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Demand for Hospitalisation: Poisson-Logit Hurdle Estimation of Inpatient Care

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Abstract: Every individual desires to be in good health and incurs substantial expenditure both on preventive and curative health care. Most individuals seek outpatient healthcare while some illnesses and ailments require hospitalisation. This paper analyses the demand for inpatient health care and the determinants of expenditure on such hospitalisation using the 2014 NSSO 71st round morbidity data and applying the Poisson-Logit Hurdle regression model. The number of times an individual is hospitalised is taken as the count data and the odds ratio of inpatient care is estimated. The estimated results show that household income, health insurance coverage, hygiene at the household and availability of good drinking water are the important determinants of both the demand for inpatient care and the number of times of hospitalisation. The health expenditure for diseases like cancer and cardiovascular illness is higher relative to other ailments.

Keywords: Hospitalisation, inpatient care, health expenditure, Poisson-Logit Hurdle regression, odds ratio

Introduction

Every person in this world desires to be in good health and wants to live a disease-free life. In fact, good health is the most basic requirement of an individual to lead a normal life and to be able and productive. In order to maintain good health, people seek healthcare both preventive and curative care. Just like individuals, the country also seeks healthy people. For the economy, good general public health is one of the most important economic goals, since most other goals are conditional on good national health. Health improves the efficiency and skills of labour and human capital and such an increase in the productivity of a healthy labour force improves the national output. Therefore, health is wealth. In the literature on the economics of health, the demand for healthcare is thus considered as a derived demand. Many issues in health economics

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such as the demand for healthcare services in the economy, allocation of resources for the development of healthcare facilities, healthcare supply through public and private sector agencies, healthcare utilisation and the gaps that exist between the demand and supply of healthcare services in the economy are some of the critical issues that have been widely recognised as the concerns of an economy.

The healthcare industry in India has been continuously expanding over the years and it contributes annually to around 4% of the GDP of India. Though the public healthcare system is wide and vast and highly subsidised, in recent years the private players have been providing significant healthcare services albeit at high costs. Despite such an increase in the quantum of hospital services offered by both private and public hospitals, India still faces a severe crisis in providing proper healthcare services to the masses and the issues in the health sector are large. With the fast growth of the population with an increasing change in lifestyle and food habits, the related disease burden is heavy. There is also a constant burden of chronic and communicable diseases added to seasonal and climate-related illnesses and the high spread of diseases during natural calamities. As the second most populated country in the world, India shares around 20% of the global disease burden. But, India has only an 8% share of doctors and nursing staff and only about 9 beds per 10000 people. The public expenditure on health is just less than 4% of the GDP. Also, the infrastructure facilities in public healthcare centres in both the rural and urban areas are inadequate and poorly equipped.

Therefore, there is an increasing reliance on the private sector for healthcare over the last few decades. Consequently, there has been a steady decline in the utilisation of public health services, especially inpatient care. Table 1 shows that during 1995-2014 the percentage of hospitalised cases in public hospitals declined, same for private hospitals increased. Further, as the infrastructure-rich private hospitals are located in urban areas, inpatient care has increased dramatically relative to the rural areas where public hospitals are the only possibility for inpatient care. This disparity in the utilisation of public and private hospitals for inpatient care cannot be overlooked while explaining the demand for inpatient care.

Table 1: Distribution of Hospitalisation by Type of Hospital

Hospital	*Rural*			*Urban*		
	1995-96	*2004*	*2014*	*1995-96*	*2004*	*2014*
Public	43.8	41.7	41.9	43.1	38.2	32.0
Private	56.2	58.3	58.1	56.9	61.8	68.0

Note: Figures represent percentages.

Source: NSSO (2014) Key Indicators of Social Consumption in India, 71st round.

This paper aims to analyse the demand for inpatient care in India. The main objectives of this paper are to identify and estimate the effects of the individual and household characteristics that determine the demand for inpatient care and to analyse the patterns of expenditure incurred by individuals on account of the utilisation of inpatient care. The demand for inpatient care is considered as the number of times inpatient care is sought and the frequency of hospitalisation by an individual. This paper uses the NSSO 71st round (January-June 2014) morbidity data and the health infrastructure data, especially in public hospitals, from the sources of the Ministry of Health and Family Welfare (MOHFW) of the Government of India. The Poisson-Logit Hurdle regression model has been used in the empirical analysis of the demand for inpatient care. The Hurdle model or a two-part model estimates two models where the dependent variable is count data and is inflated with zeroes. The first part of the Poisson-Logit Hurdle model is a logistic regression model that analyses the likelihood of an individual seeking inpatient care that includes zero cases. The second part is a Poisson regression model that analyses only the non-zero counts of the number of times an individual is hospitalised. In the Poisson-Logit Hurdle model dependent variable is assumed to follow the Poisson distribution, and tests for over-dispersion are done to ensure that the mean and the variance of the dependent variable are not statistically different from one another. The Poisson-Logit Hurdle model is estimated by the maximum likelihood estimation method. In addition to analysing the demand for inpatient care, the expenditure incurred on utilising inpatient care is analysed by the linear regression model.

Review of Literature

Alam and Karim (2006) examine the insecurities faced by the aged in India and Pakistan as a consequence of declines in fertility and mortality. They use Poisson regression to study the causal risk factors of the poor health conditions of the elderly in India analysing the 52nd round NSSO data of India. They model the number of diseases reported by an elderly person as a function of a set of household-level socio-economic variables such as consumption expenditure, type of latrines in the household, source of drinking water and individual demographic characteristics such as age, sex and literacy. The paper concludes that the changing demographic scenario in India calls for many policy-related actions. The growth in the age category of 25+ would require a matching improvement in work opportunities, and the growth in the number of elderly people would increase demand for healthcare and social security. The authors call for various actions such as the creation of stable savings instruments for old age income security,

an increase in insurance coverage for the elderly, an increase in efficiency and quality in government hospitals and healthcare facilities, and a general increase in public expenditure on health.

Levesque and Mukherjee (2010) study the changing inequalities in the utilisation of inpatient care in rural India, using the 52nd and 60th rounds of NSSO data and concentration indices to measure the inequality of inpatient care utilisation. In most of the major states of India, the utilisation of inpatient care among the poor has shown an increase from 1995-96 to 2004. However, at least in 6 states, the utilisation of inpatient care by the rich seems to have declined. But overall, both the rich and the poor seemed to utilise more inpatient care and therefore there was a reduction in the economic-status-related inequality.

Bhandari *et al*. (2010) measure the impoverishing effect of healthcare expenditure in India by estimating the number of households falling below the poverty line as a result of healthcare payments and financial coping mechanisms. The analysis of data on morbidity from the 60th round of NSSO shows significant healthcare-related impoverishment across states with much variation across states.

Babu *et al*. (2010) analyse the key health barriers that are responsible for inequities in access to health services in India, focusing on the availability, accessibility and affordability across geographic, social and economic groups. The analysis of NSSO as well as NFHS data reveals that there are insufficient investments in the public sector which is a key factor in contributing to the existing inequities.

Yen and Adamowicz (1993) use a multinomial-Poisson hurdle model to analyse the recreation demand in Canada that allows price and quality changes to affect both the choice of recreation sites as well as the frequency of trips. The estimated results show that the decision to participate i.e. to go on at least one trip for recreation does not depend on site attributes, rather income is the significant determinant of the recreation trips.

Lahiri and Xing (2004) analyse the nature of inpatient and outpatient healthcare utilisation, applying a negative binomial hurdle model to the 1992 US National Survey of Veterans. Also, a bivariate probit regression model is used to analyse the decision to use a Veterans Administration (VA) or non-veteran Administration healthcare facility. Those veterans with lower income, without health insurance coverage or those living near the health facilities are more likely to use the Veterans' Administration health system than the others. Veterans with a service-connected disability or some specific diagnosed health problems use more healthcare services than others. The estimated results show that the family income of the veteran is the most important factor in deciding the veteran's healthcare facility choice. The veteran family income has a

negative impact on inpatient care usage, but a positive effect on outpatient care usage. Other demographic characteristics such as age, marital status and employment status are not very significant in the healthcare choice of veterans.

Ricker-Gilbert *et al.* (2011) apply the double hurdle model to investigate how fertilizer subsidies affect farmers' demand for commercial fertilizer. In the first part of the hurdle model, the probability of farmers' participation in the commercial fertilizer market is estimated by a probit regression. In the second part, the demand for commercial fertilizer is estimated by a truncated normal regression model. The estimated results show that the subsidisation of fertilizers has a significant negative impact on farmers' commercial fertilizer purchases. The results from the double hurdle model show that on average each additional kilogram of subsidized fertilizer reduces farmer purchases of commercial fertilizer by 0.22 kilograms. This means that each additional kilogram of subsidized fertilizer contributes an additional 0.78 kg to total fertilizer use after accounting for the crowding-out effect.

Iles (2015), using the National Family Health Survey (NFHS) data from rural north India, estimated the demand for primary healthcare using the mixed multinomial logit model (MMNL) allowing parameter estimates to vary across individuals. The estimated coefficients of variables price and travel distance are negative indicating the declining probability of utilisation of primary healthcare in rural India with rising prices and travel costs. Further, consumer trust is an important determinant of the choice of healthcare provider.

Data and Methodology

In the empirical analysis, this paper uses the 71st round (January-June 2014) of the NSSO household survey on morbidity. The NSSO's surveys on social consumption are one of the major sources of basic quantitative information on the health sector such as morbidity, frequency of hospitalisation, pre-natal care and post-natal care by women, treatment expenditure on disease, etc. In the 71st round NSSO questionnaire, schedule 25.0 (social consumption: health has collected information on the prevalence of different diseases, extent of use of health services provided by the government, hospitalisation or medical care received and expenses incurred as inpatient of medical institutions during the last 365 days, spells of ailment of household members during the last l5 days (including hospitalisation) and expenses incurred during the last l5 days for treatment of members (not as an in-patient of medical institution), pre-natal and post-natal care for women of age 15-49 years during the last 365 days, economic independence and state of health of persons aged 60 years and above as on date of survey, besides household characteristics and demographic particulars of the households.

The 71st round of NSSO data covers 65,932 households (36,480 in rural India and 29,452 in urban India) across the Indian states and a total of 3,34,93l individuals living in these households. Out of this, a total of 51,650 individuals had utilised inpatient care in the span of one year (20l3-2014). Excluding the cases of childbirth, there are 36,725 individuals utilised inpatient care for various diseases like cancer, cardiovascular diseases, genito-urinary diseases, respiratory problems, gastrointestinal diseases, etc. In the empirical analysis, individuals who had not sought inpatient care in the last year are also included so as to study the decision behind the seeking of inpatient care. The expenditures towards both inpatient care and outpatient care are analysed for a total of 59,895 individuals who sought outpatient care in the span of 15 days prior to the date of survey, and 36,725 individuals who sought inpatient care in the span of one year prior to the date of survey.

The empirical analysis of the demand for inpatient care in this paper uses a type of count data model, the Poisson-Logit hurdle regression model, to model count variables with excessive zeroes. In the hurdle model, actually a modification of a simple count data model, the underlying assumption is that the statistical process governing individuals with zero counts and individuals with positive counts are actually different. The Poisson-Logit hurdle regression model proceeds in two parts. The first part is a dichotomous model for the counts being zero or positive and the second part is a 'truncated at zero' model for strictly positive outcomes. In this paper, the number of times an individual seeks inpatient care in the span of one year is taken as the dependent variable. Table 2 presents the descriptive statistics of the variables used in the empirical analysis of the demand for inpatient care.

Table 2: Descriptive Statistics of Variables

Variable	*Description*	*Mean*
No. of times of hospitalisation	Number of times an individual seeks inpatient care in the span of one year	0.17 (0.43)
Consumption expenditure	Monthly consumption expenditure (proxy for income) (Rs.)	9595.67 (7175.09)
Age	Age of the individual (years)	27.96 (19.79)
Age^2	Age squared	1173.68 (1348.91)
Disease	If chronic disease=1, 0 otherwise	0.05 (0.23)
Gender	If male=1, 0 otherwise	0.51 (0.50)
Drinking water	If tap/well water=1, 0 otherwise	0.89 (0.31)
Latrine	If flush/septic tank latrine=1, 0 otherwise	0.47 (0.50)
Govt. hospital	If public hospital (including HSC, ANM, ASHA, AWW, PHC, CHC)=1, 0 otherwise	0.07 (0.26)

Variable	*Description*	*Mean*
Health insurance	If any health insurance cover=1, 0 otherwise	0.15 (0.36)
Beds	No. of beds available in public hospitals per 1000 population	0.31 (0.44)
Health expenditure	Per capita health expenditure (Rs.)	6895.95 (7213.45)
Sample size	3,34,93l	

The second part of this paper analyses the expenditure incurred for both inpatient care and outpatient services separately using the general linear regression model. Expenditure of an individual's hospital visit has been taken as the dependent variable. Household size and disease types are also used as additional independent variables in the analysis of health expenditure. The disease groups contain 61 ailments classified into 16 groups of diseases and the mean medical expenditure per hospitalisation for these ailments by hospital type is presented in Table 3. Cancer and cardiovascular diseases are significant contributors to the average medical expenditure on hospitalisation. Further, the per-individual medical expenditure in private hospitals is significantly higher than that in public hospitals for each disease.

Table 3: Average Medical Expenditure per Hospitalisation for Diseases

Disease group	*Average expenditure*	*Average expenditure in public hospital*	*Average expenditure in private hospital*
Infection	8134	3007	11810
Cancer	56712	24526	78050
Blood diseases	13313	4752	17067
Endocrine, metabolic and nutrition	14117	4625	19206
Psychiatric, neurological	23984	7482	34561
Eye	9307	1778	13374
Ear	15285	6626	19158
Cardio-vascular	31647	11549	43262
Respiratory	12820	4811	18705
Gastro-intestinal	17687	5281	23933
Skin	10438	3142	14664
Musculoskeletal	21862	8165	28396
Genito-urinary	24525	9295	29608
Obstetric, neonatal	11707	2651	21626
Injuries	23491	6729	36255
Others	28003	14030	35572

Poisson-Logit Hurdle Regression Model

Let f_1 and f_2 be the probability distribution functions for non-negative integers. If f_1 governs the first part of the hurdle model and f_2 the second part, then the probability distribution of the hurdle model is given by,

$$p\,(y=0) = f_1\,(0) \tag{1}$$

$$p(y=y) = f_2(y)\frac{1-f_1(0)}{1-f_2(0)} = \phi f_2(y) \qquad y = 0,1,2..... \tag{.2}$$

where 1-$f_1(0)$ is the probability of crossing the hurdle and 1-$f_2(0)$ is the truncation normalisation for f_2. The hurdle model specification depends on the probability functions f_1 and f_2. For the Poisson model, y_i denotes the count data, x_i is the vector of explanatory variables, and λ_i is the parameter of the Poisson distribution. Thus,

$$p(y=y_i=0) = \frac{e^{-\lambda}\lambda_i^{y_i}}{y_i!} = e^{-\lambda_i} \tag{3}$$

The specification for the first part of the model i.e. the logit regression is given as,

$$Logit(p_i) = \ln\left[\frac{p_i}{1-p_i}\right] = \beta_0 + \beta_k x_k + u_i \tag{4}$$

where p_i is the probability of observing the response of an individual i utilising inpatient care expressed in terms of the odds ratio. The β's are the intercepts and the slope coefficients and u_i is the residual term.

The second part of the hurdle model is a truncated Poisson regression model given by,

$$p(y=y_i) = \frac{e^{-\lambda i}\lambda_i^{y_i}}{y_i!} \qquad y_i = 0,1,2. ..... \tag{5}$$

where y_i represents the counts, the number of hospitalisations, and λ is the mean of the Poisson distribution. The most common specification of the model is the log-linear model given by,

$$\ln(\lambda_i) = \beta x_i \tag{6}$$

The expected number of events per period is given by,

$$E[y_i \mid x_i] = \lambda_i = e^{\beta x_i} \tag{7}$$

where x_i is a vector of independent variables and β is a vector of coefficients to be estimated by the method of maximum likelihood.

The log-linear specification of the Poisson hurdle model is written as,

$$\ln \lambda_i = \beta_0 + \beta_1 Con_{exp} + \beta_2 Age + \beta_3 Age^2 + \beta_4 Gender + \beta_5 Water + \beta_6 Latrine + \beta_7 Hospital + \beta_8 Insurance + \beta_9 Beds + u_i \quad (8)$$

Empirical Results

The first part of the hurdle model i.e. the logit model takes into account both zero as well as nonzero values of the variable and analyses the decision to seek inpatient care among individuals. The second part of the hurdle model uses the count variable truncated at zero and analyses the causes of the variation in the demand for inpatient care, conditional on having sought inpatient care in the first place. The estimated Poisson-Logit-Hurdle regression of the demand for inpatient care is presented in Table 4.

Table 4: Poisson-Logit-Hurdle Regression Estimates of Inpatient Care

Dependent variable: No. of times of hospitalization

Variable	*Logit model*	*Poisson model*
Consumption expenditure	0.0004*	0.0001*
Age	0.010*	-0.001
Age^2	0.0002*	0.0001
Gender-male	-0.090*	-0.002*
Drinking water	0.016	-0.158*
Latrine	0.302*	-0.010*
Govt. hospital	-	-0.181*
Health insurance	0.248*	0.219*
Beds	-0.297*	-0.030
Constant	-3.367*	-1.408*
Log-likelihood	-85441.97	
Wald Chi-square	7081.53	

Note: * Significant at 1% level.

In the logit estimates of the demand for inpatient care, all the coefficients with the exception of drinking ware are statistically significant at 1% level. For households with higher income (consumption expenditure), the odds of visiting a hospital for inpatient care at least once in a given year are higher. This may be attributed to the fact that the increasing hospitalisation expenditure in India makes inpatient care unaffordable to poor-income households. However, people are more inclined to utilise inpatient care from both public and private hospitals when they have health insurance coverage as shown by the positive coefficient of the health insurance variable. Thus, the odds of

an individual seeking hospitalisation are higher if he/she has insurance coverage. The effect of age on the decision to seek inpatient care is significantly positive as old age-related ailments usually require hospitalisation. This is also supported by the positive coefficient of the age-squared variable.

The probability of seeking inpatient care is lower for males than for females. Women, especially during middle age and at times of pregnancy encounter gender-specific illnesses which require some duration of hospitalisation. The estimated coefficient of flush-type latrines in the household is also significantly positive suggesting that those with good systems of latrines may possess better literacy levels and better awareness of communicable diseases which may help them to report diseases better than an illiterate individual. Another important factor that determines an individual's willingness to be inpatient and hospitalisation is the quality of healthcare-related infrastructure in the state. The variable number of beds is an indicator of the infrastructure in the state. Surprisingly, the estimated coefficient of beds is significantly negative showing with more beds per 1000 population, the probability of seeking hospitalisation declines possibly indicating the poor quality of beds in general hospitals.

The Poisson regression model is estimated strictly for positive counts of the number of times an individual seeks inpatient services in a year, conditional on the patient seeking inpatient care at least once in the given year. The Poisson regression estimates show that those with higher household incomes tend to utilise the inpatient services in a hospital more frequently. The impact of income is statistically significant at 1% level. Males are found to utilise fewer inpatient services than females. Age has no effect on the number of times an individual is hospitalised. Good drinking water and a good latrine facility significantly reduce the frequency of hospitalisation as they usually contribute to a healthy environment in the family. Individuals with insurance coverage use inpatient services more often as the costs of hospitalisation are reimbursable under health insurance. As the hospitalisation costs in India have increased over the years, the catastrophic payments of the households are increasing and thus health insurance coverage is essential to meet the hospitalisation expenditures. As in the case of the logit model, the health infrastructure of the state has a negative impact on seeking inpatient care, but the coefficient is not statistically significant. Thus, household income, health insurance, household hygiene and good drinking water are the important determinants of both the demand for inpatient care and the number of times of hospitalisation of an individual in India.

In addition to the determinants of the demand for inpatient services, this paper also tries to understand the effect of diseases on the health expenditure of individuals for

hospitalisation. An OLS regression has been estimated with the total amount of health expenditure incurred for inpatient treatment as the dependent variable. The estimated coefficients of the determinants of hospitalisation expenditure are presented in Table 5.

Table 5: OLS Estimates of Hospitalisation Expenditure

Dependent variable: Medical expenditure on inpatient care

Variable	*Coefficient*
Consumption expenditure	1.10* (2.93)
Age	1.85* (3.19)
Age^2	-1.32* (2.99)
Household size	-1.02* (2.93)
Gender-male	4.79* (6.43)
Drinking water	-2.93* (4.70)
Govt. hospital	-1.46* (3.24)
Insurance	-1.79 (1.55)
Beds	1.71* (3.09)
Chronic disease	1.53* (2.61)
Infection	1.89* (2.85)
Cancer	8.16* (3.81)
Blood diseases	2.15 (1.50)
Endocrine, metabolic and nutrition	1.25* (2.72)
Psychiatric, neurological	1.84 (1.47)
Eye	0.41 (1.23)
Ear	0.21*** (1.91)
Cardio-vascular	9.15** (2.35)
Respiratory	3.58** (1.96)
Gastro-intestinal	2.74** (2.03)
Skin	1.21*** (1.82)
Musculoskeletal	1.19 (1.31)
Genito-urinary	2.56** (2.04)
Obstetric, neonatal	4.44* (4.33)
Injuries	0.54** (2.27)
Constant	1.24 (0.96)
R-square	0.32
F-value	276.29

Note: Absolute t-values are in parentheses. *, **, *** Significant at 1, 5 and 10% levels.

The expenditure for inpatient care increases with household income as shown by the significant coefficient of consumption expenditure. The age of an individual is a key determinant of the amount of expenditure incurred. As age increases, the expenditure

towards inpatient services increases on account of increased utilisation of inpatient services. But the effect of age increases expenditure at a decreasing rate perhaps due to the continuing treatment and medicines for age-related illnesses. Household size has a negative effect on hospitalisation expenditure. Males spend more on inpatient care than females. Chronic ailments increase the expenditure significantly and good drinking water facility reduces health expenditure. The availability of government hospital services and health insurance coverage significantly reduces hospitalisation expenditure. A better public health infrastructure would mean that individuals would utilise the inpatient services more often as suggested by the significant positive coefficient of the variable beds. Diseases such as cancer and cardiovascular diseases contribute more towards hospitalisation expenditure than diseases such as infections or any ENT and skin problems.

Conclusion

As health is important for everyone, healthcare and investments in health dominate the behaviour of individuals. People seek healthcare both as outpatients and inpatients in hospitals. Hospitalisation is generally avoided, but for serious diseases and ailments, patients need to be hospitalised at multiple spells. Therefore, this paper analyses the determinants of the health-seeking behaviour of individuals with respect to inpatient care in terms of the number of times of hospitalisation using the NSSO 71st round (January-June 2014) morbidity data and applying the Poisson-Logit Hurdle regression model for the counts of hospitalisation. The OLS regression model is used to analyse the expenditure on health. The estimated econometric results show that health insurance, availability of drinking water good latrine and hygienic practices at the household, besides household income, are the important determinants of both the demand for inpatient care and the number of times of hospitalisation of an individual in India. The presence of insurance coverage encourages people to utilise inpatient care more frequently. The health expenditure for diseases like cancer and cardiovascular illness is higher relative to other ailments.

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