DEMAND FOR HEALTH CARE WHEN TIME PRICES VARY MORE THAN MONEY PRICES

PREPARED FOR THE U.S. OFFICE OF ECONOMIC OPPORTUNITY
AND THE NEW YORK CITY HEALTH SERVICES ADMINISTRATION

JAN PAUL ACTON

R-1189-OEO/NYC
MAY 1973

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PREFACE

This report is one of a series of studies to determine the factors influencing the demand for medical services. Of particular interest is the attempt to predict the effect of national health insurance on this demand. There is a growing literature on demand at the level of the individual. Other Rand reports include *Coinsurance and the Demand for Medical Services*, R-964-OEO/NC, *Effects of Coinsurance on the Demand for Physician Services*, R-976-OEO, and *Price and Income Elasticities for Medical Care Services*, R-1197-NC, all by Charles E. Phelps and Joseph P. Newhouse; *Demand for Health Care Among the Urban Poor, with Special Emphasis on the Role of Time*, R-1151-OEO/NYC, by Jan Acton; and *Health and Taxes: An Assessment of the Medical Deduction*, R-1222-OEO, by Bridger Mitchell and Ron Vogel. This report differs from previous literature on the subject by focusing on alternative rationing devices that may arise as monetary expenditures by the individual shrink in importance.

This series is sponsored jointly by the Office of Economic Opportunity and the Health Services Administration of New York City through the New York City-Rand Institute. OEO is particularly interested in the determinants of the demand for health care among the poor and near-poor. HSA is interested in anticipating the long-run effect of changes in health care and especially the effect that national health insurance may have on New York City.

SUMMARY

This report analyzes the demand for health care at three different types of providers: City hospital outpatient departments (OPDs), private physicians, and hospitals. A major purpose is to anticipate the factors that may determine demand as money prices become less significant--because of either the continued spread of health insurance or the adoption of national health insurance. The report develops a model of the demand for medical services and uses it to predict the effects of changes in money prices, travel distance, time, and earned and non-earned income on the demand for care. These predictions are tested with data from a survey of users of the municipal hospital OPDs. New York City is a particularly good place to conduct this analysis because the longstanding availability of free care allows estimation of demand under conditions that might exist with some forms of national health insurance legislation. A utility maximization model was specified that allows people to "pay" with money and time in consuming medical services and other goods. It predicts, among other things, that demand for medical services will become relatively more sensitive to changes in travel time as the money prices shrink because of spreading insurance coverage. It also predicts a differential effect of earned and nonearned income on the demand for care. Changes in earned income affect the opportunity cost of time, while changes in nonearned income produce an unambiguous increase in the demand for normal goods.

A simultaneous equation system was specified with the distance traveled to the OPD specified as an endogenous variable. The principal finding of this study is that travel distance is very significant in determining the quantity of care demanded. Further, the results indicate that demand in this population is already more sensitive to changes in travel distance than to changes in money prices of medical services. In addition, the estimation results show different effects of earned and nonearned income, a significant role for health status, and different utilization by race.

1-2

Perhaps the most important implication for policy to be drawn from this study is the significant effect of nonmonetary factors in determining demand. This means persons with lower opportunity cost of time will be in a position to bid services away from those with higher opportunity cost of time. Second, if policymakers wish to increase medical consumption by target groups in the population, available instruments include shortening the travel time necessary to receive care. Finally, if increased consumption of services is a public objective, then policymakers should explicitly consider the degree to which income subsidies can be substituted for direct provision of medical services. The results of this study support findings in an earlier study that, in the range of provisions that may be under consideration, income guarantees may be as effective in increasing the demand for medical care as lowering the out-of-pocket medical expenditure for care.

ACKNOWLEDGMENTS

Raymond Lerner, then of Albert Einstein Medical College, now of the Health and Hospital Corporation of New York City, was generous in making the outpatient department survey available for analysis. He also clarified a number of points about the nature of the public medical sector at the time the data were collected; his assistance is greatly appreciated.

Michael Grossman and Rand colleagues William Butz, David Chu, John Koehler, Joseph Newhouse, and Charles Phelps provided useful discussion and criticisms, and Lindy Clark Friedlander performed diligent research assistance.

CONTENTS

I. INTRODUCTION

If only because of the size of the health sector, the demand for health care would deserve close scrutiny by researchers. In addition to its size, the health sector has been one of the most inflationary in recent years, causing increasing interest by the public and policy-makers alike. Finally, the growing numbers of proposals for significant changes in the health care system, especially proposals for federal health insurance legislation, make imperative a better understanding of the determinants of demand. This research is part of a growing literature that studies the demand for medical services using disaggregated data.[1] It differs from previous literature in concentrating on alternative mechanisms that may arise to determine demand for medical care as money prices to the patient fall through insurance.

The out-of-pocket money price of medical care has been decreasing as a proportion of total price in recent years, primarily because of the spread of health insurance and the rising opportunity cost of time (and perhaps increased time needed to receive care). There is every reason to believe that money prices will continue to fall in relative importance because of the secular trend in insurance coverage and opportunity cost of time and, perhaps even more important, the prospect of national health insurance. With the decreasing relative importance of money prices, it is reasonable to expect an alternative mechanism to control demand. A mechanism involving time is quite likely to assume this role since medical care usually requires a payment in both travel time and waiting time.[2] Indeed, substantial increases in queues and waiting lists was one of the widely noted results of the enactment of the National Health Service legislation in Britain; see Harris (1951) and citations.

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[1]See, among others, Grossman (1970), Rosett-Huang (1973), Phelps and Newhouse (1972), and Acton (1973).

[2]The importance of time as a determinant of demand was suggested by Becker (1965), its application to the demand for medical care by, among others, Leveson (1970) and Holtman (1972).

This report considers the effects of travel distance in determining the demand for medical services in New York City, an especially good "laboratory" in which to try to examine the effects of nonmonetary prices because of the long-standing availability of free care in the city's municipal hospitals and clinics.[1] After a formal model is developed of the demand for medical services that includes a payment in money and in time for private care, the predictions are tested on a cross-sectional survey of about 2600 users of the city hospital outpatient departments (OPDs).

Although limitations of the data base indicate cautious interpretation, the empirical results lend support to the model's major predictions. Empirical verification of the conjecture that time is important in determining the demand for care raises a number of important policy issues. These not only include the effect on the distribution of services to recipients of care, they also indicate powerful policy instruments for increasing the medical access of target populations. Some of these policy options--which include the location of clinics, waiting time policies, and the substitution of income maintenance for subsidized care--are discussed in the last section.

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[1] In a related study, Acton (1973) examined the role of travel time and waiting time in the demand for medical services using two surveys of poverty neighborhoods in New York. This study differs from the previous report in a number of ways. First, it is based on a survey of the users of OPDs rather than a survey of the general population in a neighborhood. Consequently, we know that everyone had nonzero utilization of the health sector. This allows the specification of a simultaneous set of equations to describe the demand at several different sources of care. Second, the chief measure of price paid for "free" public care is travel distance to the clinic. Further, travel distance is specified as endogenous in this system. In the previous study, the large proportion of observations on the limit value of zero health sector utilization forces the estimation of reduced form equations using the Tobit estimation technique.

II. MODEL OF DEMAND FOR MEDICAL SERVICES

The underlying theoretical model for this study is developed in detail in Appendix B.[1] The model concentrates on the role of money prices, time prices, and earned and nonearned income. For simplicity, the model is developed in terms of only one provider of services, but the implications for several providers can easily be drawn. In the theoretical and empirical sections to follow, I will be studing the demand for care at alternative providers--free city clinics, private physicians, and hospitals.

Assume two goods enter the individual's utility function: medical services, m, and a composite, X, for all other goods and services. Using an assumption of fixed proportions of money and time to consume m and X and the full wealth assumption, the model can be represented as follows:

Maximize

$$U = U(m,X) \tag{1a}$$

subject to

$$(p + wt)m + (q + ws)X \leq Y = y + wT, \tag{1b}$$

where

U = utility,

m = medical services,

X = all other goods and services,

p = out-of-pocket money price per unit of medical services,

t = own-time input per unit of medical services,

q = money price per unit of X,

s = own-time input per unit of X,

[1]Similar models can be found in Becker (1965), Grossman (1972), and Holtman (1972).

1-7

w = earnings per hour,

Y = total (full) income,

y = nonearned income, and

T = total amount of time available for market and own production of goods and services.

A more complicated specification of the model was not used because this simpler formulation yields most of the same predictions and because the data do not permit estimation of the unique implications of the richer specification.[1]

EFFECTS OF A CHANGE IN PRICE

It can be shown that the assumptions sufficient to make money function as a price in determining the demand for medical services are also sufficient to make time function as a price, producing negative own-time-price elasticities of demand and positive cross-time-price elasticities.[2] One of the chief interests in this study is the relative importance of money prices and time prices in determining the demand for medical services. If we let Π equal the total price per unit of medical services (that is, $\Pi = p + wt$), then the elasticity of demand for medical services with respect to money price is

$$\eta_{mp} = \frac{p}{\Pi} \eta_{m\Pi}, \tag{2a}$$

and the elasticity with respect to time (which equals the elasticity

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[1]Grossman (1972) allows the amount of medical services, m, to influence the total amount of time, T, available for production. Phelps (1973) makes the selection of insurance parameters, and therefore p, endogenous to the system. Some researchers (notably Grossman, 1970 and 1972, and his followers) have taken the Lancaster (1966) formulation of letting the argument "health" enter the utility function and then deriving a demand for medical services. The present data do not allow us to estimate the relation transforming medical services into health.

[2]Sufficient (although not necessary) assumptions are that the first derivatives of the utility function with respect to a good are positive, that the second derivatives are negative, and that the cross-partial derivatives are positive.

1-4

with respect to wt) is[1]

$$\eta_{mt} = \frac{wt}{\Pi}\eta_{m\Pi} . \tag{2b}$$

Comparing these two elasticities yields the second prediction from the formal model, namely that

$$\eta_{mt} \gtrless \eta_{mp}$$

as $wt \gtrless p$. Clearly, as p goes to zero and wt does not, the time-price elasticity will exceed the money-price elasticity. In other words, as the out-of-pocket payment for a unit of medical services falls, because of either increasing insurance coverage or the availability of subsidized care, demand becomes relatively more sensitive to changes in time prices. Further, this implies that the demand for free medical services should be more sensitive to changes in time prices than demand for nonfree services, because time is a greater proportion of the total price at free than at nonfree providers.

EFFECTS OF A CHANGE IN INCOME

Exogenous changes in income can arise either from a change in earnings per hour or from a change in nonearned income. The two effects are not, in general, equal. The assumptions that are sufficient to make money function as a price are also sufficient to mean that an increase in nonearned income will produce an increase in the demand for medical services.

The effects of a change in the wage rate cannot be determined *a priori* because of offsetting influences. An increase in earnings per hour produces an income effect, which acts to increase demand. It also raises the opportunity cost of time, which reduces demand for time-intensive activities. The net effect on the demand for medical services depends on the time intensity of the price of medical services relative

[1]These elasticities are only approximate in the long run if insurance premiums are adjusted to reflect the changes in utilization.

to the time intensity of the price of all other goods and services. The effects of a change in the wage rate, w, can be divided into an income effect and a substitution effect:

$$\frac{\partial m}{\partial w} = (T - mt - Xs)\frac{\partial m}{\partial y} - \frac{\lambda s(q + ws)(p + wt) - \lambda t(q + ws)^2}{|D|} \qquad (3)$$

where $|D|$ is a determinant of the matrix of coefficients from the maximization equations. The first term is the income effect and is, by assumption, positive. The second term is the substitution of m for X because of a change in w. It can easily be seen that the substitution effect of a change in the wage rate on the demand for medical services is positive if and only if

$$\frac{ws}{(q + ws)} > \frac{wt}{(p + wt)}, \qquad (4)$$

that is, if the time price is a larger proportion of the total price for the composite good, X, than it is for medical services, m. The substitution effect is necessarily negative for free sources of medical care since the condition in (4) will not be met as long as there is a nonzero monetary price for X. Of course, the net effect of a change in wages may still be to increase the demand for medical services if the income effect exceeds the substitution effect. Intuitively, however, the effect of a wage change on the demand for free medical services is more like a price effect for free sources of care (and therefore more likely to be negative) and more like an income effect for nonfree sources of care (and therefore more likely to be positive).

The predictions of this model on the effect of income can be summarized as follows: If a particular source of medical services supplies a normal good, then an increase in nonearned income will cause an increase in the demand for that good. A change in the wage rate has an ambiguous effect, *a priori*, but it is more likely to be associated with a negative elasticity. The earned income elasticity of demand for

free sources of care should be lower (algebraically) than the elasticity for nonfree sources of care.[1]

PREDICTIONS FROM OTHER FORMAL MODELS

As noted above, the model developed here is deliberately simplified because it is adequate to produce testable hypotheses for the variables of primary interest. There are some additional hypotheses regarding the effects of education and age from the Grossman (1972) investment model that can be tested with these data. Grossman argues that medical services are combined with other inputs the individual supplies to produce health and that it is health that enters the utility function. He then suggests that more highly educated persons will be more skillful in combining inputs to produce health and therefore will be more efficient producers of a given level of health. Thus, when all other things are accounted for, he expects to find a negative effect of education on the amount of medical services consumed. This argument requires the assumptions that the price elasticity of demand for health is less than one and that more educated persons must not have developed a "taste" for health that overcomes this savings due to increased efficiency in production.[2] In our empirical test, we will observe only the net influence of these two effects if they both exist. The second implication of Grossman's work involves the effect of age on consumption of health services. If the price elasticity of demand for health is less than one, then the demand for medical services will be positively correlated with the depreciation rate on health. In general, empirical evidence suggests that the depreciation rate increases over the life cycle, causing a positive effect of age on consumption of medical care.

[1]That is, if both are negative, the elasticity is greater in absolute value for free than nonfree sources of care.

[2]In the consumption model, he also assumes that the income elasticity is less than one; Grossman (1970, p. 59).

III. THE EMPIRICAL BASE

The data used for this study come from a 1965 survey of users of the outpatient departments of New York City municipal hospitals. Respondents were selected from a random sample of persons at the clinic; hence, the probability of being interviewed is proportional to the frequency of use of the clinics. Appendix A presents the mean values of the variables used in this analysis. In addition, the means are reported when observations are weighted by the inverse of the number of clinic visits. These weighted means indicate the mean characteristics of people who ever use the clinics, rather than the mean characteristics of the patient load at the clinics.[1]

THE SURVEY OF USERS

The respondents were questioned about their previous year's medical use and a number of sociodemographic characteristics from the previous year. The interviews at each of the OPDs were conducted in four waves spread throughout the year to cancel seasonality in usage.[2] There are advantages and disadvantages to using survey data. One of the advantages is that disaggregated data provide a more precise description of individual behavior because individual rather than aggregate values can be used for explanatory variables. This overcomes the bias away from zero that is frequently encountered in using average values in aggregate data.[3] Other advantages include the much larger sample size typically available in surveys so that variance of coefficients can be reduced. The chief disadvantage of survey data in general is that it relies on recall by the individual. This frequently leads to an

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[1]To run regressions on the weighted observations is impossible because the number of outpatient department visits is used as a dependent variable, and weighting by its inverse amounts to running a regression on a constant.

[2]Details of the study and selected analysis (chiefly analysis of variance) can be found in Lerner and Kirchner (1967), and Lerner, Kirchner, and Dieckmann (1967 and 1968).

[3]See Newhouse and Phelps (1973) for an elaboration of this point.

underreporting of some variables, particularly medical utilization and income.[1]

Underreporting will generally bias the coefficients of explanatory variables toward zero. The estimated elasticities, however, need not be biased. If people recall k proportion of their utilization in the previous year, then the estimated elasticity of demand for care with respect to, say, price is

$$\eta_{mp} = \frac{\partial km}{\partial p} \cdot \frac{p}{km} = \frac{\partial m}{\partial p} \cdot \frac{p}{m},$$

which is the same as the elasticity that would have been estimated with full recall. By the same argument, the cross-price elasticities and the elasticity of substitution of one type of provider for another should be unbiased.[2]

DISCUSSION OF SELECTED VARIABLES

Some responses to the survey were checked independently, increasing the validity of the data. Other responses were coded poorly for present analysis. The strengths and weaknesses of some of the most important variables are discussed here. Minor comments are also included in the discussion of the empirical results.

OPD. The number of outpatient department visits in the preceding year is a very accurate variable. The individuals were asked to name all the clinics used in the year, and the number of visits was verified from the patient records. The only sources of underreporting would be failure to mention a clinic that was used or errors in the hospital records.

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[1] Recall for ambulatory care seems to be extremely accurate for use in the last two weeks and for hospital use in the last year, according to Regina Loewenstein (personal communication, 1971).

[2] There is a further potential bias in this particular study because of the fee structure at the municipal hospitals. To receive free care, an individual was supposed to be unable to pay for private care (although I am told that anyone who asserted he was entitled to free care would receive it without challenge). This might have caused some persons to underreport income or use of private facilities. There is no evidence that such an error was introduced, but in the absence of verified income data the possibility exists.

HOSP. Similarly, the number of hospitalizations for the preceding year was verified with the hospitals named. Again, any errors would arise from failure to mention a unit or from errors in the hospital records.

DIST. The distance from the individual's home to the OPD of the interview was calculated in hundredths of a mile. The X-Y coordinates of the two addresses were obtained from the Geographic Coding Guide prepared by the Tri-State Transportation Commission. The distance is calculated by taking the absolute value of the difference of the X coordinates and adding it to the absolute value of the difference between the Y coordinates.[1] It is as if the person traveled by making right angle turns only and taking the shortest route. This, too, apparently represents a very accurate variable.[2]

PRIVE. The number of private physician visits in the preceding year was obtained by recording all the medical providers used for enumerated health conditions during the preceding year. For each private physician named, the frequency of use was coded as zero, once, or more than once in the preceding year. This formulation is available for up to three private physicians. For most of the persons, this was adequate information. They used no private physicians, or they used two physicians once each, and so forth. About one-quarter of the sample (649 persons) used at least one physician more than once. Clearly, we would like more information. In such cases, the number of private physician visits was estimated using the coefficients from a regression based on another study.[3] The estimated coefficients from the study were used

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[1]The process is described in Lerner, Kirchner, and Dieckmann (1967, pp. IV-3 to IV-5).

[2]The addresses of patients were not verified. Since patients were primarily supposed to use the OPD in their health district, it is possible that they misrepresented their addresses if using another OPD. There appears to be no evidence to support or deny this possibility.

[3]This other study, a random survey of low-income persons in Red Hook, a section of Brooklyn, is described in Acton (1973). Only those persons who both used the OPDs and had more than one private physician visit were used for the estimation. There were 401 such persons in the Red Hook survey (of 5,269 persons). Casual comparison suggests that the two populations are sufficiently comparable for this purpose. For

to estimate PRIVE in the current study, subject to the constraint that the estimated value be at least as great as that implied by the survey responses.[1]

Using this estimated value of PRIVE for some observations is not ideal, but its disadvantages are limited. The chief effect will be to increase the significance of the health status variables in the equation with PRIVE as the dependent variable. This is not a serious problem because health status has been found to be a significant predictor of utilization in other studies and because only one-quarter of the observations have the estimated value of PRIVE. Similarly, the estimated rate of technical substitution between OPD and private physician visits will be strengthened, but this effect is limited by the small coefficient on OPD estimated from the Red Hook sample and by the limited number of observations receiving the estimated value.

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instance, the mean number of OPD visits in the Red Hook subsample was 5.9, and in the present survey was 7.6. The mean number of private physician visits in the Red Hook subsample using both OPD and private physicians is 5.0. The estimated relation (with t-value in parentheses) from the Red Hook data was:

$$\begin{aligned}\text{PRIVE:}\ & -\underset{(1.49)}{0.0487}\ \text{OPD} + \underset{(.038)}{0.0244}\ \text{MALE} - \underset{(2.04)}{1.5794}\ \text{PR} - \underset{(0.51)}{0.3774}\ \text{BLACK}\\ & - \underset{(3.59)}{4.1603}\ \text{EXCELLENT HEALTH} - \underset{(3.75)}{3.6107}\ \text{GOOD HEALTH}\\ & - \underset{(2.37)}{2.3044}\ \text{FAIR HEALTH} - \underset{(2.56)}{0.3622}\ \text{HOUSEHOLD SIZE}\\ & + \underset{(9.51)}{10.3753},\ N = 401,\ R^2 = 0.0628.\end{aligned}$$

[1]If, for instance, the person used one physician once and another physician two or more times, then the estimated value for private physician visits must be at least three. In only two cases was the value estimated from coefficients lower than the value implied by the response.

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IV. ESTIMATION RESULTS

The demand for health care by type of provider is estimated from a simultaneous equation system using two-stage least squares. Four structural equations are specified and 28 exogenous variables are used for estimation. All the equations are overidentified by several variables.[1] After a brief overview of the model, this section describes first the structural equations and then the reduced form equations.

OVERVIEW OF THE MODEL

The four structural equations describe the volume of ambulatory and inpatient services demanded and the distance traveled to the free ambulatory care.[2] The last year's volume of OPD visits and the number of visits to a private physician (PRIVE) are the two alternative sources of ambulatory care. They are technical substitutes for one another. The number of hospitalizations (HOSP) appears to be a technical complement for outpatient care.

The distance (DIST) to the outpatient department where the interview was conducted is specified as an endogenous variable in this system. It is the chief measure of the price of an OPD visit and functions as a cross-price term for PRIVE and HOSP.[3] Distance actually measures

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[1] Since a number of the variables are dummy variables for health status or mode of transportation, they really contain less information than their number indicates. Therefore, in checking the number of excluded exogenous variables for purpose of identification, I counted a set of mutually dependent dummy variables as one variable.

[2] Some of the "exogenous" variables in this cross-sectional survey are really endogenous in a larger system that includes life-cycle behavior (such as labor-force participation and family size) and a broader set of economic decisions. Since we are specifying only a subset of these relations, it is possible that some of these exogenous variables are really proxies for common underlying theoretical variables. I tried to limit the possibility of such undesirable interference by specifying such variables as family health status only in the equations where their principal effects could be anticipated.

[3] An imprecise measure of waiting time is included. If the person says he waits longer at an OPD than at a private physician's office, WAIT takes the value one.

several things. It includes the physical distance one has to travel and the money and time costs of travel, and it is associated with higher informational costs. The informational costs represent the fact that patients generally have less difficulty in finding out about the quality and suitability of a close-by clinic (for instance, by asking neighbors or by having experienced the care themselves) than in finding out about a distant clinic. The money costs and informational costs will tend to be positively correlated with the distance traveled. However, those who previously lived near one clinic and now live further away (perhaps nearer another) have a lower information cost with the former, more distant, clinic. Therefore, the coefficient on HABIT should be positive in the structural equation for distance, but it will capture only part of the differences in information costs in this and other equations. In general, the higher information and money costs, which are subsumed in the distance variable, will cause the estimated elasticity with respect to distance to be higher than the true elasticity with respect to distance or time alone.

The important exogenous economic variables in this system are income, assets, and health insurance. Both earned (GRWAGE) and nonearned income (NWAGE) of the family are used. The measure of assets include self-reported liquid assets (LIQUID) and equity in the home (EQUITY). The insurance variable (INSF) is, unfortunately, very imprecise and indicates only whether at least one member of the family had some health insurance coverage (this survey was conducted before Medicare and Medicaid). Additional important variables in this system include the method of transportation used for the named sources of care.[1] Dummy

[1]It can be argued that the method of transportation is an endogenous variable just as is the distance traveled to OPD care. For both conceptual and practical reasons, it is considered exogenous in this model. First, it can be viewed as exogenous if before the period of observation the person has already made a decision about the methods of transportation he will use for various types of trips. We can argue that he is unlikely to alter this choice significantly during the course of the year. A more practical reason is that making the method of transportation endogenous means that the normal assumptions about the distributions of the error term would not be satisfied, and either a Tobit or probit model would be more appropriate. Estimating a simultaneous Tobit system with 12 or so endogenous variables is probably unwarranted with this data base.

variables are used relative to those who walked. For transportation to the OPD, the variable BUS1 indicates that a single bus or subway was taken; BUS2 indicates at least one transfer was necessary; private automobiles (CAR) and taxicabs (TAXI) are the remaining options. Transportation to private physicians is defined identically except that the letter P is appended to the variable names. Self-assessed health status consists of three dummy variables for excellent (EX), GOOD, and FAIR health. Additional control variables for education (EDUC), AGE, sex (MALE), and race (PR = 1 if Puerto Rican and BLACK = 1 if black), work status (WORK), number of earners in the family (ERNRS), household size (HSSIZE), and welfare status (WELF = 1 if on welfare) are included. Three variables measure the degree to which the person is a regular user of the OPD where he was interviewed. If that clinic was not his main source of care, NMAIN took the value one. The length of time he had been coming to the OPD measured in years is HABIT, and the number of OPD clinics he reported ever using is given by CLINS.

THE STRUCTURAL EQUATIONS

The specifications of the structural equations and their estimated coefficients are given in Table 1.[1] The principal value of the structural equations is to show the effects of endogenous variables on one another. The net effect of exogenous variables is clear only from the reduced form coefficients in Table 2.

The OPD Equation

The structural equation for OPD visits (Eq. (1)) includes the other three endogenous variables. Private physician visits may be technical substitutes for OPD visits, although the coefficient on PRIVE is not significantly different from zero. A possible explanation for the low significance of the coefficient is that people are seeking care for less serious conditions at the OPD and more serious conditions at the

[1]The t-values reported are the asymptotically normal values. By multiplying these by the t-adjustment factor, the Dhrymes (1969) t-statistics for 2SLS result.

Table 1

COEFFICIENTS OF STRUCTURAL EQUATIONS FROM 2SLS ESTIMATION[a]

Variables	OPD (Eq. 1)			PRIVE (Eq. 2)			HOSP (Eq. 3)			DIST (Eq. 4)		
	Coef.	t	η	Coef.	t	η	Coef.	t	η	Coef.	t	η
Endogenous												
OPD				-.052	3.37	-.27	.007	1.82	.17	-.169	1.08	-.60
PRIVE	.172	.20	.03				.021	2.40	.09			
HOSP	41.248	2.63	1.72	1.333	2.72	.29						
DIST	-7.391	2.74	-2.07	.033	.61	.05	.037	2.88	.25			
Exogenous												
GRWAGE X 10^{-4}	6.185	1.34	.24	.456	2.03	.09	-.103	1.82	-.09	.231	.52	.03
NWAGE X 10^{-3}	.838	.82	.10	.174	3.46	.10	-.034	2.70	-.09	-.045	.44	-.02
LIQUID X 10^{-2}	.015	.30	.00	.004	1.69	.01	.0004	.56	.00			
EQUITY X 10^{-2}	-.045	.76	-.01	.005	1.63	.01	.001	1.85	.01			
INSF	-3.902	1.73	-.18	.276	2.648	.07	.059	2.27	.06			
WAIT	-1.417	.59	-.05	1.178	12.12	.23				-.217	.97	-.03
FAMH	3.622	1.81	.16									
EX	6.810	1.46	.08	-1.363	6.91	-.09	-.113	2.26	-.03	-.009	.02	.00
GOOD	3.897	1.21	.23	-1.128	8.07	-.35	-.075	2.07	-.11	-.125	.36	.03
FAIR	-.272	.11	-.01	-.867	6.51	-.18	-.013	.38	-.01	-.202	.68	.03
AGE X 10^{-1}	1.254	2.50	.58	.05	1.92	.13	-.019	2.96	-.22	.085	.79	.14
BLACK	-6.976	2.52	-.35	-.364	2.91	-.10	.067	2.14	.08	-.852	3.03	-.15
PR	-3.515	1.41	-.16	-.446	3.47	-.10	.020	.59	.02	-.525	1.84	-.08
EDUC	-.334	1.56	-.27	.006	.58	.03	.005	1.85	.10			
MALE	-4.14	1.97	-.20	-.339	3.42	.09	.099	4.33	.11	-.062	.31	-.01
WELF	-3.581	1.42	-.11	-.414	3.35	-.07	.069	2.22	.05			
WORK				.259	2.04	.03	-.056	1.74	-.03	-.189	.46	-.01
NMAIN	-5.905	1.36	-.04							.079	.17	.00
HABIT	.261	2.00	.17							.018	1.03	.04
BUS1	4.277	1.47	.23							.767	3.11	.15
BUS2	15.022	2.35	.44							2.238	7.93	.24
CAR	9.775	1.43	.06							2.058	4.14	.05
TAXI	-.363	.06	.00							1.459	3.93	.06
BUS1P				2.969	17.27	.13						
BUS2P				3.203	13.75	.074						
CARP				2.050	7.21	.05						
TAXIP				2.960	9.90	.04						
CLINS										.247	.66	.20
CONSTANT	3.039	.42		1.344	4.12		.202	2.66		2.274	3.15	
t Adjustment factor	1.49	.53		.53			.37			.92		

[a]Scaling factors adjust only coefficients, not elasticities.

Table 2

COEFFICIENTS OF THE REDUCED FORM EQUATIONS[a]

Variable	OPD (Eq. 5) Coef.	OPD η	PRIVE (Eq. 6) Coef.	PRIVE η	HOSP (Eq. 7) Coef.	HOSP η	DIST (Eq. 8) Coef.	DIST η
GRWAGE X 10^{-4}	-4.027	-.15	.580	.12	-.086	-.08	.914	.13
NWAGE X 10^{-3}	.658	.08	.092	.06	-.033	-.09	-.157	-.06
LIQUID X 10^{-3}	-1.515	.04	.137	.02	.005	.00	.257	.02
EQUITY X 10^{-3}	-.868	-.02	.120	.02	.016	.01	.147	.01
INSF	4.816	.22	.087	.02	.065	.07	-.815	-.13
WAIT	-4.687	-.17	1.463	.028	.018	.02	.577	.08
FAMH	-15.812	-.70	.911	.21	.005	.01	2.678	.42
EX	-2.758	-.03	-1.398	-.09	-.144	-.04	.458	.02
GOOD	-1.055	-.60	-1.212	-.38	-.105	-.15	.054	.01
FAIR	2.53	.10	-1.072	-.22	-.041	-.04	-.631	-.09
AGE X 10^{-1}	.074	.03	.030	.73	-.016	-.18	.073	.12
BLACK	-1.949	-.10	-.242	-.64	.029	.04	-.522	-.09
PR	.435	.02	-.500	-.12	-.094	-.01	-.599	-.10
EDUC	.478	.39	-.014	-.06	.005	.10	-.081	-.24
MALE	-.392	-.02	-.196	-.05	.095	.11	.004	.00
WELF	4.625	.14	-.597	-.10	.061	.05	-.783	-.09
WORK	4.439	.09	-.082	-.01	.061	.03	-.940	-.07
NMAIN	27.767	.17	-1.592	.05	-.005	-.00	-4.623	-.10
HABIT	-.691	-.45	.041	.14	.001	.01	.135	.32
BUS1	.754	.04	.021	.01	.029	.04	.640	.12
BUS2	-8.928	-.26	.701	.11	.088	.06	3.749	.39
CAR	9.420	.06	-.370	-.01	.076	.01	.463	.01
TAXI	38.510	.46	-2.096	-.13	.044	.01	-5.063	-.22
BUS1P	-13.585	-.12	3.835	.17	.067	.01	2.300	.07
BUS2P	-14.657	-.06	4.138	.10	.072	.01	2.482	.04
CARP	-9.378	-.04	2.647	.06	.046	.00	1.588	.02
TAXIP	-13.541	-.04	3.823	.06	.067	.00	2.293	.02
CLINS	6.248	1.40	-.339	-.40	.008	.04	-.811	-.65
CONST	.601		1.814		.322		2.172	

[a]Scaling factors adjust only coefficients, not elasticities.

private physician.[1] This would cause physician visits to be neither a substitute nor a complement, making the coefficient estimate ambiguous and imprecise. Hospitalizations appear to be significant technical complements to OPD care, producing an elasticity of 1.72. This strong effect is reasonable, first, because inpatient care frequently requires ambulatory follow-up. Second, hospitalizations produce a budget effect that may increase the demand for less expensive ambulatory care. Third, the municipal OPD clinics act as ports of entry to municipal hospitals.

One of the important predictions of the formal model developed above is that distance to the OPD would function as a price in determining demand. Equation (1) gives significant support to this prediction, producing an elasticity of -2.07. It is unlikely that the time-price elasticity of demand is as high as this elasticity with respect to distance. As indicated above, the distance variable is probably picking up some of the information and monetary costs that were not measured, and therefore it overestimates the elasticity with respect to distance or travel time.[2] If this is so, then the true elasticity with respect to travel time will be smaller in absolute value. In Acton (1973), the travel-time elasticities of demand for OPD care estimated for two low-income neighborhoods in New York City (based on self-reported average travel time) lie between -0.6 and -1.0. The partial effect of method of transportation on the demand for care appears reasonable. Those

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[1] Support for this interpretation is provided by examining the partial effects of health status on the OPD and PRIVE equations. In general, we would expect sicker people to demand more care. This is not supported by the coefficients reported in Eq. (1), where none is significantly different from zero. However, the health status variables are very significant with the expected (negative) sign in Eq. (2) for PRIVE--suggesting that people may be seeking care for relatively nonserious conditions in the OPDs and taking their more serious problems to private practitioners.

[2] Herbert Klarman suggested an additional reason the true elasticity might be closer to zero than the one estimated here. Since people are supposed to receive most of their care from the OPD in their health district, they may lie about their addresses in order to appear to be going to the proper clinic. Alternatively, if the system does succeed in limiting services to those from other health districts, this, too, will make the estimated elasticity greater (in absolute value) than it would be under free selection of clinic.

who walk or take a taxi use the clinic least. Going by bus or subway produces the largest elasticities of demand, whereas using an automobile has a small positive elasticity over walking.

The PRIVE Equation

The structural equation for private physician care complements the estimates from the OPD equation with some important differences. Again, PRIVE and OPD are technical substitute goods. Hospitalizations do not have a significant coefficient in the private physician equation. Distance to the OPD functions as a cross price to PRIVE, producing an elasticity of about 0.05. This cross-price elasticity is considerably smaller than the cross-time elasticities of about 0.6 estimated for private care in Acton (1973). The reason for the difference may be the omission of a measure of the travel distance variable from the structural equation for PRIVE. All we have to measure travel distance are the dummy variables for method of transportation. In this structural equation, the partial effects indicate that walkers demand the least care, those taking one bus or subway, the most, and those using other means lie between. The very significant differences between the elasticities suggest that distance is playing an important deterrent role in demand (this conclusion is supported by the reduced form coefficients reported in Table 2).

The Hospitalization Equation

The structural equations for hospitalization reveal effects for the endogenous variables consistent with the other equations. OPD and private physician visits are complements to hospitalization, with elasticities around 0.17 and 0.09. The distance to an OPD has a positive effect on the demand for hospitalizations (elasticity equals 0.25), indicating that distance is functioning again as a cross price.

The Distance Equation

The only included endogenous variable in explaining distance to the OPD is volume of OPD services, arguing that those who go more frequently will want to reduce the travel price they have to pay. Equation (4)

indicates an elasticity of -0.60, although the t-value on the coefficient is only about one.

THE REDUCED FORM EQUATIONS

The chief value of the reduced form equations is to indicate the net influence of the exogenous variables on the dependent variables. Consequently, the effects of a few key variables will be examined across equations and the estimated coefficients will be compared with the predictions of Section II.

The Role of Travel Distance and the Value of Time

There were several predictions about the time intensity of demand for various types of care. The effect of the endogenous variable distance is shown in the structural equations; the net effect of the exogenous variables is revealed in the reduced form equations. The first prediction, that time (and travel distance) would function as a price, was supported by the structural equations. They reveal a negative (own-price) coefficient on the variable DIST in the OPD equation and a positive (cross-price) coefficient in the PRIVE and HOSP equations. Second, we expect those with a higher opportunity cost of time to demand less time-intensive care. This prediction is not supported by reduced form Eq. (8), where earned income enters the DIST equation with a positive sign and an elasticity of 0.13. However, working people travel shorter distances than nonworking people. Furthermore, people with a higher opportunity cost of time demand noticeably less time-intensive OPD and hospital care and more private physician care. A third prediction of the formal model with respect to travel time is that the elasticity of demand will be greater (in absolute value) at free than at nonfree sources of care. Data limitations prevent a powerful test, but the method of transportation variables lend support to this hypothesis. The elasticities with respect to method of transportation to OPD are generally greater (in absolute value) than the corresponding elasticities for method of transportation to private ambulatory care. Finally, as suggested above, those who have been going to one particular clinic for a long time (HABIT) are willing to travel farther to receive their care.

Income and Assets

Unless service from a provider is an inferior good, the nonearned income elasticity should be positive. Equations (5), (6), and (7) show a positive elasticity of demand for OPD and private physician services and a negative elasticity for hospital care, suggesting that outpatient care is a normal good and hospitalization is an inferior good. The effects of earned income depend on the time intensity of medical goods relative to other goods and services. The reduced form coefficients show a positive elasticity of demand for private outpatient care with respect to GRWAGE and a negative elasticity of demand for public care. This confirms the popular impression that OPD and hospital care are time intensive relative to private physicians' care and relative to all other goods and services. The net effect of assets reflect the fact that relatively poor people are using the OPD and that otherwise health care is a normal good.

Education and Age

Two other predictions from the formal models involve the effects of education and age. Grossman (1972) suggested that those with more education would, in net, be more efficient producers of health, causing a negative coefficient on education (as long as the price elasticity of demand for health is less than one). The availability of two alternative sources of care means we can introduce the additional test of whether more educated persons prefer one type of provider to another. The reduced form equation coefficients do not support the hypothesis that there is a taste preference for private care. Further, in light of the positive coefficient on EDUC in the OPD equation, the negative coefficient in PRIVE provides only tentative support to the "efficiency of production" hypothesis. The investment model also predicted a positive correlation of age and the depreciation rate on health. The present data on ambulatory utilization show a positive net effect of age, which supports the hypothesis that depreciation in the health stock increases with age. The negative coefficient on age in the hospitalization equation may indicate older persons going to nursing homes.

The remainder of the coefficients describing health status, insurance, and sociodemographic characteristics of the population generally conform to the expectations based on other studies. As found by most researchers, those in better health demand less inpatient and outpatient care. The effect of at least one family member's having fair or poor health (FAMH) produced some unexpected results. In general, the positive correlation of health status in the family and the budget effect of a very sick member should either increase utilization at each source of care or cause a shift to public care. The negative coefficient in the OPD equation (Eq. 5) is opposite and may again reflect more serious health problems being taken to private care. Although it is an imprecise variable, if anyone in the family has health insurance, the person will seek more medical services, both public and private. Blacks and Puerto Ricans generally receive less care of all types than do their white counterparts, and they travel shorter distances to receive it. Finally, men seek less ambulatory care and more inpatient care than women. This finding provides further support for the suggestion of Acton (1973) that males may let their health deteriorate further than females do before seeking medical care, so that when they do go, they require more intensive care.

V. CONCLUSION

This study supports the prediction that travel time (as measured by distance) functions as a price in determining the demand for medical services when free care is available. This survey of users of the municipal OPDs indicates negative own-price elasticities with respect to travel distance at free providers and positive cross-price elasticities for nonfree providers of care. Further, the estimated distance elasticity is considerably larger than the money-price elasticities that have been estimated by a number of researchers.[1] The predicted negative effect of earned income on distance was not found, but workers travel shorter distances, and persons with higher opportunity cost of time are more likely to use the private sector, which is relatively less time intensive than the public sector. Further, although the data do not permit a powerful test, they support the model's prediction that demand for free care is more sensitive to changes in time prices than demand for nonfree care.

The analysis of the income data variables suggests some interesting conclusions (although the unverified nature of self-reported income means nice conclusions should be regarded with caution). The nonearned income elasticities suggest that ambulatory care is a normal good and public inpatient care an inferior good. The model predicted that the influence of earned income would depend on the time intensity of medical goods versus all other goods and services. The reduced form equations show a negative earned income elasticity for public outpatient and hospital care and a positive elasticity for private ambulatory care. This implies that the substitution (or price) effect of a wage change dominates in the demand for public care and the income effect dominates for nonfree cases, as the formal model suggested.

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[1] Feldstein (1971), Davis and Russell (1972), and Rossett and Huang (1973) have all reported money-price elasticities in the range -0.5 to -1.0, although there is reason to believe these estimates are biased upward (see Newhouse and Phelps, 1973). Other more conservative measures of the money-price elasticity (using several data sources) place it around -0.15; see Phelps and Newhouse (1973).

These data lend partial support to two hypotheses of the Grossman (1970 and 1972) investment models. The observed effect of education is mixed, but the equation describing demand for private care is compatible with the interpretation that more educated persons are more efficient producers of health. Second, the effects of age in the ambulatory care equations suggest that depreciation in the health stock increases with age.

SELECTED POLICY IMPLICATIONS

Perhaps the most important policy implication of this study is the increasingly significant role we can expect time to play in determining the demand for care. As money prices out of pocket are reduced, because of either the continued spread of private insurance or the enactment of a federal health insurance scheme, demand will become more responsive to time prices. In turn, this will permit persons with a lower opportunity cost of time to bid services away from those with a higher opportunity cost of time because they will face a price that is relatively less costly. This conclusion holds even if there is not differential coverage by income class and even if there is no supply side response increasing the time prices. It is likely that a shift in demand will be accompanied by an increase in the time needed to receive a unit of medical services.[1] This will further increase the relative shift in favor of those with a lower opportunity cost of time.

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[1] This supply response is likely for a number of reasons. First, it may be optimal from the point of view of the provider to have a queue to even out the variation in demand that he experiences without having to invest in significant excess capacity. A shift in demand will generally cause the optimal queue length to change (for instance, the opportunity cost of an idle moment of the supplier's facility is higher). Second, the suppliers may not be profit maximizers, so that they do not respond to a shift in demand by charging the highest possible monetary prices but instead allow time prices to increase. In particular, physicians may be income satisficers rather than maximizers. See Newhouse (1970), Frech and Ginsburg (1972), and Newhouse and Sloan (1972) for a discussion of physician pricing behavior. Third, there may be a conscious attempt to redistribute services by discriminating in favor of those with a lower opportunity cost of time. See Nichols, Smolensky, and Tideman (1971) for a discussion of the first and third points.

A second set of implications applies to policymakers who are trying to increase medical care usage by target groups in the population. Important options to consider include shortening distance to medical facilities, shortening waiting time, and considering the degree to which income subsidies might be substituted for subsidized purchase of medical services.

CLINIC LOCATION

There is a significant and substantial own-time-price elasticity of demand for outpatient department services with respect to travel distance. A number of policy options are available for altering the effects of travel distance, ranging from improved transportation facilities to the building of new clinics and health centers. The elasticities show that moving centers closer to the users will substantially increase the demand for care at those centers. For instance, when the City, OEO, or another agency is thinking about opening a new clinic to serve a target population, it may want to consider building a number of smaller clinics rather than one large clinic to serve the population.[1] Alternatively, faster means of transportation to more distant facilities may achieve the same goal. This observation should not be interpreted as a recommendation to create more clinics or smaller clinics. Obviously the decision rests on a number of factors, such as the cost of building centers of various sizes, the benefit of serving additional persons, and the alternative means of achieving the same goals.

SHORTENING QUEUES

One alternative means of achieving the goal of increased service is to reduce waiting in existing or new facilities. Acton (1973) found significant negative demand elasticities with respect to waiting. Although they are not as large as the estimated travel time elasticities,

[1] In fact, this notion of creating satellite clinics seems to have been considered by the City of New York in recent years (Irving Leveson, personal communication, October 1972). The Kaiser-Permanente groups have used this configuration of several clinics located throughout a community associated with a central hospital.

it is clear that longer waiting times do discourage use, and mechanisms that reduce waiting time should increase use. For instance, scheduling appointments in OPDs might prove successful in reducing waiting time. This implication is not limited to New York City. Many hospitals across the nation give all the patients a morning appointment (say, 9:00) or an afternoon appointment (say, 1:30). If this results in a wait, on the average, of 90 minutes, and appointments on the hour for 9:00, 10:00, or 11:00 reduced the average wait to 30 minutes, the elasticities reported in Acton (1973, Table 3) suggest that this will increase demand approximately 12 percent.[1]

TRADEOFFS OF SUBSIDIZED CARE AND INCOME SUPPLEMENTS

Many people have expressed concern over the level of medical services consumed by target populations and conclude that a variety of measures are needed to improve access. In one form or another, most proposals reduce to a subsidized provision of services, whether through social insurance schemes such as Medicaid or various national health insurance proposals, or through direct provision of care as in Neighborhood Health Centers or the requirement that Hill-Burton hospitals provide charity care. But as Davis (1972) has correctly noted, there is seldom a consideration of the extent to which changing the income distribution will alleviate the desire to subsidize the medical purchase. Even in the Administration's proposals for income maintenance, FAP, and subsidized medical care for the poor, FHIP, there is little discussion of the degree to which one can be substituted for the other.

Income subsidy will not, in general, meet the objective of risk-spreading for medical expenses (unless it induces a significant demand for health insurance), but it will raise the average demand for medical services in the subsidized population. The equations reported in Tables 1 and 2 put us in a position to address this question of substituting income maintenance for subsidized medical care to achieve a given increase in health consumption. Since income maintenance is a nonearned source of income, the elasticity of demand for medical care with respect

[1] This is an arc elasticity based on the elasticity calculated at the mean.

to changes in nonearned income is used. A hypothetical example, not based on actual FAP and FHIP provisions, will serve to illustrate. The estimation results in Table 2 indicate that a $1000 increase in nonearned income for a family with a current nonearned income of about $400 and earned income of about $2900 (in 1965) will produce an eight percent increase in the demand for private practitioners' care per person. If the money-price elasticity of demand for ambulatory medical services is around -.15 over the range under consideration,[1] and the out-of-pocket expenditure is reduced from 25 percent of money price to 12.5 percent (the upper limit and midpoint of the FHIP coinsurance rates), then the demand for private care will increase by 10 percent. Clearly, one means of increasing private medical consumption by the poor is income supplementation, and the magnitude of the change may be comparable over the range of subsidy and income guarantee under consideration.

[1]The actual money-price elasticity may be even lower than this. See Phelps and Newhouse (1973) for a discussion of the price elasticities in several published reports.

Appendix A

DEFINITION OF VARIABLES USED AND THEIR MEAN VALUES[1]

AGE = Age in years. Means = (35.6, 31.1).

BLACK = Dummy variable equaling one if Negro or indeterminable, or other than Puerto Rican, Mexican-American, American Indian, or other white. Means = (.38, .41).

BUS1 = Dummy variable equaling one if patient's usual means of transportation to the clinic requires one bus or train. Means = (.42, .42).

BUS2 = Dummy variable equaling one if patient's usual means of transportation to the clinic requires two or more buses or trains. Means = (.23, .21).

BUS1P = Dummy variable equaling one if patient's usual means of transportation to private doctor requires one bus or train. Means = (.07, .08).

BUS2P = Same as above except two or more buses or trains. Means = (.03, .03).

CAR = Dummy variable equaling one if patient's usual means of transportation to the clinic was by car driven either by individual or a friend. Means = (.05, .06).

CARP = Same as above except to private doctor. Means = (.03, .03).

CLINS = Total number of clinics used last year. Means = (1.71, 1.29).

DIST = Distance in miles to the hospital of interview. Means = (2.14, 2.13).

EDUC = Highest grade completed, in years. Means = (6.25, 6.23).

EQUITY = Equity in home. Means = ($207, $198).

ERNRS = Number of earners in the family. Means = (.83, .91).

EX = Dummy variable equaling one if health status of patient is excellent. Means = (.095, .13).

FAIR = Dummy variable equaling one if health status of patient is fair. Means = (.30, .27).

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[1] The first mean value is for the unweighted data and the second is for the data weighted by 1/OPD to adjust for the probability of being sampled.

FAMH = Dummy variable equaling one if all family members reported health as good. Means = (.34, .33).

GOOD = Dummy variable equaling one if health status of patient is good. Means = (.46, .48).

GRWAGE = Gross annual earnings from all wage earners in the family. Means = ($2929, $3215).

HABIT = Number of years patient has been coming to current clinic. Means = (5.03, 4.10).

HOSP = Number of hospitalizations last year. Means = (.32, .30).

HSSIZE = Number of persons in individual's household. Means = (3.67, 3.92).

INSF = Dummy variable equaling one if any family member has medical insurance. Means = (.35, .36).

LIQUID = Liquid assets. Means = ($177, $207).

LNGWT = Dummy variable equaling one if patient had to wait a long time before being taken care of at the hospital where he was interviewed. Means = (.59, --).

MALE = One if male, zero if female. Means = (.38, .39).

NMAIN = Dummy variable equaling one if main source of medical care is other than the same clinic as at time of interview. Means = (.047, .064).

NWAGE = Nonearned family income in last year. Means = ($878, $802).

OPD = Number of visits in last year to a physician in a clinic. Means = (7.65, 2.97).

PR = One if Puerto Rican; zero otherwise. Means = (.34, .35).

PRIVE = Number of visits in last year to a physician in his private office. Means = (1.46, 1.63).

TAXI = Dummy variable equaling one if patient's usual means of transportation to the clinic was by taxi. Means = (.091, .095).

TAXIP = Same as above except to his private doctor. Means = (.021, .020).

WAIT = Dummy variable equaling one if patient had to wait longer in the hospital where he was interviewed than in private doctor's office. Means = (.28, --).

WELF = Dummy variable equaling one if individual had some type of welfare assistance. Means = (.24, .22).

WORK = One if individual worked either full or part time. Means = (.16, .20).

Appendix B

DETAIL OF THE FORMAL MODEL OF DEMAND FOR MEDICAL SERVICES

The formal model is developed in terms of a two-good utility function, medical services, m, and a composite good, X, and has people pay in both money and time for each good. If the proportion of money and the price per unit of the good remains fixed and the full wealth assumption is used, the objective is to maximize

$$U = U(m,X) \qquad \text{(A-1a)}$$

subject to

$$(p + wt)m + (q + ws)X \leq Y = y + wT, \qquad \text{(A-1b)}$$

where

U = utility,

m = medical services,

X = all other goods and services,

p = out-of-pocket money price to the consumer per unit of medical services,

t = own-time input per unit of medical services consumed,

q = price per unit of X,

s = own-time input per unit of X consumed,

Y = total (full) income,

y = nonearned income,

w = earnings per hour, and

T = total amount of time available for market and own production of goods and services.

I assume that all equations are twice-differentiable and that the first derivatives of the utility function are positive, the second derivatives negative, and the cross derivatives positive.[1] The conditions for

[1]These assumptions are sufficient to imply that both goods are normal and that a rise in their price will reduce demand.

maximizing utility are found by forming the Lagrangian expression

$$L = U(m,X) + \lambda[m(p + wt) + X(q + ws) - y - wT]. \tag{A-2}$$

Differentiating with respect to the three unknowns, m, X, and λ, and setting these equal to zero gives the first order conditions for a maximization:

$$\frac{\partial L}{\partial m} = U_m + \lambda(p + wt) = 0, \tag{A-3a}$$

$$\frac{\partial L}{\partial X} = U_x + \lambda(q + ws) = 0, \tag{A-3b}$$

and

$$\frac{\partial L}{\partial \lambda} = m(p + wt) + X(q + ws) - y - wT = 0, \tag{A-3}$$

where definitionally,

$$U_m \equiv \frac{\partial U}{\partial m} \text{ and } U_X \equiv \frac{\partial U}{\partial X} .$$

<u>EFFECTS OF A CHANGE IN PRICE</u>

To calculate the effect of a change in the out-of-pocket money price of m on the demand for m, we must differentiate the system of Equations (A-3) with respect to p yielding:

$$U_{mm} \frac{\partial m}{\partial p} + U_{mX} \frac{\partial X}{\partial p} + (p + wt) \frac{\partial \lambda}{\partial p} = - \lambda, \tag{A-4a}$$

$$U_{Xm} \frac{\partial m}{\partial p} + U_{XX} \frac{\partial X}{\partial p} + (q + wt) \frac{\partial \lambda}{\partial p} = 0, \tag{A-4b}$$

and

$$(p + wt) \frac{\partial m}{\partial p} + (q + ws) \frac{\partial X}{\partial p} = -m . \tag{A-4c}$$

If we designate the determinant of the matrix of coefficients $|D|$, then

$$|D| = \begin{vmatrix} U_{mm} & U_{mX} & (p + wt) \\ U_{Xm} & U_{XX} & (q + ws) \\ (p + wt) & (q + ws) & 0 \end{vmatrix} \qquad \text{(A-4d)}$$

$$= 2U_{mX}\,(q + ws)(p + wt)$$

$$- U_{XX}\,(p + wt)^2 - U_{mm}\,(q + ws)^2 .$$

Necessary conditions for maximization are that the determinants alternate in sign. Sufficient conditions for $|D|$ to be unambiguously positive are that U_{XX} and $U_{mm} < 0$ and U_{mX} and $U_{Xm} > 0$. We can solve for $\partial m/\partial p$ by Cramer's rule:

$$\frac{\partial m}{\partial p} = \frac{\begin{vmatrix} -\lambda & U_{mX} & (p + wt) \\ 0 & U_{XX} & (q + ws) \\ -m & (q + ws) & 0 \end{vmatrix}}{|D|} \qquad \text{(A-4e)}$$

$$= \frac{-mU_{mX}(q + ws) + mU_{XX}(p + wt) + \lambda(q + ws)^2}{|D|} .$$

Since λ is necessarily negative by (A-3a) and (A-3b), $\partial m/\partial p$ is unambiguously negative--medical services, m, is acting as a normal good; with a higher money price, people demand less.

Similarly, we can calculate the effect of a change in the time price of m on the demand for m. Differentiating with respect to t yields

$$U_{mm}\frac{\partial m}{\partial t} + U_{mX}\frac{\partial X}{\partial t} + (p + wt)\frac{\partial \lambda}{\partial t} = -\lambda w, \tag{A-5a}$$

$$U_{Xm}\frac{\partial m}{\partial t} + U_{XX}\frac{\partial X}{\partial t} + (q + ws)\frac{\partial \lambda}{\partial t} = 0, \tag{A-5b}$$

and

$$(p + wt)\frac{\partial m}{\partial t} + (q + ws)\frac{\partial X}{\partial t} = -mw \quad . \tag{A-5c}$$

Using Cramer's rule again,

$$\frac{\partial m}{\partial t} = \frac{\begin{vmatrix} -\lambda w & U_{mX} & (p + wt) \\ 0 & U_{XX} & (q + ws) \\ -mw & (q + ws) & 0 \end{vmatrix}}{|D|} \tag{A-5d}$$

$$= \frac{-mw\, U_{mX}\,(q + ws) + mw\, U_{XX}\,(p + wt) + \lambda w(q + ws)^2}{|D|},$$

which is also unambiguously negative. That is, time is also functioning as a price in determining the consumption of m.

For reference, it is interesting to calculate the total-price elasticity of demand for m. Differentiating Equations (A-3) with respect to (p + wt), we find

$$U_{mm}\frac{\partial m}{\partial(p + wy)} + U_{mX}\frac{\partial x}{\partial(p + wt)} + (p + wt)\frac{\partial \lambda}{\partial(p + wt)} = -\lambda, \tag{A-6a}$$

$$U_{Xm}\frac{\partial m}{\partial(p + wt)} + U_{XX}\frac{\partial x}{\partial(p + wt)} + (q + ws)\frac{\partial \lambda}{\partial(p + wt)} = 0, \tag{A-6b}$$

and

$$(p + wt)\frac{\partial m}{\partial(p + wt)} + (q + ws)\frac{\partial X}{\partial(p + wt)} = -m \quad . \tag{A-6c}$$

so

$$\frac{\partial m}{\partial(p + wt)} = \frac{\begin{vmatrix} -\lambda & U_{mX} & (p + wt) \\ 0 & U_{XX} & (q + ws) \\ -m & (q + ws) & 0 \end{vmatrix}}{|D|} \tag{A-6d}$$

$$= \frac{-mU_{mX}(q + ws) + mU_{XX}(p + wt) + \lambda(q + ws)^2}{|D|} .$$

Thus, we find that

$$\frac{\partial m}{\partial(p + wt)} = \frac{\partial m}{\partial p} . \tag{A-6e}$$

The three price elasticities are related in the following manner:

$$\eta_{mt} = \frac{wt}{(p + wt)} \eta_{m(p + wt)} \tag{A-7a}$$

and

$$\eta_{mp} = \frac{p}{(p + wt)} \eta_{m(p + wt)} . \tag{A-7b}$$

Consequently, it follows that $\eta_{mp} \gtrless \eta_{mt}$ as $p \gtrless wt$.

<u>EFFECTS OF A CHANGE IN INCOME</u>

The effects of a change in earned and nonearned income are systematically related, but they are not, in general, the same. The effect of a change in nonearned income is straightforward to calculate. Differentiating Equations (A-3) with respect to y yields:

$$U_{mm} \frac{\partial m}{\partial y} + U_{mX} \frac{\partial X}{\partial y} + (p + wt) \frac{\partial \lambda}{\partial y} = 0, \tag{A-8a}$$

$$U_{Xm} \frac{\partial m}{\partial y} + U_{XX} \frac{\partial X}{\partial y} + (q + ws) \frac{\partial \lambda}{\partial y} = 0, \tag{A-8b}$$

and

$$(p + wt) \frac{\partial m}{\partial y} + (q + ws) \frac{\partial X}{\partial y} = 1 \quad . \tag{A-8c}$$

Thus,

$$\frac{\partial m}{\partial y} = \frac{\begin{vmatrix} 0 & U_{mX} & (p + wt) \\ 0 & U_{XX} & (q + ws) \\ 1 & (q + ws) & 0 \end{vmatrix}}{|D|} \tag{A-8d}$$

$$= \frac{U_{mX} (q + ws) - U_{XX} (p + wt)}{|D|} ,$$

which is unambiguously positive. The demand for medical services is normal; with more nonearned income, people demand more.

We can see the effect of a change in the earnings per hour by differentiating with respect to w:

$$U_{mm} \frac{\partial m}{\partial w} + U_{mX} \frac{\partial X}{\partial w} + (p + wt) \frac{\partial \lambda}{\partial w} = - \lambda t, \tag{A-9a}$$

$$U_{Xm} \frac{\partial m}{\partial w} + U_{XX} \frac{\partial X}{\partial w} + (q + ws) \frac{\partial \lambda}{\partial w} = - \lambda s, \tag{A-9b}$$

and

$$(p + wt) \frac{\partial m}{\partial w} + (q + ws) = - mt - Xs + T \quad . \tag{A-9c}$$

Cramer's rule yields:

$$\frac{\partial m}{\partial w} = \frac{\begin{vmatrix} -\lambda t & U_{mX} & (p + wt) \\ -\lambda s & U_{XX} & (q + ws) \\ T\text{-}mt\text{-}Xs & (q + ws) & 0 \end{vmatrix}}{|D|} \tag{A-9d}$$

$$= \frac{(T\text{-}mt\text{-}Xs)U_{mX}(q + ws) - (T\text{-}mt\text{-}Xs)U_{XX}(p + wt) - \lambda s(q + ws)(p + wt) + \lambda t(q + ws)^2}{|D|} .$$

The effects of a change in the wage rate can be broken into an income effect and a substitution effect:

$$\frac{\partial m}{\partial w} = (T\text{-}mt\text{-}Xs)\,\frac{\partial m}{\partial y} - \frac{\lambda s(q + ws)(p + wt) - \lambda t(q + ws)^2}{|D|} . \tag{A-9e}$$

The first term, the income effect, is by assumption positive. The sign of the substitution effect depends on the relative time intensity of the goods m and X. If the time component of total price is larger for X than it is for m, there will be a positive substitution from X to m. That is, the substitution term is positive if and only if

$$\frac{ws}{(q + ws)} > \frac{wt}{(p + wt)} . \tag{A-10a}$$

It is easy to show that the substitution effect is negative if medical care is "free." Substituting p = 0 into (A-10a), canceling common terms, and multiplying through by (q + ws) yields

$$ws < (q + ws) . \tag{A-10b}$$

Therefore, the substitution effect is negative.

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