# ESTIMATION OF THE DETERMINANTS OF HOUSEHOLD HEALTH CARE EXPENDITURES IN NEPAL WITH CONTROLS FOR ENDOGENOUS ILLNESS AND PROVIDER CHOICE

**Jeffrey J. Rous**
University of North Texas, Department of Economics, Denton, Texas, USA

**David R. Hotchkiss***
Tulane University, School of Public Health and Tropical Medicine, Department of International Health and Development, New Orleans, Louisiana, USA

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*Correspondence to: Tulane University, Department of International Health and Development, 1440 Canal Street, Suite 2200, New Orleans, Louisiana 70112, USA. Tel.: +1 504 5856157, fax +1 504 5843653

# ESTIMATION OF THE DETERMINANTS OF HOUSEHOLD HEALTH CARE EXPENDITURES IN NEPAL WITH CONTROLS FOR ENDOGENOUS ILLNESS AND PROVIDER CHOICE


## SUMMARY

This paper uses the Nepal Living Standards Survey, a nationally-representative sample of households from 1996, to investigate the determinants of household out-of-pocket health expenditures. The analysis uses a multi-equation joint estimation to control for endogeneity of sickness and provider choice. The results of this analysis indicate several interesting findings. First, common unobserved factors were found to be statistically significant determinants of illness, choice of provider, and health expenditures, and may cause bias to parameter estimates if not controlled. Second, the income elasticity is estimated to be 1.02, with income having both a direct effect on health expenditure, and a indirect effect through type of provider that is chosen. Third, housing and sanitary conditions were found to have a substantial effect on illness, and as a result, out-of-pocket health care expenditures. Fourth, despite the fact that urban ill individuals who seek care are more likely to utilize care in more expensive settings, average health care expenditure among the urban sample was found to be substantially lower than among the rural sample, partly due to a lower likelihood of reporting illnesses and injuries and of using any type of health care provider.



KEY WORDS B health care expenditures, households, demand, unobserved heterogeneity, Nepal


## INTRODUCTION

In order to better understand the financial dimensions of health care systems in developing countries, a number of recent studies have carried out systematic accountings of national health expenditures based on a >national health accounts= (NHA) methodology that has been described in this journal (Berman, 1998). The results of these studies on the sources and uses of funds indicate that households are a much larger source of funds than previously thought, and that the percentage of total expenditures that come from households is negatively associated with income per capita (Rannan-Eliya *et al.*, 1997; Berman *et al*., 1995; Hotchkiss *et al* 1999; Bangladesh Ministry of Health and Family Welfare. 1998). That low-income countries have a larger household share of total health expenditure is consistent with previous national-level findings that indicate that public health spending is more responsive to income differences than private health spending. For example, a recent study found that the income elasticity for the public and private components of health care expenditures is 1.21 and 1.02, respectively (Schieber and Maeda, 1997).

The importance of households in the funding of health care in developing countries not only suggests that households are willing to expend a considerable percentage of their resources on health care, but also underscores the importance of understanding the determinants of household health care expenditure. Unfortunately, modeling the determinants of health care expenditures is a less than straight-forward undertaking. Several factors complicate attempts to obtain unbiased estimates of the impact of variables that influence health care expenditures. First, data on medical care expenditures typically exhibit a large number of observations clustered at zero, with the rest of the observations being positive and highly skewed. As a result, commonly used estimators for limited dependent variables, such as the Tobit model, may produce biased parameter estimates (Manning *et al.* 1987). Second, an individual=s health care expenditures are likely to be strongly influenced by the perception of illness, whether the person receives treatment, and the type of provider utilized. If there are unobserved factors that are correlated with health care expenditure and either the perception of illness and the likelihood of visiting a type of provider, then parameter estimates in a health expenditure model will be biased.

The purpose of this paper is to investigate the factors that influence how much households spend for health care services. In order to control for biases that result from sample selection and endogeneity, the analysis uses a multi-equation joint estimation to control for the endogeneity of sickness and the choice of health care alternative. The data used in the analysis comes from a nationally-representative household survey that was administered in Nepal in 1996. Nepal is one of the poorest countries in the world, with a per capita GDP of US$200 and a life expectancy at birth of 54 years in 1994 (World Bank 1996). Perhaps not surprisingly, relatively little is known about health expenditure in Nepal. A previous research study indicated that households were the source for three-fourths of Nepal=s total health expenditure and that households expend about 5.5 percent of their total income on health care. In addition, rural households were found to spend more on health care than urban households, after controlling for income status (Hotchkiss *et al.* 1998).

This paper is organized in the following way. After this introductory section, we describe the full-information modeling technique that controls for the endogeneity of reporting an illness and provider choice. In the third section, we discuss the Nepal data that is used in the analysis. In the fourth section, we present the parameter estimates of our three-equation model and, in order to assess the magnitude of the effects, discuss the results of a series of simulated changes in income per capita, urban/rural status, age, gender, and environmental conditions. Finally, in the final section, we present a summary and discussion of our results.

## METHODOLOGY

We assume that households generate utility from consumption of commodities. While many commodities, including the traditional goods and services, are purchased directly from the market, others, such as health, are produced by household members by combining their own time with inputs -- goods and services purchased in the market. Consumers do not receive utility from consuming health services, per se; instead they receive utility from the health that can be produced with household time and health inputs (Grossman, 1972). We further assume that each household=s utility function comprises the utility of each member of the household. Household decisions are made to maximize household utility with respect to their consumption of commodities, subject to the household=s resource constraints on income and time. That is, households choose a health provider and level of health care that will maximize household utility given the household=s level of pecuniary and non-pecuniary resources.

To analyze an individual in a household=s provider choic e and health expenditure decisions, we jointly estimate a system of three equations. The dependant variables in the three equations are illness, provider choice, and health care expenditure. Health care provider choice and health care expenditure equations are difficult to estimate for several reasons. First, individuals in developing countries generally do not visit a health care provider or spend much on health care unless they perceive themselves as either ill or injured. If there are unobserved factors that are correlated with perception of illness and either the likelihood of visiting a type of provider, or their amount of health care expenditure, then the coefficients in the provider choice or expenditure equation will be biased. Second, expenditure is likely to be a function of the type of provider visited. This is especially true in developing countries where the public sector is generally heavily subsidized. Since type of provider visited and expenditure are likely to be endogenous, including a variable indicating type of provider visited in the expenditure equation would potentially result in biased results. To control for these sample selection and endogeneity biases, we estimated the model using full-information maximum likelihood with discrete factor error term correlations.

The first equation in the system is the illness equation where S=0 if the individual is not sick and S=1 if the individual is sick. We specify the probability of becoming ill with a logistic error structure. That is,

$$\ln\left[\frac{Prob(S=1)}{Prob(S=0)}\right] = \alpha^{s} X_i^{s} + \rho_{kc}^{s} \mu_{kc} + \rho_{kh}^{s} \mu_{kh} \qquad (1)$$

where the log of the ratio of the odds that individual i has recently been ill, S = 1, relative to S = 0, is estimated. The $X^s_i$ represent a set of individual and household socioeconomic and demographic characteristics. The α, ρ, and μ represent a set of regression parameters to be estimated. $\mu_{kc}$ represents a set of unobserved community-level variables that are correlated with the outcomes in two or three of the equations and $\mu_{kh}$ represents a set of unobserved household-level variables that are correlated with the outcomes in two or three of the equations. A complete description of the μ and ρ appears in the discrete factor analysis section of this paper.

The second dependent variable in the system is the type of provider chosen, which is an unordered categorical variable. Using the logit specification, provider choice type is modeled as

$$\ln\left[\frac{Prob(P_i = j \mid S_i = 1)}{Prob(P_i = 1 \mid S_i = 1)}\right] = \alpha_j^p X_i^p + \rho_{kcj}^p \mu_{kc} + \rho_{khj}^p \mu_{kh} \tag{2}$$

where the log of the odds that individual i will chose provider type j (j=2,3) relative to type 1 is estimated -- where type 1 is no visit to a health care provider, 2 is consultation at a public clinic, and 3 is consultation at public hospital, 4 is consultation at a pharmacy, 5 is consultation at home with a private provider and 6 is consultation with an other type of private provider. Individuals are included in this equation only if they reported a recent illness. The $X_p$ represent a set of individual and household socioeconomic and demographic characteristics which affect provider choice. Note that all comparisons are relative to not visiting a provider (P = 1) but any other comparison of interest can be calculated by simple subtraction. For example, the coefficients of $X_{pi}$ for the log odds of choice 3 relative to choice 2 are $\alpha_3 - \alpha_2$. The $\alpha$, $\rho$, and $\mu$ represent a set of regression parameters to be estimated.

The third dependent variable in the system is the amount of health care expenditure a household spends on a household member when they become ill and visit either a public or private provider. The equation is empirically modeled as

$$(\ln(E_i) \mid S_i = 1, P_i \neq 1) = \alpha^e X_i^e + \beta V_i^e + \rho_{kc}^e \mu_{kc} + \rho_{kh}^e \mu_{kh} + \nu_i^e \tag{3}$$

where the dependent variable, $\ln(E_i)$, is the natural log of the amount spent on a sick member of the household that has consulted a public or private provider of health care. The natural log of health expenditure was used to reduce the effects of the skewed nature of the health expenditure variable. Individuals are included in this equation only if they had reported themselves recently ill and have visited a provider of health care. The $X_{ei}$ represent a set of observed individual and household socioeconomic and demographic characteristics that determine expenditure. $V_i$ is a vector of dummy variables indicating which type of provider was visited. As those who do not seek care are not included in the equation and consultation at a public clinic is the omitted category. $\nu^e_i$ is the disturbance term. The $\alpha$, $\beta$, $\rho$, and $\mu$ represent a set of regression parameters to be estimated. Expenditure models typically suffer from bias caused by a dependant variable with a large number of zeros. Because we only model expenditure for individuals who are ill and visit a provider, this problem is minimized. Only 35 such individuals B 2.9 percent of those who visited a provider B reported zero expenditure.

*Unobserved Heterogeneity Problems*

Households can only spend money on health care if they visit a provider, and the data set we are using collected provider and expenditure information only if the household member indicated that they had been recently ill. Since it is likely that the same unobserved factors determine illness, provider choice and expenditure, failing to control for the sample-selection into being ill and the self-selection of provider choice could lead to biased results. The source of the self-selection biases discussed above can be thought of as being derived from one cause, correlation between each outcome and the same unobserved individual-, household-, or community-level factors. The biases can therefore be referred to as "unobserved heterogeneity" biases.

In addition, the household and community-based sampling used for the survey creates inefficiencies in the estimation. The fact that each individual in each surveyed household is observed and the fact that the survey was made up of households from clusters of communities suggests that the observations in the data set from the same household or community will have similar and unobserved characteristics. Therefore, the error terms for the same individuals in each household and the error terms for individuals from the same communities might be correlated. These autocorrelation problems could result in severely compromised results if they were not controlled. The source of these inefficiencies is also be attributed to "unobserved heterogeneity" as common unobservables are responsible for the error term correlation. Fortunately, the estimation technique we employ corrects for all the unobserved heterogeneity problems discussed above.

*The Discrete Factor Method*

To remove the unobserved heterogeneity biases discussed above, we employ a discrete factor method similar to that described in Heckman and Singer (1984), Akin and Rous (1997), and Mroz (1999). The technique is full-information maximum likelihood, but instead of making a multivariate, parametric assumption about the error term (e.g., multivariate normal), a discrete, semi-parametric multivariate distribution that approximates the true distribution of the unobserved variables responsible for the correlation between the error terms is estimated. The approximated distribution is made up of a set of points of support and corresponding probability weights. The structure of the likelihood function used here is similar to the one detailed in Akin and Rous (1997)

Accounting for both community specific and household specific unobserved factors that are correlated with the error terms, required the estimation of separate community and household level distributions. To facilitate the estimation, we expand the error terms and assume the following mixed error structure for each equation to be estimated.

$$e_i^s = r_{kc}^s m_{kc}^s + r_{kh}^s m_{kh}^s + n_h^s \quad (4a)$$

$$e_i^p = r_{kc}^p m_{kc}^p + r_{kh}^p m_{kh}^p + n_h^p \quad (4b)$$

$$e_i^e = r_{kc}^e m_{kc}^e + r_{kh}^e m_{kh}^e + n_h^e \quad (4c)$$

where

$\gamma^s$ the illness equation disturbance term

$\gamma^p$ the provider choice equation disturbance term

$\gamma^e$ the health care expenditure equation disturbance term

We assume that the $\nu$ for the discrete outcomes are distributed logistically, while the $\nu$ for the continuous outcome is distributed normally, and all $\nu$ are independent. Therefore, the illness, and provider choice equations are specified much like logit and multinomial logit equations, and the expenditure equation is specified much like a continuous outcome maximum likelihood equation. We further assume that $\mu_{kc}$ represents the distribution of the community-level unobservables and $\mu_{kh}$ is the distribution of the household-level unobservables that are correlated with the three outcomes. The $\rho$ are parameters, similar to the correlation coefficient in the bivariate normal distribution, which explain the level of correlation between the outcome and $\mu_{kc}$ and $\mu_{kh}$. Because we are estimating the product of two parameters which both vary by equation, we can only estimate the product of the $\rho$ and $\mu$ of each type in each equation.

$\mu_{kc}$ represents a community-level unobservable factor that may be correlated with the equations in the model. An example might be a local doctor at a private clinic who has a great bedside manner and high quality care who not only attracts more patients but might also convince patients to consume more services. $\mu_{kh}$ represents household specific unobservable factors that affect perception of illness and may also affect provider choice and health care expenditure. An example might be a head of a household that is also a bit of a hypochondriac. In such a household, individuals may be more likely to perceive themselves as sick and more likely to go to a provider and more likely to spend more on health care. For a detailed presentation of the discrete factor technique and the likelihood function, please see Appendix A.

## DATA

The data used in this analysis come from the Nepal Living Standards Survey (NLSS), which was administered by Nepal=s Central Bureau of Statistics (CBS) with assistance from the World Bank. This nationally-representative survey collected information from 3,338 households (18,855 individuals) in 275 communities from June 1995 to May 1996. The sample was divided into four strata based on the geographic and ecological regions of the country: (1) the mountains, (2) the urban hills, (3) the rural hills, and (4) the

Terai, the flat river plain of the Ganges in the southern region of Nepal. A two-stage stratified sampling procedure was used to select the sample. In the first stage, communities were randomly selected with a probability of being included directly proportional to their population. In the second stage, a fixed number of households was randomly selected from each chosen community.

The household survey included questions pertaining to a wide array of economic, demographic, and health-related behaviors of each member of the household, not just the head of the household. The topics covered by the NLSS include demographic characteristics, access to facilities, housing, migration, food expenses and agricultural production, non-food expenditures, education, health, anthropometry, marriage and maternal history, wage employment, income, and nutrition.

The health section of the survey included questions on whether each household member was perceived to suffer from a chronic disease or from an illness or injury in the past month, whether the individuals used health care services, the type of place and practitioner that was consulted, and the consultation and travel costs for the last two consultations. These data come from the most comprehensive and complete household-level survey ever administered in Nepal. The health component of the survey captures information on the wide range of health care choices that are available in Nepal, from traditional healers in the mountain areas to modern hospitals in the capital city, Kathmandu.

This study uses information from all individuals in the sample, both adults and children. The three dependent variables used in the three equation model are whether the individual reports being ill in the month prior to the survey, the choice of health care provider type, and the natural log of how much money was spent on health care.

*Illness.* For each individual in the sample, information was collected on when the person was last ill. For young children five years of age or younger, this information was collected from the mother, or another knowledgeable adult in the household. If an illness was reported during the month prior to the survey, the individual was asked about the type of illness or injury. Table 1 shows that 9.7 percent of the 18,555 individuals reported themselves as ill in the month prior to the survey. Rural individuals were more likely to report an illness-related symptom (10.3 vs. 7.4 percent, respectively).

*Health care.* Persons who reported an illness were asked whether anyone was consulted for the illness and injury and where the person went for the consultation. Two-thirds used medical treatment and one-third did nothing. Rural individuals were less likely to use medical services than urban individuals (64.7 vs. 77.1 percent, respectively). The types of health care provider have been classified into five categories: public clinics, public hospitals, pharmacies, home visits and private facilities. Public Clinic care consists of care provided at government clinics, mobile clinics, and clinics administered by non-government organizations and religious missions. Private Care consists of any private facilities other than pharmacies, including for-profit hospitals and clinics, and non-governmental organization hospitals. Table 2 shows that the majority (56.7 percent) of individuals utilizing medical treatment first chose a public health care provider. In rural areas, public clinics are the most widely utilized source of health care, while in urban areas, private hospitals and clinics are the most frequently utilized source. Also note that urban individuals who seek out health care are almost twice as likely to use a public hospital than rural individuals.

*Health expenditure.* Information was also collected on where the first and second consultation took place and how much was spent on the consultation, including any medicines that were provided, and on travel. The dependent variable used in the health expenditure equation is the sum of the consultation and travel costs of the first consultation after the illness and symptom was recognized. Table 3 presents the total costs by the type of alternative that was utilized. Public hospitals were reported to be the most expensive source of care, followed by private facilities, public clinics, and pharmacies. That public care is associated with substantial out-of-pocket costs suggests that many public consultations involve purchasing drugs and services in the private market (Hotchkiss *et al.*, 1998). For example, a doctor may initially treat an individual in a government clinic but then continue the treatment episode in his private chambers, or an individual may consult a practitioner in a public clinic but purchase medicines from a private pharmacy, perhaps as a response to drug stock-outs. The structure of the NLSS precludes distinguishing the extent of these two possibilities for individuals whose sole treatment consists of one visit to a doctor in a public hospital or clinic. Unfortunately, we do not have the ability to determine the percent of expenditures that flows to private providers for drugs and services because the survey did not include specific questions that itemized consultation costs. Because of these limitations in the survey instrument, the costs reported in Table 3 should be interpreted as out-of-pocket costs Aassociated@ with utilizing the specific types of providers for an initial consultation. The survey did not include questions on whether individuals are covered by health insurance, which is uncommon in Nepal.

The independent variables used in the analysis include individual-, household-, and community-level characteristics. Table 4 defines the variables included in the three-equation model, and Table 5 presents descriptive statistics for those variables. One independent variable that deserves further explanation is the income measure. Ideally, we would like to use an individual=s or household=s permanent income since it will be the measure of income that most determines an individual=s or household=s expenditure. Due to variation in actual income from year to year, households are generally thought to make expenditure decisions based on their perception of their Apermanent income@ -- the amount of income they expect to earn on average. Since permanent income is impossible to measure, it needs to be proxied in some way. The NLSS does contain total household expenditure, which is a good measure of permanent income -- especially in a country with a low savings rate. As a precursor to the estimation of the three equation model described above, a permanent income instrument was created by regressing the log of per capita household expenditure on several explanatory variables. The results of this estimation can be found in Appendix C. AThe permanent income instrument is needed since total expenditure and specific expenditure categories are simultaneously determined, and direct use of total expenditure would lead to bias resulting from correlation of that explanatory variable and the error term@ (Rubin and Koelln, 1993). A log transformation of household expenditure was used to capture possible non-linearities between the determinants of expenditure and expenditure.

## ESTIMATION RESULTS

This section describes the estimation results of the three equation system. As described above, the dependent variables that were modeled are illness, the choice of health care provider, and health expenditures, and the system is estimated through a single maximum likelihood estimation procedure. After presenting the results of the estimation, we describe a set of simulation exercises that evaluates the impact of exogenous factors on provider choice and health expenditures. Although there is no real interpretive value to the unobserved heterogeneity parameters, it is important to note that many of the parameters were strongly statistically significant, indicating that a failure to control for unobserved factors could potentially bias the results. Appendix B presents a brief discussion of these parameters.

### *Illness equation results*

Because the rationale for estimating this equation is to correct for selectivity in the estimation of the choice of provider and health expenditures, the results of the determinants of reporting an illness will be discussed only briefly (see Table 6). A number of individual- and household-level characteristics emerged as statistically significant. As expected, the age of the individual was found to be significantly associated with the reporting of illnesses and injuries. One of the more interesting findings concerns gender. Although females were not significantly more likely to report illnesses than males, individuals in households headed by females were statistically significantly more likely to report illness than individuals in households headed by men. In addition, another characteristic of the head of the household that emerged as statistically significant was the number of years of schooling, which was found to be negatively associated with the likelihood of reporting an illness. With respect to the income and wealth of the household, per capita income and a number of key indicators of the environmental/sanitary conditions, such as a good floor, piped-in water, adequate garbage removal and a good toilet have the expected negative effect on illness. In addition, the level of crowding in the household, another measure of environmental conditions, was found to be positively associated with the likelihood of reporting an illness, and individuals in households where alcohol and tobacco are consumed were more likely to report a health problem, but only the former effect is statistically significant. Regarding the geographic location of the household, individuals in urban households were more likely to report an illness after controlling for other factors. Although the finding is not statistically significant, the finding is interesting in that it is in contrast to the results of the descriptive analysis, which found that urban individuals are *less* likely to report an illness than their rural counterparts. In addition, Table 6 indicates that individuals in the mountain and hill regions are more likely to report illnesses than individuals in the Terai, with only the former effecting being statistically significant.

*Choice of health care provider equation results*

Table 7 reports the results of the choice of health provider equation, which controls for the endogeneity of reporting an illness. This section briefly describes the statistical significance and sign of the coefficient estimates. (A discussion of the magnitude of these effects on provider choice is presented in the simulation section of this paper). Overall, the results indicate that a number of household- and community-level characteristics have a statistically significant effect on choice. With respect to household characteristics, the natural logarithm of income per capita was found to have a positive effect on the probability of each any type of provider vs. no provider. With the exception of pharmacy, each effect was estimated to be statistically significant. Models were also estimated using the absolute level of income per capita, but, not surprisingly, using the natural logarithm substantially improved the fit of the model.

Another interesting finding is that the demographic characteristics of the head of the household, and not of the ill individual, were found to be an important determinant of provider choice. For example, individuals living with older household heads were found to have a higher probability of using no care vs. each of the health care alternatives considered in the analysis. Furthermore, households headed by older individuals were statistically less likely to use Private Facilities than any other type of provider. On the other hand, the age of the ill individual does not seem to be a significant determinant of provider choice. Overall, these results provide an indication that households in which the head of household is older are more traditional in the manner in which they respond to illnesses and injuries.

With respect to schooling, higher educational attainment of the head of the household does seem to be associated with the use of Pharmacies vs. Public Clinics, Public Hospitals vs. Private Facilities, Pharmacies vs. Home Visits, and Pharmacies vs. Private Facilities. On the other hand, the educational attainment of the ill individual did not emerge as a statistically significant determinant. Finally, neither the gender of the head of the household nor the gender of the ill individual are found to be significantly associated with provider choice. To further the investigate the potential impact of gender, we estimated separate models for both adults and children. As with the results reported in Table 7, gender was not found to be statistically significant.

Turning to the location of the head of the household, geographic region was not only significantly associated with the reporting of illness, as described in the previous section, it was also found to significantly affect how individuals respond to sickness (Table 7). Compared to those living in the Terai, individuals living in the mountain and hill areas are more likely to use Public Clinics, Public Hospitals, and Pharmacies, and No Care vs. Home Visits. These results may reflect the fact that private health care alternatives, either facility- or home-based, are not readily available in the mountain and hill areas.

*Health expenditure equation results*

Table 8 shows the results of the estimation of the health expenditure equation, after controlling for the endogeneity of illness and provider choice. The dependent variable used was the natural logarithm of health expenditures associated with the first visit. Individual-level characteristics did not have a significant effect on the choice of provider and they don=t seem to be much of a determinant of expenditure as neither gender or educational attainment of the ill household member is a statistically significant determinant of health expenditure. On the other hand, more money was spent on individuals who were older than 15 years old compared to children four years of age and younger. While this could be a indicator of the importance that parents place on the health of their children it is quite possible that children are more often afflicted with illnesses that are cheaper to treat.

With respect to household-level characteristics, income per capita emerged as a positive and significant determinant of health expenditures. We found the percentage change in expenditure given a percentage change in income to be 1.02. In addition, individuals living in male-headed households spent more on health care services than individuals living in female-headed households. Interestingly, the older and the higher the educational attainment level of the head of the household, the less will be expended on health care. With respect to the location of the household, urban individuals spent significantly less on health care than rural individuals, but individuals living in mountain and hill areas were not found to spend a significantly different amount than Terai individuals.

One of the more interesting results of the descriptive analysis was that, on average, individuals spent more on public hospital care than on other types of health care arrangements, including care received in private facilities. The results presented in Table 8 are consistent with this finding. Individuals spend the most when they visit a Public Hospital. This is followed by Private Facilities, Public Clinics, Pharmacies and Home Visits where the least amount is spent. Differences in spending at Public Hospitals, Other Private, Pharmacies and Private Home Visits are all statistically significantly different from spending at Public Clinics.

*Simulations*

A set of simulation exercises was conducted for two reasons. First, the difficulty of directly comparing magnitudes of coefficients in logit estimation results makes simulations a useful tool for analyzing the relative magnitudes of the estimation results. Second, it is possible to determine the total net effect of a change in an exogenous variable. For example, income is negatively related to illness but positively related to expenditure. Simulations allow us to see whether an increase in income is likely to increase or decrease net health expenditure. Similarly, the joint estimation allows us to trace the effect of a change in a variable through the entire model. For example, by simulating a change a sanitation variable in the illness equation we can not only to determine the effect on illness, but also on provider choice and, finally, health expenditure. The simulation results were generated by combining the parameter estimates from the statistical estimation with the data used in the estimation. Several steps were required to complete each simulation. First, the probability of being ill was predicted for each individual in the data. Second, this probability was compared to a random number between zero and one to determine whether the individual would be considered ill for the simulation. Next, the probability of choosing each of the six types of provider was calculated for each Aill@ individual using their actual explanatory variables and the estimated coefficients. Again, a random number between zero and one was used in conjunction with the predicted probabilities to select a provider for each Aill@ individual. Finally, the amount of money expended on health care was predicted based on each individual=s characteristics and the type of provider they were predicted to visit. If the individual was predicted to seek no care as a result of their illness, then it is assumed that zero rubees were spent for health care.

*Income.* Our first simulation, reported in Table 9, includes a 10 percent increase in household income. The simulated change is predicted to result in a 2.4 percent decrease in the average likelihood that a person will consider themselves ill over the course of a month (i.e. a change in the probability of reporting illness from 10.09 percent to 9.85 percent). For those that are predicted to report illness, there is an increase in the likelihood of visiting a private provider (6.87 percent increase for Home Visit and a 16.74 percent increase for Private Facility), Public Hospital (7.88 percent increase), or Pharmacy (2.12 percent increase), and a decrease in the likelihood that an individual will visit a Public Clinic (7.03 percent decrease). Overall, the likelihood that they will not seek any care when ill falls by -11.07 percent. Health expenditures for those who are sick are predicted to increase by 10.97 percent. This increase in expenditure is partly due to an increased likelihood of seeking more expensive care (i.e. Private Facility) and also an increased level of expenditure per visit.

*Male/female-headed households*. Simulations were also used to investigate differences in health care choice and expenditure between male- and female-headed households (Table 10). While individuals in male-headed households are found to be 12.62 percent less likely to report themselves as ill, those that do report illness are slightly less likely (about 1.0 percent) to visit any provider. Ill individuals in male-headed households are 18.53 percent less likely to visit a public clinic and 28.01 percent less likely to visit a public hospital than individuals in female-headed households. Alternatively, ill individuals in male-headed households are 51.60, 35.25 and 34.14 percent more likely to seek care with pharmacies, home visits, or private facilities, respectively. Ultimately, these differences combined with the result that more is spent for care, ceteris paribus, on sick individuals in male-headed households, leads to a simulated prediction that 22.74 percent more is spent, on average, on ill individuals who seek care in male-headed households. While we find this result interesting, we cannot explain it. We believe that it is an important topic for further research.

*Age.* The age simulations allow us to quantify the illness, provider use and expenditure patterns of household members of various ages. For the age simulations, all comparisons are relative to the 15-29 year old age group. The age simulation results are presented in Table 11. They reveal that the youngest age group (age 0-4) are reported to be ill most frequently (140 percent more often than the 15-29 year old age group). They are also the group most likely to seek care (or, to have care sought for them) when ill (7.33 percent more likely to seek some kind of care than the 15-29 year olds). When care is sought for them, they are more likely to visit a public clinic (30.64 percent), pharmacy (43.35 percent), or other private care (60.49 percent) and less likely to visit a public hospital (26.42 percent) or have a private home care worker visit them (16.62 percent) than 15-29 year olds. As for expenditure when ill, the youngest age group is also one of the least expensive to care for. When ill and seeking care, 116.27 rubees are spent, on average, on household members in this youngest group. This is 29.48 percent less than for the 15-29 year old age group.

The likelihood of reporting illness for the 5-9 year old age group is, not surprisingly, much lower than for the 0-4 year old age group, (only slightly higher than for the 15-29 year old group --10.71 percent higher).

Although the provider use pattern is similar to that for the youngest group, one notable exception is that 5-9 year olds are 35 percent less likely to be treated by a private home healthcare worker (45.9 percent less likely than for 15-29 year olds). Although this age group is ill less often, the expenditure for an ill 5-9 year old exceeds that for 0-4 year olds. The predicted average expenditure is 124.7 rubees. Higher than for the younger group, but still 24.4 percent less than for the 15-29 year old age group.

At an illness reporting rate of 6.01 percent, the 10-14 year olds seem to be the healthiest age group, 14.1 percent less likely to report an illness than the 15-29 year old age group. Interestingly, while their provider use patterns seem to fairly closely resemble the older group, their expenditure when ill is not only 34.9 percent lower than for the older group, but, at 107.3 rubees per visit, the lowest of any age group.

15-29 year olds seem to be a transition group. While their illness rate, at 7.0 percent, is similar to the 5-9 (7.75 percent) and 10-14 (6.01 percent) age groups, their predicted average expenditure, at 164.9 rubees per visit, is about midway between the younger and older age groups.

Individuals in the three oldest age groups (30-44, 45-59 and over 60), report illness at roughly the same rates (11.58, 12.12, and 12.26 percent, respectively). In addition, their provider use patterns are largely similar to the 15-29 year old age group. The one exception being that individuals in both the 30-44 and 45-59 year old age groups are both roughly 28 percent more likely to seek care at a public clinic when they are ill than individuals in the 15-29 year old age group. Surprisingly, the over 60 year old age group does not share this pattern. In fact, they are 7.2 percent less likely to visit a public clinic that individuals in the 15-29 year old group.

*Urban/rural status*. We used the simulations to quantify the differences between urban and rural households (Table 12). We found that while individuals in urban households are 23.22 percent more likely to report being ill, they are 6.34 percent less likely to visit any provider when they are ill, and that they spend on average 26.28 percent less on health care for an ill household member that seeks care than rural households. In addition, it seems that urban households are 125 percent more likely to visit a public hospital and 52 percent less likely to seek care from a private home care provider than their rural counterparts. It seems likely that these differences stem from different provider characteristics in urban and rural areas. For example, higher quality and lower prices at urban public hospitals would explain both the lower expenditure and more frequent use of public hospitals in urban areas.

*Environmental Factors.* Several environmental factors are found to be important determinants of illness, as reported in Table 13. Because the majority of the effect on health expenditure is through the likelihood of becoming ill, we focus on the average predicted, per capita, expenditure for the entire sample of 18,855 individuals. The baseline predicted per capita health expenditure for the sample is 13.42 rubees per month. If no households had a good floor, then we predict that an additional 5.4 percent of individuals will report themselves as ill per month and per capita health care spending will increase 5.1 percent to 14.10 rubees per month. If all households had a good floor, then we predict that the percent reporting illness would drop 32.1 percent and per capital spending would fall 33.7 percent to 8.90 rubees. 16.3 percent of our sample currently live in households with good floors.

If no households have a good toilet, then we predict that an additional 1.6 percent of individuals will report themselves as ill per month and per capita health care spending will increase 5.1 percent to 14.11 rubees per month. If all households had a good floor, then we predict that the percent reporting illness would drop 11.3 percent and per capital spending would fall 14.3 percent to 9.24 rubees. 29.4 percent of our sample currently live in households with good toilets.

If no households have good sanitation, then we predict that an additional 2.8 percent of individuals will report themselves as ill per month and per capita health care spending will increase 3.4 percent to 13.87 rubees per month. If all households have good sanitation, then we predict that the percent reporting illness would drop 21.8 percent and per capital spending would fall 21.32 percent to 10.56 rubees. Only 9.3 percent of our sample currently live in households with good toilets. Although these simulations fall well short of proving that the benefits of sanitation and other environmental improvements exceed the cost, they do provide telling evidence as to one benefit of such improvements in Nepal, namely, reduced health costs.

## DISCUSSION

Most studies on the demand for health care use discrete choice modeling techniques to estimate the impact of individual-, household-, and community-level variables on the choice of health care provider. This type of study is important because of its role in informing health sector policies intended to improve service utilization, cost recovery, and service efficiency. However, a measure of utilization that has been neglected in the demand literature is household expenditures, despite the fact that accounting for both provider choice *and* health care expenditures is likely to provide a more complete assessment of how households react to changes in their socio-economic and environmental circumstances.

In this paper, data from a nationally representative household survey from Nepal is used to estimate a full-information maximum likelihood model that corrects for the endogeneity of illness and provider choice. Not only does this approach yield unbiased and consistent parameter estimates, it allows one to trace the effects of factors that directly influence household expenditures, and the factors that indirectly influence household expenditures through the prevalence of illness and choice of health care provider. An improved understanding of both types of effects can be useful to government decision-makers in a number of different ways. For example, assessments of the impact of income per capita on health expenditures can be used to improve the design of social safety net mechanisms that protect the poor from structural adjustments, assessments of the impact of environmental and sanitation investments can be used in economic evaluations of the averted costs of health care, and assessments of health care reforms initiatives on health expenditures can be used to track whether and how those initiatives influence household expenditures for the treatment of illnesses.

This study reveals a number of interesting findings that are of both methodological and programmatic interest. First, common unobserved determinants were found to be statistically significant determinants of illness, choice of provider, and health expenditures, and may cause bias to parameter estimates if not controlled. While it=s impossible to identify the exact factors that are at work in the Nepal context, possible influences include the level of health knowledge and education, the severity of the health problem, community norms, and the availability and quality of public outreach services within the community. What is clear is that demand studies that do not account household- and community-level unobservables may result in misleading findings and, as a result, sub-optimal resource allocations by government decision-makers.

Second, the elasticity of expenditure with respect to income was found to be 1.02, which is consistent with finding from previous studies (Schieber and Maeda, 1997). Although higher income per capita is associated with a lower likelihood of reporting illnesses and injuries, thereby lowering health expenditures, increases in income per capita ultimately leads to higher health care expenditures through both indirect and direct mechanisms. Households with higher income per capita have higher utilization rates, and are more likely to choose a private health care provider or a public hospital, and a lower probability of choosing a public clinic for care. In addition to these indirect effects on health care utilization, income also has a direct effect, as households with greater income per capita spend more on health care after controlling for the type of treatment alternative that is chosen and other determinants of demand.

Third, while many studies that have been carried out in developing countries have found that improved sanitation and water supply have a large impact on morbidity and mortality that occur due to infectious diseases (i.e., Esrey 1996; VanDerslice and Briscoe 1995), few studies have rigorously estimated the impact on household health care expenditures. The results of simulated changes in environmental conditions, such as the introduction of toilets, improved water supplies, and better floor materials, are found to be associated with large reductions in household health care expenditures for the entire sample. Depending on the cost of improvements to housing, and sanitation, it is quite possible that such improvements could pay for themselves simply on the basis of reduced illness and health expenditure.

Fourth, despite the fact that urban ill individuals who seek care are more likely to utilize care in more expensive settings (i.e., public hospitals, pharmacies, and private facilities), average health care expenditure among the urban sample was found to be substantially lower than among the rural sample. This is partly due to a lower likelihood of reporting illnesses and injuries among urban individuals and of using any type of health care provider (after controlling for other factors). In addition, for any type of treatment alternative, urban individuals on average were found to spend less than their rural counterparts, a result that is consistent with the findings of a previous study of the Nepal household survey used in the present study (Hotchkiss *et al.* 1999).

There are a number of ways that future research can make important contributions to our understanding of the determinants of household health care expenditures. First, there is a need to compliment this study with one that includes detailed provider-specific information on the price and quality of care. This will make it possible to estimate the impact of health care reform interventions on out-of-pocket health care expenditures, thereby improving our understanding of the important role that households play in the financing of health care. Secondly, the type of causal model estimated in this study should be replicated using better data on medical expenditures, such as the amounts spent on consultations, tests, and medicines, where these service are obtained. Third, household surveys should include measures of the biological/clinical aspects of health status. This type of information, combined with measures of the public health interventions, would yield improved estimates of program impact and averted health care costs.

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**Table 1: Percent of individuals reported to be ill or injured in the past month, percent who used health care, and mean age, by urban/rural status.**

| | | Urban/Rural Status | |
|---|---|---|---|
| **Variable** | **Total** | **Urban** | **Rural** |
| Percent Ill or Injured in the Past Month | 9.7 | 7.4 | 10.3 |
| Percent Seeking Treatment | 66.6 | 77.1 | 64.7 |
| Mean Age | 24.0 | 25.8 | 23.6 |
| N | 18,555 | 1,827 | 17,028 |

| **Table 2: Percent distribution of individuals reported to be ill in the past month, by type of care first utilized, and by urban/rural status.** | | | | |
|---|---|---|---|---|
| | | | **Urban/Rural Status** | |
| **Type of Care** | **Overall** | | **Urban** | **Rural** |
| n | 1,216 | | 215 | 1,001 |
| **Public** | | | | |
| Clinics | 38.6 | | 13.0 | 44.1 |
| Hospital | 18.1 | | 29.8 | 15.6 |
| Total Public | 56.7 | | | |
| **Private** | | | | |
| Pharmacy | 10.9 | | 13.0 | 10.5 |
| Home Visit | 8.6 | | 3.3 | 9.8 |
| Hospital/Other | 23.8 | | 40.9 | 20.1 |
| Total Private | 43.3 | | 57.2 | 40.4 |
| | | | | |
| **Total Percent** | 100.0 | | 100.0 | 100.0 |

**Table 3: Average out-of-pocket consultation and travel costs for the visit, by source of care and by urban/rural status.**

| | Total | | Consultations/Medicine | | Travel | |
|---|---|---|---|---|---|---|
| **Type of Care** | **Mean** | **S.D.** | **Mean** | **S.D.** | **Mean** | **S.D.** |
| | | | | | | |
| Total | 413.12 | 1096.20 | 383.12 | 1020.14 | 30.01 | 143.72 |
| Public Clinic | 289.35 | 627.14 | 277.46 | 606.11 | 11.89 | 63.62 |
| Public Hospital | 787.42 | 1801.57 | 703.75 | 1693.75 | 83.67 | 215.36 |
| Pharmacy | 226.92 | 285.47 | 220.29 | 272.93 | 6.63 | 44.55 |
| Home Visit | 151.54 | 196.85 | 151.54 | 196.85 | NA | NA |
| Other Private | 509.78 | 1314.77 | 470.47 | 1194.88 | 39.31 | 202.21 |

Source: Nepal Central Bureau of Statistics/World Bank, Living Standards Measurement Survey, 1996.

| Table 4: Description of independent variables. | |
|---|---|
| **Variable** | **Description** |
| **Individual characteristics** | |
| Age 0 - 4 years | = 1 if individual is less than 5 years of age, = 0 otherwise |
| Age 5 - 9 years | = 1 if individual is 5 to 9 years of age, = 0 otherwise |
| Age 10 - 14 years | = 1 if individual is 10 - 14 years of age, = 0 otherwise |
| Age 15 - 29 years | = 1 if individual is 15 to 29 years of age, = 0 otherwise |
| Age 30 - 44 years | = 1 if individual is 30 to 44 years of age, = 0 otherwise |
| Age 45 - 59 years | = 1 if individual is 45 to 59 years of age, = 0 otherwise |
| Age 60 or more years | = 1 if individual is 60 years of age or older, = 0 otherwise |
| Male | = 1 if individual is male, = 0 if individual is female |
| Not household head | = 1 if individual is not the head of the household, = 0 otherwise |
| Education | Number of years of schooling completed, or if individual is an adult, number of years of schooling completed by mother |
| **Household characteristics** | |
| Age of household head | Age of head of household |
| Male household head | = 1 if household head is male, = 0 if household head is female |
| Education of household head | Number of years of schooling completed by household head |
| Ln of income per capita | Natural log of total household expenditures per capita |
| Household size | Number of persons reported to be living in household |
| Crowding | Household size/Number of rooms in household |
| Good floor | = 1 if floor is made of wood, store, or cement, = 0 otherwise |
| Good roof | = 1 if roof is made of wood, placks, iron, cement, or tiles, = 0 otherwise |
| Piped water source | = 1 if drinking water comes from piped water supply, = 0 otherwise |
| Good sanitation | = 1 if household uses underground drain system for wastes, = 0 otherwise |
| Good garbage disposal | = 1 if household disposes garbage by truck or private collector, = 0 otherwise |
| Good toilet | = 1 if household has flush or non-flush toilet, = 0 otherwise |
| Kerosine | = 1 if kerosine is most frequently used fuel for cooking |
| Alcohol | = 1 if household purchased alcoholic beverages in 10 months of the previous year, = 0 otherwise |
| Smokes | = 1 if household purchased tobacco in 10 months of the previous year, = 0 otherwise |
| **Community characteristics** | |
| Urban | = 1 if community is urban, = 0 if community is rural |
| Mountain | = 1 if community is in a mountain area, = 0 otherwise |
| Hills | = 1 if community is in a hill area, = 0 otherwise |
| Bus stop | = 1 if community is within an hour travel time of a bus stop |
| Health facility | = 1 if community is within an hour travel time of a public health facility |

| **Table 5: Descriptive statistics for variables included in multivariate model.** | | |
|---|---|---|
| **Variable** | **Mean** | **Standard Deviation** |
| Individual characteristics | | |
| Age 5 - 9 years | 0.14 | 0.35 |
| Age 10 - 14 years | 0.12 | 0.33 |
| Age 15 - 29 years | 0.26 | 0.44 |
| Age 30 - 44 years | 0.16 | 0.37 |
| Age 45 - 59 years | 0.11 | 0.31 |
| Age 60 or more years | 0.07 | 0.26 |
| Male | 0.49 | 0.50 |
| Not household head | 0.82 | 0.39 |
| Education | 2.19 | 3.85 |
| Household characteristics | | |
| Age of household head | 45.55 | 14.03 |
| Male household head | 0.90 | 0.30 |
| Education of household head | 2.65 | 4.09 |
| Ln of income per capita | 8.77 | 0.57 |
| Household size | 6.97 | 3.44 |
| Crowding | 0.58 | 0.44 |
| Good floor | 0.16 | 0.37 |
| Good roof | 0.14 | 0.34 |
| Piped water source | 0.40 | 0.49 |
| Good sanitation | 0.09 | 0.29 |
| Good garbage disposal | 0.10 | 0.30 |
| Good toilet | 0.29 | 0.46 |
| Kerosine | 0.10 | 0.31 |
| Alcohol | 0.27 | 0.44 |
| Smokes | 0.75 | 0.43 |
| Community characteristics | | |
| Urban | 0.20 | 0.40 |
| Mountain | 0.12 | 3.22 |
| Hills | 0.49 | 0.50 |
| Bus stop | 0.52 | 0.50 |
| Health facility | 0.76 | 0.43 |

| Table 6: FIML results of the determinants of reporting an illness in the month prior to the survey. | | | |
|---|---|---|---|
| **Independent Variable** | **Beta** | **Standard Error** | |
| Individual characteristics | | | |
| Age 5 - 9 years | -1.296 | 0.169 | *** |
| Age 10 - 14 years | -1.610 | 0.191 | *** |
| Age 15 - 29 years | -1.430 | 0.167 | *** |
| Age 30 - 44 years | -0.682 | 0.135 | *** |
| Age 45 - 59 years | -0.606 | 0.140 | *** |
| Age 60 or more years | -0.635 | 0.153 | *** |
| Male | -0.047 | 0.065 | |
| Not household head | -0.052 | 0.094 | |
| Completed years of schooling | -0.001 | 0.011 | |
| Head-of-household characteristics | | | |
| Age | -0.001 | 0.003 | |
| Education | 0.032 | 0.016 | ** |
| Male | -0.220 | 0.098 | ** |
| Household characteristics | | | |
| Natural log of income per capita | -0.531 | 0.226 | ** |
| Drinks alcohol | 0.157 | 0.072 | ** |
| Smokes | 0.097 | 0.072 | |
| Household size | -0.098 | 0.023 | *** |
| Crowding | 0.424 | 0.115 | *** |
| Number of rooms | -0.013 | 0.027 | |
| Good floor | -0.611 | 0.218 | *** |
| Good roof | 0.687 | 0.249 | *** |
| Pipe water source | -0.200 | 0.087 | ** |
| Good sanitation | -0.382 | 0.183 | ** |
| Good garbage disposal | -0.124 | 0.112 | |
| Good toilet | -0.250 | 0.095 | *** |
| Kerosine | 0.140 | 0.178 | |
| Good light | -0.208 | 0.129 | |
| Good stove | -0.041 | 0.184 | |
| Community characteristics | | | |
| Urban | 0.341 | 0.227 | |
| Mountain | 0.267 | 0.157 | * |
| Hills | 0.081 | 0.102 | |
| | | | |

| | | | |
|---|---|---|---|
| Constant | -0.185 | 1.928 | |

| Table 7: FIML results of the determinants of health care alternative. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pub. Clinic vs. No Care | | | Pub. Hosp. vs. No Care | | | Pharm. vs. No Care | | | Home Visit vs. No Care | | | Priv. Fac. vs. No Care | | |
| **Independent Variable** | **Beta** | **Std. Err.** | | **Beta** | **Std. Err.** | | **Beta** | **Std. Err.** | | **Beta** | **Std. Err.** | | **Beta** | **Std. Err.** | |
| Individual characteristics | | | | | | | | | | | | | | | |
| Age 5 - 9 years | 0.100 | 0.260 | | -0.110 | 0.328 | | -0.951 | 0.496 | * | -0.682 | 0.531 | | -0.153 | 0.291 | |
| Age 10 - 14 years | -0.508 | 0.313 | | -0.164 | 0.355 | | -0.388 | 0.446 | | -0.359 | 0.508 | | -1.050 | 0.380 | *** |
| Age 15 - 29 years | -0.638 | 0.254 | ** | -0.158 | 0.291 | | -0.471 | 0.367 | | -0.262 | 0.388 | | -1.059 | 0.274 | *** |
| Age 30 - 44 years | -0.478 | 0.250 | * | -0.288 | 0.301 | | -0.726 | 0.394 | * | -0.465 | 0.410 | | -0.902 | 0.278 | *** |
| Age 45 - 59 years | -0.454 | 0.285 | | -0.051 | 0.346 | | -0.452 | 0.450 | | -0.622 | 0.463 | | -1.258 | 0.349 | *** |
| Age 60 or more years | -0.688 | 0.341 | ** | -0.114 | 0.392 | | -0.872 | 0.526 | * | 0.096 | 0.475 | | -0.826 | 0.389 | ** |
| Male | -0.009 | 0.171 | | 0.284 | 0.199 | | 0.343 | 0.270 | | -0.207 | 0.286 | | -0.120 | 0.192 | |
| Not household head | -0.220 | 0.234 | | 0.318 | 0.276 | | 0.103 | 0.360 | | -0.036 | 0.399 | | -0.069 | 0.279 | |
| Completed years of schooling | 0.042 | 0.029 | | -0.015 | 0.033 | | -0.022 | 0.042 | | -0.056 | 0.052 | | 0.036 | 0.032 | |
| Head-of-household characteristics | | | | | | | | | | | | | | | |
| Age | -0.017 | 0.007 | * | -0.016 | 0.009 | * | -0.013 | 0.011 | | -0.020 | 0.012 | * | -0.034 | 0.009 | *** |
| Male | -0.158 | 0.238 | | -0.282 | 0.267 | | 0.143 | 0.390 | | 0.419 | 0.433 | | 0.292 | 0.278 | |
| Education | -0.066 | 0.034 | ** | -0.012 | 0.039 | | 0.032 | 0.050 | | -0.103 | 0.056 | * | -0.087 | 0.038 | ** |
| Household characteristics | | | | | | | | | | | | | | | |
| Log of income per capita | 0.712 | 0.385 | * | 0.943 | 0.477 | ** | 0.183 | 0.613 | | 2.690 | 0.681 | *** | 2.789 | 0.478 | *** |
| Household size | 0.097 | 0.035 | *** | 0.067 | 0.044 | | -0.069 | 0.058 | | 0.211 | 0.058 | *** | 0.221 | 0.042 | *** |
| Community characteristics | | | | | | | | | | | | | | | |
| Urban | -1.185 | 0.404 | *** | -0.021 | 0.411 | | 0.312 | 0.531 | | -2.189 | 0.680 | *** | -0.990 | 0.407 | ** |
| Mountain | -0.283 | 0.255 | | -0.045 | 0.336 | | -0.080 | 0.596 | | -0.405 | 0.391 | | -3.351 | 0.768 | *** |
| Hills | 0.056 | 0.215 | | -0.287 | 0.242 | | 0.417 | 0.380 | | -0.774 | 0.336 | ** | -1.699 | 0.241 | *** |
| Health facility within 60 min. | 0.894 | 0.200 | *** | 0.420 | 0.296 | | 1.448 | 0.393 | *** | 0.230 | 0.310 | | 0.692 | 0.312 | ** |
| Bus stop within 60 min. | -0.100 | 0.220 | | 0.973 | 0.256 | *** | 0.536 | 0.344 | | -0.026 | 0.323 | | 0.249 | 0.230 | |
| Constant | 3.249 | 3.799 | | -1.019 | 4.312 | | -7.909 | 3.242 | ** | -13.591 | 5.786 | ** | -17.647 | 4.333 | *** |

| **Table 8: FIML results of the determinants of household health care expenditures.** | | | |
|---|---|---|---|
| | | **Standard** | |
| **Independent Variable** | **Beta** | **Error** | |
| Individual characteristics | | | |
| Age 5 - 9 years | 0.001 | 0.121 | |
| Age 10 - 14 years | -0.080 | 0.145 | *** |
| Age 15 - 29 years | 0.408 | 0.117 | *** |
| Age 30 - 44 years | 0.499 | 0.119 | *** |
| Age 45 - 59 years | 0.419 | 0.140 | *** |
| Age 60 or more years | 0.651 | 0.155 | *** |
| Male | -0.099 | 0.083 | |
| Not household head | -0.067 | 0.113 | |
| Completed years of schooling | -0.004 | 0.014 | |
| Head-of-household characteristics | | | |
| Age | -0.009 | 0.004 | ** |
| Male | 0.216 | 0.112 | * |
| Completed years of schooling | -0.056 | 0.016 | *** |
| Household characteristics | | | |
| Natural log of income per capita | 1.022 | 0.198 | *** |
| Household size | 0.050 | 0.018 | *** |
| Community characteristics | | | |
| Urban | -0.520 | 0.165 | *** |
| Mountain | -0.162 | 0.139 | |
| Hills | -0.003 | 0.090 | |
| Type of Facility Used | | | |
| Use of Public Hospitals | 0.659 | 0.106 | *** |
| Use of Pharmacies | -0.220 | 0.127 | * |
| Use of Home Visits | -0.562 | 0.150 | *** |
| Use of Private Facilities | 0.339 | 0.104 | *** |
| | | | |
| Constant | -12.7152 | 1.6862 | *** |

| Table 9: Income Simulation (Percentage Difference from Baseline in Parentheses) | | |
|---|---|---|
| | Baseline | 10 percent Increase in Household Income |
| Illness* | | |
| Illness Reported | 10.09 | 9.85 (-2.38%) |
| Provider Choice* | | |
| No Provider Seen | 15.00 | 13.34 (-11.07%) |
| Public Clinic | 36.42 | 33.86 (-7.03%) |
| Public Hospital | 10.02 | 10.81 (7.88%) |
| Pharmacy | 2.36 | 2.41 (2.12%) |
| Private Home Visit | 27.37 | 29.25 (6.87%) |
| Other Private | 8.84 | 10.32 (16.74%) |
| Health Expenditure* | | |
| Mean Expenditure | 156.49 | 173.65 (10.97%) |
| Median Expenditure | 96.73 | 112.09 (15.88%) |
| Mean Expenditure for Entire Sample | 13.42 | 15.06 (12.21%) |

* Simulation based on statistically significant coefficients.

| Table 10: Gender of Household Head Simulations (Percentage Difference from Female in Parentheses) | | |
|---|---|---|
| | All Households Female Head | All Households Male Head |
| Illness* | | |
| Illness Reported | 11.49 | 10.04 (-12.6%) |
| Provider Choice | | |
| No Provider Seen | 15.52 | 16.36 (5.4%) |
| Public Clinic | 40.69 | 33.15 (-18.5%) |
| Public Hospital | 14.21 | 10.23 (-28.0%) |
| Pharmacy | 1.88 | 2.85 (51.6%) |
| Private Home Visit | 20.65 | 27.93 (35.3%) |
| Other Private | 7.06 | 9.47 (34.1%) |
| Health Expenditure* | | |
| Mean Expenditure | 132.17 | 162.22 (22.7%) |
| Median Expenditure | 88.10 | 104.25 (18.3%) |
| Mean Expenditure for Entire Sample | 12.83 | 13.62 (6.2%) |

* Simulation based on statistically significant coefficients.

| Table 11: Age Simulations (Percentage Difference from 15-29 Year Old Group in Parentheses) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0-4 | 5-9 | 10-14 | 15-29 | 30-44 | 45-59 | 60+ |
| Illness* | | | | | | | |
| Illness Reported | 16.80 (140.0%) | 7.75 (10.7%) | 6.01 (-14.1%) | 7.00 | 11.58 (65.5%) | 12.12 (73.14%) | 12.26 (75.14%) |
| Provider Choice | | | | | | | |
| No Provider Seen | 11.65 (-34.1%) | 14.52 (-17.9%) | 18.08 (2.3%) | 17.68 | 16.20 (-8.4%) | 16.30 (-7.8%) | 16.58 (-6.2%) |
| Public Clinic | 36.92 (30.6%) | 45.36 (60.5%) | 30.94 (9.5%) | 28.26 | 36.13 (27.8%) | 36.40 (28.8%) | 26.23 (-7.2%) |
| Public Hospital | 8.69 (-26.4%) | 8.58 (-27.3%) | 12.23 (3.6%) | 11.81 | 11.72 (-0.8%) | 13.82 (17.0%) | 12.21 (3.4%) |
| Pharmacy | 3.77 (43.4%) | 1.61 (-38.8%) | 3.33 (26.6%) | 2.63 | 2.29 (-12.9%) | 3.1 (17.9%) | 2.20 (-16.3%) |
| Private Home Visit | 26.59 (-16.6%) | 17.24 (-45.9%) | 28.24 (-11.4%) | 31.89 | 24.88 (-22.0%) | 24.09 (-24.5%) | 35.01 (9.8%) |
| Other Private | 12.39 (60.5%) | 12.70 (64.5%) | 7.19 (-6.9%) | 7.72 | 8.78 (13.7%) | 6.29 (-18.5%) | 7.76 (0.5%) |
| Health Expenditure* | | | | | | | |
| Mean Expenditure | 116.27 (-29.5%) | 124.73 (-24.4%) | 107.33 (-34.9%) | 164.88 | 190.8 (15.7%) | 185.52 (12.5%) | 220.20 (33.6%) |
| Median Expenditure | 116.27 (-29.5%) | 85.21 (-23.4%) | 68.36 (-38.6%) | 111.29 | 129.05 (16.0%) | 123.01 (10.5%) | 142.18 (27.8%) |

* Simulation based on statistically significant coefficients.

| Table 12: Urban Rural Simulations (Percentage Difference from Rural in Parentheses) | | |
|---|---|---|
| | All Households Rural | All Households Urban |
| Illness | | |
| Illness Reported | 9.82 | 12.10 (23.22%) |
| Provider Choice* | | |
| No Provider Seen | 16.02 | 21.35 (33.27%) |
| Public Clinic | 34.86 | 33.10 (-5.05%) |
| Public Hospital | 8.87 | 19.96 (125.03%) |
| Pharmacy | 2.31 | 3.89 (68.40%) |
| Private Home Visit | 28.74 | 13.58 (-52.75%) |
| Other Private | 9.20 | 8.13 (-11.63%) |
| Health Expenditure* | | |
| Mean Expenditure | 165.49 | 122.00 (-26.28%) |
| Median Expenditure | 103.36 | 75.87 (-2660%) |
| Mean Expenditure for Entire Sample | 13.91 | 9.95 (-21.57%) |

* Simulation based on statistically significant coefficients.

| Table 13: Environmental Simulations (Percentage Difference from Baseline in Parentheses) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Baseline | No households Have Good Floor | All Households Have Good Floor | No households Have Good Toilets | All Households Have Good Toilet | No households Have Good Sanitation | All Households Have Good Sanitation |
| Illness* | | | | | | | |
| Illness Reported | 10.09 | 10.63 (5.35%) | 6.85 (-32.10%) | 10.25 (1.59%) | 8.95 (-11.30%) | 10.37 (2.78%) | 7.89 (-21.80%) |
| Provider Choice** | | | | | | | |
| No Provider Seen | 15.00 | 14.84 (-1.10%) | 15.62 (4.13%) | 15.19 (1.27%) | 16.36 (9.07%) | 14.86 (-0.93%) | 16.78 (11.87%) |
| Public Clinic | 36.42 | 35.74 (-1.90%) | 34.62 (-4.90%) | 34.12 (-6.32%) | 36.35 (-0.19%) | 35.66 (-2.09%) | 33.22 (-8.80%) |
| Public Hospital | 10.02 | 10.42 (3.99%) | 10.96 (9.38%) | 11.50 (14.77%) | 9.30 (-7.19%) | 11.73 (17.07%) | 11.03 (10.08%) |
| Pharmacy | 2.36 | 2.44 (3.39%) | 2.76 (16.95%) | 3.53 (49.58%) | 2.78 (17.80%) | 2.4 (1.69%) | 2.95 (25.00%) |
| Private Home Visit | 27.37 | 27.40 (0.11%) | 26.26 (-4.10%) | 26.85 (-1.90%) | 25.97 (-5.12%) | 26.80 (-2.08%) | 27.40 (0.11%) |
| Other Private | 8.84 | 9.15 (-0.40%) | 9.78 (10.63%) | 8.81 (-0.34%) | 9.24 (4.53%) | 8.55 (-3.28%) | 8.63 (-2.40%) |
| Health Expenditure** | | | | | | | |
| Mean Expenditure | 156.49 | 155.82 (-0.004%) | 153.92 (-1.60%) | 162.32 (3.73%) | 153.74 (-1.76%) | 157.20 (0.45%) | 160.82 (2.77%) |
| Median Expenditure | 96.73 | 102.16 (5.61%) | 100.18 (3.57%) | 101.91 (5.36%) | 105.31 (8.87%) | 102.56 (6.03%) | 100.69 (4.09%) |
| Mean Expenditure for Entire Sample | 13.42 | 14.10 (5.07%) | 8.90 (-33.7%) | 14.11 (5.12%) | 11.51 (-14.26%) | 13.87 (3.40%) | 10.56 (-21.32%) |

* Simulation based on statistically significant coefficients.
** Environmental variables not included in this equation.

APPENDIX A: DISCRETE FACTOR ANALYSIS AND LIKELIHOOD FUNCTION

To briefly explain the discrete factor approximation method, let the individual's contribution to a

$$L_i(m) = \prod_{m=1}^{M} L_{im}(m)$$

conditional likelihood function over M equations be

(5)

If we assume the unobserved heterogeneity components of the error term which are correlated with each outcome, μ, follow a known continuous distribution (e.g. the normal distribution), the bias could be removed

$$L_i = \int_{k=-\infty}^{\infty} L_i(f(m_k))d\, m_k$$

by integrating

(6)

where $f(m_k)$ is the probability density function of μ. Since it is impossible to know the distribution of the unobserved heterogeneity term that is correlated with the outcomes, we instead approximate the continuous distribution with a discrete probability distribution. The probability distribution is made up of a finite number of "mass points" and associated probabilities. These mass points and their probabilities are simultaneously estimated with the other coefficients in the model. If the density of μ is given by Prob(μ = $\varsigma_k$) = $PW_k$, k= 1...K with $PW_k > 0$ and then the integral reduces to

$$L_i = \sum_{k=1}^{K} PW_k\, L_i(m_k).$$

(7)

To obtain parameter estimates using full-information maximum likelihood (FIML), we maximize the following unconditional likelihood function.

$$L_i = \prod_{c=1}^{C} \sum_{kc=1}^{Kc} PW_{kc} \prod_{h=1}^{H} \sum_{kh=1}^{Kh} PW_{kh} \prod_{i=1}^{I} (P_{si})^{dsi} (1-(P_{si}))^{1-dsi}$$

$$\left(\prod_{j=1}^{P} (P_{ji})^{dpji}\right)^{dsi} \left(\left(\frac{1}{\sigma_e}\phi(e_i - \alpha_e Xe_i - \rho^{e}_{kc}\mu_{kc} - \rho^{e}_{h}\mu_e)\right)^{dsi}\right)^{dpi} \qquad (8)$$

where:

| | | |
|---|---|---|
| i | = | individual 1...I |
| h | = | household 1...H |
| c | = | community 1...C |
| p | = | provider choice j = ,1...P |
| $\phi$ | = | the standard normal probability density function |

$$Prob(s_i = 1) = \frac{1}{1 + \exp(\alpha_s X_{si} + \rho^{s}_{kc}\mu_{kc} + \rho^{s}_{kh}\mu_{kh})}$$

| | | |
|---|---|---|
| $P_{si}$ | = | probability of i becoming ill |

dsi = 1 if individual is ill and 0 if not ill

$P_{pji}$ = probability of i choosing provider j where all the parameters with subscript j = 1 are

$$Prob(P_i = j) = \frac{\exp(a_{pj} X_p + r^p_{kcj} m_{kc} + r^p_{khj} m_{kh})}{\sum_{j=1}^{P} \exp(a_{pj} X_p + r^p_{kcj} m_{kc} + r^p_{khj} m_{kh})}$$

normalized to zero.

ji = 1 if individual chooses provider j and 0 if not

dpi = 1 if individual visits either public or private provider and 0 if does not visit provider

$Pw_{kc}$ = probability weight of mass point kc - community-level

$PW_{kh}$ = probability weight of mass point kh - household-level

## APPENDIX B: DISCRETE FACTOR RESULTS

The unconditional likelihood function was estimated with five mass points to approximate the community-level unobservable distribution ($\mu_{kc}$) and three mass points to approximate the household-level unobservable distribution ($\mu_{ki}$). The approximation of the community- and household-level distribution are specified such that the factor loads ($\rho_{ki}$ and $\rho_{ki}$) are allowed to vary over the mass points. This means that only the product of $\rho_k$ and $\mu_k$ can be estimated. Tables B1 and B2 show the probability weights (PW) associated with each mass point in the community- and household-level distributions respectively. Tables B1 and B2 also includes all the products of $\rho_k$ and $\mu_k$ over the mass points and three equations for the community- and household-level distributions respectively. The $\rho_{kc}\mu_{kc}$ and $\rho_{ki}\mu_{ki}$ for mass point 1 in each distribution are generally fixed at 0.0 to identify the remainder of the individual-level unobserved heterogeneity parameters. In this case, we found that individuals in households with certain types of unobserved characteristics were extremely unlikely to visit Public Clinics or Pharmacies. Therefore, we normalized the first mass point at -4 in those cases to facilitate the estimation.

The information in these tables indicate that the error terms in all three equations are correlated with an unobserved community- and household-level factor. The significance of these unobserved heterogeneity results strongly suggest that estimating the equations without allowing for error term correlation could produce biased results. A likelihood ratio test was performed to test the null hypothesis that the 42 unobserved heterogeneity parameters (28 $\rho_{kc}\mu_{kc}$ and 14 $\rho_{ki}\mu_{ki}$ ) are equal to zero. This test had a chi-square test statistic of 955.3. Since the chi-square critical value for a 95 percent test with 50 degrees of freedom is roughly 67.5, the null hypothesis that the 42 heterogeneity parameters are jointly zero is strongly rejected.

Estimated Community Level Error Term Correlation Parameters

| | $\rho_{1c}\mu_{1c}$ | $\rho_{2c}\mu_{2c}$ | $\rho_{3c}\mu_{3c}$ | $\rho_{4c}\mu_{4c}$ | $\rho_{5c}\mu_{5c}$ |
|---|---|---|---|---|---|
| Probability Weight | 0.038 | 0.440 | 0.211 | 0.245 | 0.066 |
| Illness | 0 | -0.4704*<br>(0.2622) | 0.9302***<br>(0.2686) | 1.0119***<br>(0.2693) | 1.0581***<br>(0.2892) |
| Provider Choice: 2 vs. 1 | 0 | -0.6293<br>(0.6262) | -2.6274***<br>(0.6273) | -0.2409<br>(0.5900) | -0.3716<br>(0.6260) |
| Provider Choice: 3 vs. 1 | 0 | -1.4095**<br>(0.6812) | -0.8949<br>(0.6359) | -0.8060<br>(0.6489) | -0.6116<br>(0.7112) |
| Provider Choice: 4 vs. 1 | 0 | -0.0543<br>(0.8529) | -0.2425<br>(0.8367) | -1.0401<br>(0.8821) | 2.4786***<br>(0.8409) |
| Provider Choice: 5 vs. 1 | 0 | -0.9302<br>(0.5999) | -1.5886***<br>(0.5928) | -1.4385**<br>(0.6315) | -1.9385***<br>(0.7803) |
| Provider Choice: 6 vs. 1 | 0 | 0.1571<br>(1.0539) | 0.8120<br>(0.9928) | 0.1655<br>(1.0381) | -0.6780<br>(1.1225) |
| Expenditure | 0 | 2.2123***<br>(0.2357) | 1.6291***<br>(0.2379) | 1.6036***<br>(0.2260) | 1.4776***<br>(0.2460) |

| Estimated Household Level Error Term Correlation Parameters | | | |
|---|---|---|---|
| | $\rho_{1c}\mu_{1c}$ | $\rho_{2c}\mu_{2c}$ | $\rho_{3c}\mu_{3c}$ |
| Probability Weight | 0.577 | 0.409 | 0.014 |
| Illness | 0 | 4.7403***<br>(0.5253) | 4.7920***<br>(1.0643) |
| Provider Choice: 2 vs. 1 | -4 | -8.7016***<br>(2.6195) | 20.5076***<br>(5.0166) |
| Provider Choice: 3 vs. 1 | 0 | -7.7506***<br>(2.6355) | 18.6313***<br>(5.1053) |
| Provider Choice: 4 vs. 1 | -4 | 3.8399*<br>(2.2392) | -1.2186<br>(1.9420) |
| Provider Choice: 5 vs. 1 | 0 | -10.1058***<br>(2.6253) | 17.9147***<br>(5.0159) |
| Provider Choice: 6 vs. 1 | 0 | -6.8251***<br>(2.6692) | 18.8211***<br>(4.9688) |
| Expenditure | 0 | 7.1693***<br>(0.2153) | 3.469***<br>(0.2917) |

Appendix C: Log of Per Capita Household Income Equation Results

| Number of obs = 3373 | | $R^2$ = 0.5150 | |
|---|---|---|---|
| | | Root MSE = .53491 | |
| **Regressor** | **Coefficient** | **Std. Err.** | **t-Score** |
| hhsize | -0.1026767 | 0.0101465 | -10.119 |
| headmale | -0.1379371 | 0.0349702 | -3.944 |
| headage | 0.0091421 | 0.0008977 | 10.184 |
| headeduc | 0.0509743 | 0.0036283 | 14.049 |
| headagr | -0.0548699 | 0.0312153 | -1.758 |
| headprof | 0.139849 | 0.0389912 | 3.587 |
| urban | 0.5681357 | 0.0743019 | 7.646 |
| mount | 0.1870124 | 0.0668041 | 2.799 |
| hill | 0.2180477 | 0.0454179 | 4.801 |
| region2 | 0.0141253 | 0.0511185 | 0.276 |
| region3 | -0.0142057 | 0.056725 | -0.25 |
| region4 | -0.3763348 | 0.0701474 | -5.365 |
| region5 | -0.2975725 | 0.0792871 | -3.753 |
| mag5_14 | -0.001102 | 0.0164478 | -0.067 |
| mag15_29 | 0.1180341 | 0.0172935 | 6.825 |
| mag30_44 | 0.1158424 | 0.0243181 | 4.764 |
| mag45_59 | 0.104084 | 0.0273986 | 3.799 |
| fag5_14 | 0.0153891 | 0.0160141 | 0.961 |
| fag15_29 | 0.0925619 | 0.0208134 | 4.447 |
| fag30_44 | 0.0864301 | 0.0234645 | 3.683 |
| fag45_59 | 0.0495297 | 0.0251579 | 1.969 |
| constant | 8.546653 | 0.0743437 | 114.961 |

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