WHAT DO MEDICAL SERVICES BUY? EFFECTS OF DOCTOR VISITS ON WORK DAY LOSS

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INTRODUCTION

Do doctor visits reduce work time lost due to illness? The health economics literature has extensively examined the supply and demand side of the medical services market, studying the role of new technologies, the effects of health insurance, increasing health expenditures, and many other factors, that are often unique to this market.[1] The majority of work on demand models for medical services assumes that these services are productive, rather than consumption, goods. Theoretical models generally assume that medical services improve health, and thus reduce work days lost due to illness [Grossman, 1972a; 1972b; Acton, 1975]. To date, the relationship between health inputs (i.e., medical inputs) and outputs (e.g., reduced work loss days or restricted activity days) has received little empirical scrutiny. This study investigates the productivity of doctor visits. The health output is measured by reductions in work loss days.

If doctor visits are indeed productive, the number of days lost from work due to illness will be reduced. The analysis of this hypothesis has received virtually no empirical investigation. One exception is a relatively early study by Newhouse [1970] which found that doctor visits increase days lost from work. In examining the relation between health inputs and output Fuchs acknowledges that "...the significance of the marginal contribution of medical care to health (so measured) remains to be established" [1993, 23], and "the connection (between medical care and health) at the margin is highly circumscribed" [*ibid.*, 38]. For example, results associated with the RAND Health Insurance Experiment "show that the 40 percent increase in services on the free-care plan had little or no measurable effect on health status for the average adult" [Newhouse, 1993, 243].[2]

Any empirical study attempting to identify the productivity of doctor visits must overcome the fact that illness of unobserved severity induces individuals to visit a physician, and also stay away from work. The severity of the illness influences both the decision to obtain medical services and the number of work days lost. This positive correlation between doctor visits and work loss days may result in an underestimation of the effect of doctor visits on work day loss, therefore understating the productivity of medical services. An empirical model that tests this relationship must allow for the endogeneity of doctor visits, the dichotomous nature of the visit variable, and the non-negativity constraint of work days lost. Using a detailed econometric

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technique, this study is the first to incorporate these aspects of the data-generating process into a model of the effects of doctor visits on days lost from work.

Not all doctor visits reduce work loss. Visits can affect work days lost due to illness in several ways. In some cases diagnostic services may result in treatment of a condition, thus requiring that the individual be absent from his or her work place. In other cases, utilizing medical services may be independent of work loss. For example, the treatment of skin conditions may not affect the number of days lost.[3] Finally, some treatments may reduce the amount of work loss. A possible productivity effect of doctor visits, measured in terms of reduced sick time, is most easily observed in this latter treatment type, and thus is the focus of this study.[4]

The best test regarding the productivity of doctor visits results when doctor visits and work loss can be clearly attributed to a particular underlying health condition and when doctor visits have the potential to have a clear economic payoff for patients, for example, in reducing days lost from work. To address these issues, this study focuses on conditions where doctor visits are most likely to be productive in terms of reducing work loss. To cover a wide variety of conditions for which a doctor visit may reduce work loss, three data sets are analyzed. In particular, we focus on individuals with influenza (an acute condition), asthma (a chronic condition), and individuals with impairments (for example, individuals with a missing limb or hearing loss). Individuals with impairments were selected because the effects of any additional medical condition may be magnified for these individuals, creating a compounded negative effect on their ability to work.

Incentives to visit a physician to reduce work loss due to illness are affected by earnings. While a high-earning worker has incentives to visit a doctor to save two extra working days, a low-income individual may only be willing to incur the same costs if four days are gained. In addition to examining whether doctor visits reduce work loss days, this study also examines whether low-income individuals save more working days by visiting a physician.

The answer to the question of whether doctor visits reduce work loss has important implications, both for the validity of assumptions regarding medical services' productivity in health production, and in public policy. If doctor visits do not affect work loss, then doctor visits may be consumption goods rather than productive inputs for health. Alternatively, a negative effect on work time lost would indicate that doctor visits are a productive input in an individual's health. Also, the estimates in this study allow a comparison of benefits (measured in reduced work loss) and costs from a doctor visit. Conclusions regarding the impact on the welfare of society resulting from doctor visits can be drawn.

MODEL

The output of medical services is improved health. Most studies that make health the dependent variable use a production function approach.[5] Previous work has assumed that good health (*H*), is produced by a production function,

$$H=H(m, x, e) \tag{1}$$

which has as one of its inputs medical services, *m*, [Grossman, 1972a]. Increased medical care leads to improved health, that is $H/ m > 0$. Good health is not only produced by medical care, but also depends on goods inputs such as nutrition and exercise, denoted by the composite input x, as well as on the genetic endowment of the individual, *e*. Thus $H/\delta x > 0$ and $\delta H/\delta e > 0$. In addition good health has been assumed to depend on education, income, gender, age, and environmental pollution.

Many health problems have significant components that can be attributed either to the genetic endowment (*e*) or other highly individual specific components, such as inadequate prenatal care or poor nutrition during early childhood. However, these variables are often unobserved. This unobserved heterogeneity can bias inferences about the measures that potentially improve health [Rosenzweig and Schultz, 1983]. For example, the variable x may represent exercise, which is hypothesized to strengthen the heart. However, if individuals with weak hearts exercise less vigorously, an estimate of the effects of exercise may overstate the true effects and is therefore biased. This study, which attempts to ascertain the effects of medical services, faces a related problem: individuals with a low genetic health endowment may obtain medical services and still show symptoms of low levels of health. The bias here is in the opposite direction than the bias noted in the previous example. In this case the estimate of the effect of medical services on health is likely to understate the beneficial effects of these services.

Health can be measured in terms of mortality, morbidity, or self-evaluation of health status. In this study, health is measured by the number of days lost at work due to illness, which is a frequently employed measure of good health [Grossman, 1972b].[6] Work loss, however, is influenced by some economic variables in addition to those included in equation 1, which reflect, in part, biological variables which determine good health. More educated workers are predicted to miss fewer days from work since their work responsibility tends to be greater [Grossman, 1972a]. Women tend to be more productive in the non-monetary home sector, and thus are also expected to miss more work days [Machnes, 1992]. Other variables employed to explain variations in work loss days are earnings and age [Meyer et al., 1995].

An individual will obtain medical service up to the point where the marginal benefit from the service equals its marginal costs. One benefit from visiting a doctor is the increased earnings resulting from reducing the number of work loss days. Individuals with higher earned income forego more earnings by missing work than those with lower incomes. Thus, high-income individuals have an incentive to obtain medical services to reduce work loss by fewer days. For example, to reduce work loss by one day, an individual with \$100 daily earnings will visit a doctor at a cost of \$50 per doctor visit. However, if a worker earns \$40 per day, and faces a \$50 bill for medical services, he will only visit a doctor if he expects that work loss will be reduced by more than one day.

Another way of thinking about this issue is that individuals with higher earnings will visit a doctor when severity of illness is lower because the benefits from a work day gained are higher. Since incentives to obtain medical services differ between these groups, the equilibrium number of work days saved differs between high- and low-income individuals. Doctor visits are predicted to be more "productive" (measured in terms of reduction in work day loss) for low-earning individuals. An individual with higher earnings will find it advantageous to incur the costs to visit a doctor for a few days saved while a low-earning individual will only obtain medical services if more days are saved.

ECONOMETRIC SPECIFICATION

The empirical model tests whether physician visits affect days lost from work due to illness. To perform the test, a work loss equation (Tobit) is specified. The Tobit specification is motivated by the fact that the work loss variable is censored at zero, meaning that work loss days can not be negative. The decision to obtain services from a medical doctor is measured as an indicator variable, reflecting whether a doctor visit occurred. The estimated parameters of the work loss equations are unbiased if none of the explanatory variables are correlated with the error term in the Tobit equation. However, there is good reason to suspect that unobserved components affect both the decision to visit a doctor and the number of work days missed due to illness.[7] For example, unobserved severity of illness causes doctor visits and work day loss.

A single equation technique underestimates the effect of a doctor visit on the amount of time lost from work. Thus, a single equation Tobit estimator is biased. In this paper this issue is addressed by the estimation of a simultaneous Tobit-probit model, whose corresponding likelihood function, to my knowledge, has not been estimated previously. For this simultaneous model a work loss equation and a doctor visit equation (probit) are specified.[8] The probit specification is motivated by the dichotomous nature of the doctor visit variable. If the unobserved components affect both variables in the same direction, the disturbances in both equations are positively correlated.

Let y_{1i}^* be individual i's propensity to take days off from work, and let y_{1i}^* be positive when work loss is observed. When the propensity to miss work days is negative, no work loss is observed since work loss is constrained to be non-negative. Let y_{2i}^* be an individual's net benefit from visiting a doctor. y_{2i}^* is positive when the individual visits a physician and negative when he or she decides not to visit a physician. Let $\mathbf{X}_{1i}$ be the observed vectors of selected economic and demographic characteristics of individual i that determine work loss, and $\mathbf{X}_{2i}$ be a vector of variables determining doctor visits ($\mathbf{X}_{1i}$ is a subset of $\mathbf{X}_{2i}$) and a set of other exogenous variables, and let β_1 and β_2 be vectors of coefficients. The error terms ϵ_1 and ϵ_2 capture unobserved variables such as severity of illness. The described data-generating process can be written as

(2.1) $$y_{1i}^* = \gamma y_{2i} + \mathbf{X}_{1i}\beta_2 + \epsilon_{1i}\sigma_1,$$

(2.2) $$y_{2i}^* = \mathbf{X}_{2i}\beta_2 + \epsilon_{2i},$$

(2.3) $$y_{1i} = y_{1i}^* \text{ if } y_{1i}^* > 0,$$

(2.4) $$y_{1i} = 0 \text{ if } y_{1i}^* \leq 0,$$

(2.5) $$y_{2i} = 1 \text{ if } y_{2i}^* > 0,$$

(2.6) $$y_{2i} = 0 \text{ if } y_{2i}^* \leq 0.$$

The assumptions on the error terms are

(2.7) $$E(\epsilon_1) = E(\epsilon_2) = 0,$$

(2.8) $$E(\epsilon_1\epsilon_2) = \rho,$$

(2.9) $$E(\epsilon_1^2) = E(\epsilon_2^2) = 0,$$

(2.10) $$E(\epsilon_{ji}\epsilon_{j'i'}) = 0; j, j' = 1, 2; i = 1, ..., n; i \neq i',$$

where ρ is the correlation coefficient between the disturbances, and measures the correlation between the error terms. This model was estimated using a maximum-likelihood technique suggested by Berndt et al. [1974]. Starting values for the simultaneous estimation model were obtained from the single equation estimates and a grid search was used for the starting value of ρ.[9]

Identification of all coefficients in the simultaneous equation system is achieved if at least one variable in the doctor visit equation does not appear in the work loss equation, and if the omitted variable is uncorrelated with work loss.

In this simultaneous equation system, the *type* of health insurance, reflecting the cost of visiting a doctor, the extent to which the employer pays for the health insurance, and membership in Health Maintenance Organizations were excluded from the work loss equation. For identification of β_1 and γ it is sufficient that at least one of the instruments is uncorrelated with the decision of whether to take days off from work.

The types of health insurances considered are private insurance, Medicare, and Medicaid. For the instrument to be valid, the *type* of insurance individuals select should be uncorrelated with work day loss. Whether an individual chooses Medicare or Medicaid largely depends on income, age, and possibly education. The regression controls for these variables in the work loss equation. However, the type of insurance determines the cost of visiting a physician, and thus is predicted to be correlated with doctor visits.

A concern with the health insurance variables as instruments may be that unobserved health status may be correlated with work loss days and whether an individual has health insurance. However, this study considers as an instrument the type of insurance carried, not whether insurance is carried. Further, health status is controlled for by examining the behavior of individuals with a specific chronic or acute condition. Controlling for health status, by examining only individuals with a specific conditions, assures similarity of health status for the individuals analyzed. Further, differences in tastes for leisure are controlled for by analyzing only full-time employed individuals.

The other two instruments used are HMO membership and whether the employer pays for health insurance coverage. These variables are correlated with physician visits [Stratmann and Allard, 1995], but exogenous with respect to work loss days.

DATA

A doctor's visit is most productive in terms of reducing work loss days when services are geared to recovery or the suppression of symptoms that induce work loss. This study analyzes employees who have influenza, a condition for which the recovery time can be shortened by visiting a doctor.[10] In addition to being an appropriate medical condition for the proposed test, the analysis of influenza is of interest because of its high incidence rate relative to other acute conditions. For example, in the representative 1989 National Health Interview Survey (NHIS), of all acute conditions, influenza was by far the most prevalent; twenty-one percent of the individuals with an acute condition reported having influenza. Thus, influenza is of interest for analysis because it is an important contributor to total work loss.[11]

One potential problem in analyzing the data is that the observer does not know whether the doctor visit or work loss was attributable to influenza. However, in the NHIS individuals were asked about the total number of work loss days in the previous two week period, whether the work loss was attributable to a particular condition, whether a doctor was visited in the previous two week period, and whether a doctor was visited for a particular condition. In analyzing the effect of influenza on doctor visits, the data used were doctor visits and work loss that was attributable to influenza.

If only influenza were analyzed, one might wonder how robust these findings are with respect to other conditions, for which doctor visits may reduce work loss days. I also analyzed corresponding data for individuals with impairments. Studying the effect of doctor visits on work loss for this sample of individuals has the disadvantage of not knowing exactly what motivated these individuals to obtain a physician's services. For example, the doctor visit may have been unrelated to the condition that induced work day loss. However, if the unobserved determinants that motivated a visit and motivated work loss days are the same, they will be captured by the estimated correlation coefficient in the simultaneous model. The advantage of using this sample is that the incentive to use doctor services efficiently is particularly strong for this group. The effect of any given illness is magnified for individuals with impairments. While non-impaired persons may be able to work when they are ill, impaired persons with the same illness may find attending work to be prohibitively expensive. For example, under normal conditions an impaired person may have difficulty undertaking a task that involves moving an obstacle. For a person with an impairment, feeling weakened by an extra illness, this task may be impossible. Thus, inidividuals with impairments may receive a higher payoff from doctor visits than individuals without impairments, implying that the returns from using a physician's services is particularly large for impaired persons.

Lastly, a sample of individuals with a chronic conditions is analyzed. The individuals in this sample reported the number of work loss days that occurred due to the asthma condition, and whether a doctor was seen for this condition in that period. The advantage of examining this condition is that it is a different condition category (chronic versus acute) than was previously examined. Perhaps not unexpectedly, of all of those who have a chronic condition, work day loss may not have occurred in the last two weeks prior to survey participation. Thus, the disadvantage of this data set is that only five percent (29 individuals) of the asthma sample incurred work loss days.[12] Thus the marginal effect of a doctor visit must be recovered from these relatively small number of observations.

Data were obtained from the 1989 NHIS.[13] The data source specified whether an individual had influenza (an acute condition), and whether he or she visited the doctor for that condition. The data source also specified how many days of lost work occurred due to influenza. Only the behavior of individuals who were employed over the relevant period and had a work loss attributable to the particular condition examined were analyzed. In an analogous manner, work loss data and doctor visit data were obtained for individuals with asthma (a chronic condition). Therefore for this sample, work loss data and doctor visit data are those pertaining to asthma.

The model predicts the estimated coefficient for doctor visits to be a negative. Control variables included in the work loss equations are motivated by previous studies. Women are expected to use more of their allowed sick days since their productivity at home is generally higher and their incomes are lower [Machnes, 1992]. Consistent with previous studies, the other variable in the work loss regression was the individual's education [Silver, 1970], measured in years of formal education. Education may improve the efficiency with which individuals produce health.

Generally, older persons are less healthy, so I employ the natural logarithm of age as an explanatory variable for work loss and predict a positive sign on age [Silver, 1970]. However, since older workers have fewer opportunities for alternative employment, the cost of dismissal is higher. Therefore, age is expected to negatively affect work loss. The log of income is used to measure the opportunity costs associated with work loss.[14] Higher opportunity costs are predicted to be negatively related to days absent from the workplace.[15] It has been documented that black individuals have a higher morbidity than whites [see, for example, Health United States, 1994, 15ff, 96ff]. To capture this effect and the effect of other socio-economic variables not captured by education, age, and income, a race variable is added to the work loss equation.

Instruments for doctor visits have to be correlated with doctor visits but not with work day loss. Instruments chosen reflect the price of visiting a physician. The price of visiting a doctor differs with the type of insurance carried by individuals. Thus the quantity demanded differs by type of insurance.[16] Instruments chosen are indicator variables, which denote the type of insurance partly or entirely paying for an individual's medical bills: Medicare, Medicaid or another public assistance program, and private insurance coverage. Workers whose health benefits are paid out of pretax income have incentives to select more expensive health insurance, thus implying that they face a lower price of visiting a doctor, leading to an increased demand for medical services. Therefore, the empirical analysis includes variables indicating whether the employer paid the insurance premium. Membership in a Health Maintenance Organization (HMO) may also affect demand for medical care. HMO members face lower prices for visiting a physician than those without insurance, suggesting a positive correlation between HMO membership and doctor visits. Thus, HMO membership, in addition to the health insurance variables, also serves well as an instrument that is likely to be exogenous to the decision to incur work loss days. Further, HMOs encourage visits to general practitioners and approximately 80 percent of all doctor visits are visits to general practitioners [NHIS, 1989]. This aspect of HMO membership also suggests a positive correlation between HMO membership and doctor visits.[17] Therefore, an indicator variable for membership is included in the instrument equation.

Means and standard deviations of the variables used in the analysis are given in Table 1.[18] Doctor visits and work loss days are positively correlated for the influenza, asthma, and impairment conditions and the correlations are statistically significant.[19] These simple positive correlations do not indicate that doctor visits reduce work loss days, but the opposite. As noted previously, omitted variables may cause movement of work loss and doctor visit variables in the same direction.

RESULTS

Results from the influenza and the impairment samples are presented in Table 2. The first and third columns contain estimates from the single equation models and the second and third column show estimates from the simultaneous models. The coefficient on doctor visits is positive and statistically significant for the influenza sample in the single equation model. The corresponding parameter estimate in the simultaneous model is negative and statistically significant. The size of the estimated Tobit coefficient implies that the marginal effect of a doctor visit is a 2.7 day reduction in work loss.[20] As expected, the correlation coefficient ρ is positive and statistically significant at the 1 percent level.

When the error terms are correlated, a single equation estimation technique attributes unobserved severity of sickness to doctor visits, leading to a positive correlation between doctor visits and work loss days. As indicated by the estimate of the doctor visits on work loss days in the simultaneous equations model, the problem is severe: the estimated coefficient is positive and statistically significant in the single equation model, while it is negative and statistically significant in the simultaneous model.[21] The positive coefficient on doctor visits in the single equation model can be attributed to the fact that sick individuals visit a doctor and incur work loss days. The simultaneous coefficient estimate on the doctor visit variable signifies that visits are productive because they reduce work loss days.

None of the other estimated coefficients switch signs when moving from the single equation model to the simultaneous model. In general, the size of the estimated coefficients increases in absolute value and the corresponding standard errors increase a bit. Non-whites have more work loss days than whites, and males have fewer work loss days than females. More educated workers incur fewer work loss days.

TABLE 1
Means and Standard Deviations in Parenthesis

Variable	Influenza	Impairments	Asthma	Variable Description
Work Loss	1.24	0.60	0.14	measured in days
	(1.44)	(2.02)	(0.73)	
Work Loss	1.95	3.62	2.52	measured in days
given Work Loss >0	(1.37)	(3.71)	(2.01)	
Doctor Visit	0.21	0.30	0.16	Doctor visit =1,
	(0.41)	(0.45)	(0.37)	0 otherwise
Education	13.14	12.90	13.35	years of schooling
	(2.29)	(2.84)	(2.70)	
Income	35,557	35,097	36,716	in 1989 dollars
	(21,006)	(20,338)	(21,369)	
Race	0.89	0.90	0.85	White = 1,
	(0.32)	(0.31)	(0.36)	0 otherwise
Male	0.45	0.55	0.48	Male = 1,
	(0.50)	(0.50)	(0.50)	0 otherwise
Age	35.1	42.4	37.3	measured in years
	(11.1)	(13.9)	(12.8)	Private Insurance
	0.84	0.85	0.84	Private Ins.=1,
	(0.37)	(0.36)	(0.15)	0 otherwise
Membership in HMO	0.25	0.22	0.27	HMO member=1,
	(0.43)	(0.41)	(0.44)	0 otherwise
Medicare	0.006	0.075	0.02	Medicare=1,
	(0.079)	(0.263)	(0.15)	0 otherwise
Medicaid	0.021	0.012	0.009	Medicaid=1,
	(0.142)	(0.110)	(0.096)	0 otherwise
Insurance Premium	0.28	0.27	0.26	Premium paid by
Paid by Employer	(0.45)	(0.44)	(0.44)	employer=1, 0 otherwise
Number of observation	995	4609	542	
Number of observation	634	765	29	with work loss>0

For impaired individuals the single equation model predicts 0.8 more work loss days incurred when visiting a doctor (Table 2, columns 3 and 4). This parameter estimate on doctor visits is statistically significant at the one percent level. Simultaneous estimation produces a reversal of the sign, revealing that doctor visits actually reduce work loss days by approximately 2.9 days (Table 4, column 3 and 4). This estimate is statistically significant and the asymptotic t-ratio associated with this estimate is −2.3. These results reveal the doctor visit coefficient in a single equation model to be biased downwards. In the impairment model, the correlation among unobserved variables inducing individuals both to visit a doctor and to incur work loss is relatively large ($\rho = 0.39$) and the estimated correlation coefficient is statistically significant at the one percent level.[22]

The coefficients on race and gender variables have the same sign as those in the influenza model and are statistically significant. Older individuals are less likely to incur work loss days. Besides the coefficient on doctor visits, the largest change in the coefficient from the single equation model to the simultaneous model is on the educa-

TABLE 2
Work Loss Regressions: Influenza and Impairments
Parameter Estimates and Asymptotic Standard Errors
Coefficient (Std. Error) [Marginal Effect]

Dependent Variable	Single Equation Model: Influenza	Simultaneous Equation Model: Influenza	Single Equation Model: Impairments	SimultaneousEquation Model: Impairments
Intercept	0.902 (1.068)	3.407 (2.131)	2.736 (2.525)	9.629 (4.143)
Doctor Visit	0.567 (0.166) [0.256]	-6.071 (3.376) [-2.733]	4.332 (0.321) [0.841]	-14.585 (6.334) [-2.89]
Education	-0.039 (0.029) [0.017]	-0.097 (0.054) [-0.044]	-22.048 (5.737) [-4.247]	8.911 (13.111) [1.768]
Log Income	-0.093 (0.095) [-0.042]	-0.049 (0.144) [-0.022]	0.321 (0.216) [0.062]	0.135 (0.307) [0.027]
Race	-0.253 (0.215) [-0.113]	-1.147 (0.564) [-0.513]	-1.430 (0.467) [-0.277]	-1.244 (0.623) [-0.246]
Male	-0.178 (0.136) [-0.081]	-0.431 (0.252) [-0.394]	-0.372 (0.303) [-0.072]	-3.062 (1.007) [-0.607]
Log Age	0.418 (0.208) [0.189]	0.460 (0.330) [0.207]	-2.727 (0.449) [-0.529]	-3.289 (0.662) [-0.653]
σ_I	2.017 (0.062)	2.022 (0.038)	6.830 (0.205)	7.341 (0.197)
ρ	———	0.136 (0.042)	———	0.393 (0.029)
Log Likelihood	-2147.4[a]	-2145.7	-6433.5[a]	-6424.3

a. This log likelihood value corresponds to the system likelihood with ρ constrained to equal zero.

TABLE 3
Work Loss Regressions: Asthma
Parameter Estimates and Asymptotic Standard Errors for Selected Variables
Single Equation Tobit Model and Simultaneous Tobit-probit Model

Dependent Variable	Single Equation Model	Simultaneous Equation Model
Doctor Visit	4.075 (1.225) [0.530]	-54.06 (28.47) [-6.91]
ρ	———	0.489 (0.141)
Log Likelihood	-389.6[a]	-381.0

The standard errors are in parentheses while the marginal effect is shown in brackets.
a. This log likelihood value corresponds to the system likelihood with ρ constrained to equal zero. Asymptotic standard errors are in parentheses.

tion variable. Here the coefficient is negative and statistically significant in the single equation model, and positive but not statistically significant in the simultaneous model.

Results for the asthma model are presented in Table 3. Paralleling the previous results, the doctor visit coefficient in the model for individuals with asthma is positive and statistically significant in the single equation model and negative and statistically significant in the simultaneous equations model. The marginal effect of doctor visits for individuals with chronic asthma in the simultaneous equations model is relatively large relative to the previous results. In this model a doctor visit associated with asthma reduces work loss days due to asthma by 6.9 days. One cause of this large effect may be that, in the absence of a doctor visit, a stay at a hospital would have been necessary. A likelihood ratio test rejects the single equation specification, indicating that the simultaneous specification is significantly better. The other estimated coefficients of the simultaneous model have both the same signs, and similar levels of statistical significance as in the impairment models, and are thus not reported in Table 3.

Since opportunity costs of work loss are lower for low-income workers, the model predicts that more saved work loss is associated with doctor visits by low-earnings individuals than high-earnings individuals. For all three conditions the samples of workers with below average earnings was analyzed. Then the estimated marginal effects of a doctor visit for these samples are compared with the results from the entire samples. The effect of doctor visits is examined for low earnings rather than high-earnings individuals because the number of instruments for doctor visits available in this study is larger and exhibits more variability for the low-income sample. For example, the instrument Medicaid is not available for the high-income sample, and only very few observations in the high-income sample have Medicare insurance. The explanatory and instrumental variables used for the tests are identical to those in Table 2 and Table 3. In addition, as was noted above, the marginal effect of a doctor visit for asthma had to be recovered from only 29 observations. Cutting the sample down, using only observations with less than mean income, results in 20 data points with positive work loss days. Thus emphasis is placed on the results stemming from influenza and impairments.

Test results are presented in Table 4. For all three conditions, the likelihood ratio tests indicate that the simultaneous model is the proper one for these samples. For influenza and impairments, doctor visits by individuals with below mean overall sample earnings produce a larger reduction in work loss than doctor visits by individuals of all earnings ranges. For example, Table 2 showed a 2.7 day reduction in work loss days due to influenza while Table 4, Column 1 indicates that the marginal effect is a 4.1 day reduction. For impairments the reduction increases from an average of a 2.9 work day gain to a 5.1 day work gain. For asthma a 20 percent reduction in work loss savings (from 6.9 to 5.5 work days) is found for individuals with below average earnings (Table 4, Column 3). However, as noted previously, this may be due to the small sample size of positive work loss days.

There may be an alternative explanation for doctor visits' lower marginal effect for low-earnings workers visits in the asthma sample. Different from influenza, the alternative to treatment for chronic asthma by a physician may not be to miss an extra day from work, but to be admitted to a hospital — resulting in costly, and possibly lengthy, treatment. In this situation a low-earnings worker may opt to visit a physician early for an asthma episode, to avoid an expensive hospital stay. This would explain the lower marginal effect of doctor visits in Table 4, column 3.

CONCLUSIONS

This study contributes to an understanding of the relationship between health inputs and output. In this paper the measure for inputs is whether an individual visited a doctor and the output measure is work day loss, the negative of health. One acute and two chronic conditions were examined.

The findings show that unobserved heterogeneity makes individuals obtain services from a physician and incur work loss. Thus, the coefficient on doctor visits is biased downwards if a single equation technique is employed, implying that the single equation model underestimates the effect of medical services. Doctor visits are shown to reduce work loss only once the unobserved heterogeneity is accounted for in the model.

The productivity effect of doctor visits is substantial for all conditions analyzed. For example, individuals with influenza can cut work loss by 2.5 days and those with chronic asthma can cut work loss by 7 days by visiting a physician. Over consumption of medical services is consistent with no correlation between doctor visits and reductions in work loss days. The findings indicate that though there may be over-consumption of medical services, at the margin doctor visits are still productive.

Further, estimation results show that, for influenza and impairments, larger work loss reductions are associated with doctor visits by low-earnings workers. The results are consistent with the hypothesis that doctor visits (for the analyzed conditions) are productive and that these medical services are used as an investment good in the production of good health. The finding that work loss days saved is larger for low-earnings workers supports the view that individuals carefully balance costs and benefits of a doctor visit. Purchasing services from a medical doctor appears to be a rational allocation of resources. Assuming a daily minimum pay of approximately $40 (at eight work hours at the minimum wage) a worker's losses associated with 2.5 days of work are at least $100. Assuming that a cost of a doctor visit for the diagnosis of, for example, influenza, is approximately $60, on average, visiting a physician appears as a worthwhile investment.

TABLE 4
Summary Statistics and Estimation Results: Individuals With Less Than Average Income of Total Sample

	Influenza	Impairments	Asthma
Number of observations	576	2697	297
Number of observations with work loss >0	369	461	20
Work loss: mean and standard deviation	1.266 (1.418)	0.696 (2.090)	0.428 (1.264)
Given work loss > 0: mean and standard deviation	1.976 (1.318)	3.722 (3.753)	2.50 (1.93)
Doctor visit: mean and std. deviation	0.210 (0.408)	0.294 (0.456)	0.131 (0.338)
Doctor visit coefficient and standard error, simultaneous model	-8.983 (4.566)	-22.480 (9.988)	-44.257 (26.127)
Doctor visit marginal effect, simultaneous model	-4.142	-5.123	-5.532
Single equation log likelihood[a]	-1230.2	-3795.0	-205.8
Simultaneous equation log likelihood	-1224.1	-3787.0	-199.4
and standard error	0.570 (0.058)	0.412 (0.038)	0.625 (0.204)

a. This log likelihood value corresponds to the system likelihood with ρ constrained to equal zero.

NOTES

1. For a review of the health economics literature, see Weisbrod [1991].
2. On the other hand, analyzing interstate differences, Auster, Leveson, and Sarachek [1969] found a negative correlation between state medical expenditures and state mortality rates.
3. Though a doctor visit may not be productive when measured in terms of reduction in work days lost, it may be productive by increasing an individual's utility. This study focuses on observable output of doctor visits, namely reductions in work loss days.
4. Doctor services constitute 22 percent of personal health care expenditures [United States Department of Health and Human Services, 1995]. This figure does not include expenses for medications prescribed by the doctor.
5. See, for example, Auster et al. [1969], Rosenzweig and Wolpin [1986, 1988], Grossman and Joyce [1990], and Blau et al. [1996].

6. Other measures for disability days include restricted activity days or school loss days. See Fuchs [1993] for a discussion regarding issues of measuring health.
7. White [1973] has shown that morbidity induces demand for medical services. In this context morbidity can be thought of as one of those unobserved variables that induce work loss and induce demand for medical services from physicians.
8. Examples for good discussions of Tobit and probit models are Amemiya [1985] and Maddala [1983].
9. The likelihood function is available from the author upon request.
10. Since influenza is a virus and, as such, does not respond to antibiotics, the most likely reason why doctor visits can reduce work loss days is that patients receive medications that minimize coughs and congestion. Influenza also can make a person more susceptible to bacterial pneumonia, and prescribed antibiotics may avoid such secondary bacterial infections.
11. The impact of influenza in restricted activity days is discussed in Sullivan et al. [1993].
12. As indicated in Table 1, 643 out of 1039 observations reported work loss due to influenza and 765 of the 4609 impaired individuals reported work loss days.
13. The data used in this analysis were obtained by combining the following files from the 1989 National Health Interview Survey: the Health Insurance Supplement, the Household Record, and the Condition Record.
14. The reason for using the log of income and log of age rather than income, income squared, age, and age squared is that the log specification makes maximization of the likelihood function of the simultaneous model easier, since the maximum must be found over fewer parameters. Using the squared variables in equations 2.1 and 2.2 would have increased the number of parameters by four.
15. Exact incomes were not reported in the NHIS; instead, incomes were reported in $1000 brackets up to $20,000, and $5000 brackets from $20,000 to $50,000. All incomes greater than $50,000 were reported as $50,000. Because of this, the income variable used is equal to the median of the income bracket in which each observation occurs, and is equal to median income of those households with an income above $50,000.
16. For empirical documentation for the relationship between quantity of medical services demanded and the price of these services, see, for example, Manning, et at. [1987], Cameron [1988], Stratmann and Allard [1995].
17. If individuals in HMOs, on average, are healthier than non-members, HMO membership may be correlated with work loss days. However, a comparison of health status of members of the sample revealed no significant differences between HMO members and non-members. Further, no significant differences in work loss between these groups were detected.
18. Given that individuals interviewed were asked about the number of work loss days over a two week period, work loss is censored at fourteen, in addition to being censored at zero. However, the upper bound of fourteen work loss days was only binding for a few observations in each sample and thus this upper bound is not quantitatively important. For example, in the influenza sample, only one observation had fourteen work loss days.
19. The correlation coefficients between doctor visits and work loss days are 0.165 (0.0001) for influenza, 0.200 (0.0001) for impairments, and 0.178 (0.0001) for asthma, where the p-values are in parenthesis.
20. The marginal effects were calculated following the method suggested by McDonald and Moffit [1980].
21. The simultaneous estimates (with asymptotic standard errors in parentheses) for the doctor visit equation for influenza (Table 3) are: -0.129 (0.094)*sex -0.340 (1.438)*lnage -0.310 (0.194)*ed +0.047 (0.066)*lninc -0.416 (0.136)*race 0.100 (0.078)*hmo -0.142 (0.087)*all +0.639 (0.295)*medicare +0.046*(0.086) priv +0.264*(0.209) medicaid. The simultaneous estimates (with asymptotic standard errors in parentheses) for the doctor visit equation for impairments (Table 4) are: -0.408 (0.041)*sex -0.172 (0.067)*lnage +4.674 (0.798)*ed +0.064 (0.030)*lninc +0.032 (0.068)*race +0.006 (0.037)*hmo +0.065 (0.036)*all +0.230 (0.075)*medicare +0.217*(0.060) priv -0.133*(0.138) medicaid. The quantitative and qualitative results of the first stages corresponding to Tables 5 to 6 were similar to the results reported above.
22. The data on the asthma condition included only five individuals having Medicaid. The number of observations was insufficient to obtain a reasonably precise estimate on this variable in the instrument (probit) equation. The estimated standard error in that regression was over 500 times as large as the estimated coefficient. Thus the likelihood function of the simultaneous model did not converge when Medicaid was included as an instrument. (The area around the maximum was "too" flat). The results shown come from the likelihood function of the simultaneous model when Medicaid is omitted as an instrument.

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