (DOCFEE).[18] The family's income constraint limits the purchase of y and DOCPRV and DOCCUR by:

(6a) $\text{INC} = p_y \cdot y + \text{DOCFEE}^* (\text{DOCCUR} + \text{DOCPRV})$

Maximizing the mother's expected utility subject to the time (5) and income (6a) constraints yields (a la Section 2) a health care demand system for nonworking mothers ($t_w = 0$) of the form:

(7) $\text{PARTIME} = f_0(p_y, \text{DOCFEE, TIMCOST, INC}|\cdot)$

(8) $\text{DOCPRV} = g_0(p_y, \text{DOCFEE, TIMCOST, INC}|\cdot)$

(9) $\text{DOCCUR} = h_0(p_y, \text{DOCFEE, TIMCOST, INC}|\cdot)$

and for working mothers ($t_w > 0$) of the form:

(10) $\text{PARTIME} = f_w(p_y, \text{FULINC, FULFEE, WIFWAGE}|\cdot)$

(11) $\text{DOCPRV} = g_w(p_y, \text{FULINC, FULFEE, WIFWAGE}|\cdot)$

(12) $\text{DOCCUR} = h_w(p_y, \text{FULINC, FULFEE, WIFWAGE}|\cdot)$

where FULINC $= h + z + T$*WIFWAGE, and FULFEE = DOCFEE + WIFWAGE*TIMCOST. As the NAS survey of households does not give estimates of h and z, FULINC is approximated by (T-2,000)*WIFWAGE + INC under the assumption that all working mothers work forty hours a week for fifty weeks each year. The direction and extent of bias this assumption introduces in our estimate of income effects are discussed in Section 4.

The specification of the working-mother model in (10)–(12) has implicitly assumed that the woman is free to vary working hours, t_w, to meet her preferences. This may or may not be true. If the woman is constrained to work $\bar{t}_w$ hours or not at all, the working-mother's time constraint changes to:

(5a) $T - \bar{t}_w = T_H = t_L + \text{PARTIME} + \text{TIMCOST}^*(\text{DOCCUR} + \text{DOCPRV})$

where T_H measures available time for "home" activities. The income constraint reduces to a fixed INC $= h + z +$ WIFWAGE*$\bar{t}_w$. Under this assumption of rationed work hours, the derived demand system for the working wife becomes:

(10a) $\text{PARTIME} = f_{wr}(p_y, \text{INC, DOCFEE, TIMCOST}, T_H|\cdot)$

(11a) $\text{DOCPRV} = g_{wr}(p_y, \text{INC, DOCFEE, TIMCOST}, T_H|\cdot)$

(12a) $\text{DOCCUR} = h_{wr}(p_y, \text{INC, DOCFEE, TIMCOST}, T_H|\cdot)$

The "rationed" (10a)–(12a) and the "equilibrium" (10)–(12) working-wife models will be compared in Section 4.

The Demand Effects of an Uncertain Health Care Technology

Estimates of the ENT health attribute production function will provide estimates of the average impact of care and the variability or uncertainty of that impact on ENT health for each of the three inputs for each of the four wife education-provider type subsamples. The estimates of the average effects (β_{it}) of curative doctor care (MEANDOCC), preventive doctor visits (MEANDOCP), and parents' time (MEANPART) are given by the corresponding estimated regression coefficients from logit model in (4). Estimates of the uncertainty of input effects ($\sigma^2_{v_{it}}$) are provided by the square of the corresponding regression coefficient's standard error, normalized to a common sample size, and will be denoted by VARDOCC, VARDOCP, and VARPART, respectively. These estimates of means (β_{it}'s) and variances ($\sigma^2_{v_{it}}$'s) from each of the four subsamples will then be used as child-specific independent variables in the demand models (7)–(12a) to test for the effects of changes in health care technology on the demand for health-related goods and services.

An *a priori* motivation for this specification of the β's and σ^2_v's in our demand model is to assume that the mother behaves as a Bayesian. Starting with an uninformative (flat) prior distribution on the β's, she observes a sample of children passing through the health care system—her own children and her neighbors'—and subjectively "estimates" a posterior distribution. This posterior distribution will correspond to the distribution of our maximum likelihood estimates of the parameters of the logit health care technology. The sample of children used to obtain each mother's posterior distribution is assumed to come from that mother's education-provider subgroup.[19]

The Child's Health

The healthiness of a child at the time of the mother's decision to consume health services is also expected to influence household allocations. A child with a history of past illnesses may be more susceptible to ENT diseases and thus induce closer monitoring by parents and doctor. Using a history of colds (COLDHIST = 1, 0 otherwise) as an indicator of susceptibility, we expect COLDHIST to be positively related to PARTIME, DOCPRV, and DOCCUR. In addition, a child who displays current symptoms of illness will be more likely to be taken to the doctor for curative care. Our survey provides information on children's complaints of dizziness, earaches, loss of hearing, and plugged ears (EARPAIN = 1, 0 otherwise), which we expect to be positively related to the decision to seek curative care (DOCCUR).

How the mother reacts to health susceptibility and complaints of her children may be a function of the characteristics of the child and the family. Specifically, we test for the effects of child age (AGE), sex (MALE), and the number of other children in the family under twelve (N) on the mother's decision to seek care given the presence of COLDHIST or EARPAIN.

Parent Preferences and Health Attitudes

Parents' attitudes toward the medical care system as well as their view of children's role in the family should also influence the family's demand for child health care. Such attitudes are introduced as (1,0) dummy variables. One might expect parents who profess to have faith in the curative power of doctors (DOCFAITH = 1) to be more likely to use curative care, perhaps at the expense of preventive care and parents' time. Parents who consider their health to be good or excellent (PARHEAL = 1) are presumably enjoying the benefits of healthiness and therefore wish to protect the health of their children—either to further protect their own health or because healthy parents and healthy children are complements for many consumption activities. Future-oriented parents (FUTURE = 1)—indicated by disagreement with the statement "Nowadays a person has to live pretty much for today and let tomorrow take care of itself"—might presumably be sensitive to the investment as well as the consumption benefits of health care and thus increase health-enhancing activities. Also included are variables to reflect possible difference in reference group norms in regard to the importance and/or effectiveness of health care—(BLACK = 1) if the family is black and (RELIGION = 1) if the family attends religious services once or more a week. The final family variable tested is whether the mother is currently married (MARD = 1, 0 otherwise). There may be some sharing of child-raising tasks, thereby reducing the *individual* time costs of the activities causing an increase in demand.

The Demand System's Error Structure

The demand specification is completed by the assumption of an additive influence of a random error term (w_i) in each demand equation, where:

(13) $E(w_i) = 0, E(w_i^2) = \sigma_{wi}^2$

The error term from demand equation i (say, DOCCUR) is distributed $N(0, \sigma_{wi}^2)$ and need *not* be independent of the error term from demand equation j (say, DOCPRV), distributed as $N(0, \sigma_{wi}^2)$. That is, $E(w_i, w_j) \neq 0$ is assumed for this health care demand system.

4. THE FAMILY'S PROVISION FOR ITS CHILDREN'S HEALTH: MODEL ESTIMATION

The results of the model's estimation are summarized below. Part A presents and discusses the estimation of the ENT health attribute production functions. Part B summarizes the testing of our model of the demand for child health care.

A.

Table 2 presents the maximum likelihood estimates of the parameters of the logistic specification for the NOSICK and NOEARINF health attributes for the four education-provider subsamples of our child population. The maximum likelihood estimation procedure converged in all case within ten iterations. The test statistic for the overall significance of the production model, −2 log (likelihood ratio), is distributed as χ^2 with seven degrees of freedom and is reported in the final column. The χ^2 values are all highly significant except for the high school private subsample. For this subsample, we can reject the null hypothesis that all β_{it}'s are in fact zero at the 0.84 confidence level for the NOSICK equation but at only the 0.5 level for the NOEARINF equation.

The parameter estimates for the child's health history (EARSCAR, COLDHIST) are negative, as expected, and generally exceed their standard errors. Also, as expected, older children (AGE) have fewer colds, fewer ear infections, and are generally healthier. Family income per person (INCPC) is never a significant determinant of children's ENT health, though there is some reason to believe this measured effect of income is biased toward zero. (see below, Note 22).

The parameter estimates for curative doctor visits (DOCCUR) were developed in two stages to remove a possible simultaneity between DOCCUR and the presence of illness. DOCCUR informa-

TABLE 2 Health Attribute Production Functions

Sample	PARTIME/N	DOCPRV	DOCCUR	INCPC	EARSCAR	COLDHIST	AGE	CONSTANT	χ^2 (DOF = 7)
			Dependent Variable: NOSICK						
Eighth grade–public	3.59[b]	−1.23[b]	4.37[a]	−.44	−1.31[a]	−.51	.33	−3.13	14.05
(n = 136)	(1.65)	(.55)	(2.70)	(.42)	(.78)	(.88)	(.17)	(2.93)	
High school–public	−.01	.01	1.46[b]	−.06	−1.16[b]	−.62[b]	.26[b]	−.05	34.89
(n = 718)	(.3)	(.15)	(.71)	(.17)	(.48)	(.27)	(.07)	(.83)	
High school–private	.11	.04	−.32	−.12	−1.19	−.14	−.15[a]	2.11[a]	10.43
(n = 469)	(.41)	(.24)	(1.03)	(.21)	(.83)	(.38)	(.10)	(1.32)	
College–private	−.45	.47[b]	.45	−.05	−.71	.68	.34[b]	−.42	30.23
(n = 369)	(.32)	(.23)	(.45)	(.17)	(1.03)	(.40)	(.08)	(.81)	

Sample	PARTIME/N	DOCPRV	DOCCUR	INCPC	EARSCAR	COLDHIST	AGE	CONSTANT	χ^2 (DOF = 7)
			Dependent Variable: NOEARINF						
Eighth grade–public	5.80[b]	−1.62[b]	4.11	−.59	−1.36[a]	−.71	.24	−2.41	14.58
(n = 136)	(2.51)	(.75)	(3.29)	(.59)	(.84)	(1.15)	(.20)	(3.54)	
High school–public	.30	.10	.69	−.27	−1.61[b]	−.61[b]	.32[b]	.68	42.21
(n = 718)	(.37)	(.19)	(.88)	(.20)	(.52)	(.33)	(.09)	(1.06)	
High school–private	.45	−.37	.23	.18	−1.49	.70	.15	1.97	6.45
(n = 469)	(.74)	(.35)	(1.48)	(.38)	(1.12)	(.70)	(.16)	(2.01)	
College–private	−.16	.66[b]	−.04	.13	−1.18	.35	.36[b]	−.24	23.32
(n = 369)	(.41)	(.29)	(.56)	(.22)	(1.09)	(.50)	(.10)	(1.01)	

NOTE: Standard errors within parentheses.

[a] Coefficient significantly different from zero at the 0.90 level for a two-sided asymptotic t test.

[b] Coefficient significantly different from zero at the 0.95 level for a two-sided asymptotic t test.

tion was obtained from a family questionnaire administered from December 1970 to April 1971. The medical examinations of the children to determine the presence of ENT infections were begun in January 1971. Since illness does determine DOCCUR (see the role of EARPAIN in tables 4 and 5), a simultaneous equation bias in the production function estimates is therefore a danger. To try to remove this bias, the maximum likelihood estimates in Table 2 are based on a predicted value of DOCCUR as the independent variable, where the exogenous determinants of DOCCUR are the nonillness independent variables (prices, income, non-health-related child characteristics, parent attitudes) of the DOCCUR demand equation.[20]

Six of the eight DOCCUR coefficients are positive, as expected, but only two are significantly different from zero. There are two possible reasons for the insignificant effects of DOCCUR. First, for many ENT infections the physician can provide little in the way of direct and effective treatment. For most viral infections, for example, the physician's role is to monitor the disease and to minimize the long-run dangers rather than to "cure" the present illness. But second, in cases wherein physicians can offer effective care, particularly by prescribing antibiotics, patients may often receive this care by phone rather than through an office visit. The parents describe the symptoms and the doctor calls the pharmacy. This format for care is most likely to be used by patients with private physicians in which a "trusting" doctor-parent relationship has been established. Indeed, we notice that curative visits are never significant for the private provider subsamples.

DOCCUR is significant and quite important for children using public providers. Why? First, when doctors and drugs can help, children using public providers must generally go for an office visit to receive their prescription. Because public clinic physicians rarely know the parents personally, the phone cannot be used for a substitute office visit. Second, and perhaps more important, in the many instances in which the physician cannot provide an effective treatment for the present ENT incident, the curative visit may still be a useful preventive encounter. The causes and dangers of the child's present illness are explained to the parent, who also can be taught to look for warning signals and to administer future preventive measures. The parent and the child learn by the *example* of the present illness. Thus curative visits in the past can be an important source of present preventive practices, thereby having a significant positive impact on NOSICK.

Preventive doctor visits—check-ups—have a significant positive effect on health for children only with college-educated mothers using private providers. This seems reasonable since the check-up visit with a private physician often is a lesson in child health practices as well. Because college-educated mothers are more likely to ask questions and to understand the answers, the impact on children's health should be greater for this group. The significant but *negative* sign for preventive visits in the eighth grade-public sample is a bit of a puzzle. Rather than argue that public clinics are a depository of infectious diseases (thus the more you visit, the lower the likelihood of health), the cause of this perverse sign is more likely statistical. Our model is probably not well specified for this subsample. Specifically, for these children COLDHIST is not an adequate control for the presence of chronic, perhaps allergic, ENT infections. COLDHIST is defined by *the parents' response* to the question, "Does your child have three or more colds a year?" For each of the other three subsamples, about 35 per cent of the children were described by their parents as having a history of colds. The corresponding figure for the eighth grade-public sample was 25 per cent, suggesting a possible underreporting of children with potentially chronic ENT problems. If this is so, and if clinic doctors have encouraged the mothers of these children to come in for regular check-ups, then the negative sign can be explained.

Parents' time per child is significant, positive, and quantitatively important only for children from the eighth grade-public sample. There are reasons, however, to believe that the coefficients on PARTIME/N may be biased downward. Parents' time per child is an "input" not only for the provision of children's physical health but for other child attributes as well, especially sense of self and intellectual development. As these other facets of child development are likely to be produced jointly with health, any production function of health that omits these "joint products" from the specification will likely lead to biased input coefficient estimates. The difference between the estimated and the true input coefficients defines the bias and can be measured by $\beta_{EST} - \beta_{TRUE} = \partial,\xi$, where ∂ is the coefficient of the omitted variable (self-worth, IQ) regressed on the included variables (PARTIME/N in this instance) and ξ is the coefficient of the omitted variable regressed on the dependent variable (NOSICK, NOEARINF). As parents' time per child is likely to be positively related to self-worth and IQ, ∂ will be positive. If we treat child development as a truly joint production process, then over most ranges of the "outputs" the output attributes will be inversely related to one another, *given parental* *inputs*. Thus ξ will be negative.[21] If these arguments are valid, then $\beta_{TRUE} > \beta_{EST}$ for PARTIME/N; the estimates in Table 2 are biased toward zero.[22]

Do the ENT health care technologies described in Table 2 differ across the four education-provider subsamples and, if so, is there a pattern to these differences? Table 3 summarizes our estimates of this technology for overall ENT health. Mean effects of the three health care inputs (β_{it}) are equal to the coefficients from NOSICK, whereas estimates of the variances of their effects ($\sigma^2_{v_{it}}$) are set equal to the squared value of the coefficients' standard errors after normalizing standard error estimates for a common sample size ($n = 200$). Formal tests for the equality of the β_{it}'s and of the $\sigma^2_{v_{it}}$'s can be offered, assuming that the underlying distribution of our parameter estimates is normal. However, the asymptotic properties of the "instrumental variable" logit estimator used to derive β_{it} are not known, so such formal tests for equality of coefficients are probably misplaced.[23]

A casual inspection of the parameter estimates in Table 3 does suggest that children from different mother education-provider subsamples are exposed to different health care technologies. And there appears to be a pattern to these technological differences. The simple correlations of mother's years of schooling with each child's assigned (by membership in a subsample) values of β_{it} and $\sigma^2_{v_{it}}$ show a positive relationship of parental education to β_{it} for DOCPRV (0.85) and negative relationships between education and β_{it} for PARTIME/N(−0.74), β_{it} for DOCCUR (−0.59), and for all $\sigma^2_{v_{it}}$'s (−0.72 for $\sigma^2_{v_{it}}$ for PARTIME/N; −0.44 for DOCPRV; −0.86 for DOCCUR). Comparing the high school-public provider and the high school-private provider subsamples, the children using public providers can expect higher average effects from curative doctor

TABLE 3 The Logit Technology for Children's ENT Health

	Health Care Inputs					
	PARTIME/N		DOCPRV		DOCCUR	
Sample	β_i	$\sigma^2_{v_i}$	β_i	$\sigma^2_{v_i}$	β_i	$\sigma^2_{v_i}$
Eighth grade–public	3.59	1.84	−1.23	.20	4.37	5.15
High school–public	−.01	.31	.01	.07	1.46	1.86
High school–private	.11	.39	.04	.14	−.32	2.44
College–private	−.45	.20	.47	.10	.45	.36

visits and a lower variance but lower average effects with lower variances for preventive visits.[24]

This pattern of effects of parental education on the ENT technology does not lend strong support to our original hypothesis of a positive relationship between parental education and the effectiveness of health care inputs. Only for preventive visits (DOCPRV) do we see a clear dominance favoring the health technology "available" to children with more highly educated mothers—the average effect rises and the variance falls as education rises.

As mother's education rises, parental time per child has a smaller average impact on health, but the variance or uncertainty of that impact declines as well. But because of the likely bias in our estimate of the PARTIME/N coefficient, this conclusion must be considered tentative at best. Although our earlier arguments have pointed toward a downward bias in estimates of the PARTIME/N coefficient, it may also be true that this bias is greatest for the subsamples with more highly educated mothers. This will be true *if* the impact of a given amount of parents' time on child IQ and sense of self-worth rises as parental education rises. There is some evidence that this is so.[25] If the marginal impact of parents' time on IQ and self-worth (as measured by $\partial > 0$) rises as mother's education rises, and if the tradeoff of child health and IQ or self-worth (measured as $\xi < 0$) does not fall in absolute value as education rises, then our measure of downward bias in β_{it}, $\partial\xi$, will be larger in absolute value for children in the more highly educated mother subsample. The results above may therefore underestimate the true, perhaps positive, relationship between parental education and the average health effectiveness of time with children.

The apparent dominance of public over private providers in Washington, D.C. (discussed above) may explain, in part, the negative correlation between mother's education and the average effect of DOCCUR. Because the lower-educated mothers almost always use public providers (which increases β for this sample) and college-educated mothers always use private providers, we are not able to identify the separate education and provider influences on the family's health technology for these two groups. If the measured positive effect of public providers dominates the (assumed) positive effect of education, then the negative correlations between β_{DOCCUR} and mother's education will result.

Although the evidence here does not force us to reject our original hypothesis that education can improve the health technology, neither does it give it strong support. Overall, the results are more suggestive than conclusive. Although health care services do appear on balance to have a positive effect on children's ENT health, the observed outcomes for any particular child are quite uncertain. The estimates in Table 3 are best interpreted not as a true measure of the best ENT care technology but rather as selected families' perceptions of their received technology. Such an interpretation will still be sufficient for testing the effects of an uncertain technology on the demand for health care commodities. The results are reported in Part B below.

B.

Tables 4 and 5 summarize the results from estimating the demand model for working and nonworking mothers, respectively.

The estimation procedure in all cases was ordinary least squares, which, because each demand equation in the model specifies an identical vector of independent variables, also provides maximum likelihood estimates with our assumed error structure.[26] Given the four assumptions outlined at the beginning of Section 3—the assumed exogeneity of health insurance coverage, family provider of physician services, mother's work status, and number of children—ordinary least squares rather than a two-staged least squares procedure will be justified.[27]

Estimated equations (1a), (2a), and (3a) (Table 4) correspond to a *linearization* of the "equilibrium" specification for working mothers defined by (10)–(12). FULINC is positively related to preventive and curative doctor visits (normal goods) but *negatively* (and significantly) related to parents' time with children. As expected, an increase in FULFEE reduces doctor visits and also reduces parents' time with children. WIFWAGE, the "price" of parents' time with children, is *positively* related to PARTIME and negatively related to doctor visits.

If taken at face value, the results from Equation (1a) suggest that for working mothers "time with children" is an inferior good with respect to income changes and a Giffen good with respect to changes in the price of time, WIFWAGE. There is an alternative and perhaps more plausible explanation for these results. For employed women in our sample with relatively high-paying jobs, the labor market does not permit them to work as many hours as they wish at their current wage. Women who are constrained to work fewer hours than they prefer value market time more highly than time in home activities. Thus, for women in high-paying occupations, children doctor visits that often require time off from

TABLE 4 Working Mothers' Demand for Health Care Activities (n = 880)

Independent Variables	Dependent Variables								
	PARTIME			DOCPRV			DOCCUR		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
INC	—	−.0094[a] (.0053)	—	—	.0196[b] (.0084)	—	—	.017 (.014)	—
FULINC	−.00011[b] (.000005)	—	−.0000094[a] (.0000055)	.000020[b] (.000008)	—	.000015 (.000009)[a]	.000017 (.000015)	—	.000019 (.000014)
FULFEE	−.0047[b] (.0021)	—	—	−.0099[b] (.0032)	—	—	−.012[b] (.005)	—	—
DOCFEE	—	−.0046[b] (.0021)	−.0043[b] (.0021)	—	−.0099[b] (.0033)	−.0097[b] (.0035)	—	−.011[b] (.006)	−.0091[a] (.0057)
TIMWAGE	—	—	−.013 (.012)	—	—	−.010 (.019)	—	—	−.0474 (.032)
WIFWAGE	.063[b] (.031)	—	.067[b] (.033)	−.072 (.048)	—	−.046 (.054)	−.068 (.081)	—	−.028 (.089)
TIMCOST	—	−.00058 (.00057)	—	—	−.00029 (.00091)	—	—	−.0018 (.0015)	—
MEANPART	—	—	.19[b] (.10)	—	—	—	—	—	—
VARPART	—	—	−.054[a] (.032)	—	—	—	—	—	—
MEANDOCP	—	—	—	—	—	.395[b] (.165)	—	—	—
VARDOCP	—	—	—	—	—	−.67 (.91)	—	—	—
MEANDOCC	—	—	—	—	—	—	—	—	−.034 (.056)

VARDOCC	—	—	—	—	—	—	—	—	−.052
									(.048)
COLLEGE	.14[a]	.14[a]	—	.24[b]	.25[b]	—	.39[a]	.39[b]	—
	(.08)	(.08)		(.13)	(.12)		(.21)	(.20)	
HSPRV	.13[a]	.11	—	.041	.055	—	.17	.18	—
	(.08)	(.07)		(.11)	(.11)		(.20)	(.19)	
HSPUB	−.0073	−.011	—	.11	.11	—	.10	.12	—
	(.07)	(.07)		(.11)	(.11)		(.18)	(.18)	
EARPAIN	—	—	—	—	—	—	.77[b]	.75[b]	.75[b]
							(.16)	(.16)	(.16)
COLDHIST	.047	.049	.049	.18[b]	.17[b]	.17[b]	.40[b]	.41[b]	.41[b]
	(.037)	(.036)	(.036)	(.058)	(.06)	(.06)	(.10)	(.09)	(.09)
AGE	−.0079	−.0081	−.0081	−.086[b]	−.086[b]	−.073[b]	−.086[b]	−.073[b]	−.073[b]
	(.0054)	(.0055)	(.0054)	(.008)	(.008)	(.008)	(.015)	(.014)	(.014)
MALE	−.018	−.018	−.019	.05	.056	.057	−.025	−.029	−.027
	(.033)	(.034)	(.033)	(.05)	(.053)	(.054)	(.089)	(.088)	(.089)
N	−.019	−.019	−.019	−.0026	−.0041	−.0038	−.084[b]	−.084[b]	−.084[b]
	(.015)	(.015)	(.015)	(.023)	(.023)	(.025)	(.039)	(.039)	(.039)
DOCFAITH	.039	.032	.032	−.14[b]	−.14[b]	−.122[b]	.081	.076	.11
	(.038)	(.037)	(.038)	(.059)	(.06)	(.062)	(.099)	(.098)	(.10)
PARHEAL	.0046	.012	.016	.144[b]	.14[b]	.15[b]	.044	.04	.11
	(.046)	(.045)	(.047)	(.072)	(.07)	(.075)	(.12)	(.12)	(.12)
FUTURE	−.0013	.0069	.0076	.085[b]	.074	.061	.025	.029	.044
	(.034)	(.034)	(.025)	(.054)	(.054)	(.058)	(.09)	(.09)	(.093)
BLACK	−.12	−.12	−.15[a]	.011	.005	−.033	.05	.071	−.021
	(.09)	(.09)	(.09)	(.14)	(.11)	(.158)	(.24)	(.24)	(.244)
RELIGION	.067[a]	.066[a]	.063[a]	−.014	−.012	−.029	.021	.022	.08
	(.039)	(.039)	(.041)	(.062)	(.062)	(.066)	(.11)	(.10)	(.10)
MARD	.061	.052	.095[b]	.074	.074	.11	−.12	−.12	−.12
	(.045)	(.044)	(.046)	(.071)	(.069)	(.075)	(.12)	(.12)	(.12)
$\bar{R}^2$	.04	.04	.04	.19	.18	.14	.12	.11	.12

NOTE: Standard error within parentheses.
[a] Coefficient significantly different from zero at the 0.9 level.
[b] Coefficient significantly different from zero at the 0.95 level.

TABLE 5 Nonworking Mothers' Demand for Health Care Activities ($n = 812$)

Independent Variables	Dependent Variables: PARTIME (4a)	PARTIME (4b)	DOCPRV (5a)	DOCPRV (5b)	DOCCUR (6a)	DOCCUR (6b)
INC	−.0057	−.0028	.019[b]	.0098	.018	.019
	(.0058)	(.0055)	(.010)	(.011)	(.014)	(.014)
DOCFEE	.0013	.0022	−.0025	−.0011	−.0073	−.0064
	(.0024)	(.0026)	(.0043)	(.0046)	(.0061)	(.0066)
TIMCOST	−.0011[b]	−.0011[b]	−.0022[b]	−.0024[b]	−.0028[b]	−.0032[b]
	(.00053)	(.00053)	(.00091)	(.0009)	(.0013)	(.0014)
MEANPART	—	−.14		—		
		(.11)				
VARPART	—	−.062[b]		—		
		(.026)				
MEANDOCP	—	—		.56[b]		
				(.22)		
VARDOCP	—	—		−1.75[b]		
				(.81)		
MEANDOCC	—	—		—		−.001
						(.05)
VARDOCC	—	—		—		−.0085
						(.05)
COLLEGE	.16[b]	—	.48[b]	—	.17	
	(.072)		(.12)		(.18)	
HSPRV	.051	—	.24[b]	—	.14	
	(.059)		(.10)		(.15)	
HSPUB	.085[a]	—	.29[b]	—	.095	
	(.052)		(.09)		(.13)	
EARPAIN	—	—	—	—	.068	.071
					(.14)	(.15)
COLDHIST	.041	.042	−.00035	−.00042	.54[b]	.54[b]
	(.036)	(.037)	(.062)	(.007)	(.09)	(.09)
AGE	.0056	.0048	−.076[b]	−.076[b]	−.053[b]	−.054[b]
	(.0053)	(.0047)	(.0092)	(.0091)	(.013)	(.014)
MALE	−.016	−.021	.013	.015	.097	.11
	(.033)	(.019)	(.057)	(.06)	(.083)	(.08)
N	−.026[b]	−.026[b]	−.0068	−.0054	−.024	−.032
	(.013)	(.013)	(.023)	(.031)	(.033)	(.033)
DOCFAITH	−.015	−.0038	−.0021	−.024	−.0058	−.019
	(.037)	(.038)	(.065)	(.069)	(.094)	(.098)
PARHEAL	.036	.025	−.059	−.035	−.057	−.017
	(.037)	(.038)	(.064)	(.068)	(.093)	(.097)

TABLE 5 (Concluded)

Independent Variables	Dependent Variables					
	PARTIME		DOCPRV		DOCCUR	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
FUTURE	−.12[b]	−.095[b]	.075	.035	.26[b]	.21[b]
	(.036)	(.036)	(.061)	(.065)	(.08)	(.092)
BLACK	−.11[a]	−.13[a]	.052	.052	−.52[b]	−.52[b]
	(.068)	(.068)	(.11)	(.12)	(.17)	(.17)
RELIGION	−.011	−.0011	.087	.011	−.048	.10
	(.038)	(.037)	(.065)	(.068)	(.095)	(.095)
MARD	.012	.013	.19[b]	.23[b]	.062	.073
	(.043)	(.044)	(.075)	(.08)	(.11)	(.11)
$\bar{R}^2$	.04	.03	.15	.09	.11	.11

NOTE: Standard error within parentheses.
[a] Coefficient significantly different from zero at the 0.9 level.
[b] Coefficient significantly different from zero at the 0.95 level.

work are less attractive relative to off-work parent's time as a mechanism for protecting children's health. Therefore as WIFWAGE rises, time with children is substituted for doctor visits. Indeed, WIFWAGE *as a cross-price effect* (i.e., with FULFEE included) is negatively related to DOCPRV (almost significant at the 0.9 level) and DOCCUR in equations (2a) and (3a).

This "rationed" working-mother model was tested directly in (1b), (2b), and (3b). On the criterion of minimizing the sum of squared residuals, the "equilibrium" model performed slightly better than the "rationed" model—1a(207.2) vs. 1b(207.8), 2a(513.2) vs. 2b(517.1), 3a(1434) vs. 3b(1438)—but the explanatory power of the two models for the whole sample is nearly identical. Equations (1c), (2c), and (3c) split FULFEE into its two components, DOCFEE and the product TIMCOST*WIFWAGE = TIMWAGE. If the "equilibrium" model is the correct specification, then the coefficients on DOCFEE and TIMWAGE should be nearly equal and equal to the coefficient on FULFEE. Only in the DOCPRV equation does this appear to hold. In the PARTIME and DOCCUR equations the coefficient on TIMWAGE is two to five times larger than the coefficient on DOCFEE.

On balance, then, the rationed working-hours model is probably closer to the truth, particularly for working mothers with higher wages. Unfortunately, our wage data are based on broad occupational grouping and do not give us enough variation to split the sample and test for this structural break directly. However, a "compromise" model was tested that included INC, DOCFEE, TIMCOST, and WIFWAGE, each as explanatory variables. The coefficient estimates for INC, DOCFEE, and TIMCOST were identical to those presented in (1b), (2b), and (3b), and the WIFWAGE coefficients were similar to the estimates in (1a), (2a), and (3a). The price and income results appear quite robust across all working-mother specifications.

Equations (1ab), (2ab), and (3ab) give a first test of the hypothesis that health care technologies influence health care consumption. Here education-provider dummy variables for each of our four subsamples were used in the demand equations. The eighth grade-public dummy was excluded to avoid singularity. The children in the college-private subsample (COLLEGE) receive significantly more of each health care input than do children in the high school-private (HSPRV), high school-public (HSPUB), or eighth grade-public subsamples. As the other likely effects of mother's education on health care consumption are accounted for in our model through WIFWAGE, N, and labor force participation, the education-provider dummy variables may be detecting consumption differences attributable to perceived differences in the family's health care technology. If so, and if the pattern of the ENT technology with respect to mother's education is as described in Table 3, then mothers are risk averse with respect to their children's health, preferring the low mean-low variance inputs to the high mean-high variance activities.

Equations (1c), (2c), and (3c) provide one direct test of the mean-variance hypotheses. From Table 3, the expected effects and the variance of the effects of the health care activities from each subsample for the NOSICK equation were assigned to each child according to his subsample membership. The only exception was that negative mean effects were assigned a value of zero under the assumption that mothers do not really believe doctors' or parents' time is detrimental to their children's health.

The coefficient estimates imply that changes in the uncertain health care technology do appear to affect consumption decisions in intuitively reasonable ways. An increase in the average health effectiveness of parents' time (MEANPART) increases the time working mothers spend with their children, whereas an increase in the uncertainty of those effects (VARPART) reduces time spent with children.[28] Both effects are significant. An increase in the effectiveness of preventive visits increases DOCPRV, whereas an increase in variance tends to reduce DOCPRV, but this last result is not statistically significant. DOCCUR appears unaffected by health care technology, suggesting that curative visits may be largely motivated by a desire for parental reassurance and comfort ("Have I done all that's possible?") rather than direct child health effects. From our previous results in (3ab), it appears that college-educated mothers are more sensitive to this reassurance motive.

The remainder of the results in Table 4 are straightforward and need no extensive interpretation. The health history of the child (EARPAIN, COLDHIST) influences the decision to seek care in the expected way. Older children (AGE) get less attention and less doctor care, as do children from larger families (N). There is no sign of sexual discrimination (MALE) by the working mother in her care for children. Religious mothers spend more time with their children; working black mothers spend slightly less time with their children. Healthy parents (PARHEAL) and future-oriented (FUTURE) parents tend to use preventive care more, whereas mothers with faith in the curative power of doctors (DOCFAITH) use preventive care less.

The pattern of the results for the nonworking-mother sample (Table 5) are generally similar to those for working mothers. We do, however, lose the inferior-good quality of parents' time with children. The coefficient on INC in the PARTIME equation is negative, but not significantly different from zero. DOCPRV and DOCCUR are normal goods. Changes in doctor fees (DOCFEE) have no appreciable effect on health care consumption, but changes in time costs per doctor visit are quite important. Higher doctor visit time costs reduce *all* health care activities, doctor visits as well as parents' time with children.

The effects of health care technology on health care consumption are basically similar to those observed for working mothers, except that the mean effect of parents' time on health is no longer a significant positive stimulus to PARTIME. DOCCUR is again immune to changes in the technology, suggesting that parental reassurance may be the key motivation for curative visits for nonemployed mothers as well as for working mothers.

In Table 6 are the elasticities (at the means) of the health care activities with respect to prices, income, technology, and the number of children in the family. Price elasticities (FULFEE, DOCFEE, TIMWAGE, WIFWAGE) rarely exceed 0.15 in absolute value, supporting previous results on the price insensitivity of health care demands.[29] Variation in the TIMCOST of doctor visits is one of the strongest determinants of utilization, particularly for

TABLE 6 Health Care Consumption Elasticities

Independent Variables	Dependent Variables					
	Working-Mother Sample			Nonworking-Mother Sample		
	PARTIME	DOCPRV	DOCCUR	PARTIME	DOCPRV	DOCCUR
INC	−.046	.243	.205	~0	.168	.152, .161
FULINC	−.12, −.10	.559, .419	.461, .516	—	—	—
FULFEE	−.022	−.116	−.137	—	—	—
DOCFEE	−.016, −.015	−.086, −.085	−.092, −.076	~0	~0	−.037, ~0
TIMWAGE	−.017	~0[a]	−.147	—	—	—
WIFWAGE	.099, .106	−.295, ~0	~0	—	—	—
TIMCOST	−.016	~0	−.119	−.032	−.170, −.186	−.208, −.237
MEANPART	.012	—	—	−.007	—	—
VARPART	−.032	—	—	−.041	—	—
MEANDOCP	—	.454	—	—	.069	—
VARDOCP	—	~0	—	—	−.265	—
MEANDOCC	—	—	~0	—	—	~0
VARDOCC	—	—	−.12	—	—	~0
N	−.025	~0	−.270	−.043	~0	~0

[a] If the t statistic for the variable is <1, the elasticity is defined ~0

nonworking mothers. Here the elasticities range from −0.17 for DOCPRV to −0.23 for DOCCUR.

The estimates of income elasticities show that the inferior-good influence of income on parents' time with children is only a mild one. For the working-mother sample, a 10 per cent rise in income leads to at most a 1 per cent fall in parents' time. There is no adverse effect of income on PARTIME for the nonworking-mother sample.

Estimates of the elasticity of doctor visits with respect to income center at 0.16 for the housewife sample and range from 0.2 to 0.56 in the working-mother sample, depending on the model specification—FULINC yielding the higher estimates. The results for FULINC appear to be biased upward, however, because of the assumption regarding working hours needed to define the variable. The true income elasticity is probably closer to 0.25.[30]

The sensitivity of DOCCUR and PARTIME to changes in the health care technology is slight, but the utilization of preventive visits (DOCPRV) does seem rather responsive to alterations in the perceived technology.

Finally, children in larger families have less time with parents, but the actual amount lost is very small. For the working-mother sample, however, there is a significant reduction in curative doctor visits as N increases.

5. TOWARD A PUBLIC POLICY FOR CHILDREN'S HEALTH

ENT infections are one of the most prevalent of childhood diseases. In addition to the discomfort for the child, parental anxiety, and lost days from school and work that such diseases generate, there are possible long-run implications to ENT illness as well. Left untreated, ear infections can lead to permanent hearing loss and/or damage to the child's central nervous system. Chronic ENT disease may mean poor school performance, poor adult health, and losses in future earnings.[31] If one of our health care objectives is to reduce the prevalence of this class of diseases, what policy instruments will work? Our empirical analysis of the family's provision of children's health provides some initial insight into this question. Table 7 lists the expected elasticities of a child's ENT health with respect to three prominently mentioned sets of policy instruments: (1) exogenous income and/or wage subsidies, (2) health insurance, and (3) the availability of care.

TABLE 7 The Elasticities of ENT Health with Respect to Economic Policy Instruments

		Target Population					
		Eighth Grade		High School		College	
Policy	Instrument	Working Mother	Nonworking Mother	Working	Nonworking	Working	Nonworking
Income	INC	.03	.02	.017	.013	.02	.014
	WIFWAGE	.016	—	*	—	*	—
Health insurance	DOCFEE	−.027	−.006	−.007	−.003	−.007	−.002
Access to care	TIMCOST	−.023	−.048	−.01	−.017	−.005	−.013

* See text.

The results are based on the elasticities in Table 6 and on calculated elasticities from Table 2 for the NOSICK and NOEARINF equations. For an upper estimate of the effectiveness of policy on children's ENT health, the higher of the two input elasticities from NOSICK and NOEARINF was used. A zero rather than a negative elasticity was assigned to DOCPRV in the eighth grade-public health equation and to PARTIME/N for the college-private health equation. The only elasticities that are substantially different from zero are 0.16 with respect to PARTIME/N and 0.17 with respect to DOCCUR for the eighth grade-public subsample, 0.082 with respect to DOCCUR for the high school-public subsample, and 0.045 with respect to DOCPRV and 0.041 with respect to DOCCUR for the college-private subsample. The elasticities in Table 7 are based on the sum of policy-induced changes in the use of health care inputs (PARTIME, DOCCUR, DOCPRV) times these average effects of inputs on health.[32] The results are disaggregated by the mother's educational level and work status.

Exogenous income transfers (INC) have a consistently positive effect on children's health, primarily through the inducement to buy more medical inputs. The effects of changes in the mother's wage is unclear. Children whose employed mothers have low levels of education are stimulated by the increase in WIFWAGE to substitute parents' time for less effective doctor visits. The net effect is an increase in the child's chances for ENT health. A similar conclusion probably holds for the employed mother, high school, and college subsamples as well, but a likely downward bias in our estimate of the effects of parent's time obscures this result.

A fall in the out-of-pocket costs of physician visits or in the time cost of such visits also has a positive net effect on a child's health prognosis. Such changes prompt an increase in use of physician services without inducing a sufficiently strong offsetting reduction in home care.

Although the effects of these policy changes on ENT health move in the expected direction, what is perhaps surprising is how small the average policy impact appears to be. Any sizable improvements in ENT health prospects resulting from these economic policy instruments will prove exceedingly costly. To increase the probability of NOSICK from 0.9 to 0.91—a 1 per cent improvement—may require an increase in income equal to about 50 per cent of husband's earnings (the main element in "exogenous" income) or a 25–50 per cent reduction in TIMCOST. A reduction in doctor fees appears no more effective. A 100 per cent reduction in out-of-pocket costs (from $6 to $0), as with universal coverage national health insurance, will increase the probability of no ENT infections for a child from about 0.9 to 0.91–0.93. And each of these calculations assumes no offsetting rise in TIMCOST or fall in quality of care, both of which may arise when increased aggregate demand hits the ambulatory care supply constraint. Whether these health gains can justify such costly policy measures remains to be seen.

The more effective policy strategies may be to improve medical technology and parental health knowledge or to alter the patterns of adult-child interactions. Improvements in medical technology or the health effectiveness of parents' time with children not only yield direct health payoffs through the attribute production function but also appear to induce an increased utilization of the more effective inputs. The net effect may be quite sizable. From our production and demand models, for example, a 10 per cent increase in the average health effectiveness of parents' time or doctor visits will lead to a 4 per cent increase in the probability of NOSICK for children whose mothers have an eighth grade education or less. For children in the higher mother-education subsamples a 1–2 per cent increase in probability of NOSICK may result. In addition, for children in the eighth grade sample, family planning or quality day care may be a useful policy for improving a present child's health prospect. Reducing the number of children under twelve (N) by half can lead to a 2 per cent increase in the probability of NOSICK.[33] The reduction in N increases parents' time with each child as well as the likelihood that a child, once sick, will be given curative care. These two effects have a significant pro-health impact for children in the lower-education subsample.

The point of presenting these numbers is not that they constitute a true basis for a children's health policy, but rather to argue that we should think seriously about analyzing policy alternatives that move beyond the usual income and price instruments of the economic model. At least for one important class of childhood diseases, improvements in health will not come easily. Efforts to influence the family's health performance through the economic parameters of price and income will yield only marginal improvements in children's ENT health. Changes in medical technology, parent health knowledge, and the patterns of adult-child interaction *may* be the more promising policy directions.

National health insurance may still be our protector against the financial risks of major illness, but it is not likely to be the cure for our children's runny noses.

DATA APPENDIX: VARIABLE DEFINITIONS

The variables are defined below and their means (variances) are given for each of the relevant subsamples.

Subsample Key

Eighth grade-public:	8GPUB	High school-public:	HSPUB
High school-private:	HSPRV	College-private:	COLPRV
Working mothers:	WM	Nonworking mothers:	NWM

Variable List

AGE: Age of the child in years.

8GPUB	HSPUB	HSPRV	COLPRV	WM	NWM
7.28	6.84	6.96	7.07	7.38	6.56
(11.07)	(10.27)	(9.14)	(10.65)	(9.80)	(10.24)

BLACK: 1 if child is black, 0 otherwise.

WM	NWM
.96	.93
(.03)	(.07)

COLDHIST: 1 if the child has three or more colds a year as reported by parents, 0 otherwise.

8GPUB	HSPUB	HSPRV	COLPRV	WM	NWM
.25	.34	.36	.35	.34	.32
(.20)	(.21)	(.23)	(.23)	(.22)	(.21)

DOCCUR: Number of visits to the doctor within the last six months for ENT diseases as reported by the parents.

8GPUB	HSPUB	HSPRV	COLPRV	WM	NWM
.65	.63	.73	.96	.72	.72
(1.01)	(1.36)	(1.81)	(2.58)	(1.85)	(1.54)

DOCFAITH: 1 if parents agree with "Doctors can cure most serious diseases"; 0 otherwise.

WM	NWM
.72	.73
(.19)	(.19)

DOCFEE: Average out-of-pocket costs for doctor visits as reported by parents.

WM	NWM
5.99	3.63
(64.80)	(53.29)

DOCPRV: Number of doctor check-ups for the child per year as reported by the parents.

8GPUB	HSPUB	HSPRV	COLPRV	WM	NWM
.42	.66	.69	.99	.70	.69
(.56)	(.79)	(.72)	(.74)	(.72)	(.77)

EARPAIN: 1 if child has complained to parents in last two weeks of loss of hearing, dizziness, earaches, plugged ears; 0 otherwise.

WM	NWM
.083	.098
(.07)	(.09)

EARSCAR: 1 if either left or right ear shows scarring of tympanic membrane, 0 otherwise.

8GPUB	HSPUB	HSPRV	COLPRV
.04	.026	.025	.018
(.04)	(.034)	(.024)	(.029)

FUTURE: 1 if parents disagree with "Nowadays, a person has to live pretty much for today and let tomorrow take care of itself"; 0 otherwise.

WM	NWM
.51	.41
(.25)	(.24)

INC: Annual family income in 000's.

WM	NWM
8.69	6.11
(19.27)	(17.22)

INCPC: Annual family income per member of family in 000's.

8GPUB	HSPUB	HSPRV	COLPRV
.87	1.11	1.84	2.55
(.71)	(.62)	(1.04)	(1.39)

MALE: 1 if child is a male, 0 otherwise.

WM	NWM
.51	.51
(.25)	(.25)

MARD: 1 if mother currently married, 0 otherwise.

WM	NWM
.63	.58
(.23)	(.25)

N: Number of children in the family between the ages of 6 months and 12 years.

WM	NWM
2.40	3.03
(1.38)	(1.77)

NOSICK: 1 if child has no diagnosed ENT disease at time of medical survey, 0 otherwise.

8GPUB	HSPUB	HSPRV	COLPRV
.93	.90	.93	.89
(.062)	(.09)	(.06)	(.09)

NOEARINF: 1 if child has no diagnosed symptoms of ear infection (tympanic membrane *not* red or amber/yellow), 0 otherwise.

8GPUB	HSPUB	HSPRV	COLPRV
.96	.93	.97	.94
(.042)	(.059)	(.025)	(.058)

PARHEAL: 1 if mother considers her health good or excellent, 0 otherwise.

WM	NWM
.84	.68
(.14)	(.21)

PARTIME: Amount of time parents spend with all children per day in play or conversation. Based on response to the question "Do you usually play or converse with your children: (1) every day, (2) every other day, (3) once or twice a week, (4) twice a month, (5) once a month or less." Answers were scaled assuming each daily contact with all children was about two hours.

WM	NWM
1.79	1.82
(.25)	(.23)

PARTIME/N: Total estimated time divided by number of children between 6 months and 12 years.

8GPUB	HSPUB	HSPRV	COLPRV
.72	.75	.92	1.09
(.26)	(.25)	(.31)	(.34)

RELIGION: 1 if parents attend religious services once or more a week, 0 otherwise.

WM	NWM
.26	.30
(.18)	(.21)

TIMCOST: The average travel plus average waiting time per child visit to the doctor in minutes.

WM	NWM
47.93	53.37
(880.90)	(1024)

WIFWAGE: Estimated hourly wage of working mothers based on mother's occupation and Washington, D.C., *Area Wage Survey* data.

WM
2.81
(1.32)

NOTES

1. Based on an estimated 20,000 practicing pediatricians earning an average income of $40,000 yearly. The public budget figures include spending at the federal, state, and local level on maternal and child health services and school health. *Statistical Abstract of the United States*, 1973, pp. 68, 71.
2. We concentrate on physical healthiness both in the theoretical and empirical portions of this study simply because the "economic model" is not well-suited for handling the discrete "taste changes" that are likely to accompany changes in mental health.
3. See also Michael Grossman, *The Demand for Health: A Theoretical and Empirical Investigation* (New York: National Bureau of Economic Research, Occasional Paper No. 119, 1972), and Charles Phelps, *Demand for Health*

Insurance: A Theoretical and Empirical Investigation, R-1054-OEO, The Rand Corporation, July 1973.

4. This approach differs from the work of Grossman, *The Demand for Health*, wherein subjective indices are used to specify the individual's healthiness—for example, individual judgments of own health as poor, fair, good, excellent. Grossman is sensitive to the limitations these subjective indices place on his conclusions. Although conclusions about the statistical significance and relative importance of variables can often be made in models involving ordinal dependent variables (see Sanford Labovitz, "The Assignment of Numbers to Rank Order Categories," *American Sociological Review* (June 1970), conclusions about measured marginal impacts are not valid. To correctly specify and estimate a "health production function" requires cardinal, not ordinal, measures of output.
5. This is the approach to health care uncertainty used in all previous work. See, for example, Phelps, *Demand for Health Insurance.*
6. One attractive specification of the attribute technology is to specify (1) as Cobb-Doublas where (1a) incorporates the random effect of $\tilde{u}$ as a shift parameter, $e^{\tilde{u}}$, and $\tilde{v}$ as an additive random term attached to the coefficients on x_i. When $\tilde{u}$ and $\tilde{v}$ are normally distributed, health care attributes, A_t, will be lognormally distributed. For a full development of this case, see Robert Inman, "Health-Care Demand When Outcomes Are Uncertain," mimeo., University of Pennsylvania, 1974.
7. The demand specification above assumes that the consumer's health insurance coverage is exogenously set, either through employment or publicly provided coverage. The recent work of Charles Phelps, *Demand for Health Insurance*; and Isaac Ehrlich and Gary Becker, "Market Insurance, Self-Insurance and Self-Protection," *Journal of Political Economy* (July–August 1972), has led to the development of models in which health care demand and insurance coverage are jointly determined. Our model fits easily into their framework and extends their analysis by allowing for the uncertain effects of health care (self-protection) activities. In the more general model, the consumer's allocation problem can be split into two sequential decisions. At the start of each period, the consumer decides on the level of health insurance coverage, knowing the market prices of x and y, his income I, μ, σ^2_u, β, σ^2_v, A_0, and the market-determined price of health insurance. The demand specifications in (3) above are conditional on the extent of health insurance coverage, especially the coinsurance rate that reduces the gross market prices for health services to the net price, p_x, which is used in (3). Substituting $\phi_i(\cdot)$ into the consumer's utility function $U[x, y, A(x)]$ and optimizing over the insurance parameters allows us to specify preferred insurance coverage (see Phelps, *The Demand for Health Insurance*). Once coverage is set, the consumer buys care according to (3). This extension of our model argues that the price of insurance should be included in the demand equations for health-related goods and services.
8. Of course, if we sufficiently restrict the specification of (1a), and (2), predictions about the demand effects of changes in μ, σ^2_u, β, and σ^2_v do emerge. See, for example, S. Turnovsky, "A Model of Consumer Behavior under Conditions of Uncertainty in Supply," *International Economic Review* (February 1971), and Walter Oi, "The Economics of Product Safety," *The Bell Journal of Economics and Management Science* (Spring 1973). Turnovsky assumes a quadratic specification for $U(\cdot)$ in (2), whereas Oi assumes a perfect insurance market for commodity failures (in our case, sickness) or a "far-sighted" consumer making many purchases of the good with the uncertain

effect. Neither specification seems particularly attractive for our problem. In another paper, "Health Care Demand When Outcomes Are Uncertain" (mimeo.), University of Pennsylvania, 1974, I develop the demand specifications for a constant relative risk-aversion utility function with lognormally distributed health attributes. There I show that in the three-good cares (preventive care, curative care, and y) with a single health attribute, consumers who are sufficiently risk averse with respect to health (the Pratt-Arrow measure of relative risk aversion exceeding 1) will increase their use of preventive or curative care as the expected marginal health impact for the good increases ($d\beta_{it} > 0$) or as the uncertainty of the marginal health impact declines ($d\sigma^2_{v_{it}} < 0$). Section 4 presents some tentative evidence to support this prediction in the case of children's health.

9. The emphasis here on the consumption benefits of child health care does not preclude the notion that health care can be a means to a further end—say, good school performance. However, the model does ignore the human capital formation motive for child health care allocations. See, for example, Michael Grossman, "The Correlation between Health and Schooling," National Bureau of Economic Research, Working Paper No. 22, December 1973; and Marc Nerlove, "Household and Economy, Toward a New Theory of Population and Economic Growth," *Journal of Political Economy*, Part II (March–April 1974). I provide some tentative evidence on the choice between the two models in Section 4. See the discussion of the variable FUTURE below, and the results in tables 4 and 5 for this variable.
10. The survey was conducted as part of the National Academy of Sciences, Institute of Medicine, study entitled "Contrasts in Health Status: An Analysis of Contrasting Forms of Medical Care Delivery." The survey involved a detailed questionnaire of family health attitudes, economic status, and utilization of health care facilities within six months prior to the date of the interview. Interviews were conducted from December 1970 to April 1971. There were 1,435 families in the study's final sample. Children between the ages of 6 months and 12 years in the sample families were then given a detailed ENT clinical examination and those over 3 years were given sight and hearing examinations as well. Approximately 2,600 children were examined by the survey's panel of physicians. My working sample based on complete data for all variables used in this study came to 1,692 children.
11. An earlier version of this paper also examined nose infections, but Lee Benham correctly pointed out that because of the very low prevalence rate and often small sample sizes, these results were virtually useless.
12. For a biological model generating a logit specification for (1,0) health attributes, see J. Truett, J. Cornfield, and W. Kannel, "A Multivariate Analysis of Risk of Coronary Care," *Journal of Chronic Disease* (April 1967).
13. See David Kessner and D. McEldowney, "The Epidemiology of Otitis Media," in K. S. Gerwin and A. Glorig (editors), *Otitis Media: Proceedings of the National Conference* (Springfield, Illinois: Charles C. Thomas, 1972).
14. Parents' time per day per child in play or conversation is based on the parents' response to the question, "Do you usually play or converse with your children: (1) every day, (2) every other day, (3) once or twice a week, (4) twice a month, (5) once a month or less?" Answers were then scaled into an estimate of total parents' time (PARTIME) with all children by assuming that each daily contact with all children consumed about two hours. Recent work by Arleen Leibowitz, "Education and Home Production," *American Economic Review* (May 1974), finds that parents do spend, on average, about two hours per day on the

physical and educational care of their children. Leibowitz also finds that the amount of time per contact is *not* significantly related to parents' educational levels. This fact is relevant, since our production model will be estimated for subsamples based on mothers' educational levels.

15. See L. Pratt *et al.*, "Physicians' Views on the Level of Medical Information among Patients," in W. Scott and E. Volkhaut (editors), *Medical Care: Readings in the Sociology of Medical Institutions* (New York: John Wiley, 1966); and R. Duff and A. Hollingshead, *Sickness and Society* (New York: Harper and Row, 1968). Also, J. Samora *et al.*, "Knowledge about Specific Diseases in Four Selected Samples," *Journal of Health and Human Behavior* (Fall 1952); S. S. Kegeles *et al.*, "Survey of Beliefs about Cancer Detection and Taking Papanicoloan Tests," *Public Health Reports*, No. 80, September 1965; and D. Rosenblatt and E. Suchman, "The Under-utilization of Medical Care Service by Blue Collarites," in *Blue Collar World* (Englewood Cliffs, New Jersey: Prentice-Hall, 1954), have found that lower socioeconomic families have less accurate information about the causes and characteristics of many diseases than higher socioeconomic families.
16. TIMCOST equals the average travel and waiting time for the child for doctor visits over the six months prior to the family interview. If the child did not go to the doctor during this period, TIMCOST was calculated as the average travel plus waiting time of his or her siblings' visits.
17. WIFWAGE is approximated by the average hourly earnings for the occupational class in which the mother is employed. Exact wage data were not available. Occupational wage information was obtained from the *Area Wage Survey*, 1970, Bureau of Labor Statistics, Washington, D.C.
18. DOCFEE equals the average out-of-pocket costs of the child's physician visits during the six months prior to the family interview. If the child did not go to the doctor during this period, DOCFEE was set equal to the average out-of-pocket costs for the child's siblings' visits. Defining DOCFEE as an average of out-of-pocket costs sidesteps the errors-in-variables problems that arise because of the common physician practice of "two-part" pricing—charging a high initial price for each "work-up" visit and then low to zero prices for all follow-up visits.
19. Theil's work on "models with random coefficients" offers a richer econometric specification of our model, closer to the spirit of the work in Section 2. See Henri Theil, *Principles of Econometrics* (New York: John Wiley, 1971), pp. 622–627. In the framework above, uncertainty about health effects arises only because of inadequate inference on the part of the consumer of a true, "certain" health effect, β. Actually, of course, β is rarely known exactly even by health professionals with large samples. Theil's specification allows the variance of β to remain, even as sample size increases. For testing of our demand model, the extension into Theil's "models with random coefficients" is probably not worth the added effort. But in an analysis of health attribute production functions, it is an extension that should be seriously considered.
20. Comparing the results in Table 2 with my initial estimates of the DOCCUR coefficient shows a significant downward bias in the DOCCUR coefficient when this "instrumental variables" procedure was not employed. The estimates of the other coefficients in the model are nearly identical between the two estimating procedures. However, the asymptotic properties of this instrumental variables procedure for the logit model are not known, and the reader should treat these parameter estimates with suitable caution.
21. The coefficient ξ is in effect the slope of the "production possibility frontier"

for child attributes. Given a level of family inputs, more of one attribute may mean less of another.

22. An argument similar to the one just presented for the bias in the PARTIME/N coefficients can be developed for the income per capita variable as well. If parental income is positively related to child IQ and self-worth, as one might expect ($\delta > 0$), then from the model above, the estimated coefficients on INCPC will be biased toward zero. As with the bias to parents' time effects, I know of no evidence that will permit us to judge the seriousness of this underestimation.

    The arguments here are not likely to apply to the doctor visit inputs or to past health states since the direct relationship of these variables to IQ or self-worth are likely to be negligible ($\delta \sim 0$).

23. If the parameter estimates, $\tilde{\beta}_{it}$, are normally distributed as $N(\beta_{it}, \sigma^2_{v_{it}})$, then statistical tests for the equality of means and variances across subsamples for each health care input can be made. For a test of equality of variances, the test statistic is the ratio of variance estimates that is distributed as F with parameters $(n - 1, n - 1)$, where $n = 200$. The null hypothesis of equal $\sigma^2_{v_{it}}$'s is rejected for all comparisons made by pairs at the 0.9 level and for all but three at the 0.99 level. For a test of equality of means ($= \beta$'s) of two normal populations with known but different variances, the test statistic is $Z^2 = (\beta_0 - \beta_1)^2 / (\sigma_0^2/n + \sigma_1^2/n)$, which is distributed as χ^2 with one degree of freedom. The null hypothesis of equal mean effect was rejected for all pairwise comparisons at the 0.9 level except for the comparison of β_{it} for DOCPRV for the high school-public and the high school-private subsamples.

    Yet even if one accepts the normality assumption for β_{it}, the formal tests for equality of the PARTIME/N coefficients and their variances are biased in an unknown direction because of the bias in our estimates of PARTIME/N. Although we can say with some confidence that β_{it} for PARTIME/N is biased downward, no conclusions about the direction of bias in its standard error can be made. Thus $\sigma^2_{v_{it}}$ is biased away from the true variance in an unknown direction and the formal tests above for PARTIME/N are therefore biased in an unknown direction. Caution should be the keyword here.

24. The pattern is identical for the coefficients and variance estimates from the NOEARINF equation.

25. See, for example, Arleen Leibowitz, "Home Investments in Children," *Journal of Political Economy* (March–April 1972), Part II; and Jerome Kagan and H. A. Moss, "Parental Correlates of Child's IQ and Height," *Child Development* (September 1959).

26. See Arnold Zellner, "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias," *American Statistical Association Journal* (June 1962).

27. The fact that our analysis is restricted to the provision of ENT health for children makes the first three assumptions less troublesome than they might be for an adult health study or a study of "major" (e.g., crippling) child diseases. Family health coverage is largely exogenous (publicly provided or part of the employee contract) for our sample. For those families buying supplemental insurance, it is unlikely that this coverage will be motivated by a child's ENT diseases.

    The choice of the provider—and subsequently the provider's location, which helps define TIMCOST—is also likely to be independent of a child's ENT health. The possible exceptions are children with chronic ENT problems, but they appear to be few in our sample. Acton's simultaneous equation estimate of the role of outpatient visits as a determinant of travel distance is negative, as expected, but not significant. However, in Acton's work distance is a significant (negative) determinant of outpatient visits, a result similar to the one obtained here. See Jan Acton, "Demand for Health Care When Time Prices Vary More Than Money Prices," R-1189-OEO/NYC, The Rand Corporation, May 1973.

The mother's work status is also independent of the family's provision for ENT health. The correlations of mother's work status (1 if works, 0 otherwise) with DOCCUR, PARTIME, DOCPRV, EARPAIN, and COLDHIST never exceed 0.03.

The fourth assumption that assumes the exogeneity of family size is counter to recent household models that argue that number (N) and "quality" of children (of which ENT health is a part) are jointly determined. An alternative view of the parents' decision to have and care for children is to treat the decisions as a sequential process of decision, learning, and decision subject to the constraint that we cannot freely destroy the fruits of prior labor. In such a model, parents decide to have a child and once it is born care for that child as they see fit. The child is a blessing or a burden relative to prior expectations. If a blessing ("quality" greater than expected), they decide to have another. Once born, the parents care for both children as best they choose. Again they compare expected "joy" to received "joy" and decide to have another child or stop the process. It is clear that the fertility-child "quality" model being suggested here is recursive and allows us to identify the true effects on the provision of children's health. Unfortunately, our data base is not sufficiently rich to allow enough degrees of over-identification so that N might be made endogenous and permit us to test these alternative models of the fertility/child-raising process.

28. The fact that our estimates of the mean effect and the variance of this effect are biased for PARTIME/N will not alter our conclusions if the degree of bias is nearly constant across the four subsamples. I have argued earlier, however, that the degree of bias may be systematically related to mother's education. If so, the mother's education should be included in (1c) along with MEANPART and VARPART. But multicollinearity between these variables prevents us from drawing any inferences about the effects of technology in this case. The results in (1c) must therefore be treated as tentative, limited by the proviso that the bias in MEANPART and VARPART is not systematically related to parental education.
29. See, for example, J. P. Newhouse and Charles E. Phelps, "New Estimates of Price and Income Elasticities of Medical Care Services," in this volume.
30. To check for this bias, I reestimated equations (1a), (2a), and (3a), specifying preferred hours worked (t_w) to be a linear function of WIFWAGE. Substituting $t_w = \alpha + \delta$ WIFWAGE into the definition of FULINC [=INC + $(T - t_w)$*WIFWAGE] and this new specification of FULINC into our demand model yielded reduced-form equations in prices, technology, tastes and INC, WIFWAGE, and WIFWAGE^2. Estimating these equations gave "corrected" utilization elasticities with respect to income of about 0.25, suggesting that the true elasticities lie nearer the lower end of the original range.
31. For an interesting study relating childhood health to schooling and adult earnings, see Michael Grossman, "The Correlation between Health and Schooling," National Bureau of Economic Research, Working Paper No. 22, December 1973.
32. The use of the elasticities based on mean health effect, β_{it}, without regard to the

standard errors of these estimates implicitly assumes that society should be risk neutral when allocating resources to children's health. For arguments to justify this assumption, see Kenneth Arrow and Robert Lind, "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review* (June 1970).

33. For a summary of other studies that find that smaller families mean healthier children, see Joel D. Wray, "Population Pressure on Families: Family Size and Child Spacing," in National Academy of Sciences, *Rapid Population Growth* (Baltimore: Johns Hopkins Press, 1971).

6 COMMENTS

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Inman raises two important questions in this paper: (1) How do physician visits and parents' time spent with children affect children's health? and (2) How responsive are parents to the health benefits their children receive from these two inputs? To provide answers to these questions, he develops and estimates a production function for children's health and a demand function for health inputs. I will comment on each of these in turn.

In the production function for children's health, health status is measured by three dummy variables indicating whether the child had an ear, nose, or throat infection; an inner ear infection; or a cold. Approximately 10 per cent of the children in the sample had one or more of these illnesses; less than 3 per cent had a cold. The combination of the relatively small sample sizes and the small proportion of ill children raises serious questions about the reliability of the production function estimates. As an extreme case, Table 2 indicates an eighth grade sample size of 136. According to the overall sample characteristics, approximately 4 children in that group had colds. The dependent (dummy) variable therefore has a value of 1 in approximately 132 cases and zero in the other 4. It is difficult to have confidence in production function estimates based on such small numbers.

Even if the sample size is accepted as adequate for estimating the systematic association between children's health status and the inputs examined, the results in Table 2 provide only very weak support for the view that children's health status is positively associated with inputs of physician visits and parents' time. Of the 36 estimates of input coefficients reported, 22 are positive and 14 negative. Furthermore, these estimates are rarely significantly different from zero. I am not persuaded that productivity benefits from these inputs have been shown.

The demand function includes the usual price and income components plus variables obtained from the production function concerning the mean and the variance of the effect of parents' time and physician visits on children's health. Inman's approach is clever. It provides a method of investigating the response of parents to the benefits and uncertainties of inputs to improve their children's health. As these inputs become more effective, the demand should increase, *ceteris paribus*. As the variance of the effects increases, however, the demand should decline if consumers are risk averse. The problem here, however, is that the measures of health benefits used in the demand equation are taken from the production function estimates. If there are no benefits from physician visits or parents' time, or if the production function estimates are not reliable because of sample size, the coefficient estimates for the health productivity variables in the demand equation will not be meaningful. Thus I do not believe that the estimated coefficients of the variables representing the mean and variance of productivity of parents' time and physician visits shown in Table 4 are reliable indicators of parents' demands for these services.

There is a further problem in the demand equation. Several variables that contain both wage (price) and income components are included simultaneously. Consider the composition of the variables included in equations (1a), (2a), and (3a) in Table 4. WIFWAGE is the estimated hourly wage of the mother based on the earnings of women with the same occupation in the Washington, D.C., area. The average occupational wage rate surely includes a large permanent income component, and the coefficient of this variable will in part measure the impact of income on the demand for parents' time and physician visits. FULINC is a measure of full family income that includes the wife's occupational wage times a fixed number of hours per year plus other family income. FULFEE includes wife's wage multiplied by the time cost of visiting a physician plus the physician's fee. In addition, three dummy variables are entered for parents' years of schooling. These variables are also proxies for permanent income. Since several measures of income and wage rates are included simultaneously as independent variables, the interpretation of the individual coefficients is not obvious. This is perhaps why some of the results appear curious when given a straightforward interpretation. For example, Inman writes, "WIFWAGE, the 'price' of parents' time with children, is *positively* related to PARTIME (parents' time with children) and negatively related to doctor visits. These results suggest that for working mothers time with children is an inferior good with respect to income changes and a Giffen good with respect to changes in WIFWAGE!" Economists have been seeking a Giffen good for a long time. Before we conclude that the quest has ended, additional analysis will be necessary to obtain more precise measures of the income and substitution effects.

The problems discussed above are primarily attributable to data deficiencies and should not detract from Inman's contribution in raising some important issues. He has been clever in developing a model that examines both the productivity of inputs on health status and the effects of productivity and uncertainty on the demand for inputs. It is time that we knew more about these questions, and Inman has given us a good start.

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There are a number of aspects of Inman's analysis that deserve comment. Let me first offer a more general commendation. Although the health of children has attracted little attention from economists, it is clearly a major area of current public policy concern. Although the government health care initiatives of the 1960s diminished social-class differences in the receipt of medical care among adults, their impact on children's medical care was modest at best. The ramifications of poor health status and underconsumption of care among children in lower social classes are probably very significant; Grossman's recent work (1973) suggests that the formation of "health capital" in childhood has very significant effects on the accumulation of several forms of human capital in later life. We are indebted to Inman, as well as Grossman, for bringing the issue to our attention in a forceful and interesting way.

As for the empirical analysis, let me first point out that Inman's production function estimates are not exactly encouraging. Leaving aside the few coefficients with significant and correct signs, his results generally suggest that both parental and professional inputs to the medical care production process have little or no impact on the ENT health of children and that the same is true of the "material environment" (INCPC). But if this is the case, what weapons have we in the war against ENT disease? Are we really as helpless as these results imply? Perhaps because I have been brainwashed by the medical profession and the social epidemiologists, I am reluctant to accept this conclusion and therefore am inclined to search for other explanations of these results.

One possible explanation concerns the way Inman has divided his sample. By estimating separate equations for samples defined by educational level, he seems to have substantially limited the range of variation of a number of variables within each equation. For example, data in his appendix suggest systematic variations across samples in per capita income and parental time inputs that are large relative to within-sample standard errors. This homogeneity within samples may be an important explanation for the consistently insignificant findings.

Another explanation, and the one that I regard as most important, relates to Inman's choice of dependent variables. These are 0-1 dummies indicating the presence or absence of colds or ear infections. By and large, these illnesses probably tend to be mild and short-lived even if untreated. The importance of their prevalence as a measure of health status is not readily apparent. But what is most significant is the resistance of these infections (particularly viral infections) to prevention or amelioration by medical care of either the professional or parental variety. Therefore, zero marginal products for medical care inputs are generally what we would expect.

It could, however, be argued that an alternative interpretation of Inman's dependent variables is more appropriate. Given the natural history of most ENT infections, variations in their prevalence rates at any point in time are largely determined by variations in incidence rates; and variations in incidence rates are probably associated with more fundamental differences in physical health that determine susceptibility to infection. Inman's dependent variables could therefore be viewed as proxies for these more fundamental differences. Should we not then be surprised at the result that the "material environment" and parental and professional care have no appreciable effects on these differences?

Again the answer is no, but for a different reason. The differences in physical health that determine susceptibility must certainly be highly correlated with recent health history. But if his dependent variable is a proxy for these differences, Inman's inclusion of independent variables describing recent health history leads me to expect the insignificance of other independent variables. This same point could be made by an unfair analogy. If we obtained data from a cross-section of firms and ran a regression in which today's capital stock was the dependent variable and the two independent variables were yesterday's capital stock and something else, we would hardly be shocked to find that only the coefficient for yesterday's capital stock was significant.

One other possible explanation of the production function results should at least be mentioned. In their more extensive study of the data used by Inman, Kessner, *et al.* (1974) concluded that the medical services provided to children suffering from ear infections were of poor or at best mediocre quality. If there is a relationship between this quality rating and the efficacy of care provided, then Inman's findings are attributable, at least in part, to the failures of individual physicians rather than the limitations of medical science.

In summary, I am not sanguine about curing our children's runny noses, but I would not conclude from Inman's results that health policy can do little to affect the ENT health of children. There is, after all, considerable evidence—from the National Health Examination Survey and elsewhere—that variations exist among income and educational groups in the more serious consequences of ear infection, such as scarring of the eardrum and resultant hearing loss. (Differences in Inman's sample means for EARSCAR bear this out.) I strongly suspect that these variations are attributable to differences in medical care, parental care, and the "material environment" and that policies relating to these variables would indeed pay off in terms of better ENT health. The problem for now is to build on the work considered here to obtain more reliable quantitative estimates of policy effects.

Turning to Inman's estimated demand functions, I shall only offer several brief comments. First, it is interesting that in the doctor-visit equations for the working-mothers sample, the cross-price effects (i.e., the wage coefficients) are negative. A possible explanation is that the time cost of medical services includes time at home in following the doctor's orders as well as travel and waiting time.

Second, the use of out-of-pocket cost as a price measure poses problems because it does not take account of differing insurance coverage. That is, insured persons may purchase more services per doctor visit than uninsured persons or they may frequent higher-quality providers, and their out-of-pocket costs may be the same or higher. Clearly, they face a lower price than uninsured persons, although the out-of-pocket cost measure of price will understate this difference.

Third, I am uneasy with the parental time demand equations for several reasons. The reported means and standard deviations of the parental time variable indicate very little variability. I suspect that this is not true in reality but that Inman's measure is simply too crude to pick up much of the variability that in fact exists. Also, since this variable measures total time input, only a small part of which will be health-related, it is surprising to find significant cross-effects for the time and money prices of medical care. This is rather like finding that the demand for television sets is significantly related to the price of tickets to a baseball game. Finally, I am not wholly convinced by Inman's argument that parental time inputs and the number of children are not simultaneously determined. Even if parents do not formulate multiperiod maximization problems, they may have rather stable preferences for the manner (including time inputs) in which they raise their children, and they will take these into account in deciding how many children to have.

I have thus far avoided discussing Inman's theoretical framework. But with national health insurance so much in the air, I suppose it is imperative that one's comments achieve universal coverage. For the sake of completeness, then, I offer the following two observations.

First, Inman has skillfully expanded on previous work by explicitly introducing uncertainty into his demand model. However, this may be a mixed blessing. Although it adds realism, it also complicates empirical implementation. Given our current difficulties in simply getting reasonable estimates for production function coefficients, one cannot help but feel a little nervous about demand functions that include the *variances* of these coefficients as independent variables.

Second, Inman's logit production functions differ from previous work in that past health status enters multiplicatively. In the past, this variable has been added to a health-increment production function to obtain current health status. The difficulty with Inman's multiplicative specification is that it results in marginal products for medical care that decrease as past health status decreases. The sicker you are, the less the doctor can do for you. Although there may be some instances in which this is true, as a generalization it is not very appealing. It also seems to suggest that illness reduces the demand for medical care, a result that is certainly counter-intuitive.

I would like to conclude with a more general observation, a comment on my comments. A number of the criticisms I have raised about the empirical work in this paper relate directly to deficiencies in data. Although Inman's analysis is interesting and well executed, it is obviously constrained by these deficiencies. And it is just as obvious that further progress in this important area of economic research will depend on the relaxation of data constraints. I believe the best way to ensure this progress is to become actively involved in designing and generating more useful bodies of data.

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