DEMAND FOR HEALTH CARE AMONG THE URBAN POOR, WITH SPECIAL EMPHASIS ON THE ROLE OF TIME

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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 and *Effects of Coinsurance on the Demand for Physician Services*, R-976-OEO, both by Charles E. Phelps and Joseph P. Newhouse, and *Demand for Health Care When Time Prices Vary More than Money Prices*, R-1189-OEO/NYC, by Jan Paul Acton. 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 the City.

SUMMARY

This report examines the determinants of the demand for medical services by type of provider. A major purpose of this study is to anticipate the factors that may ration 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 on the demand for care of changes in money prices, travel time and waiting time, and earned and non-earned income. These predictions are tested using household survey data from two New York City neighborhoods that were about to receive an OEO Neighborhood Health Center. New York is a particularly good place to conduct this analysis because the availability of an extensive public health sector allows us to observe demand behavior that might exist under some form of National Health Insurance.

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 and waiting time as the money prices shrink with spreading insurance coverage. The model also predicts differential effects of earned and non-earned income on the demand for care. The predictions of the model were tested for public and private ambulatory and inpatient care.

The demand equations had as explanatory variables the parameters thought to be important from the theoretical model plus a number of socio-demographic variables to control for level of demand. The Tobit technique was used for estimating the coefficients of the multivariate equations. Data limitations do not permit estimation of a money price elasticity, but this limitation is not as severe in this study as it might be because of the extensive use of free services (for which the money price is zero).

The principal finding of the study is that travel and waiting time function as prices in rationing the demand for medical services. With higher time prices, people demand less care from a given type of provider. Furthermore, the magnitude of the effects suggests that, at least in these two populations, demand is already more sensitive to variation in time prices than it is to variation in money prices of medical services. In addition, there were significant (and different) effects of changes in earned and non-earned income on demand, a very significant effect of health-status on demand, and significant differences by race.

One important implication of this study is the support for the assertion that time may replace money as the chief determinant of demand under National Health Insurance or extensive private coverage. A second is that if we wish to increase medical access of certain target populations, then reducing the travel or waiting time associated with receiving care is an important alternative to consider. A third implication is that when we are considering ways to increase the access of poor persons to medical care, we should explicitly consider the degree to which an income subsidy fills that goal rather than a direct subsidy of medical care. The research reported here suggests that, in the range of coinsurance rates that may be under consideration, income guarantees may be as effective in increasing aggregate demand for medical care by the poor as lowering the out-of-pocket medical expenditure for the care.

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CONTENTS

I. INTRODUCTION

This study examines the demand for medical services by type of provider with particular emphasis on the role of time as a determining factor. The demand for health and medical services has attracted considerable interest in recent years because of the dramatic increase in health expenditures and because of substantial cost inflation in that sector. Although the causes of this rise in demand and cost inflation are complex to analyze, there is reason to believe that the substantial spread of reimbursement insurance in the last 20 years has played a major role by reducing the out-of-pocket money price the consumer faces in buying medical care.[1] Health research is focusing more and more on the economic determinants of this demand--explicitly including third party expenses.[2] Surprisingly, there has been almost no discussion of alternative rationing mechanisms that might become effective if money prices continue to decrease in importance as a result of spreading third party reimbursement. Since there is every reason to believe that money prices will continue to decline in relative importance because of (1) the secular trend in third party coverage, (2) the rising opportunity cost of time, (3) increases in time required to receive care, and, perhaps most important, (4) the prospect of National Health Insurance, it is necessary to examine other factors that may control demand.

In this report I suggest that travel time and waiting time may replace money prices as the chief determinant of demand.[3] First, I

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[1]See Newhouse and Acton (1972) for a discussion of this point.

[2]See especially Davis and Russell (1972), Feldstein (1971), Phelps (1973), Phelps and Newhouse (1973) and Rosett and Huang (1973).

[3]If demand increases in response to spreading insurance, in addition to increases in waiting and travel times, the supply responses may be to (a) increase the number of referrals to other providers, (b) cause a postponement in treating some conditions, or (c) change the quality of services being provided. Increased referrals and postponement are alternative forms of greater time costs. In this study,

develop a model of the demand for medical services with time explicitly included as part of the price of the goods purchased. The model predicts that the time-price elasticity of demand for medical services will exceed the money-price elasticity as out-of-pocket money prices become smaller. It also predicts that changes in time prices will have a greater effect on demand for free medical services than on the demand for non-free services. The model further predicts a differential effect of earned and non-earned income on the demand for medical services. A rise in non-earned income increases the demand for medical services; the effect of a rise in earned income cannot be predicted because it produces both an income and a price effect (by raising the opportunity cost of time).

The data used to test the predictions of this model were taken from two household surveys conducted in New York City. The City is a particularly good laboratory to estimate the importance of time prices and possible behavior under National Health Insurance because of the long-standing availability of free ambulatory and inpatient care through municipal hospitals and clinics. Thus, we get some notion of the steady-state behavior of a population with free, governmentally sponsored care available. Demand equations are estimated for four types of medical care: public ambulatory, private ambulatory, public inpatient, and private inpatient. In addition to a number of controlling variables for health and socio-demographic status, the important explanatory variables include travel and waiting times to alternative sources of care, and earned and non-earned income. The results indicate that in low-income neighborhoods of New York City, time-price elasticities already exceed the money-price elasticity of demand for care.

The report concludes with a number of implications for policy with regard to location of health facilities, queuing practices at ambulatory facilities, and the possibility of substituting income subsidies for subsidy of medical services.

I am concentrating directly on the role of waiting and travel time. The importance of time in determining demand was explored by Becker (1965); its importance in medical care by, among others, Leveson (1970), Holtman (1972), and Auster and Ro (1972).

II. CONSUMPTION MODEL OF THE DEMAND FOR MEDICAL SERVICES

To develop empirically testable hypotheses, a model of the demand for medical services is specified.[1] Details of the model and its implications are described in Appendix C; the major predictions are summarized here. The model concentrates on the role of money prices, time prices, and earned and non-earned income in determining the demand for medical care. The empirical section concentrates on demand for care from public and private providers of ambulatory and inpatient care. For simplicity, the formal model is developed in terms of only one provider of services, but the implications for several providers can easily be drawn.

I assume two goods enter the individual's utility function: medical services, m, and a composite, X, for all other goods and services. With the 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

$$U = U(m,X) \qquad (1a)$$

subject to

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

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 consumed,

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[1] Similar models can be found in Grossman (1970), Becker (1965), and Acton (1973).

q = money price per unit of X,

s = own-time input per unit of X,

w = earnings per hour,

Y = total (full) income,

y = non-earned income, and

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

First, note the consumption of medical services, m, does not affect the amount of time available for production, T.[1] Second, p is the out-of-pocket expenditure for a unit of medical services, incorporating any deductible and coinsurance rate the individual faces from insurance. It would be appealing to make these insurance parameters endogenous, but data limitations do not permit the estimation of demand for insurance along with the demand for services.[2] Third, the manner in which the goods produce utility is not specified. Some researchers have entered the argument "health" in the utility function and allowed health to be produced by combining medical services with other inputs.[3] The argument "health," enters because of a demand for the "healthy days" it will cause. The interested reader may consult Phelps (1972) or Grossman (1972) for these alternative motivations of the demand for medical services. For present purposes, an understanding of this mechanism is not necessary. The simpler formulation used here yields most of the same predictions as the other specifications. Furthermore, the data do not allow us to estimate the manner in which medical services are translated into health.

EFFECTS OF A CHANGE IN PRICE

Assumptions sufficient to make money function as a price in determining the demand for medical services are also sufficient to

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[1] See Grossman (1972) for a formulation allowing this feature.

[2] See Phelps (1973) for a theoretical and empirical treatment with insurance endogenous.

[3] See Lancaster (1966) for a similar formulation of demand in terms of the attributes of a good.

make time function as a price.[1] Therefore, the first prediction of this model is that if medical services are a normal good, time will function as a price--producing negative own time-price elasticities of demand and positive cross time-price elasticities.

One of the chief interests in this study is the relative importance of money 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 price is[2]

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

That is, the elasticity with respect to one component of the price equals the elasticity with respect to the total price weighted by the share of the total price due to that component. 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

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[1]Although they are more restrictive than necessary, sufficient 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.

[2]As shown in Appendix C, $\eta_{m(wt)} = \eta_{mt}$. These elasticities are only approximate in the long run if insurance premiums are adjusted to reflect the changes in utilization.

to changes in time prices. Furthermore, this implies that the demand for free medical services should be more responsive to changes in time prices than demand for non-free services, because time is a greater proportion of the total price at free than at non-free 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 non-earned 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 non-earned income will produce an increase in the demand for medical services. So the first prediction about income is that there will be a positive non-earned income elasticity of demand for normal goods.

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 to the time intensity of the price of all other goods and services. We can break the effects of a change in the wage rate, w, 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 an income effect and is, by assumption, positive. The second term is the substitution of m for X because of a change in w. We can establish that the substitution term 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 Eq. (4) will not be met as long as there is a non-zero monetary price for X; that is, an increase in the wage rate will always cause a substitution effect away from the free good. 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 primarily a price effect (and therefore likely to be negative) and the effect of a wage change on the demand for non-free sources is primarily an income effect (and therefore likely to be positive).

The predictions on the effect of income can be summarized as follows: If a particular source of medical service supplies a normal good, then an increase in non-earned income will cause an increase in the demand for that good. A change in the wage rate has an ambiguous effect, *a priori*, but 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 non-free sources of care.[1]

PREDICTIONS FROM OTHER FORMAL MODELS

The simplified consumption model is adequate to generate empirically verifiable hypotheses for the variables of primary interest in this study. The Grossman (1970, 1972) investment model provides additional predictions regarding the effects of education and age that can be tested with the present data. Grossman enters health into the utility function and lets health be produced by combining medical and other inputs. He argues that more educated persons will be more skillful in combining medical inputs to produce health, so that, when all other things are accounted for, he expects to find a

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

negative relation between education and the amount of medical services demanded. His argument requires the assumption that the price elasticity of demand for health is less than one[1] and that more educated persons have not developed a "taste" for health that overcomes the savings due to increased efficiency in production. In my empirical test, I observe the net effects of efficiency and taste only if both exist.

The second implication of the Grossman formulation involves investment in health over the life cycle. If the price elasticity of demand for health is less than one, then the effect of age on the demand for medical care is positive if the depreciation rate on health rises with age and negative if it falls with age. In general, we may suspect that the depreciation rate increases over the life cycle, causing a positive effect of age on the consumption of medical care. However, the evidence presented below (and in Acton, 1973), suggests that in poor populations, substantial depreciation in the health stock may be taking place early in life.

SUMMARY OF PREDICTIONS FROM FORMAL MODELS

Briefly, the important predictions for empirical testing from the formal model of demand for health services include:

(1) Time will function as a normal price, with a negative own time-price elasticity of demand and a positive cross time-price elasticity of demand.

(2) Demand for free care will be more sensitive to changes in time prices than will demand for non-free care.

(3) The elasticity of demand for medical services with respect to non-earned income is unambiguously positive (unless care from a particular type of provider is an "inferior" good).

(4) The elasticity of demand with respect to earned income is indeterminate *a priori*, but the price effect is expected to dominate for free care (and thus reduce demand) and the income effect is expected to dominate for non-free care (and thus increase demand).

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[1]In the consumption model he needs to assume that the price and income elasticities are both less than one; Grossman (1970, p. 59).

(5) In the absence of differences in taste for particular types of providers, more education is expected to reduce the demand for care. If there are taste differentials (with the more educated preferring private care), there will be a negative elasticity with respect to education for public care and an elasticity biased upward (possibly positive) for private care.

(6) The human capital model predicts that older persons will demand more medical services than younger ones unless the rate of depreciation in health is higher for the younger persons.

III. THE DATA BASE

In this section, I discuss the source of the data used for estimation, the definition of the variables used for analysis, and the expected effect of these variables. The data used came from two household surveys conducted in 1968 by the National Opinion Research Center (NORC) for the Office of Economic Opportunity (OEO). The surveys were conducted in Brooklyn, New York, to establish baseline characteristics on the population before the Red Hook and Charles Drew (in Bedford-Stuyvesant—Crown Heights) Neighborhood Health Centers were established. Both surveys were conducted on straight probability samples of the target population (I will refer to them as Red Hook and Bedford-Crown). In the completed survey, approximately 1,500 households, containing almost 5,000 individuals, had been interviewed in each study. The completion rates were 82 and 81 percent for the two samples, and there is no evidence of bias in the non-completed interviews.[1]

An advantage in using survey data is that it provides much more detail about the variables of interest than the use of aggregate data. Consequently, it allows more precise estimates of the relationships. A weakness of survey data is that it relies chiefly on self-reporting by the individual for some of the most important variables (notably medical utilization and income). Since the actual amounts are usually underreported, the coefficients may be biased. As long as the underreporting (or overreporting) is proportional, the elasticities will be

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[1]NORC conducted a total of ten baseline surveys for OEO. The Bedford-Crown survey was the second survey and Red Hook the third. The survey instrument improved somewhat, so occasionally we have useful information on the Red Hook sample that is not available for Bedford-Crown. A description of the Bedford-Crown study, along with the survey instrument and selected findings, is available in Richardson (1969a). A similar report on the Red Hook study is Richardson (1969b). Selected findings for the first three NORC studies (Atlanta and the two Brooklyn surveys) are presented in Richardson (1970). Additional analysis is found in Acton (1971).

unaffected.[1] Consequently, in the empirical section I concentrate on the elasticities of the important variables.

SELECTED CHARACTERISTICS OF THE RED HOOK POPULATION

The Red Hook population contains about 25,000 persons. The racial breakdown is 26 percent Puerto Rican, 43 percent "other white," and 30 percent Negro. It is a relatively stable neighborhood (77 percent had lived in the Red Hook area for more than five years); average family size is 4.7 persons. The average income is $5030 per year. Twenty percent of the households had at least one member receiving welfare, and 23 percent fell below the OEO poverty line. The mean age is 27.3 years and the mean educational level is 6.8 years in the full sample.

Approximately 33 percent of the Red Hook population saw a physician in the Out-patient Department (OPD) of a Municipal Hospital or a free-standing clinic during the year, and 48 percent saw a physician in his private office. The average number of visits for users of these physicians is 5.2 and 3.8 per year. In the preceding year, over nine percent of the survey population was hospitalized at least once, and, on the average, hospitalized persons spent 14.6 days in the hospital during the year. Almost 14 percent of the population reported having at least one chronic health condition limiting activity. There is a strong negative correlation between number of chronic conditions and family income, with the under $3000 individuals reporting five times as many chronic conditions as the over $7000.

SELECTED CHARACTERISTICS OF THE BEDFORD-CROWN POPULATION

The general characteristics of the Bedford-Crown survey are similar to the Red Hook population and can be summarized quickly. Bedford-Stuyvesant--Crown Heights is a predominantly black neighborhood.

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[1]Let k proportion of the variable $\bar{x}$ be reported, then the estimated (price) elasticity $\eta_{xp} = (\partial kx/\partial p)(\bar{p}/k\bar{x}) = (\partial x/\partial p)(\bar{p}/\bar{x})$, the same elasticity that would have been estimated with correct reporting.

Blacks constitute 84 percent of all residents, Puerto Ricans 7 percent, and "other white" 9 percent. The mean income is $5599. In Bedford-Crown, almost 20 percent of the families fall below the OEO poverty line and 24 percent had at least one member receiving welfare. Average household size is 4.3 persons. Females head 41 percent of the Bedford-Crown households; only 32 percent of households were so headed in Red Hook. The mean age is 25.2 and educational level is 7.3 years in the full sample.

Although almost 15 percent of respondents reported at least one chronic health condition limiting activity, medical utilization appears generally lower in Bedford-Crown than in Red Hook. Broken down by type of physician visit, 29 percent saw a physician at the OPD of a Municipal Hospital or a clinic (5.0 visits per year), and 40 percent saw a physician in his private office (3.9 visits). Hospitalization shows a similar comparison with Red Hook. Less than 8 percent of the population was hospitalized for an average of 15.3 days per person hospitalized.[1]

DEFINITION OF VARIABLES USED AND EXPECTED EFFECT

In this subsection, I discuss the nature of the variables used for the empirical analysis and their expected effect on the demand for medical services. For reference, Appendix A lists the variables in alphabetical order and provides a brief definition and the mean values. The four dependent variables cover volume of ambulatory and inpatient care. The number of physician visits in an OPD or clinic is

[1]Conversations with OEO officials have indicated that the acceptance of the Neighborhood Health Centers has been different for the two populations. The Red Hook population is changing its behavior by coming to the center for early care and preventive medicine. In Bedford-Crown, the population comes in chiefly for treatment of advanced and chronic conditions. There may be some persistent differences in the two populations that will be reflected in the analysis below. It could simply be a different acceptance of the Neighborhood Health Centers. The Bedford-Crown center is located in a very rough neighborhood and, purportedly, taxi drivers refuse to travel there. This does not appear to be true for the Red Hook neighborhood.

OPDC and the number of private office visits is PRIV. Days of hospitalization in public (municipal) and private (voluntary or proprietary) hospitals are DAZPUB and DAZPRIV. The discussion here will focus on explanatory variables by type--time price, income, socio-demographic and so forth--and the interpretation that may be given to them.

Price Variables

Although the surveys conducted by NORC provide us with both travel time and waiting time information, they did not query the respondents about the money prices paid for medical services. I will consider the bias the omitted money-price variables may cause in the estimation after discussing the time variables, but the problem is not severe since the appropriate monetary price for free care is zero anyway.

The questions about travel time and waiting time were similar in form. After determining the usual source of medical care (general practitioner, specialist, clinic, etc.) NORC asked: "How long does it usually take you to get there (the way you usually go)?" (The travel times used for this analysis are for a round trip.) In the Red Hook Survey they asked a similar question about usual waiting time. They then asked if there were a most trusted source of medical care, and if so, what it was (same options as usual source). Again, a waiting time question was posed in Red Hook. For analysis, it was necessary to associate these times for usual and trusted sources with the dependent variables OPDC and PRIV. This was accomplished by creating travel time variables, TOPDC and TPRIV, and two waiting time variables, ATOPDC and ATPRIV. The waiting time to usual source of care was used for creating the TOPDC variables if the usual source was an OPD or clinic; if it was not, and the trusted source was an OPD or clinic, then the travel time to a trusted source was used. Similarly, if the usual source was a private practitioner, then that time information was used to create TPRIV and ATPRIV. If the usual source was not a private practitioner, but the trusted source was, the trusted source information was used. When trusted and usual providers were of the same type, the time information for the usual source was used. When the above algorithm failed to assign a value to one or more of the time variables (typically because usual and trusted sources of care were both private and TOPDC and ATOPDC were therefore not available), the mean value for those who reported a time were used.[1]

Depending on the particular application of the results, the chief interest may be in the effect of the time variables themselves, or there may be greater interest in the effect of the time variables multiplied by the opportunity cost of the unit of time. Each of the four time-price variables is multiplied by the earned income per minute for working persons to create four alternative time price variables: CTOPDC, CATOPDC, CTPRIV, CATPRIV. When the person is not working or

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[1]The use of a mean value rather than zero for these non-responses was necessary to avoid the implausible situation that higher own time prices are associated with lower utilization except for zero utilization when own time prices are zero. A predicted value of own time price might have been used, but that option is deferred for further analysis. It was necessary to use the mean value for about three-fourths of the times associated with free care and about one-fourth of the times associated with non-free care in both samples.

Using the mean to replace missing values reduced the efficiency in estimating that coefficient, but Charles Phelps demonstrated that use of the mean for some observations does not bias the remaining coefficients so long as the mean is uncorrelated with the remaining variables. Consider the bivariate case where m observations on x_i are known and the next p are replaced with the mean (their true value is $\bar{x}_i + u_i$). The OLS estimator of β is $b = \{\Sigma_m(xy) + \Sigma_p[(x + u)y]\}/[\Sigma_m x^2 + \Sigma_p(x + u)^2] = \{\Sigma_m[(xx\beta) + x\varepsilon] + \Sigma_p[(x + u)\ (x\beta + \varepsilon)]\}/[\Sigma_m x^2 + \Sigma_p(x + u)^2]$. The measurement error for the subset, p, of observation is $u_i = (\bar{x} - x_i)$ so that $\sigma^2_{u_p} = \sigma_{x_p}$ and $\sigma^2_{(x+u)_p} = 0$, where the subscripts on variances indicate the subsample to which they relate. The probability limit of b can be shown to be plim $b = (\sigma^2_{x_m} + \sigma^2_{x_p} + \sigma_{xu_p})\beta/(\sigma^2_{x_m} + \sigma^2_{(x+u)_p})$. Since, in subsample of size p, $\sigma^2_{x_p} + \sigma^2_{u_p} + 2\sigma_{xu_p} = 0$ and $\sigma^2_{x_p} = \sigma^2_{u_p}$, it follows $-\sigma_{xu_p} = \sigma^2_{x_p}$ and plim $b = (\sigma^2_{x_m} + 0)\beta/(\sigma^2_{x_m} + 0) = \beta$.

there is no earned income reported for the family, \$ .01 per minute is used as the value of time.[1]

The travel and waiting time data were reported in intervals. For purposes of estimation, I used interval midpoints. The highest value (recorded as an open interval) was calculated by smoothing a cumulative distribution function through the interval midpoints and estimating an intercept. The mean value for travel time to the sources of care generally requiring no out-of-pocket money expenditure, TOPDC, was 72.9 minutes in Red Hook and 64.0 minutes in Bedford-Crown. The corresponding mean travel time for private physician visits, TPRIV, which generally required a money payment, was 44.6 minutes for Red Hook and 48.8 for Bedford-Crown. The greater mean value for travel time to "free" sources of care provides preliminary evidence to support the theoretical model developed above; people seem to be substituting time payments for money payments in their demand for care. The mean waiting times from Red Hook are 59.1 minutes for ATOPDC and 73.7 minutes for ATPRIV. Although waiting time appears greater at private providers, the total time required to receive free care still exceeds that for non-free care.

The expected effect of the time variables should be clear from the theoretical development. TOPDC and ATOPDC are the own time prices for OPDC and the cross time prices for PRIV. They should have a negative effect on utilization at OPDC and positive effect on PRIV.

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[1]It is necessary to use a non-zero value for the opportunity cost of a unit of time if travel and waiting time are to play a role in determining demand for a specific provider by non-working persons. Otherwise, we are assuming that, in effect, the person is indifferent between traveling a short distance for care and traveling a great distance. Further, physician visits by children frequently cause an adult to spend time accompanying them. The value of 60 cents per hour for this group is arbitrary, but it can be motivated to some degree as a plausible value for the cost of hiring a babysitter. The value of 60 cents is lower than any observed value of earnings per hour in either sample (which was over \$1.00 per hour). A number of researchers have taken a much more detailed look at valuing the time of persons out of the labor force (see, for instance, Gronau, 1973a and b, and references cited). I did not feel a more complicated approach was justified in the current application because of limited information about time allocation of individual family members.

Similarly, TPRIV and ATPRIV are the own time prices for PRIV and cross time prices for OPDC and should act accordingly. The absence of money-price information acts to bias the estimated effect of time prices associated with non-free sources of care. If there is a negative correlation between money prices and time prices, then the absence of money prices in the regression will bias the coefficient on TPRIV upward. This will bias upward (toward zero) the effect of own time price in the PRIV equation and bias downward the effect of cross time prices in OPDC.

For a number of reasons, the demand for medical services may be more responsive to changes in travel time than to changes in waiting time. Travel frequently requires a monetary expense that varies with distance or time; facilities that are farther away require a greater (and unobserved) financial payment. Waiting time does not have this implicit monetary charge. Furthermore, all other things equal, it may be more pleasant to spend a given amount of time waiting than traveling. Both effects lead us to expect a greater elasticity of demand for travel time than for waiting time.

Income

Earned (EARN) and non-earned (NEARN) income were asked in the survey instrument by household. The mean earned income reported in Red Hook was $4110 and non-earned income was $920 per year. The earned and non-earned incomes for Bedford-Crown were $4532 and $1067. The theoretical model showed an unambiguously positive non-earned income elasticity of demand for medical services. The model was developed with medical services as only one good. When there are four components for public and private ambulatory and in-patient care, some may act as inferior goods. In particular, there may be a negative income elasticity of demand for OPDC and DAZPUB. The elasticity with respect to earned income was indeterminate because an increase in earned income also increased the opportunity cost of time.

Relatively few problems were encountered in the income measures in this data file. The figures for earned and non-earned income apply to each member of the family. This differs from the procedure used to create the variables CTOPDC, CATOPDC, CTPRIV, and CATPRIV, where earned income was attributed only to working members of the family. I took the total reported income and subtracted the elements that were non-earned to create the earned income variable. In a few cases, the sum of non-earned incomes exceeded the stated total income (typically, zero was recorded for total, but a monthly Social Security income was reported). In these cases, the amount created by summing up the components was used.

Age

The age term is entered as AGE and AGE^2 to allow for non-linearity in the demand for medical services. The Grossman (1972) formulation suggested a positive correlation between age and the depreciation rate on health. The non-linear specification allows detection of variations in the depreciation rate through the life cycle. In particular, Acton (1973) suggested that the city's poor population may be allowing great depreciation in early years of life.

Insurance

The insurance information is coded in categories that are not mutually exclusive. For ambulatory care, I was forced to create a variable, NOAMB, taking the value one if the person unambiguously had no ambulatory coverage. In Red Hook, this meant he either had no insurance at all or Medicare without the doctor coverage and without private insurance. In Bedford-Crown, this meant only that there was no coverage at all. For inpatient care, two dummy variables, CAID and CARE, could be created to indicate if the person had Medicaid or Medicare. Ideally, I would have liked to have the specific deductible and coinsurance rates of the person faced at the margin, but this was totally beyond the available data.

NOAMB should have a positive sign in the equation for OPDC and a negative sign in the PRIV equation, if their effects are significant. If we assume that, all other things the same (such as out-of-pocket payment), people would prefer to be in a non-governmental hospital, then CAID and CARE should have a negative sign in the equation for

DAZPUB and a positive sign in the DAZPRIV equation. Indeed, it is the popular impression in New York City that the availability of Medicare and Medicaid caused an exodus of patients from City Municipal Hospitals to the private and voluntary hospitals.

Health Status

Several measures of health status are available that seem to be equally powerful in explaining use.[1] I chose CHRON, the number of chronic health conditions that limit activity, because it was available in both surveys. Other variables that could have been used in one data file or the other include: number of days in bed last year; number of days in bed or indoors last year; and self-perceived health status (excellent, good, fair, poor). When I ran regressions with these alternative measures, they all entered with the anticipated sign and were highly significant (t-ratios on the coefficient in excess of 4) and the remaining coefficients were quite stable.

I expect CHRON to enter with a positive sign in all equations. Persons with chronic conditions are more likely to suffer losses to their health stock during the year--making (at least partial) replacement more likely.[2] This is the gross effect of a decrement in health status. It may be that sufficient decrements in health will have a significant income effect, causing a shift to less expensive forms of care. The chief influence of this income effect should be captured in the income coefficients (which is one reason they will be entered non-linearly). If a differential effect on health status persists, it will probably be reflected in a greater coefficient in the OPDC and DAZPUB equations than in the other two equations.

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[1] Ideally, health status lagged one period would be used. It was not available, but its absence is not too serious since the underlying stock of health is highly correlated from one year to the next.

[2] In addition, people with more chronic health conditions probably have a lower stock of health to begin with, so that it takes more medical inputs to achieve a given replacement of health than it would if they had started with a greater stock. This argument assumes that the function transforming medical inputs to health has decreasing returns to scale.

Hospitalization

Days of both public (DAZPUB) and private (DAZPRIV) hospital care were entered in the ambulatory equations to measure decrements in the health stock that occurred during the year. As such, they should act like the health status measures; the more days of hospitalization, the more likely the person is to consume ambulatory care.[1] This should produce positive coefficients on DAZPUB and DAZPRIV in both the OPDC and PRIV equations. I speculate that those who received public inpatient care should be more likely to consume public than private ambulatory care. Those who received private hospital care are more likely to consume private ambulatory care, all other things equal. At least two factors lead us to expect a positive coefficient on DAZPRIV in the OPDC equation. First, many people have insurance that covers inpatient care, but not outpatient (Medicare without Part B is an example).[2] These people may seek inpatient care in private hospitals and ambulatory care in public facilities. Second, there may be an income effect of a long hospitalization in a private facility that causes the person to shift to the public sector for his ambulatory care.

Education

The highest grade completed is coded in years (EDUC). If the Grossman (1972) hypothesis is correct that more highly educated persons are more efficient producers of health, then there should be a negative coefficient in all four equations. If, on the other hand, more highly educated persons have a taste for private over public providers, then we should have a negative coefficient in the OPDC and DAZPUB equations. The coefficient in the PRIV and DAZPRIV equations

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[1] To some degree, inpatient and outpatient care may be substitutes for one another, but I expect their complementary nature to dominate. I checked the sensitivity of the remaining coefficients to the inclusion and exclusion of these hospital variables and found the coefficients practically unchanged.

[2] If everyone's insurance coverage were known in detail, this would not be a problem; but NOAMB is an imperfect measure, as indicated above.

would then be biased toward zero because of the offsetting effects of the efficiency effect and the taste preference.

Race

Two dummy variables are created for Negroes (BLACK) and Puerto Ricans (PR). Since many of the factors expected to affect demand are already entered (notably income and health status), the coefficients on these two variables should reflect differences due to taste for a particular type of provider or discrimination faced by members of particular races. If discrimination is playing a significant role, we should find negative coefficients on BLACK and PR in the PRIV and DAZPRIV equations and positive coefficients in the OPDC and DAZPUB equations.

Sex

A dummy variable, MALE, was created taking the value one if male and zero otherwise. The expectation, based on the aggregate consumption by sex (and ignoring child-bearing as the explanation), is that males will be less intensive users of the system. This may, however, reflect a higher opportunity cost of time that is not controlled for in aggregate data; the current test should shed some light on the partial effect of sex, given value of time. An interesting additional hypothesis to test with this data base is that once they become ill, men will tend to remain under care longer (in a public system that does not require a significant monetary payment at the margin) because they have let their health stock deteriorate more than women have. Thus, we may find a positive coefficient on MALE in DAZPUB.

Household Size

The final variable entered is a variable for household size (HSIZE). All other things the same, larger households will have a lower income per capita, reducing the demand for care at non-free sources. On the other hand, taking a lifetime view of family decision-making, the number of children is an object of choice, making total family income the relevant variable and causing HSIZE to be relatively insignificant.

IV. ESTIMATION TECHNIQUES AND RESULTS

Before discussing the results of the estimation of the theoretical model, I shall devote a word to estimation techniques. Whenever a non-negligible proportion of the observations of the dependent variable take on an extreme value (either high or low), the assumptions underlying ordinary least squares (OLS) regression break down. Intuitively, the reason is that OLS requires equal variance in the error terms associated with the dependent variable, regardless of the values of the independent variables. When the dependent variable is constrained (say it must be greater than or equal to zero), then the variance is reduced near zero. Indeed, in this example, we can never observe negative values.

Such is the case in the estimation here; we never observe negative consumption of medical services. Furthermore, a large proportion of the population reports a zero consumption of any one particular type of service. This general problem was addressed by Tobin (1958), who developed a maximum likelihood estimator for such data (called the Tobit estimator). The technique estimates an index from which can be determined the probability of a non-zero purchase and the expected value of that purchase, given the explanatory variables. As the data approach the assumptions underlying OLS estimation, the Tobit results approach OLS results. See Phelps (1973) for a lucid discussion of the Tobit estimator.

In the theoretical model developed in Section II, a general utility function was used. For purposes of estimation, I have deliberately not specified a particular utility function in order to put as few restrictions as possible on the results. Instead, I have entered important explanatory variables in linear and quadratic form. The system can be viewed as the first two terms of a Taylor expansion around whatever is the true model.

The results of the Tobit estimation are given in Tables 1 and 2. For reference, the OLS estimation results are presented in Appendix B. For reasons just discussed, the Tobit estimations receive all our

Table 1

TOBIT REGRESSION RESULTS WITH TIME WEIGHTED BY THE WAGE RATE (C·TIME)

	Red Hook Dependent Variables								Bedford-Crown Dependent Variables							
	OPDC(Eq. 1)		PRIV(Eq. 2)		DAZPUB(Eq. 3)		DAZPRIV(Eq. 4)		OPDC(Eq. 5)		PRIV(Eq. 6)		DAZPUB(Eq. 7)		DAZPRIV(Eq. 8)	
Variables	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.
CHRON	3.79	12.56	1.88	8.74	17.66	4.10	11.58	10.86	5.32	15.06	3.18	11.79	16.07	5.78	10.76	6.27
EDUC	-.262	4.58	-.0164	.43	1.85	1.63	.441	1.81	-.167	2.41	.121	2.49	-.603	.85	1.29	3.20
MALE	-.705	1.89	-1.79	7.25	5.24	.70	-1.32	.81	-2.06	4.86	-1.87	6.06	2.88	.66	-8.28	3.19
PR	3.72	7.76	-1.29	4.01	8.53	.85	-.735	.35	4.20	3.81	-4.26	5.58	16.46	1.27	9.08	1.51
BLACK	3.66	8.29	-1.27	4.38	3.73	.41	-6.20	3.08	3.96	4.73	-3.29	6.75	22.52	2.14	3.08	.65
HSIZE	-.369	3.71	-.489	7.30	-.863	.43	-1.31	2.88	-.182	1.60	-.194	2.30	.264	.25	-.800	1.16
AGE	.048	1.19	.039	1.41	.810	.90	.484	2.46	.0053	.10	.0340	.90	1.92	3.02	.632	1.80
AGE2 $X10^{-3}$	-.679	1.30	-.608	1.71	-9.78	.76	-6.45	2.27	-.595	.85	-.207	.41	-25.99	2.69	-8.77	1.69
CTOPDC	-.921	1.70	.905	2.23	29.16	2.85	.176	.07	-.895	2.65	-.0171	.07	-8.24	2.17	-4.34	2.10
CTOPDC2	.0139	.25	-.0698	1.85	-1.76	1.71	-.0458	.17	.0722	2.99	-.0074	.38	.930	3.39	.126	.78
CATOPDC	-2.46	3.34	-.515	.97	-46.0	3.40	-2.92	.81								
CATOPDC2	.296	3.31	.0562	.93	4.98	2.77	.349	.80								
CTPRIV	1.159	3.65	-.0174	.09	10.73	1.12	1.20	.92	.286	1.02	-.147	1.08	10.82	1.41	3.00	1.56
CTPRIV2	-.0374	1.87	.0154	1.38	-1.40	.94	-.0304	.37	-.0154	1.03	.0051	1.37	-2.85	1.65	-.154	1.14
CATPRIV	.743	1.86	-.481	2.48	-10.64	1.66	-2.96	2.24								
CATPRIV2	-.0626	1.55	.0186	1.35	.408	.87	.204	2.26								
NOAMB	-1.19	2.60	-1.28	4.25					-.416	.83	.0324	.09				
EARN $X10^{-3}$	.236	1.82	.0813	1.19	2.24	.72	.990	1.80	.0020	.02	.282	3.83	.795	.64	.765	1.24
EARN2 $X10^{-7}$	-.312	2.96	.0262	.61	-3.24	1.01	-.610	1.43	.0213	.52	-.0784	2.32	-1.39	1.72	-.0663	.27
NEARN $X10^{-3}$	.248	.82	.289	1.40	7.87	1.03	-.667	.50	2.21	6.50	-.824	3.22	.135	.04	4.02	1.88
NEARN2 $X10^{-7}$	.0278	.05	-.0922	.24	-17.56	1.05	3.55	1.57	-3.20	5.19	.547	1.18	.343	.06	-5.96	1.53
DAZPUB	.110	3.18	-.0701	2.08					.131	4.47	.0120	.45				
DAZPRIV	.221	9.14	.0438	2.37					.199	6.54	.124	5.12				
CARE					15.17	.68	11.48	2.32					.839	.05	11.65	1.35
CAID					9.08	.93	8.67	4.09					15.53	2.95	9.17	2.74
CONST	-4.33	5.60	1.13	2.24	-189.76	10.63	-48.71	13.62	-9.30	8.38	-1.31	1.75	-147.98	10.87	-84.65	12.67
Prob. Y>limit $\|X=\bar{X}$	.2803		.4144		.0128		.0684		.2686		.3369		.0227		.0512	
Chi^2	724		347		68		258		562		485		117		143	
(df)	(23)		(23)		(22)		(22)		(19)		(19)		(18)		(18)	

Table 2

TOBIT REGRESSION RESULTS WITH TIME ENTERED

Independent Variables	Red Hook Dependent Variables: OPDC(Eq. 9) Coef.	t-val.	PRIV(Eq. 10) Coef.	t-val.	DAZPUB(Eq. 11) Coef.	t-val.	DAZPRIV(Eq. 12) Coef.	t-val.	Bedford-Crown Dependent Variables: OPDC(Eq. 13) Coef.	t-val.	PRIV(Eq. 14) Coef.	t-val.	DAZPUB(Eq. 15) Coef.	t-val.	DAZPRIV (Eq. 16) Coef.	t-val.
CHRON	3.84	12.90	1.87	8.82	16.92	3.94	11.55	10.87	5.43	15.20	3.28	12.26	16.75	5.97	10.79	6.27
EDUC	-.262	4.60	-.028	.764	2.05	1.82	.428	1.77	-.154	2.23	.0940	1.96	-.599	.84	1.22	3.01
MALE	-1.33	3.72	-1.57	6.67	.921	.13	-2.33	1.48	-2.19	5.24	-1.91	6.30	1.26	.30	-9.34	3.65
PR	3.44	6.93	-.992	3.03	-1.99	.20	-3.38	1.53	3.92	3.56	-4.06	5.34	14.60	1.12	9.46	1.57
BLACK	3.55	7.88	-1.28	4.42	-5.19	.56	-7.65	3.74	3.51	4.18	-2.69	5.54	20.63	1.95	4.76	1.07
HSIZE	-.287	2.94	-.503	7.70	.274	.14	-1.09	2.44	-.132	1.17	-.188	2.27	.521	.49	-.646	.95
AGE	-.005	.12	.043	1.63	.376	.43	.381	1.98	-.0148	.29	.0284	.79	1.79	2.84	.533	1.55
AGE2 $X10^{-2}$	-.017	.33	-.059	1.73	-.571	.46	-.548	1.96	-.0360	.52	-.0145	.30	-2.47	2.55	-.778	1.52
TOPDC	-.197	9.34	.108	5.95	.485	.96	.184	1.62	-.201	6.69	.190	6.49	-.889	3.35	-.200	1.04
TOPDC2 $X10^{-3}$	.817	9.50	-.447	6.02	-.690	.36	-.738	1.62	1.10	7.26	-1.07	7.02	4.53	3.41	.859	.88
ATOPDC	-.201	5.01	.052	1.59	-1.69	2.25	-.263	1.31								
ATOPDC2 $X10^{-2}$	.160	4.93	-.059	2.19	1.53	2.63	.265	1.67								
TOPRIV	.065	4.10	-.067	6.89	.135	.41	.148	2.21	.0469	2.57	-.090	7.32	.264	1.38	-.225	2.28
TOPRIV2 $X10^{-3}$	-.239	2.62	.443	7.71	.286	.16	-.620	1.60	-.302	2.93	.538	7.96	-1.77	1.54	1.64	3.11
ATPRIV	.029	1.19	-.156	10.47	.438	.89	-.279	2.80								
ATPRIV2 $X10^{-2}$	-.009	.55	.104	10.15	-.337	1.01	.198	2.90								
NOAMB	-.859	1.88	-1.42	4.78					-.656	1.31	.257	.74				
EARN $X10^{-3}$	-.045	.40	.110	1.95	-1.89	1.12	.316	.72	-.131	1.50	.253	4.14	-.687	.52	.173	.32
EARN2 $X10^{-7}$	-.139	1.64	-.009	.29	1.08	1.48	-.229	.84	.0842	2.52	-.084	3.23	-.352	.36	-.0252	.12
NEARN $X10^{-3}$	.210	.70	.289	1.42	6.42	.87	-.894	.67	2.07	6.03	-.707	2.78	-.543	.16	3.76	1.75
NEARN2 $X10^{-6}$	.024	.45	.024	.66	-1.38	.87	.377	1.68	-.300	4.85	.0266	.58	.0910	.16	-.608	1.55
DAZPUB	.083	2.42	-.041	1.24					.127	4.38	.0118	.43				
DAZPRIV	.226	9.50	.043	2.38					.202	6.69	.122	5.09				
CARE					16.32	.74	12.33	2.50					1.55	.09	12.88	1.49
CAID					9.06	.94	8.62	4.05					15.53	2.90	8.93	2.65
CONST	7.00	3.88	1.16	.88	-190.99	4.97	-49.31	5.74	-2.40	1.32	-6.73	4.39	-115.63	6.16	-70.59	6.27
Prob. Y>limit $\mid X=\bar{X}$	.2472		.3533		.0095		.0741		.2396		.3255		.0337		.0404	
Chi^2	954		679		84		266		618		608		113		148	
(df)	(23)		(23)		(22)		(22)		(19)		(19)		(18)		(18)	

attention. In general, the coefficients presented in Tables 1 and 2 are very significant.[1] Furthermore, their signs and relative magnitudes lend support to the theoretical implication derived in Section II. Since it is difficult to make a quick judgment of the net effect of variables entered in quadratic form, Table 3 gives the elasticities of the expected value locus of the four dependent variables with respect to all quadratically estimated explanatory variables, calculated at the mean values.

THE TIME VARIABLES

The effects of time can be measured either from Table 1, where travel and waiting times are multiplied by a measure of the opportunity cost of time, or from Table 2, where time is entered in natural units only. As shown in Appendix C, the elasticity of demand with respect to time equals the elasticity with respect to time weighted by the opportunity cost of time. There are likely to be biases in each set of coefficients such that the true elasticities with respect to time prices are greater in absolute value than those estimated. Consider first the specification with time weighted by the opportunity cost of time (Table 1). Since the opportunity cost of time had to be inputed to non-working persons and is not entirely precise even for working persons, the wage rate is measured with error. This error will bias the coefficients on the time variables in Table 1 toward zero. Thus, the true elasticities will be greater (in absolute value) than those implied by the first specification. Consider the alternative specification employing time in natural units (Table 2). In light of the model developed in Appendix C, $w \cdot t$ is the correct variable, so that regressions employing t alone constitute an omitted variable bias.

[1] The "t" statistics are asymptotic tests in the Tobit framework. With samples of 5000, they probably are good guides to significance. Further, the Chi^2 statistics test the hypothesis that the vector of coefficients is zero; they, too, are highly significant.

The reader should not attach too much importance to the equations for public hospitalization since the number of non-zero observations is very small.

If w and t are negatively correlated (as seems reasonable), the coefficients estimated in Table 2 will also be biased toward zero.[1] In general, the elasticities implied by the coefficients in Table 2 exceed in absolute value those implied by Table 1, suggesting that the bias due to the error in measuring the opportunity cost of time is greater than the bias caused by omitting it from the specification. I shall discuss both specifications; almost all of the remaining coefficients are quite stable between Tables 1 and 2. The chief exceptions are the income coefficients--which are discussed in the next subsection--but even so, their elasticities are reasonably stable. The other apparent instabilities (PR and BLACK in the DAZPUB equations) reflect coefficients that were not significantly different from zero in either specification. Since both sets of estimated elasticities understate the true elasticity, I will concentrate on the generally larger ones implied by Table 2.

Let us first concentrate on the travel time-price elasticities for ambulatory care using time in natural units. The elasticities

[1]Figure 1A shows the quantity of care demanded as a function of either t or wt. People who appear to have high time inputs to the purchase of care (indicated on the line marked t) tend to have proportionately lower values of wt because of the negative correlation of w and t. Conversely, those who appear to have low time inputs tend to have higher opportunity cost of time and therefore proportionately higher values of wt. The same result holds for the cross-time prices indicated in Fig. 1B. Thus, the true elasticity with respect to wt will be greater than that implied by the regression on t alone.

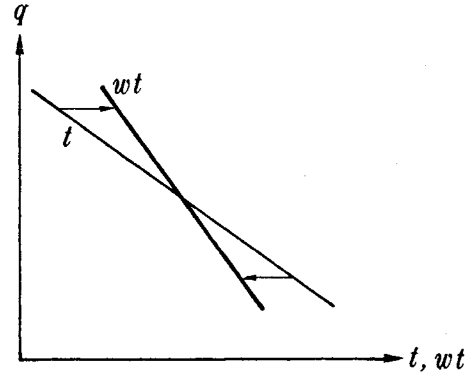

Fig. 1a—Relation between own-time prices and quantity

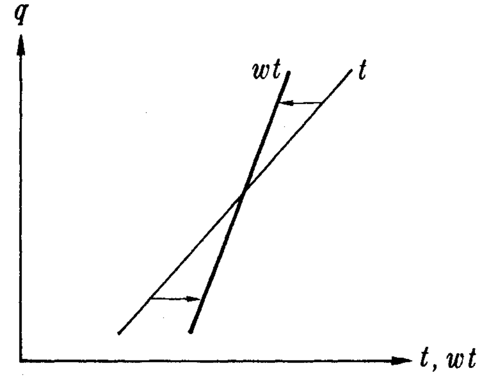

Fig. 1b—Relation between cross-time prices and quantity

Table 3

ELASTICITIES OF EXPECTED VALUE OF DEPENDENT VARIABLE, EVALUATED AT THE MEAN[a]

Independent Variables	Red Hook Dependent Variables								Bedford-Crown Dependent Variables							
	OPDC		PRIV		DAZPUB		DAZPRIV		OPDC		PRIV		DAZPUB		DAZPRIV	
	(Eq. 1)	t-val.	(Eq. 2)	t-val.	(Eq. 3)	t-val.	(Eq. 4)	t-val.	(Eq. 5)	t-val.	(Eq. 6)	t-val.	(Eq. 7)	t-val.	(Eq. 8)	t-val.
CTOPDC	-.199	2.14	.185	2.26	1.427	3.14	.005	.02	-.162	2.43	-.011	.22	-.445	1.73	-.410	2.39
CATOPDC	-.327	3.18	-.083	.94	-1.663	3.41	-.186	.77								
CTPRIV	.153	3.78	.002	.06	.302	1.10	.077	.97	.047	.99	-.030	1.04	.246	.86	.214	1.60
CATPRIV	.126	1.85	-.110	2.64	-.550	1.76	-.252	2.14								
EARN	-.014	.30	.078	2.37	-.073	.28	.152	1.60	.015	.29	.172	4.10	-.111	.56	.210	1.57
NEARN	.037	1.16	.046	1.84	.177	.93	-.001	.01	.251	6.60	-.136	4.06	.012	.09	.193	1.90
AGE	.049	.74	.028	.55	.312	.87	.273	1.97	-.096	1.20	.107	1.67	.821	2.98	.315	1.56
	OPDC		PRIV		DAZPUB		DAZPRIV		OPDC		PRIV		DAZPUB		DAZPRIV	
	(Eq. 9)	t-val.	(Eq. 10)	t-val.	(Eq. 11)	t-val.	(Eq. 12)	t-val.	(Eq. 13)	t-val.	(Eq. 14)	t-val.	(Eq. 15)	t-val.	(Eq. 16)	t-val.
TOPDC	-.958	8.08	.640	5.14	1.241	1.64	.415	1.45	-.619	4.56	.629	4.16	-.994	2.65	-.394	1.06
ATOPDC	-.120	1.12	-.202	1.82	.301	.61	.224	.91								
TPRIV	.332	5.08	-.252	5.28	.316	.87	.310	2.55	.137	1.83	-.337	5.82	.224	.93	-.216	1.25
ATPRIV	.196	2.73	-.050	.94	-.193	.48	.070	.53								
EARN	-.110	2.54	.086	2.73	-.182	.82	.039	.47	-.040	.86	.147	4.08	-.229	1.39	.046	.38
NEARN	.039	1.16	.046	1.68	.158	.79	-.014	.20	.244	6.13	-.128	3.75	-.019	.15	.180	1.69
AGE	-.064	.95	.057	1.07	.077	.21	.166	1.26	-.133	1.65	.098	1.47	.695	2.74	.243	1.20

[a]The t values test the significance of the above at the mean.

are given in Table 4. In this table we find support for many of the hypotheses generated in Section II. Travel time is indeed functioning as a normal price, producing negative own time-price elasticities and positive cross time-price elasticities. Furthermore, the magnitude of the own time-price elasticities exceeds that of own money-price elasticities reported by other researchers. Using disaggregated data from several sources, Phelps and Newhouse (1973) derive money price elasticities for private care on the order of -.15 in the range of 25 percent to 0 percent coinsurance--well below (in absolute value) the -.25 to -.337 estimated here for private care and -.6 to -1.0 estimated for public care. Even using the much higher elasticities for all ambulatory care of between -.5 and -1.0 reported by Rosett and Huang (1971), Feldstein (1971), and Davis and Russell (1972), the travel-time elasticities appear to be of at least a comparable size.

The hypotheses developed above also suggested that demand should be more responsive to changes in TOPDC than to changes in TPRIV--which is the case. In both Red Hook and Bedford-Crown, the own travel time-price elasticities with respect to TOPDC exceed those for TPRIV by a factor of two or three times. Similarly, the cross elasticities for TOPDC are significantly greater than those for TPRIV. The elasticities calculated for the C•TIME variables support the conclusions drawn for the TIME variables above. Found in Table 3 are negative own-price elasticities, positive cross-price elasticities, and larger responses to CTOPDC than CTPRIV. The one exception is Equation 6, where there is a negative cross time-price elasticity of demand for PRIV with respect to CTOPDC.

Table 4

TRAVEL TIME-PRICE ELASTICITIES FOR AMBULATORY CARE

(Equations 9, 10, 13, and 14)

	Red Hook		Bedford-Crown	
	TOPDC	TPRIV	TOPDC	TPRIV
OPDC	-.958	.332	-.619	.137
PRIV	.640	-.252	.629	-.337

The effect of waiting time is similar to travel time as a determinant of demand. But, as predicted, the elasticities with respect to waiting time are smaller (in absolute value) than the elasticities with respect to travel time. The own waiting time-price elasticities of demand for OPDC and PRIV are -.120 for ATOPDC and -.050 for ATPRIV. The cross elasticities are .196 for ATPRIV and -.202 for ATOPDC. The last figure, giving a negative cross-price elasticity of demand for PRIV with respect to ATOPDC, is the only violation of the theoretical implications developed above.[1] Otherwise, waiting time also functions as a normal price, with demand being more responsive to changes in waiting time at OPDs and clinics than it is to waiting times at private physicians' offices.

We can draw some limited inferences about the effect of time prices on the demand for inpatient care. We do not have a direct measure of the time prices associated with hospitalization. The effects of travel and waiting times for outpatient care should be interpreted primarily as cross-prices to inpatient care--the more time one must spend getting ambulatory care, the more likely one should be to demand inpatient care. To a limited degree, we may wish to consider TOPDC a measure of travel time to public hospitals--the DAZPUB variable--because all municipal OPDs are located in a hospital. In Red Hook Equations 3, 4, 11, and 12, inpatient and outpatient care seem to be operating as substitutes. The longer one must wait for ambulatory care, the more likely one is to use inpatient care. The opposite appears to be true in Bedford-Crown. It is not clear why this difference exists at this level of analysis, but it may be compatible with the hypothesis that residents of Bedford-Crown are seeking care only for the more serious health conditions, and in those cases, inpatient and outpatient care are complements.[2]

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[1]This apparent contradiction may be because the estimated maximum occurs where ATOPDC = 45 minutes. The mean, used for calculating the elasticity, is 59 minutes, which is one standard deviation above the critical point.

[2]Using a 1965 survey of users of the municipal hospitals' OPDs (specifying a simultaneous equation system with public and private ambulatory care and public hospitalization all endogenous), I found complementarity in public ambulatory and inpatient care. See Acton (1973).

INCOME

The theoretical model predicted that the elasticity of demand for all forms of medical services with respect to non-earned income should be positive unless public care is an inferior good, in which case the elasticity is negative in OPDC and DAZPUB. The sign of the elasticity with respect to earned income was indeterminate because of offsetting effects of income and the time price, although I suggested that it should be lower in free sources than non-free sources of care. Broadly speaking, the empirical results in Table 3 support these hypotheses. With few exceptions, a positive elasticity with respect to non-earned income was found in all equations. With respect to earned income, a generally positive elasticity was found for private care and a negative elasticity for public care. There is little evidence to support the hypothesis that public care is an inferior good (that is, that the elasticity of demand for OPDC and DAZPUB with respect to NEARN is negative). Although the signs of the income elasticities are reasonably stable between Red Hook and Bedford-Crown, the size varies and the whole set of findings must be regarded as provisional.

A note on alternative specification of the equations is in order. Instead of using earned and non-earned income as explanatory variables, I also estimated the entire set of equations using only total income--entered as income and income squared.[1] This alternative specification was used because I thought there might be a high degree of collinearity between EARN and NEARN and the waiting and travel time variables--especially when they were weighted by earned income. This alternative specification left the remaining coefficients virtually unchanged (to the third decimal place) and the significance of INC and INC2 was roughly the same as either EARN and EARN2 or NEARN and NEARN2. The other point worth noting about alternative specifications is the effect of the C·TIME versus the TIME variables on the income elasticities. Although the EARN elasticities vary somewhat, the elasticities with respect to NEARN are identical in the two specifications.

[1]This comparison was carried out using OLS--whose results approach Tobit asymptotically--because patterns of significance and collinearity were found to carry over well to Tobit results.

In Red Hook, substantial support is found for the hypothesis that medical services are normal goods--producing an elasticity of demand with respect to non-earned income of about 0.04 or 0.05 for ambulatory care and 0.16 for inpatient care.[1] The elasticities with respect to earned income are positive for private sources of care and negative for public sources, supporting the suggestion that they should be smaller for the free sources of care because a change in the wage rate has a greater price effect in demand for free care. In net, the price effect of a wage change dominates in the demand for public care and the income effect dominates in the demand for private care.

The Bedford-Crown results produce elasticities somewhat less in conformity with the predictions of the model and there are two sign reversals of corresponding elasticities between the C·TIME and TIME specifications. I will discuss only aberrations from the picture just described for Red Hook. In Equations 6 and 14, there is a negative non-earned income elasticity of demand for private physician care that appears robust, suggesting that public care is a normal good, and private ambulatory care is an inferior good. When I discuss the effects of race on demand for care, there is some suggestion of discrimination, and part of the effect may appear here. The two sign reversals occur for earned income in Equations 5 and 13 and for non-earned income in Equations 7 and 15. The latter may be explained by the critical point lying near the mean of the data, but the former is not as easily accounted for.

Otherwise, the general pattern of effects of income on demand for care that was reported in Red Hook holds in Bedford-Crown. The only support in either set of regressions for the hypothesis that public

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[1]These estimated elasticities may be biased downward by a transitory component in non-earned income. The negative elasticity for private hospital days, Equations 4 and 12, is caused by the elasticity's being calculated at the mean of the data ($920), which was just to the left of the minimum of our estimated relationship ($939 in Equation 4 and $1183 in Equation 12, which is within one-seventh of a standard deviation of the mean). For approximately half the sample, the non-earned income elasticity has the expected positive sign. For most other equations, the critical point is not within one standard deviation of the mean of the data.

care is an inferior good is found in Equation 15, where the non-earned income elasticity of demand for DAZPUB is -.019.[1]

The estimated elasticities with respect to non-earned income allow calculation of the approximate magnitude of the full wealth elasticity. The full wealth elasticity equals the non-earned income elasticity multiplied by the increase of the share of full wealth due to non-earned income.[2] Let full earned income (wT) be the earning of a person employed full time and assume that all employed persons are working full time.[3] Then the implied full wealth elasticity of demand for OPDC is 0.202 and for private care is 0.251 in Red Hook.[4]

In discussing the remaining effects, I will concentrate on the specification with the time variables in natural units, Equations 9-16.

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[1] Michael Grossman pointed out that, in general, we can expect to find lower elasticities with respect to earned income in Eqs. 9-16 than in Eqs. 1-8. Consider the simplified form of a demand equation,

$$m = a + bp + cY, \tag{4a}$$

where $p = wt$ and $Y = y + wT$. We expect $b < 0$ and $c > 0$. Substituting into (4a) yields

$$m = a + bwt + cwT + cy, \tag{4b}$$

similar to Eqs. 1-8. With wt held constant, the coefficient, c, on full earnings should be positive. When we estimate

$$m = a' + b't + c'wT + dy, \tag{4c}$$

the coefficient c' could be negative. The elasticities reported in Table 3 generally support this prediction that the earnings elasticities in Eqs. 9-16 are lower than those in Eqs. 1-8.

[2] Since $(\partial m/\partial Y) = (\partial m/\partial y)$, it follows that $\eta_{mY} = (\partial m/\partial Y)\ (\bar{Y}/\bar{m}) = (\partial m/\partial y)(\bar{Y}/\bar{m}) \cdot (\bar{Y}/\bar{y}) = \eta_{my}(\bar{Y}/\bar{y})$.

[3] If the reader wishes to make other assumptions about the definition of full wealth, then the elasticities can be adjusted accordingly. For instance, if T is taken as referring to a 24-hour day instead of a 40-hour work week, the full wealth elasticities reported here should be scaled up by 4.2.

[4] The corresponding elasticities for the Bedford-Crown sample, 1.317 and -.714, reflect the estimated coefficients on NEARN, and the comments made above apply.

AGE

The human capital formulation predicts a positive correlation of the demand for care and rate of depreciation on the health stock. We can infer where in the life cycle depreciation is greatest by examining the age coefficients. The age curve is either monotonically decreasing (Equations 9 and 13) or is an inverted U shape (Equations 10, 11, 12, 15, and 16 all peak between 32 and 36 years). Both patterns support the conclusion that substantial decrements in health take place early in life for these populations. The only curve that is monotonically rising is the demand for private physician care in Bedford-Crown (Equation 14), and its coefficients are not significantly different from zero.

INSURANCE

The greatest effect of insurance is seen in the demand for hospital care. In all cases, the estimated coefficients are positive, although the coefficients in the DAZPUB equations (Equations 3, 7, 11, and 15) are not statistically significantly different from zero in general. The significant effects support the popular image that Medicare and Medicaid caused an increase in the demand for private hospitalization. We cannot conclude, however, that this lowers demand for public hospital care (which should have produced significant negative coefficients in the DAZPUB equations). The picture with respect to insurance for ambulatory care is less certain, no doubt because of the imprecise definition of the explanatory variable NOAMB. The only statistically significant results (at 5 percent or lower, Equations 2 and 10) show people with no ambulatory insurance demanding less care from private physicians.

HOSPITALIZATION

By and large, people who reported being hospitalized were likely to be users of ambulatory facilities. As suggested, people who reported public hospitalization were more likely to use public ambulatory care than private ambulatory care (the coefficients for DAZPUB in the PRIV Equations 2, 6, 10, and 14 were either negative or not significantly different from zero). Those who reported private hospitalization were significantly more likely to use both public and private ambulatory care.

HEALTH STATUS

The health status variables are the most consistently significant predictors of demand for care. Greater numbers of chronic health conditions produce higher utilization of all forms of medical services (with "t" ratios ranging from 4 to over 16). We suggested that poorer health stock might produce an income effect, making greater demand for free than for non-free care for those with chronic conditions. The evidence is consistent with this hypothesis.[1]

EDUCATION

It was postulated that more educated persons might be more efficient producers of health, leading to a negative coefficient on education. On the other hand, those with higher education might have developed a taste for more health services, particularly non-free services. The two effects should yield a negative coefficient on EDUC in the OPDC and DAZPUB equations and coefficients biased upward in PRIV and DAZPRIV. This pattern is found in the estimated demand for ambulatory care. There is a significant negative coefficient on education in the demand for OPDC and clinic services. The mixed effect of efficiency and taste is shown by coefficients biased upward in Equations 2, 6, 10, and 14. In the demand for inpatient care, education has a positive effect in all but one case, when its "t" value is .84.

RACE

Generally, the coefficients on the race variables are very significant for ambulatory care but not significant for inpatient care. The observed relations are compatible with an interpretation that Blacks and Puerto Ricans either have an aversion to private care or that they face discrimination in private ambulatory care. There are significant

[1] It is probably not worth conducting a rigorous test of this hypothesis, which requires calculation of the covariance among equations, but it seems valid.

negative coefficients on both BLACK and PR in the PRIV equations and significant positive coefficients in OPDC. There is a definite substitution of public for private care, all other things held constant. The coefficients in the hospital equations are less significant, but when their "t" value exceeds 1.96, they support the conclusion of substituting public for private care.

SEX

I generally expected a negative coefficient on the dummy variable for MALE. The possible exception was a positive (or at least greater) coefficient in the DAZPUB equation if men had let their health stock deteriorate more and thus, once hospitalized, would remain longer. These two hypotheses are supported in all the estimated relations, although the positive coefficient in the DAZPUB equations is not significantly different from zero.

HOUSEHOLD SIZE

Finally, all other things the same, HSIZE should produce a negative coefficient in paid sources of care. For reasons that are not entirely clear, there is also frequently a negative coefficient on HSIZE in the public sources of care. It may be that the larger family size is increasing the opportunity cost of everyone's time (especially that of the parents) and thus reducing all use of services.

V. CONCLUSION AND SELECTED POLICY IMPLICATIONS

CONCLUSION

The objective of this study was to measure the major factors influencing demand for medical services. In particular, we were looking for a mechanism that might replace money prices in determining demand as money price out of pocket became small. Considerable theoretical and empirical support was found for the suggestion that time prices would fill that role. Travel and waiting time appear to be operating as normal prices, producing a negative own price elasticity and a positive cross price elasticity of demand for medical services. As predicted by the model, elasticities were greater with respect to times associated with free care than times associated with non-free care. The magnitude of the own elasticity with respect to travel time is -.6 to -1.0 for public outpatient care and between -.25 and -.34 for private outpatient care. These elasticities are significantly greater than the money-price elasticities of about -.15 over the range 0 to 25 percent coinsurance reported by Phelps and Newhouse (1972) for a Palo Alto group. The estimated elasticities with respect to travel time weighted by earnings are in the order of -.15 to -.2 for OPDC care and nearly zero for private care but, as discussed, these estimates are biased significantly towards zero. Further, as predicted, demand is more sensitive to changes in travel time than to changes in waiting time, producing elasticities several times as large for travel as for waiting time. The conclusion is clear that time is already functioning as a rationing device for demand in this New York population, and its importance seems to exceed that of money prices.

The theoretical model predicted a positive elasticity of demand with respect to non-earned income. I found a picture of mixed statistical significance, but when significant, elasticities were around 0.04 to 0.05 for ambulatory care and 0.15 to 0.20 for inpatient care. The sign of the earned income elasticity of demand could not be predicted *a priori* because of the offsetting income and price effects of a wage change, but I expected a change in the wage rate to act more like a price effect with respect to the demand for free care and more like income effect on the demand for non-free care. In fact, negative elasticities were found for free care and positive elasticities for non-free care, roughly of the same absolute magnitude as the non-earned income elasticities.

SELECTED POLICY IMPLICATIONS

A number of policy considerations are suggested by the significant elasticities found for time prices and earned and non-earned income. The most important involves the distribution of medical services as out-of-pocket monetary expenses are reduced, either because of continued spread of health insurance or because of the enactment of some National Health Insurance scheme. Persons with a lower opportunity cost of time will take greater advantage of a reduction of out-of-pocket monetary costs than those with higher opportunity cost of time because their time prices are lower. This conclusion holds even with no differential subsidy of monetary costs and no supply response to an increase in demand. Moreover, there is likely to be a supply response to a shift in demand that increases the time needed to receive medical services (increased waiting time or perhaps increased travel time due to more referrals).[1] This will increase further the relative shift in favor of those with lower opportunity cost of time (although the increase in the vector of time prices will reduce aggregate demand over what it would be with no supply response). In any case, the general effect of a reduction in personal monetary prices will be to shift the distribution of medical services.

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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.

Among the important additional policy considerations if one wishes to increase aggregate demand for services are shortening travel time 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

A significant own time-price elasticity of demand was found for outpatient department and clinic services with respect to travel time. A number of policy options are available to the government for altering travel time, ranging from improved transportation facilities to the building of new clinics and health centers. The travel time elasticities show that moving centers "closer" in time will 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 that are substantially closer, on the average, to the individuals, rather than building one large clinic to serve the population.[1] 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 to create 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. One alternative means of achieving the goal of increased service is to reduce waiting time in existing new facilities.

Shorter Queues

There are two points the City may wish to note about waiting time and the demand for care. First, it is a popular impression that patients have to wait considerably longer in outpatient departments of hospitals than in private physicians' offices. The reported waiting times for 1968 show that, for this population, mean waiting time was less at OPD

[1]One form might be for several satellite clinics to be associated with a more centrally located referral clinic.

and clinics than in private physicians' offices. The second point, however, is that longer waiting times do discourage use, and mechanisms that reduce waiting time should increase use. For instance, appointments rather than unscheduled visits in OPDs might prove successful in reducing waiting time. This implication is not limited to the City. Many hospitals across the nation use a system of giving all the patients a morning appointment (say 9:00) or an afternoon appointment (say 1:30). If this algorithm results in a wait, on the average, of 90 minutes and an alternative scheduling (say appointments on the hour for 9, 10, or 11) reduces the average wait to 30 minutes, the elasticities reported in 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 the poor and conclude that a variety of measures are needed to improve access. In one form or another, most boil down 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 two 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.

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. Although it will not meet the objective of risk spreading, income maintenance will increase aggregate medical care demand for the poor.

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

Since income maintenance is a non-earned source of income, I use the elasticity of demand for medical care with respect to changes in non-earned income.[1] A hypothetical example, not based on actual FAP and FHIP provisions, will serve to illustrate. The Red Hook results in Table 3 indicate that a $1000 increase in non-earned income for a family with a current non-earned income of $450 and earned income of about $4100 will produce a 6.3 percent increase in the demand for private practitioners' care per member. This change is probably a lower bound on the increase, since the non-earned income elasticity may be biased downward by a transitory component. If the money-price elasticity of demand for ambulatory medical services is around -.15 over the range under consideration,[2] 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 achieving the objective of increased aggregate medical consumption by the poor is income supplementation, and the magnitude of the change may be very comparable over the range of subsidy and income guarantee under consideration.

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[1]This calculation ignores substitution effects induced by changes in the marginal tax rate implicit in the income maintenance proposals.

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

Appendix A

DEFINITIONS OF VARIABLES USED AND THEIR MEAN VALUES[1]

AGE	= Age in years. Means = (27.3, 25.2).
AGE2	= AGE^2. Means = (1200, 1006).
ATOPDC	= Waiting time, on the average, at Municipal Outpatient Departments (MDOPD) or Free-Standing Clinics (CLIN), in minutes. Available for Red Hook only. Mean = (59.1).
ATOPDC2	= $ATOPD^2$. Mean = (3717).
ATPRIV	= Waiting time, on the average, in a private physician's office, in minutes. Available for Red Hook only. Mean = (73.7).
ATPRIV2	= $ATPRIV^2$. Mean = (6530).
BLACK	= Dummy variable equaling one if Negro or indeterminate, or other than Puerto Rican, Mexican-American, American Indian, or other White. Means = (.30, .84).
CAID	= One if the person has Medicaid coverage and is under 65 years of age; zero otherwise. Means = (.32, .36).
CARE	= One if person has Medicare coverage; zero otherwise. Means = (.07, .04).
C·TIME	= For all time variables prefixed by "C" it is the corresponding variable without the prefix "C" multiplied by the opportunity cost of time. The opportunity cost of time is measured by the earnings per minute of family workers if the individual is working and is set to $.01 per minute if the individual is not working or if there is no reported earned income for the family.
CATOPDC	Mean = ($1.17).
CATOPDC2	" = (3.61).
CATPRIV	" = ($1.39).
CATPRIV2	" = (5.32).
CTOPDC	Means = ($1.42, $1.57).
CTOPDC2	" = (5.46, 6.66).
CTPRIV	" = ($ .88, $1.24).
CTPRIV2	" = (2.98, 6.76).
CHRON	= Number of reported chronic health conditions limiting activity. Means = (.20, .21).

[1]The mean values are reported first for Red Hook and second for Bedford-Crown.

DAZPRIV = Number of days hospitalized in last year in a non-governmental hospital. Means = (1.07, .69).

DAZPUB = Number of days hospitalized in last year in a city or other governmental hospital. Mean = (.30, .50).

EARN = Earned family income in last year. Means = ($4110, $4532).

EARN2 = $EARN^2$. Means = (35388091, 45129544).

EDUC = Highest grade completed, in years. Means = (6.8, 7.3).

HSIZE = Number of persons in individual's household. Means = (4.7, 4.3).

MALE = One if male, zero if female. Means = (.46, .44).

NEARN = Non-earned family income in last year. Means = ($920, $1067).

NEARN2 = $NEARN^2$. Means = (3326386, 3996932).

NOAMB = One if the person unambiguously has no insurance coverage for ambulatory care; zero otherwise. Means = (.21, .23).

OPDC = Number of visits in last year to a physician in Outpatient Department of a Municipal Hospital or to a clinic not connected to a hospital. Means = (1.68, 1.46).

PR = One if Puerto Rican; zero otherwise. Means = (.26, .07).

PRIV = Number of visits in last year to a physician in his private office. Means = (1.83, 1.56).

TOPDC = Travel time, on the average, to and from Municipal Outpatient Department or free-standing clinic, in minutes. Means = (72.9, 64.0).

TOPDC2 = $TOPDC^2$. Means = (6085, 4424).

TPRIV = Travel time, on the average, to and from private physician's office (PRIV), in minutes. Means = (44.6, 48.8).

TPRIV2 = $TPRIV^2$. Means = (3096, 3521).

Appendix B

RESULTS OF ORDINARY LEAST SQUARES ESTIMATION

Table B-1

OLS REGRESSION RESULTS WITH TIME WEIGHTED BY THE WAGE RATE (C·TIME)

Independent Variables	Red Hook Dependent Variables: OPDC Coef.	OPDC t-val.	PRIV Coef.	PRIV t-val.	DAZPUB Coef.	DAZPUB t-val.	DAZPRIV Coef.	DAZPRIV t-val.	Bedford-Crown Dependent Variables: OPDC Coef.	OPDC t-val.	PRIV Coef.	PRIV t-val.	DAZPUB Coef.	DAZPUB t-val.	DAZPRIV Coef.	DAZPRIV t-val.
CHRON	2.27	17.27	1.37	11.22	.495	4.65	2.70	17.30	2.52	17.71	1.95	14.43	1.08	6.80	1.14	7.42
EDUC $X10^{-2}$	-10.02	4.53	-.262	.128	.783	.413	4.24	1.53	-4.62	1.91	-1.27	.550	-3.58	1.26	.0317	1.16
MALE	-.137	.949	-.709	5.30	.471	3.93	.182	1.03	-.259	1.72	-.575	4.02	.503	2.97	-.0313	.190
PR	.556	2.96	-.557	3.19	.0803	.497	-.157	.664	.0829	.220	-1.33	3.73	.552	1.29	.672	1.62
BLACK	.622	3.65	-.473	3.00	-.0348	.240	-.502	2.37	.260	.996	-1.09	4.38	.352	1.19	.304	1.06
HSIZE	-.076	1.99	-.186	5.25	-.062	1.94	-.087	1.85	-.0740	1.83	-.028	.724	.087	1.88	-.004	.0903
AGE	.062	3.85	.0162	1.08	.0112	.711	-.0179	.772	.0394	2.08	.042	2.34	.048	1.96	.024	.998
AGE2 $X10^{-3}$	-.818	3.92	-.113	.584	-.0673	.288	.301	.878	-.540	2.13	-.425	1.76	-.418	1.14	-.236	.663
CTOPDC	.124	.565	.081	.399	.621	3.41	-.175	.654	-.246	2.09	.062	.552	-.167	1.26	-.148	1.15
CTOPDC2 $X10^{-2}$	-1.88	.941	-.247	.133	4.41	2.65	1.17	.482	1.65	1.77	-.081	.092	1.43	1.37	.186	.184
CATOPDC	-.712	2.45	-.053	.196	-.619	2.56	.243	.685								
CATOPDC2 $X10^{-1}$	.716	2.20	.0422	.140	.653	2.41	-.192	.483								
CTOPRIV	.224	1.99	.135	1.30	-.102	1.09	.112	.818	.051	.709	-.153	2.25	-.0276	.344	.0716	.921
CTOPRIV2 $X10^{-2}$	-.854	1.24	.139	.217	.313	.544	-.500	.592	-1.76	.872	.289	1.51	-.024	.105	-.152	.693
CATPRIV	-.0020	.017	-.151	1.38	-.197	2.01	-.265	1.85								
CATPRIV2 $X10^{-2}$	.0857	.102	.319	.408	.811	1.15	1.51	1.46								
NOAMB	-.234	1.35	-.434	2.69					.0647	.369	.012	.071				
EARN $X10^{-4}$	.0264	.065	.590	1.56	-.075	.221	.0027	.0053	.0581	.160	1.11	3.20	.366	.876	.640	1.58
EARN2 $X10^{-8}$	-.151	.577	-.185	.762	.0737	.338	-.0596	.186	.0274	.170	-.309	2.01	-.166	.912	-.084	.473
NEARN $X10^{-4}$	1.13	.946	.834	.753	1.89	1.82	-2.00	1.31	7.16	5.98	-.277	.244	1.24	.883	2.89	2.12
NEARN2 $X10^{-8}$	-1.34	.627	-.153	.077	-2.07	1.14	4.31	1.62	-10.73	5.18	.075	.038	-2.35	.992	-4.48	1.95
DAZPUB	.0299	1.80	-.0278	1.81					.059	4.52	.0086	.687				
DAZPRIV	.135	11.95	.0285	2.72					.0961	7.11	.0898	6.99				
CARE					-.304	.722	.464	.754					-1.18	1.81	.715	1.13
CAID					.062	.387	.534	2.26					.293	1.27	.293	1.31
CONST	1.48	5.02	2.60	9.52	.035	.141	.918	2.53	.782	2.08	1.66	4.65	-1.16	2.72	-.780	1.89
R^2	.1316		.0647		.0128		.0734		.1187		.0866		.0165		.0190	

Table B-2

OLS REGRESSION RESULTS WITH TIME ENTERED

Independent Variables	Red Hook Dependent Variables								Bedford-Crown Dependent Variables							
	OPDC		PRIV		DAZPUB		DAZPRIV		OPDC		PRIV		DAZPUB		DAZPRIV	
	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.	Coef.	t-val.
CHRON	2.27	17.40	1.34	11.17	.476	4.50	2.69	17.26	2.53	17.81	1.98	14.71	1.08	6.83	1.14	7.43
EDUC	-.099	4.53	-.0076	.378	.011	.562	.042	1.52	-.045	1.86	-.020	.853	-.036	1.29	.026	.955
MALE	-.289	2.09	-.618	4.84	.409	3.54	.144	.845	-.304	2.05	-.586	4.17	.462	2.77	-.068	.422
PR	.386	1.99	-.472	2.64	-.143	.862	-.358	1.46	.047	.126	-1.22	3.42	.516	1.21	.693	1.67
BLACK	.505	2.92	-.482	3.02	-.200	1.36	-.585	2.70	.210	.800	-.893	3.58	.319	1.07	.371	1.29
HSIZE	-.055	1.46	-.186	5.36	-.054	1.73	-.080	1.72	-.061	1.53	-.027	.704	.093	2.04	.0047	.106
AGE	.048	3.09	.018	1.25	.0047	.303	-.022	.959	.0302	1.65	.039	2.28	.043	1.77	.020	.852
AGE2 X10^{-3}	-.680	3.36	-.112	.600	-.022	.095	.326	.960	-.432	1.75	-.396	1.69	-.365	1.00	-.205	.582
TOPDC	-.046	4.90	.028	3.20	.0055	.710	.0094	.821	-.052	4.23	.0434	3.72	-.037	2.66	-.0051	.376
TOPDC2 X10^{-3}	.217	5.69	-.119	3.3/	.037	1.16	-.043	.906	.286	4.59	-.237	4.00	.151	2.14	.033	.481
ATOPDC	-.046	2.56	.017	1.05	-.031	2.05	-.012	.551								
ATOPDC2 X10^{-3}	.348	2.42	-.175	1.32	.323	2.68	.196	1.11								
TOPRIV X10^{-1}	.133	2.22	-.178	3.21	.0031	.061	.202	2.74	-.0060	.094	-.300	4.96	-.0036	.050	-.085	1.22
TOPRIV2 X10^{-4}	-.404	1.13	1.49	4.53	-.114	.383	-1.08	2.48	-.083	.235	1.68	5.02	.124	.312	.692	1.79
ATPRIV X10^{-2}	.624	.688	-5.90	7.04	.319	.421	-2.13	1.91								
ATPRIV X10^{-4}	-.234	.378	3.89	6.84	-.355	.689	1.33	1.75								
NOAMB	-.151	.876	-.474	2.97					.027	.157	.089	.536				
EARN X10^{-4}	-.588	1.73	.531	1.69	-.283	.992	-.191	.455	-.376	1.23	.962	3.31	-.0434	.122	.446	1.30
EARN2 X10^{-8}	.157	.836	-.147	.845	.168	1.07	-.0037	.016	.188	1.48	-.284	2.35	-.0083	.058	-.105	.748
NEARN X10^{-4}	.953	.801	.675	.614	1.94	1.87	-1.94	1.27	6.59	5.50	-.039	.034	1.15	.818	2.81	2.06
NEARN2 X10^{-8}	-.763	.358	-.609	.310	-1.89	1.04	4.37	1.64	-10.10	4.88	-.628	.320	-2.29	.964	-4.58	1.99
DAZPUB	.021	1.28	-.018	1.20					.058	4.45	.0102	.826				
DAZPRIV	.136	12.12	.029	2.68					.097	7.16	.088	6.90				
CARE					-.251	.602	.513	.835					-1.10	1.68	.810	1.28
CAID					.088	.547	.542	2.29					.274	1.18	.288	1.28
CONST	4.19	5.67	3.04	4.46	.116	.188	.622	.684	2.96	4.31	.675	1.03	.543	.698	-.438	.581
R^2	.1453		.0885		.0235		.0754		.1221		.0945		.0177		.0193	

Appendix C

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 the variables are defined as on pp. 3-4. 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 are positive.[1] The conditions for maximizing utility are found by forming the Lagrangian expression

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

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:

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

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

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

and

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

where definitionally,

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

EFFECTS OF A CHANGE IN PRICE

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:

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

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

and

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

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

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

$$= U_{mX} (q + ws)(p + wt) + U_{Xm} (q + ws)(p + wt)$$

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

Under the assumptions that U_{XX} and $U_{mm} < 0$ and U_{Xm} and $U_{mX} > 0$, $|D|$ is unambiguously positive. We can solve for $\partial m/\partial p$ by Cramer's rule:

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

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

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

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

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

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

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

and

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

So,

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

$$= \frac{- m\, U_{mX}(q + ws) + mU_{XX}(p + wt) + \lambda (q + ws)^2}{|D|}. \quad \text{(A-6d)}$$

Thus, we find that

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

The three price elasticities are related in the following manner:

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

and

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

Consequently, it follows that

$$\eta_{mp} \gtreqless \eta_{mt}$$

as

$$p \gtreqless wt.$$

EFFECTS OF A CHANGE IN INCOME

The effects of a change in earned and non-earned income are systematically related, but they are not, in general, the same. The effect of a change in non-earned 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

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

Thus,

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

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

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

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

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

and

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

Cramer's rule yields:

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

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

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

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

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

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

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

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

Therefore, the substitution effect is negative.

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