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Who Receives Medical Care? Income, Implicit Prices and the Distribution of Medical Services among PregnantWomen in the United States

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Abstract

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We examine in this paper how medical treatments are distributed among pregnant women in the United States in 1980, according to both their initial health and their economic resources. Different implicit pricing regimes for allocating medical services are modeled and their implications for the distribution of services elaborated. We found that (i) more-educated women and women with husbands having higher incomes receive a disproportionate share of the four major treatments studied; (ii) prenatal treatments are more likely to be provided to less-healthy infants (mothers) within schooling and income groups; and (iii) treatment differentials by education and income are increased by controlling for behavior that affects the pre-treatment healthiness of the infant. The results are consistent with the existence of a market regime for medical care that allocates health treatments to those who demand them, whether the demand is due to superior knowledge of the benefits of health, greater resources, or preferences. Mothers of healthier infants are more likely to postpone seeing a doctor, visit a doctor less often, and are less likely to receive treatments while pregnant. This compensatory allocation of medical services, combined with the inability of the researcher to measure directly all contributions to pre-treatment health, can lead to erroneous inferences concerning the efficacy of the treatments. Controlling for initial health status is shown to significantly change measures of the therapeutic benefits of medically-administered treatments in the US health care system.

It is now a well-established fact that high-income and highly-educated persons in the United States are healthier than their poorer and less-educated counterparts (Taubman and Rosen, 1982; Fuchs, 1985). In part because of concern about income disparities in health, public resources have been allocated to subsidize medical care to vulnerable, poor populations in the United States (Corman and Grossman, 1985). For example, the Medicaid program, enacted in 1965, finances medical services for poor families who are eligible for Aid to Families with Dependent Children. Medicare provides similar subsidies to the old; amendments to Title V of the Social Security Act of 1963 authorize federal grants to facilitate the provision of prenatal and obstetrical care to low-income populations in "medically underserved" localities, and the Women, Infants and Children (WIC) program, begun in 1983, provides grants to local agencies for the provision of food supplements to pregnant and lactating women.

Coexisting with these federal health subsidies directed to low-income groups the federal tax code permits medical expenditures to be deducted from gross taxble income (though restrictions have tightened over the years). This "tax subsidization" (Pauly, 1986) of medical care clearly benefits most persons with high incomes confronting high marginal tax rates. The pervasiveness of untaxed health benefits in compensation packages of full-time workers is yet another way tax policy subsidizes health care for selected groups. It is thus unclear what the net distributional consequences are of these varied interventions in health care pricing.

Despite concern about inequities in health care, little is known about the distribution of the actual use of medical services across groups defined by income, education, race, or initial health, or whether inequalities in the after-tax pricing of medical care mitigate or exacerbate health differentials. Indeed, in an environment in which health is a normal consumer good and is influenced in part by the behavior of consumers (consumption of health-related goods), and medical services ("treatments") are substitutes for such health-related goods, it is not obvious that those with higher-income will consume more treatments even under a regime in which the implicit prices of medical treatments are not affected by income. It is therefore not possible to infer from only the distribution of medical services used by income class or by race whether agents face different implicit prices for such services. Moreover, a regime in which treatments are complementary to health-related goods could not be distinguished from a regime in which high-income agents (consumers/producers of health) pay lower prices (net of taxes) for treatments.

Table 1 presents simple statistics on the incidence of four common treatments provided to pregnant women across race, income, and education classes, based on a probability sample of all women having a legitimate live birth in 1980 in the United States. Among these women of similar, but by no means identical, pre-treatment health status, there are some striking differences in treatment incidence. For example, Black mothers were 40 percent less likely to have received an x-ray than White mothers but were almost 20 percent more likely to have received a caesarean section; amniocentesis was 50 percent less likely, x-rays 26 percent less likely and caesarean section 24 percent less likely to have been provided to mothers whose husbands earned less than $6000 in 1979 compared to mothers whose husbands income was at least $30000. Mothers with at least some college-level schooling, moreover, were almost twice as likely as mothers with less than nine years of schooling to have received an x-ray while pregnant.

The inequities in medical treatments received by socioeconomic groups indicated in Table 1 do not imply that the less-healthy receive fewer treatments; it is possible that goods deleterious to (infant) health have

Table 1

Percent of Pregnant Women Receiving Selected Medical Services, by Type of Treatment, and by Race, Schooling of Mother and Husband's Income in 1980

	Treatment			
Population	Amniocentesis	Ultrasound	X-Ray	Caesarean Section
White	4.4	41.4	16.9	17.0
Black	4.9	40.8	10.0	21.1
Husband's Income				
≤6000 ($)	3.5	42.1	13.1	14.4
6000-15000	4.1	41.0	15.5	17.1
15000-21000	4.1	41.7	17.5	18.2
21000-30000	5.4	40.9	18.0	17.8
≥30000	7.0	43.2	17.7	19.0
Mother's Schooling				
≤8 years	6.3	35.2	9.9	16.2
9-11 years	4.7	38.8	13.4	15.4
12 years	3.7	42.1	15.2	16.5
≥13 years	4.9	42.2	19.2	18.9

Source: 1980 National Natality Followback Survey.

greater income elasticities, or health-augmenting goods have lower income elasticities than does health. For example, highly-educated mothers may postpone births relative to less-educated mothers, which may be potentially harmful to infant health, requiring more careful monitoring and treatments. In the absence of information on pre-treatment health status it is thus difficult to evaluate how formal medical services are distributed across agents.

In this paper, we examine how medical treatments associated with care during pregnancy are distributed in the United States within and across pre-treatment health groups. The existence of a probability sample of pregnant women (births) affords a special opportunity to study one group that is relatively homogeneous, but not identical, in health status for whom the relevant medical treatments are relatively small in number and whose relevant health-related behavior is also well-documented.[1] Moreover, medical care provided to expectant mothers is important since it is care supplied simultaneously to two generations.

In section 1, we show that it is possible to distinguish health care regimes characterized by distributive <u>cum</u> pricing mechanisms (prices, subsidies, rationing) with knowledge of the technology of pre- and post-treatment health production, and by comparing the overall distribution of treatments to individuals by their socioeconomic characteristics with the distribution <u>within</u> groups defined by their pre-treatment health status. In section 2, we report estimates of how consumption decisions by the mothers interact with the medical procedures to affect one salient health outcome measure, birthweight. In section 3, reduced-form and conditional (on pre-treatment health) treatment equations are estimated to assess the effects of pre-treatment health status and socioeconomic characteristics of pregnant women on the probability of their receiving each of the four medical treatments. Our results indicate (i) that the efficacy of the treatments varies according to the conditions of the birth that are associated with pre-treatment choices made by women; (ii) that these pre-treatment conditions vary significantly with income, education and race; (iii) that treatments are more likely to be provided to the less-healthy births (mothers), but, (iv) that disparities in the incidence of treatments by income, education and race among women with otherwise identical birth characteristics, i.e., pre-treatment health, are greater than such disparities not conditioned on birth characteristics. This means that the lower incidence of treatments among poor, less-educated mothers, evident in Table 1 understates the inequality in treatment incidence when differences in pre-treatment health conditions are taken into account. However, we show that this differential between within-health status group inequalities and the inequalities unconditioned on health status does not lend support to the hypothesis that the implicit price of medical care is lower for the higher-income groups. On the other hand, we find that Black mothers with otherwise identical, health-relevant birth characteristics, income, and education are significantly less likely to receive two of the four treatments in Table 1; neither socioeconomic status nor differences in birth characteristics can account for these racial disparities.

1. The Demand for Health and the Demand for Medical Care

To depict usefully the interrelationships between the behavior of agents who are heterogeneous in health, their use of medical services, and the health care "delivery system," it is important to distinguish two types of health inputs--prescribed medical inputs provided by medical practitioners ("treatments") and other goods consumed by agents that affect health but which also yield utility directly. To highlight this, assume that health is produced in a two-stage process. In the first stage, an agent i's pre-treatment health h^i is a function of his own consumption of good X^i and an exogenous endowment

μ, such that

(1) $$h^i = h(X^i,\mu^i).$$

We will assume that X is a healthy good, such that $h_j > 0$ (and $h_{jj} < 0$) for j = 1,2, although the analysis could be symmetrically couched in terms of X being bad for health (but contributing directly to utility).

In the second stage, final health H^i is influenced by medical treatments received t^i as well as pre-treatment health status,

(2) $$H^i = H^1(t^i,h^i) = H^2(t^i,X^i,\mu)$$

where $H_j > 0$, j = 1,2. We will assume that the treatments are ameliorative, substitutes for the X-good, so that $H_{12} < 0$, but it is only important that the efficacy of the treatment depend on pre-treatment health or X.

Agent i maximizes his utility, given by

(3) $$U^i = U(H^i,X^i,z^i),$$

where $U_j > 0$, j = 1,2,3, and Z is a non-health good, subject to a budget constraint:

(4) $$F^i = Z^i p_z + X^i p_x + t^i p_t\ (F^i) + c,$$

where F^i is agent i's income, p_z and p_x are prices of X and Z, respectively, assumed to be the same across all agents, $p_t(F^i)$ is the price per treatment, which may be a function of income, and c is a fixed (capitation) fee, discussed below.

We may distinguish three medical care regimes using (4). In the first, "normal market" regime (I), treatments are supplied as in an ordinary market so that $p_t' = 0$ and $c = 0$; all agents pay for each treatment they receive ("fee-for-service") and face the same treatment price. In a subsidized fee-for-service regime (II), implicit treatment prices vary with income. For example, with a progressive income tax and health care deductibility, $p_t' < 0$. Both regimes I and II are characterized by consumer sovereignty--private agents consume treatments based on their knowledge of treatment efficacy, from (2), and their preferences subject to (4). The medical provider's (doctor's) roles are to supply information on treatment efficacy and to supply (apply) the treatment if it is wanted by the agent.[2]

A third regime (III) (compulsory health insurance) can be characterized as $p_t = 0$ while $c > 0$; medical treatments are "free"; agents pay a fixed fee independent of the treatments they receive. In this last regime, it is necessary to specify the allocation rule for treatments, given the absence of a direct price and consumer sovereignty. For example, the allocation rule may be determined from the maximization of health value-added across agents, i.e.,

$$\max_{t^i} \Sigma(H^i(t^i,h^i) - h^i) \tag{5}$$

subject to a global resource constraint $T = \Sigma tp$, where p is the resource cost per treatment. However the rules are established, the doctor primarily makes the decision concerning the distribution of treatments.

It is possible to consider a fourth regime in which agents can pay different fixed fees c^i for different health plans that entitle them to a fixed schedule of treatments depending on pre-treatment health. In that regime, <u>average</u> levels of treatments would differ across agents paying different capitation fees but not within fee groups. That is, within fee-groups, doctors determine the allocation of treatments. However, this regime is similar to and indistinguishable from the first two regimes in terms of its implications for the relationship between income and treatments, since agents still choose the (average) level of treatments they want by selecting a different plan, at a different cost--all agents may face the same fee schedule or agents may face different implicit fee schedules if there are income-related subsidies.

We use the model to consider three questions. First, what is the relationship between pre-treatment health and treatments under the three regimes, i.e., is the allocation of treatments by health status among people with identical incomes different across regimes? Second, what is the relationship between income and health treatments under each regime, and third, how does the regime affect the distribution of treatments by income among people of the same pre-treatment health status compared to the distribution by income across all people. More formally, the questions can be posed in terms of the regime-specific properties of the reduced-form and conditional (on X) demand equations for treatments. These are derived from the model and are given by (6) and (7),

$$(6) \qquad t^i = t(\mu^i, p_x, p_z, p_t, F^i)$$

$$(7) \qquad t^{i*} = t^*(X^i, \mu^i, p_z, p_t, F^i)$$

The conditional demand equation (7) describes the outcome of an experiment in which each agent is assigned a fixed level of X but can freely choose the non-health good z and obtains treatments according to the prevailing health care regime. If X^i is fixed at the level the agent would otherwise have chosen in the absence of quantity constraints, we can employ the theory of rationing (Houthakker and Tobin, 1950) to ascertain the effects on the level of treatments received of a change in pre-treatment health status, or X^i and μ, and of variations in income for given pre-treatment health status.

Consider first how treatments vary with "exogenous" variations in pre-treatment inputs and the endowment within an income group. In the standard market regime (I) or in a regime with fee subsidies but agent sovereignty (II), this is simply

$$\text{(8)} \qquad \frac{dt^{i*}}{dX^i} = \frac{s_{xc}}{s_{xx}} h^i$$

where the s_{ij} are the Hicks compensated substitution effects for good i with respect to the price of good j. When treatments and the health-related good X are substitutes in production and consumption, $s_{xt} > 0$ and the less-healthy among agents with identical incomes receive more treatments. Of course, if X and health are sufficiently strong complements in the welfare function (exercise and health?), it is possible that those agents consuming high levels of X will also demand more treatments, even if X and t are substitutes in health production; the association between pre-treatment health and the level of treatments depends both on the health technology and on preferences.

Under a rationing regime (III), such as one in which treatments are allocated across agents to maximize health value-added, as in (5), however, the relationship between pre-treatment health (or health inputs) and treatments depends solely on the properties of the health technology:

$$\text{(9)} \qquad \frac{dt^{i*}}{dX^i} = -\frac{H_{12}}{H_{11}} h_1, \quad \frac{dt^{i*}}{d\mu^i} = -\frac{H_{12}}{H_{11}} h_2 .$$

Preferences for health play no role as they do under an agent-sovereignty regime. Knowledge of the health technology is then sufficient to ascertain how the rationing or compulsory health insurance regime would allocate medical treatments across people of different health status compared to any existing health care system.

It is, of course, impossible to predict how the income-treatment association will differ across the three health delivery regimes without imposing a great deal more structure on the model. It is thus not possible to infer the regime from the distribution of treatments by income. However, comparisons of reduced-form and conditional (on pre-treatment health) income effects on treatments can under certain conditions identify how income and health care prices interact, with few additional assumptions. In the rationing regime, for example, there is no relationship between income and treatments among agents with the same pre-treatment health status; treatments vary across income groups under that regime solely due to differences in the consumption of X (which varies by income) or in endowments (which do not vary with income, by assumption). The absence of any income effect conditional on pre-treatment health status thus identifies a system in which formal health services are allocated on the basis of "need" alone, defined strictly in health terms.

When treatments are allocated in a normal market, (no agent-specific prices), the conditional income effect on treatments is not zero, but is

$$\frac{dt^{i*I}}{dF^i} = \frac{dt^{iI}}{dF^i} - \frac{s_{xt}}{s_{xx}} \frac{dX^{iI}}{dF^i} , \tag{10}$$

where dt^{iI}/dF^i is the reduced-form income effect from (6) and dt^{i*I}/dF^i is the conditional income effect from (7) under regime I. The conditional income effect will be positive, if X is a normal good and X^i and health treatments are substitutes. Moreover, it is readily seen from (10) that treatments will vary more strongly (and positively) with income among agents with the same pre-treatment health status than across all agents. This is merely the well-known result from rationing theory, an application of LeChatelier's principle, that conditional income effects exceed reduced-form income effects for goods that are substitutes for the "rationed" good. Thus, if treatments are allocated in a regular market, "controlling for" differentials in pre-treatment health increases disparities in treatment by income rather than reduces them.

When treatment prices vary with income, the <u>difference</u> between the health-conditioned income effect and the unconditional or reduced-form income effect is given by

$$(11) \qquad \frac{dt^{i*II}}{dF^i} - \frac{dt^{iII}}{dF^i} = - \frac{s_{xt}}{s_{xx}} \left[\frac{dX^i}{dp_t} p_t' + \frac{dX^{iII}}{dF^i}\right] .$$

Here, because income and price effects move together, when health-related consumption goods and treatments are substitutes and $p_t' < 0$ (higher-income agents are subsidized), the conditional income effect on treatments may be less than the unconditional effect--income-related disparities in treatments may be smaller within groups of similar pre-treatment status than across the whole population. If low-income agents tend to receive the highest medical care subsidies, however, the relationship between income and treatments within health groups will be stronger than the association between income and treatments for the overall population, as in the normal market case. The intuition for the former result, which provides a (weak) test for the existence of a regressive health pricing regime, is that expression (11) combines two well-known results from rationing theory - that conditional exceed unconditional income effects and conditional own (compensated) price effects are weaker than their unconditional counterparts for (normal) goods that are substitutes for the fixed good. If a rise in income also lowers the treatment price, the weakening of the price effect offsets the usual strengthening of the income effect.

Another reason why implicit treatment prices may vary with income is given in the household production literature (Becker, 1965; Acton, 1975). If the value of time is higher for high-income agents and use of medical care is a time-intensive activity, then the shifts in substitution and income effects across conditional and unconditional treatment equations reinforce each other. Only if the implicit subsidy to high-income agents is sufficiently high will unconditional exceed conditional income effects on treatments.

Estimation of the health technology and of both reduced-form and conditional (on health) treatment equations thus provides a means (i) of ascertaining how medical treatments are allocated according to health status in a given health-regime, (ii) of comparing the existing health-related treatment allocations to those that would exist under a "needs-based" system, and (iii) of describing the manner in which medical care costs and income interact on balance, in addition to providing measures of income disparities in the allocation of medical treatments within groups comparable in pre-treatment health status.

2. Prenatal Care and Birthweight

a. The Data and Specification of the Technology

The preceding discussion suggested that to assess how the prevailing medical care regime influences the distribution of medical services across heterogeneous agents requires information not only on agents' socioeconomic characteristics and medical treatments received, but also on agents' pre-beatment health status and on behavior relevant to health. Such an analysis of the distribution of medical treatments among adults would be heroic indeed. There is an enormous range of behavior that may potentially relate to health and many health indicators. Moreover, information on the entire life-history of each agent would presumably be required. The analysis of prenatal infant care, however, is more feasible since the life-history of the relevant agent is necessarily short, specific indicators of health appear to be more salient than others, and the number of behaviors and treatments potentially relevant to birth outcomes is relatively small.

The 1980 National Natality Followback Survey (NNFS) is well-suited to an analysis of the distribution of treatments across infants and pregnant women. It provides birth outcome information on a probability sample of all live births in the United States in 1980 combined with information on the socioeconomic characteristics of the child's parents, on the mother's behavior while pregnant that is deemed relevant by the medical profession to birth outcomes, and on all medical treatments received by the mother during her pregnancy and at the birth of the infant based on birth certificate information and on questionnaires sent to both the mother and her doctor(s). From these data, a working sample of 7669 legitimate births with the requisite information was obtained. The 1980 NNFS was drawn by over-sampling (4 to 1) from the strata of births under 2500 grams, with the objective of better understanding the determninants of low birthweight. If we neglected the weighting of the sample by the dependent variable, our analysis would yield biased and inconsistent estimates. We have, thus, repeated observations on births over 2500 grams four times, to create a self-weighting sample, and reduced the number of degrees of freedom in statistical tests to the original sample size.

From information provided on the county or county-group of mother's residence in the 1980 NNFS, variables were appended to the individual data to characterize the county or county-group of residence to serve as identifying instruments in the empirical analyses, described below. These variables include the characteristics of local medical and family planning infrastructure, medical personnel, public expenditures, composition of employment and unemployment, and local prices of cigarettes and alcohol, and are described in Appendix Table A.

We employ as our indicator of early child health the weight of the child at birth, a salient predictor of both infant mortality and subsequent health and intellectual achievement (National Academy of Sciences, 1985). We first estimate the birthweight production function, corresponding to (2), in order to answer three questions. First, does parental behavior, net of medical treatments influence the birth outcome (child health)? Second, do prenatal medical treatments affect birthweight? Third, is the efficacy of medical treatments related to the characteristic of the birth; namely, do the effects of medical treatments interact with the pre-treatment behavioral inputs chosen by parents? We have in part already answered the first question in our prior analyses of birthweight (Rosenzweig and Schultz, 1982 and 1983) based on data for 1967-69 from a predecessor survey to the 1980 NNFS. In those analyses we found that such pre-treatment behavior as the timing and number of births, smoking by the mother, and the rapidity with which prenatal care was first sought by the mother after conception significantly affected birthweight and fetal growth. However, we did not examine the effects of these inputs net of subsequent prenatal medical treatments nor the interactions between treatments and the parentally-chosen inputs, due to the lack of information on medical services in those earlier data.

In the present analysis we examine the influence on birthweight of the pre-treatment variables mentioned and three common medical procedures applied prior to delivery to identify and monitor potential problems of the pregnancy--amniocentesis, ultrasound and fetal x-rays. In addition we evaluate how the (prior) interval between births and the number of visits made by the mother during her pregnancy affects birthweight. The interval between the current birth and the previous birth is commonly attributed a role in determining the mother's health and the child's birthweight, at least for short intervals (National Academy of Sciences, 1985). The number of prenatal visits in addition to the delay in first seeking prenatal medical care provides another indicator of the mother's actual use of medical care. The American College of

Obstetricians and Gynecologists (1982) recommends a mother plan on about 13 prenatal care "visits;" the average number in the 1980 NNFS was 10.9. The timing of initial prenatal care and number of visits are, of course, inversely correlated. Consequently the measured effect of each is sensitive to whether the other variable is excluded.

Of the four treatments administered to pregnant women considered here--amniocentesis, ultrasound, x-ray, and caesarean section--the first three are used to confirm fetal development and position during pregnancy, whereas the caesarean section procedure pertains to the actual delivery of the infant. The first three procedures applied during the pregnancy thus may directly affect the development of the fetus and are included among the determinants of birthweight.

As discussed, neither the pre-treatment health behavior of parents nor the treatments are likely to be randomly allocated. The existence of unmeasured, exogenous characteristics of births possibly known to the parents and/or doctors makes it likely that all of the potential health-related decision variables will be correlated with the error term in the production function equation, as we found in our earlier study. It is even more likely that the medical procedures are used selectively. If, for example, the treatments are predominantly used (avoided) in cases where the pregnancy is likely to result in a low birthweight baby, the treatments might appear to exhibit an inverse (direct) partial correlation with birthweight to the extent that the included variables do not comprehensively measure the initial health of the fetus or mother. But when this correlation is estimated by methods that are free of bias due to treatment selection, a positive (negative) birthweight effect might be inferred for an average mother.

To obtain consistent estimates of the effects of both the treatments and the pre-treatment parental behavior, we employ two-stage least squares. The model suggests that prices (or their proxies) of the inputs as well as the prices of all consumption goods, whether or not such goods influence health, serve as natural instruments for estimation of the parameters of the production technology, as long as such prices are uncorrelated with the unmeasured health endowment. Accordingly, we use our community-level variables, listed in the appendix, as well as parents' schooling attainment and husband's income as identifying instruments. That is, the demand equations (6) are the first-stage equations.[3]

Economic theory does not provide any insights into the functional form of the biological production function describing the relationships between parental behavior, medical treatments and health. In the 1967-69 NNS we analyzed general second-order approximations of the linear and log-linear production functions (i.e., Leontief-Diewert and Translog specifications) to allow for these and other nonlinearities and interactions in the birthweight production function. Our statistical tests of the significance of the many additional parameters required to fit these second-order approximations were rejected when appropriate estimation procedures were employed; nonlinearities may nonetheless be important in certain cases, but they proved difficult to estimate because of collinearity of inputs and the data requirements of the two-stage estimation technique. In our analysis of the 1980 NNFS we have retained the quadratic term for mother's age and test for interactions between the medical treatments and the endogeneous birth characteristics. A quadratic in births or parity was never statistically significant in the two-stage estimates, and only specifications omitting those variables are reported. Moreover, the birthweight effect of birth order is apparently due to lower weight for the first child; an indicator of whether or not the birth is the first is thus included in all specifications, but number of births is excluded. The first birth dummy variable is also needed to estimate the effect of the prior birth interval, which is of course undefined for first births.

In addition to the endogeneous treatment variables and pre-treatment birth characteristics, we also include in the specification of the birthweight technology four characteristics of the birth and the mother not subject to choice but likely to be related to birthweight--the height and race of the mother, the sex of the infant and whether or not the birth is part of a multiple birth (plural). Inclusion of the race of the mother (Black or not-Black) enables a test of the hypothesis that racial differences in birthweight can be explained solely in terms of differences in parent behavior and/or a different incidence of formal, prenatal medical treatments.

Estimation of the birthweight technology using consistent methods also permits measurement of the individual birthweight endowment for the mothers in the sample. To compute the birth endowments, the consistent two-stage estimates of the birthweight production function are combined with the actual birth characteristics and treatments for each woman to predict her child's birthweight

$$B_i^e = \beta_o + \beta_1 X_i + \beta_2 t_i \tag{12}$$

where the β denote the linearized parameter estimates of the second form of equation (2). The difference between realized birthweight and predicted birthweight, from (12), is defined as the birthweight endowment u_i, although it also includes an error associated with measurement, i.e.,

$$u_i = B_i - B_i^e = \mu_i + e_{1i} \; . \tag{13}$$

This measure of the health endowment of the child is included in the reduced-form equations for the various forms of health behavior and the treatments discussed in section c, below, to assess how both the parents' behavior and the allocation of treatments respond to the endowed healthiness of the child.

b. Estimates of the Birthweight Effects of Parent Behavior and Treatments

Table 2 reports the OLS and two-stage least squares (TSLS) estimates for three specifications of the birthweight production function: the first excludes the specific medical treatments (cols. 1 and 2). The second specification includes in linear form the three prenatal medical treatments (cols. 3 and 4). The third specification permits treatment effects to vary by the mother's age, the parity of the birth, and whether the pregnancy results in a multiple birth (cols. 5 and 6).

Estimation procedure does substantially alter inferences concerning the effects of both the medical treatments and parent behavior net of treatments. For example, among the birthweight inputs determined by the parents, the OLS results indicate that the length of the previous birth interval is inversely associated with birthweight, whereas the TSLS estimates indicate the opposite. It may be inferred that mothers who are more likely to have (to have had) large healthy babies for reasons that are uncorrelated with our instruments also tend to space their births closer together, generating the observed inverse partial association (OLS estimates). The consistently-estimated (TSLS) biological effect of an added year's spacing, on the other hand, is a gain of nearly 50 grams. To evaluate the effect of being a first born, it is necessary to subtract from the coefficient on "first-born" the previous birth interval coefficient multiplied by the average interval for later births (46.3). The two-stage least squares estimates imply first born babies are about 300 grams lighter, on average, while

Table 2

Estimates of the Birthweight Production Function Including Medical Treatments

Inputs	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Procedure	OLS	TSLS	OLS	TSLS	OLS	TSLS
Conditions at birth						
Age of mother[a]	14.0	118	10.7	127	12.2	178
	(2.37)[b]	(2.35)	(1.81)	(2.45)	(2.02)	(2.34)
Age squared[a]	-.225	-2.27	-.158	-2.46	-.183	-2.65
	(2.07)	(2.41)	(1.44)	(2.52)	(1.63)	(1.81)
First Born[a]	-113	-186	-114	-199	-113	119
	(12.4)	(2.19)	(12.5)	(2.17)	(10.1)	(0.71)
Previous birth interval[a]	-.428	2.55	-.427	2.11	-.440	3.79
	(2.98)	(1.77)	(2.97)	(1.39)	(3.05)	(1.76)
Behavior of mother while pregnant						
Delay before saw doctor[a]	14.8	-8.43	14.6	-14.8	14.8	-9.25
	(6.92)	(0.45)	(6.84)	(0.75)	(6.91)	(0.33)
Prenatal care visits[a]	27.0	26.3	26.9	23.7	26.8	33.3
	(26.8)	(3.63)	(26.7)	(2.91)	(26.6)	(2.78)
Cigarettes smoked per day[a]	-11.0	-13.7	-11.1	-13.8	-11.0	-11.5
	(25.5)	(4.01)	(25.5)	(3.73)	(25.5)	(2.25)
Medical treatments during pregnancy						
Amniocentesis[a]	-	-	-88.2	310	-137	-376
			(5.44)	(1.40)	(1.58)	(0.22)
Ultrasound[a]	-	-	8.17	51.5	-43.7	779
			(1.21)	(0.75)	(1.09)	(1.24)
X-Ray[a]	-	-	14.7	-156	193	5.40
			(1.63)	(1.46)	(3.50)	(5.46)
Amniocentesis x age of mother[a]	-	-	-	-	2.27	27.0
					(0.79)	(0.47)
Amniocentesis x plural birth[a]	-	-	-	-	188	4938
					(1.85)	(2.12)
Amniocentesis x birth order[a]	-	-	-	-	-72.7	61.5
					(1.96)	(0.05)
Ultrasound x age[a]	-	-	-	-	1.63	-24.3
					(1.12)	(1.09)
Ultrasound x plural birth[a]	-	-	-	-	123	-13.9
					(2.40)	(0.15)
Ultrasound x birth order[a]	-	-	-	-	18.3	-193
					(1.27)	(0.61)
X-Ray x age[a]	-	-	-	-	-6.29	-194
					(3.20)	(5.65)
X-Ray x plural birth[a]	-	-	-	-	116	1335
					(2.20)	(1.22)
X-Ray x birth order[a]	-	-	-	-	-41.4	-1155
					(2.17)	(3.00)

Exogenous characteristics of child and mother						
Black	-228	-257	-227	-266	-225	-259
	(18.9)	(16.1)	(18.8)	(15.4)	(18.6)	(10.2)
Female infant	-149	-149	-150	-146	-150	-144
	(22.8)	(21.7)	(22.9)	(20.1)	(11.8)	(14.8)
Plural birth	-945	-974	-949	-961	-1075	-1628
	(38.5)	(36.3)	(38.5)	(28.7)	(25.7)	(2.39)
Height of mother	32.6	32.9	32.5	33.4	32.5	35.7
	(26.3)	(25.2)	(26.2)	(23.9)	(26.2)	(19.0)
Intercept	915	-297	989	-384	969	-2051
	(8.40)	(0.46)	(6.77)	(0.53)	8.45)	(1.90)
R^2	.150	-	.151	-	.152	-
F	412	263	327	200	201	77.8

a. Endogenous variable.

b. Asymptotic t-ratios in parentheses beneath coefficients the OLS estimates indicate that first-born children, ceteris paribus, weigh only 93 grams less than any younger siblings at birth.

Adverse selection by mothers is evident in the estimates of the consequences of delay by the mothers in seeing a doctor while pregnant. The number of months that elapse into the pregnancy prior to a doctor visit is positively and significantly associated with birthweight according to the (biased) OLS estimates, but is negatively and insignificantly related to birthweight in the two-stage estimates. This strong selection bias was also found in our prior work on the earlier sample. The number of prenatal care visits the woman had at the time of her delivery, however, is positively associated with her having a larger baby whichever estimation procedure is used--the two-stage estimates in column 2 suggest that added prenatal visits exert a small but not insignificant benefit to the child's birthweight of 26 grams per visit. The gross quantitative effect of prenatal visits, moreover, is not reduced when the various medical treatments that might occur during such visits are explicitly entered into the second specification of the birthweight production function. The estimates indicate that a mother who had, say, five visits rather than the sample average of 11 would incur a deficit in her child's birthweight of about 140 grams or 4.2 percent, on average (i.e., 24 x 5.9 = 142).

The two-stage least squares estimates also assign substantial importance to the mother's age in influencing the baby's birthweight; fertility timing is important. The optimal maternal age at birth is 26 in all specifications. The magnitude of the estimated TSLS age gradient is substantial; a mother at age 18 or 34 could expect according to the estimates in col. (4) of Table 2 to have a child who would be 160 grams smaller than a mother who has her child at the preferred age of 26. The estimates of the effects of the other pre-treatment variables on birthweight conform to our prior findings, including the importance of maternal smoking and the existence of a significant Black-White birthweight differential (in favor of Whites) net of both parental inputs and medical procedures (Rosenzweig and Schultz (1983)). In sum, the parents' pre-treatment behavior, net of treatments, significantly influences the birth outcome.

The estimates of the effects of the three prenatal treatments in specification 2 also show the importance of adjusting for the non-random allocation of medical care for inferring the health effects of such care. For example, the OLS estimate of the birthweight effect of amniocentesis is significant and negative (-88 grams), whereas the estimates that correct for treatment selection suggests that this procedure increases the baby's birthweight by 310 grams, although the estimate is not very precise. X-rays, on the other hand, appear to be related to a 16 gram weight gain in the OLS regression, but according to the two-stage estimates this procedure contributes to a weight loss of 156 grams. However, the two-stage estimate is again statistically significant at only the 15 percent confidence level. Neither the direct nor the instrumental variable estimates of the effects of ultrasound procedures detect any effect on birthweight.

In the third specification, the estimates indicate that the birthweight effects of both amniocentesis and fetal x-rays vary significantly with the characteristics of the fetus and mothers with, however, ultrasound again being insignificantly related to birthweight. In particular, amniocentesis enhances the weight of babies at birth when the births are plural, and fetal x-rays appear to reduce birthweight most for older mothers and for higher-parity births, but are beneficial when the births are plural. That is, among young mothers having their first birth and carrying more than one baby, x-rays on net may aid in increasing birthweight. Treatments thus matter for birth outcomes, and their effects depend on the pre-treatment choices of parents.

Finally, If all relevant behavioral inputs are accounted for in our analyses, our estimate of the Black-White birthweight deficit, of about 7 percent, from column 6 of Table 2, may be interpreted as biological in origin, in accord with some of the medical literature suggesting that the smaller pelvic structure of Black women may be conducive toward low-weight Black babies at birth (with subsequent more rapid post-natal growth among survivors of low-weight infancy). The inherent frailty of Black infants that these results suggest has important implications for the interpretation of racial differences in the distribution of medical treatments, discussed below.

c. Reduced-Form Estimates: Pre-Treatment Inputs and Treatment Equations

Table 3 reports the estimates of the reduced-form equations relating the exogeneous characteristics of the mothers and their children to (i) pre-treatment health-related decisions of the parents and (ii) the probability of receiving each of the four medical treatments. With respect to the latter, Table 3 recapitulates Table 1, except that one can assess the effects of socioeconomic characteristics on the probabilities of receiving the treatments in a multivariate context, and measure the effects of the exogeneous endowment of the infant on both the mother's pre-treatment behavior and the treatments.

The NNFS provides three variables characterizing the socioeconomic status of the family, the mother's and father's schooling attainment, and the husband's income. To capture possible non-linearities at the lower tail of the income distribution, evident in Table 1 for some of the treatment variables, we also constructed a categorical variable taking on the value of one if the husband's income was less than $6000. To the extent that subsidized medical care is provided as part of compensation for full-time workers, we would expect the effects of husband's income (and husband's schooling) to reflect both income and health price (subsidy) effects, while the effects of the schooling attainment of

Table 3

Effects of Exogenous Health Status and Parental Characteristics on Characteristics of Births and Probabilities of Receiving Specific Medical Treatments[a]

Selected Explanatory Variables/ Estimation Procedure	(1) Mother's Age at Birth OLS	(2) Number of Births OLS	(3) Delay in Prenatal Care OLS	(4) Number of Visits OLS	(5) Smoking OLS	(6) Amnio-centesis MLProbit	(7) Ultra-sound MLProbit	(8) X-Ray MLProbit	(9) Caesarean Section MLProbit
Exogenous health status	-.371	-.0562	.198	-.290	1.32	-1.89	-6.19	-.354	-.142
($x10^{-3}$)	(8.26)[b]	(4.77)[b]	(12.4)	(8.64)[b]	(17.4)[b]	(42.1)[c]	(4.75)[c]	(22.7)[c]	(9.52)[c]
Mother's schooling	.417	-.0877	-.0546	.102	-.555	-.00558	.00544	.0309	.0218
	(27.2)	(21.8)	(10.0)	(8.93)	(21.5)	(0.62)	(1.21)	(5.64)	(4.14)
Husband's schooling	.123	-.0316	-.0384	.0863	-.125	.00939	.0236	.0153	-.00361
	(8.52)	(8.33)	(7.47)	(7.99)	(5.13)	(1.09)	(5.60)	(2.97)	(0.72)
Husband's income	151	23.1	-10.9	6.95	-11.0	12.7	-.0132	2.39	1.62
($x 10^{-6}$)	(39.9)	(23.2)	(8.08)	(2.45)	(1.72)	(5.85)	(0.01)	(1.82)	(1.25)
Husband's income	.138	.0397	.171	-.301	.844	.100	.0250	-.0334	-.109
≤ $6000	(1.36)	(1.49)	(4.75)	(3.97)	(4.94)	(1.54)	(0.88)	(0.90)	(3.02)
Black	.299	-.215	-.250	-.559	-.148	.0931	-.0530	-.234	.178
	(0.88)	(2.41)	(2.10)	(2.20)	(0.26)	(2.41)	(0.22)	(0.87)	(0.80)

a. Table does not report coefficients for community-level variables listed in Apendix Table A-1 and included in the specifications.

b. Absolute values of t-ratios beneath coefficients in column.

c. Absolute values of asymptotic t-ratios beneath coefficients in column.

the mother, for given husband's income, will more nearly correspond to pure income effects, as less than one-half of married women below age 49 hold full-time jobs. Schooling may also reflect health (time) preference, and/or abilities to produce (pre-treatment) health (Grossman, 1972; Fuchs, 1982; Haveman and Wolfe, 1984). If mother's schooling is associated positively with preferences for health, given prices and income, or schooling augments household and market productivity equally, the difference between reduced-form and conditional mother's schooling effects on treatments would be similar to that associated with pure income effects. If, as noted above, those women with higher levels of schooling have higher opportunity costs of time, and receiving treatments is a time-intensive activity, then conditional will exceed reduced-form schooling effects even if pure income effects are small or non-existent. The correspondences between the reduced-form and conditional (on pre-treatment health inputs) effects of husband's income and schooling in the treatment equations may thus differ.

The estimated effects of the healthiness (μ_i) of the child, net of parental and medical inputs, on both sets of inputs are significantly different from zero at the 0.005 level, despite the unavoidable errors in measuring the birthweight endowment, as discussed earlier. The estimates indicate that each of the four medical treatments is less likely to be provided to observationally identical mothers with healthier (heavier) infants. Pre-treatment health and medical treatments are evidently substitutes; that is, treatments are allocated disproportionally to the problem pregnancies.

The relationships between the endogenous, pre-treatment characteristics of the births and the endowments also suggest compensatory behavior by parents. In particular, mothers with healthier infants delay seeking medical care and visit the doctor less often. Thus, healthier infants receive significantly less medical care. Moreover, mothers with healthier infants (net of inputs) are more likely to have the infants later in life (which beyond age 26 reduces birthweight) and to smoke more cigarettes while pregnant (which reduces birthweight for any age at birth). These results thus suggest that inequalities across infants in endowed health, as measured by birthweight net of parental and medical inputs, are greater than inequalities in actual birth outcomes as a result of both the compensatory pre-treatment resource allocative decisions of parents and the allocation of medical treatments.

The pre-treatment endogenous birth characteristics and the probabilities of receiving medical treatments are also significantly correlated with the socioeconomic characteristics of parents. The results in Table 2 suggested that parental decisions concerning the timing, spacing, and number of births, and smoking during the pregnancy affect birthweight net of treatments while the treatments affect birthweight differentially according to the endogenous characteristics of the birth. The reduced-form results in Table 3 indicate that parents' socioeconomic characteristics significantly influence pre-treatment decisions; thus, it is not surprising that net of endowments, the medical treatments are also correlated with the characteristics of the parents. The existence of the reduced-form associations between parental socioeconomic characteristics and the likelihood of prenatal treatments cannot therefore inform us on whether infants of similar pre-treatment health--gross of parental inputs--are equally likely to receive medical treatments regardless of parental resources. This is because parents with different schooling levels and income evidently bring to the medical system for treatment infants with different characteristics.

The reduced-form estimates reported in Table 3 indicate that husband's income and mother's schooling have qualitatively similar effects. For example, infants born to lower-(husband's) income parents are born earlier in the mother's life-cycle, and, particularly in low-income households, are of lower parity, receive medical care less frequently and later after conception, and are more exposed to maternal smoking. The mothers of such infants are also significantly less likely to receive amniocentesis and x-rays while pregnant, and are less likely to receive a caesarean section at the birth of the child (particularly, in the latter case, for mothers with husbands earning less than $6000 per year). Infants born to less-educated mothers, given their father's schooling and income, tend to be born earlier in the mother's life-cycle, and to be of higher parity. Such mothers also seek prenatal care less frequently and less-rapidly, smoke more while pregnant and are less likely to receive x-rays and a caesarean section.

For given parental socioeconomic characteristics, Black infants also have different (endogenous) characteristics compared to White infants-- they tend to be of lower parity and to receive prenatal medical care significantly less rapidly and less frequently. Black mothers are no less likely, however, given their income and education, to receive ultra-sound, x-rays or a caesarean section than are White mothers, but are significantly less likely to receive amniocentesis. The gross differentials by race in the incidence of medical services among pregnant women evident in Table 1 can thus almost wholly be accounted for by racial differences in parents' education and income. However, Black infants differ in endogenous characteristics from infants born to White mothers, as is evident in columns 1 through 5 in Table 3. Moreover, Black infants, for given pre-treatment inputs, are smaller than White infants (Table 2). Thus, the absence of significant treatment differentials in the reduced-form equations does not imply that there are no racial differentials in the incidence of medical treatment among infants <u>comparable</u> in health-related characteristics. To assess this distributional issue, as noted at the outset, requires that the determinants of treatments be assessed "controlling for" pre-treatment conditions,which we examine below.

d. Conditional Treatment Equations

Table 4 reports two-stage, maximum-likelihood probit estimates of the effects of the endogenous, pre-treatment birth characteristics of the infant and of parents' socioeconomic characteristics on the likelihood of receiving each of the four medical treatments. Table 5 reports the test statistics associated with assessing the null hypotheses for each treatment that (i) the pre-treatment birth characteristics are uncorrelated with the treatment equation residuals (which include the unmeasured health status of the infant) and (ii) the set of parental socioeconomic characteristics (income and schooling), net of the birth characteristics influencing child health and the efficacy of the treatments, are not significantly associated with the probability of receiving the treatment.[4] For all but amniocentesis, these hypotheses are rejected at at least the .01 level; both hypotheses are rejected at the .10 level for amniocentesis. Thus, the results reported in Table 4 suggest that net of the important health-related characteristics of infants determined in part by parents, parental income and schooling play an additional role in who gets treatments.[5] The regime of equal treatments for equal conditions does not appear to characterize the allocation of medical care, circa 1980 in the United States, with respect to pregnant women.

The estimates in Table 4 also indicate that the incidence of prenatal treatments differs by the characteristics of the child that are influenced by parents' decisions. For example, infants with mothers who delay seeing a doctor and who smoke are less likely to receive any of the four treatments, while mothers of closely-spaced infants are more likely to receive x-rays and a

Table 4

Effects of Birth Characteristics and Parental Characteristics on

Medical Treatments: Two-Stage ML Probit Estimates

Selected explanatory variables	Amniocentesis		Ultrasound		X-Ray		Caesarean Section	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Birth Characterstitics								
Exogenous health status ($x10^{-2}$)	-.114	-.119	.0154	.0340	-.0334	-.0595	-.0383	-.0646
	(11.6)[b]	(6.52)	(3.34)	(4.13)	(5.99)	(5.97)	(7.08)	(6.58)
Age of mother at birth[a]	-.295	-.266	-.159	-.0440	-.228	-.578	-.626	-1.82
	(1.00)	(0.58)	(1.17)	(0.21)	(1.39)	(2.30)	(3.78)	(7.23)
Age of mother squared[a] ($x10^{-2}$)	.553	.498	.239	-.060	.398	1.03	1.17	.339
	(1.00)	(0.59)	(0.34)	(0.16)	(1.29)	(2.22)	(3.89)	(7.35)
Number of birth[a]	.380	.623	-.294	-.0080	-.0367	.181	.157	.126
	(2.06)	(2.51)	(3.46)	(0.07)	(0.36)	(1.36)	(1.56)	(7.35)
First born[a]	.215	1.26	.441	1.06	-.543	-.633	.0360	-.363
	(0.32)	(1.58)	(1.45)	(2.91)	(1.49)	(1.44)	(0.10)	(10.84)
Previous birth interval([a])	-.00686	-.00482	.0207	.0407	-.00777	-.0228	-.0170	-.0209
	(0.90)	(0.38)	(5.88)	(6.99)	(1.82)	(3.23)	(4.08)	(3.02)
Mother smokes[a]	-.0464	-.0596	-.0198	-.0253	-.9338	-.00657	-.0215	-.00234
	(2.66)	(1.67)	(2.48)	(1.60)	(3.52)	(0.34)	(2.26)	(0.12)
Delay in prenatal visit[a]	-.170	-.184	-.133	-.0409	-.268	-.354	-.243	-.222
	(1.82)	(1.37)	(2.96)	(0.67)	(4.94)	(4.69)	(4.62)	(3.05)
Plural birth	.201	.242	.620	.507	.618	.620	.594	.617
	(1.70)	(1.62)	(9.83)	(6.69)	(9.35)	(7.43)	(9.01)	(7.49)
Characteristics of parents								
Mother's schooling	-	-.0184	-	.0456	-	.0456	-	.0765
		(0.48)		(2.61)		(2.13)		(3.70)
Husband's schooling	-	.0144	-	.0468	-	.00911	-	.0135
		(0.91)		(6.44)		(1.03)		(1.57)
Husband's income ($x10^{-6}$)	-	.292	-	.0625	-	3.41	-	2.72
		(0.04)		(2.02)		(0.81)		(0.67)
Husband's income ≤ 6000	-	.0565	-	.0771	-	-.0424	-	-2.96
		(0.61)		(1.88)		(0.84)		(5.93)
Black (mother)	-.0283	-.085	-.0282	-.897	-.247	-.0485	.137	.471
	(4.30)	(3.57)	(1.19)	(2.23)	(2.03)	(0.85)	(2.04)	(1.90)

a. Endogenous variable.

b. Asymptotic t-ratios in parentheses beneath coefficients.

Table 5

Test Statistics, Treatment Equations[a]

Treatment	Test: Endogeneity of Birth Characteristics	Test: Influence of Parental Characteristics
Amniocentesis	12.3	32.0
Ultrasound	50.6	230.2
X-Ray	36.3	171.0
Caesarean Section	72.9	140.0
X^2 Critical value, .05	12.6	35.2
X^2 Critical value, .01	16.8	41.6

a. Likelihood ratio tests.

caesarean section but are less likely to receive ultrasound.[6] Consistent with the estimates in Table 2 indicating that amniocentesis and x-rays significantly augment the birthweight of babies born in a plural birth, both procedures (as well as ultrasound and caesarean section) are significantly more likely to be applied when there is a plural birth. Despite, however, the finding reported in Table 2 that x-rays lower birthweight for higher-parity births born to older mothers, such treatments appear to be provided more frequently to such births. But, of course, x-rays and the other procedures may aid in ameliorating other conditions associated with maternal age and parity than weight at birth.

Which of the two alternative market regimes characterizing the allocation of medical treatments dominates--the regressive tax-subsidy regime (II) or the market regime? Infant health and the set of prenatal treatments appear to be substitutes, as indicated by the reduced-form endowment effects on the probabilities of treatments in Table 3. The income effects on treatments should therefore be algebraically higher when estimated conditional on endogenous infant health attributes compared to the estimated income effects from the reduced forms when the market regime is characterized by income-independent prices. If implicit prices fall sufficiently with income, however, the conditional "income effects" will be smaller than the unconditional income effects.

In the case of the three treatments for which we can reject with confidence the hypothesis that their provision depends solely on the health-related conditions of the pregnancy, the change in the coefficient associated with the mother's schooling across the conditional and unconditional reduced-form equations yields an unambiguous result. The conditional schooling coefficient is positive, statistically significant, and higher than its reduced-form counterpart by nearly a factor of 10 for ultrasound, by 50 percent for x-rays, and by 300 percent for caesarean sections. Mothers of similar pre-treatment health status, but with greater resources and/or demand for health, are not only more likely to receive the three medical treatments, but health-conditioned education differences in treatment incidence exceed those differences unconditioned on health status. This pattern is in accord with health being a normal good in a normal market for health treatments; thus, we can find no evidence for the proposition that the implicit price of treatments falls strongly with income.[7]

The results for the husband's income variables are somewhat less clear, because of the lack of precision of most of the income coefficients in Tables 3 and 4. However, the conditional linear income coefficients are greater than their reduced-form counterparts for all three treatments for which the set of socioeconomic variables are statistically significant (Table 5). Moreover, the statistically significant negative non-linear income term for caesareans (Table 3) rises algebraically by 200 percent in the conditional equation and retains its statistical significance. There is thus little evidence of a negative association between the implicit treatment price and income. Most certainly, moreover, caesarean sections are significantly more likely to be provided to more educated and higher income families even among women with the same health status.

Table 4 also indicates that there exist significant racial differences in the likelihood of receiving medical treatments among women with apparently identical pre-treatment health conditions--Black mothers otherwise identical with respect to both pre-treatment birth characteristics and schooling and income are significantly less likely to receive amniocentesis and x-rays and are marginally more likely to receive a caesarean section compared to White mothers.[8] The latter differential is consistent with the evidence concerning racial differences in pelvic structure; however, the lower likelihood of receiving amniocentesis and x-rays among Blacks is surprising given the evidence in Table 2 that even for given parental inputs Black babies are frailer than White babies. It is notable that differences in pre-treatment behaviors across race groups, not accounted for in the reduced-forms or in the gross racial differentials displayed in Table 1, mask significant racial disparities in treatment incidence. These differentials by race were not apparent in either the gross treatment rates by race (Table 1) or in the reduced-form equations accounting for the incidence of treatments by race controlling only for socioeconomic status. Controlling for (endogenous) initial health status can be important for understanding how the health care system allocates medical treatments across socioeconomic groups.

3. Conclusion

In this paper we have examined how medical treatments are distributed among pregnant women according to both their initial health and their economic resources under different implicit pricing regimes for allocating medical services. We showed that when the following three conditions hold--(i) medical treatments and pre-treatment health status are substitutes in the sense that treatments are ameliorative; (ii) pre-treatment health is influenced by agents' behavior; and (iii) treatments are allocated in a market with uniform prices--then differences in health status prior to treatment will not only <u>not</u> account for disparities in treatment by income and education, but such disparities will be greater within groups of identical pre-treatment health status than across such groups in the entire population.

Based on a probability sample of married pregnant women having a legitimate live birth in 1980 in the United States, we found that (i) more-educated women and women with husbands having higher incomes receive a disproportionate share of the four major treatments studied, (ii) the prenatal treatments are more likely to be provided to less-healthy infants (mothers) within schooling and income groups, and (iii) treatment differentials by education and income are increased by controlling for those behaviors that affect the pre-treatment healthiness of the infant. The results thus are consistent with the existence of a market regime for medical care that allocates health treatments to those who demand them, whether the demand is due to superior knowledge of the benefits of health, greater resources, or preferences. We thus could not find evidence that the tax subsidization of health care dominantly influences the allocation of these forms of medical care, nor evidence that health-related subsidies targeted to the poor have eliminated income disparities in treatments.

It is also shown that the healthiness of the mother and child, net of the influences of both prenatal inputs and treatments, may jointly affect pre-treatment parental decisions and the use of subsequent treatments. We found that, as expected, mothers of healthier infants were more likely to postpone seeing a doctor, visited the doctor less often, and were less likely to receive treatments while pregnant. This compensatory allocation of medical services, combined with the inability to measure directly all contributions to pre-treatment health that are observed by the decision-making agents (parents and doctors), can lead to erroneous inferences concerning the efficacy of the treatments. This selection bias in the use of medical care makes it appear, for example, that one prenatal procedure, amniocentesis, reduces birthweight while its use appears to actually increase birthweight when selection is taken into account. Controlling for initial health status can therefore significantly change measures of the therapeutic benefits of medically-administered treatments in the U.S. health care system.

Finally, Black mothers were found to have lower birthweight infants than do Whites net of treatments and their own pre-treatment health behavior. Despite this, they are more likely to postpone visiting a doctor, and see a doctor less frequently. And even when pre-treatment behavior, schooling, and income are taken into account, Black mothers are no more likely than White mothers to receive x-rays and are significantly less likely to receive either amniocentesis or ultrasound. Black mothers are marginally more likely, however, to receive a caesarian section with its associated higher mortality rates. The allocation regime behind the distribution of medical treatments to pregnant women in the United States, which appears to be consistent in several regards with a conventional market regime, is also marked by an unexplained tendency to serve the Black population less extensively than it does the White.

References

Acton, Jan P., "Nonmonetary Factors in the Demand for Medical Services," Journal of Political Economy 83, May 1975, 595--614.

Aday, L. A.; Fleming, G. F. and Anderon, R., Access to Medical Care in the U.S.: Who Has it, Who Doesn't, Chicago: Pluribus Press, 1984.

Becker, Gary S., "A Theory of the Allocation of Time," Economic Journal 75, September 1965, 493-517.

Blandon, Robert J.; Aiken, Linda H.; Freeman, Howard E.; Kirkman-Liff, Bradford; and Murphy, John W., "Uncompensated Care by Hospitals or Public Insurance for the Poor, Does it Make a Difference?" The New England Journal of Medicine, May 1, 1986, 1160-1165.

Colle, Anne D. and Grossman, Michael, "Determinants of Pediatric Care Utilization," Journal of Human Resources 13, (Supp.), Spring 1978, 115-158.

Corman, Hope and Grossman, Michael, "Determinants of Neonatal Mortality Rates in the U.S., A Reduced Form Model," Journal of Health Economics 4, 1985, 215-236.

Fuchs, Victor R., "Time Preference and Health: An Exploratory Study," in V. Fuchs (ed.), Economic Aspects of Health, National Bureau of Economic Research, Chicago: Chicago University Press, 1982, 93-120.

Fuchs, Victor R., The Health Economy, Cambridge: Harvard University Press, 1985.

Goldman, Fred and Grossman, Michael, "The Demand for Pediatric Care: An Hedonic Approach," Journal of Political Economy 86, 1978, 259-80.

Grossman, Michael, The Demand for Health: A Theoretical and Empirical Investigation, New York: Columbia University Press, 1972.

Haveman, Robert and Wolfe, Barbara, "Education and Economic Well-Being: The Role of Non Market Effects," Journal of Human Resources 19, Summer 1984, 377-407.

Manning, William G.; Newhouse, Joseph P., and Ware, John E., Jr., "The Status of Health in Demand Estimation; or Beyond Excellent, Good, Fair and Poor," in V. Fuchs (ed.), Economic Aspects of Health, National Bureau of Economic Research, Chicago: Chicago University Press, 1982.

National Academy of the Sciences, Committee to Study the Prevention of Low Birthweight, Preventing Low Birthweight, Washington, D.C.: National Academy Press, 1985.

National Institute for Child Health and Development, Caesarean Childbirth, NIH Publication No. 82-2067, 1982.

Newey, Whitney, "Maximum Likelihood Specification Testing and Conditional Moment Tests," Econometrica 53, September 1985, 1047-1070.

Pauly, Mark V., "Taxation, Health Insurance, and Market Failure in the Medical Economy," Journal of Economic Literature 24, June 1986, 629-675.

Rosenzweig, Mark R., and Schultz, T. Paul, "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and their Effects on Birthweight," Journal of Political Economy 91, October 1983, 723-746.

Smith, Richard J. and Blundell, Richard W., "An Exogeneity Test for a Simultaneous Equation Tobit Model with an Application to Labor Supply," Econometrica 54, May 1986, 679-688.

Taubman, Paul and Rosen, Sherwin, "Healthiness, Education, and Marital Status," in V. Fuchs (ed.), Economic Aspects of Health, National Bureau of Economic Research, Chicago: Chicago University Press, 1982, 121-40.

Tobin, James and Houthakker, Hendrik, "The Effects of Rationing on Demand Elasticities, The Review of Economic Studies 18, (1950-51), 140-153.

FOOTNOTES

1. There have been a number of prior important economic and epidemiological studies of the demand for medical care (e.g., Acton, 1975; Colle and Grossman, 1978; Goldman and Grossman, 1978; Aday, et al., 1982). These studies, however, a) are of populations heterogeneous in health conditions, b) examine only visits to medical personnel, not the distribution of services delivered by such personnel, and c) "control" for initial health conditions by employing subjective indicators of healthiness (excellent, good, fair, etc.) ascertained subsequent to the use of the medical services. As shown in Manning et al. (1982), the use of these post-treatment, subjective health measures to take account of initial health status leads to significant biases in the estimates of income and/or schooling effects on medical care use. Employment of objective indicators of health, even measured prior to treatment, as controls, however, would still lead to inconsistent estimates, as we discuss below, since health and use of medical inputs may reflect the same underlying preferences or biological propensities for healthiness.

2. There is thus scope for the doctor to "create" demand by overstating the efficacy of treatments. Competition among doctors presumably reduces this asymmetric information problem, but we focus on distributional rather than efficiency issues here.

3. Inferences about the effects of health care pricing regimes based on the differential behavior of agents participating in different private health care plans are made difficult because agents' preferences for health and innate healthiness clearly influence the choice of medical care insurance (adverse selection). Identification restrictions needed to ascertain the effects of the health plans are unclear. The RAND health insurance study

(Manning et al.,1982) based on the randomization of insurance schemes provides some important insights with respect to price-induced health behavior for the experimental groups studied, but cannot provide information about the actual distribution of medical care across homogeneous groups in the United States associated with the current medical care pricing cum tax system.

4. The two-stage probit estimation procedure and tests for endogeneity are discussed in Newey (1985) and Smith and Blundell (1986).

5. Note that we cannot use our estimates from Table 4 to compute the distribution of treatments under a regime in which only the efficacy of the treatments (pre-treatment health) matters, as in a compulsory health insurance regime, based on the pre-treatment variable coefficients. This is because a change in the pricing of medical services would induce a corresponding change in the distribution of pre-treatment health-related consumption goods (moral hazard).

6. While the timing of the first visit (delay) to a doctor or clinic by the mother is a decision made principally by the mother and represents a pre-treatment "condition" which the doctor may need to take into account, the number of prenatal visits reflects the treatments provided and is thus influenced as well by the doctor. The number of visits by the mother to the doctor is not therefore employed as a measure of pre-treatment health status in estimating the determinants of treatment incidence net of pre-treatment health conditions.

7. If education and income were merely proxies for pre-treatment health conditions not reflected in the other behavioral variables, they would be negatively correlated with the probability of receiving a treatment, if

health is a normal good. This is because, as seen in Table 3, treatments are more likely to be provided to less-healthy infants/mothers.

8. It is notable that in 1978 the maternal mortality rate for caesarean deliveries was four times that of vaginal deliveries (National Institute of Child Health and Development, 1982).

Appendix Table A
Instrumental Variables, Data Sources and Sample Statistics

Variable Definition	Data Source	Sample Mean[a] (Standard Deviation)
Medical Services Available: County		
Physicians per capita 1980 ($x10^3$)	Co-stat-1	1.14 (1.44)
OB/GYN per capita 1975 ($x10^3$)	AGI	.275 (.155)
General Practitioner per capita 1975 ($x10^3$)	AGI	.874 (.316)
Hospital family planning clinics per capita 1980 ($x10^5$)	AGI	.713 (.181)
Health Dept. family planning clinics per capita 1980 ($x10^5$)	AGI	.603 (.905)
Planned Parenthood clinics per capita 1980 ($x10^5$)	AGI	.145 (.313)
Other family planning clinics per capita ($x10^5$)	AGI	.0903 (.366)
Government Programs: County		
Expenditures per capita on Hospitals 1980	Co-stat-1	.334 (.122)
Expenditures per capita on Education 1980	Co-stat-1	.0519 (.0557)
Hospital beds per capita 1980	Co-stat-1	.00831 (.0163)
AFDC maximum monthly benefits for family of four ($)	Urban	298. (111.)
Food stamps bonus potential if only income is AFDC per family of four ($)	Urban	84.3 (31.7)
Labor market: County		
Employment share in Agriculture	Co-stat-1	.0474 (.0552)
Employment share in Construction	Co-stat-1	.0606 (.0202)
Employment share in Manufacturing	Co-stat-1	.222 (.0903)
Employment share in Transportation	Co-stat-1	.0724 (.0177)
Employment share in Wholesale/Retail Trade	Co-stat-1	.205 (.0235)
Employment share in Financial Services	Co-stat-1	.0582 (.0217)
Employment share in Educational Services	Co-stat-1	.0861 (.0245)

Employment share in Business Services	Co-stat-1	.0402 (.0142)
Employment share in Entertainment	Co-stat-1	.0415 (.0195)
Employment share in Health Services	Co-stat-1	.0734 (.0170)
Employment share in Public Administration	Co-stat-1	.0524 (.0318)
Urban share of Population	Co-stat-1	.725 (.262)
Unemployment Rate for Females in 1980 (%)	Co-stat-1	6.63 (2.28)
Unemployment Rate for Males in 1980 (%)	Co-stat-1	6.61 (2.60)
Prices, Taxes, Regulations: State		
Alcohol state monopoly	Facts	.309 (.462)
Tax on gallon of wine ($)	Facts	.552 (.579)
Cigarette price/pk. 1974 (¢)	Tobacco	45.5 (4.92)
Cigarette price/pk. 1979 (¢)	Tobacco	60.4 (4.81)
Cigarette sales tax/carton 1974 (¢)	Tobacco	9.48 (7.96)
Cigarette sales tax/carton 1979 (¢)	Tobacco	13.6 (10.7)
Beer average Jan. and July price 1976 (6 pk)	Ornstein	1.80 (1.89)
Beer average Jan. and July price 1979 (6 pk)	Ornstein	2.06 (.221)
Liquor 8 brand average price 1976 (fifth)	Ornstein	6.59 (.532)
Liquor 8 brand average price 1979 (fifth)	Ornstein	6.96 (.588)
Ethnic and Racial Origin: Individual		
Mother race Asian	NNS/MQ	.0268 (.161)
Mother race Black	NNS/MQ	.0781 (.268)
Mother origin Irish	NNS/MQ	.308 (.461)
Mother origin Puerto Rican	NNS/MQ	.00941 (.0966)
Mother origin Cuban	NNS/MQ	.00182 (.0426)
Mother origin Mexican	NNS/MQ	.0453 (.208)
Father race Asian	NNS/MQ	.0258 (.159)

Father origin Irish	NNS/MQ	.233 (.423)
Father origin Puerto Rican	NNS/MQ	.00903 (.0945)
Father origin Cuban	NNS/MQ	.00194 (.0440)
Father origin Mexican	NNS/MQ	.0418 (.200)
Child race Black	NNS/BC	.0818 (.274)
Mother origin all Hispanic countries (including other Spanish)	NNS/MQ	.0713 (.257)
Personal Characteristics: Individual		
Mother's education (years)	NNS/MQ	12.7 (2.31)
Father's education (years)	NNS/MQ	13.0 (2.53)
Father's income ($/year)	NNS/MQ	15,814. (8817.)
Father's height (inches)	NNS/MQ	69.9 (6.31)
Father's weight (pounds)	NNS/MQ	174. (28.8)

[a]Sample weighted, with births of less than 2500 grams given one fourth the weight, since they were selected four times as frequently as births greater or equal to 2500 grams.

Data sources codes:

Co-stat-1: U.S. Bureau of the Census, Washington, D.C., County Statistics file, 1984.

AGI: Alan Guttmacher Institute TT0519, 1-2 July 1985. Personal Correspondence Stanley Henshaw.

Tobacco: The Tax Burden on Tobacco, The Tobacco Institute, Washington, D.C., 1983.

Ornstein: Stanley I. Ornstein, UCLA. Personal correspondence, June 1985, and Professor Michael Grossman, NBER/CUNY Graduate Center.

Facts: 1980 Facts and Figures, The Tax Foundation, 1980. Table 200.

Urban: Toby Campbell and Marc Bendeck, A Public Assistance Data Book, Urban Institute, Washington, D.C., October 1977. yExhibit 31A, p. 105.

NNS: National Natality Survey 1980; MQ--Mother's Questionnaire; BC--Birth Certificate; H--Hospital Questionnaire.