Health Policy 103 (2011) 255–265

Contents lists available at SciVerse ScienceDirect

Health Policy

journal homepage: www.elsevier.com/locate/healthpol

New estimates of elasticity of demand for healthcare in rural China

Zhongliang Zhou[a,1], Yanfang Su[b,1], Jianmin Gao[a,*], Ling Xu[c,**,1], Yaoguang Zhang[c]

[a] School of Public Policy and Administration, Xi'an Jiaotong University, 76 Yanta West Road, Xi'an 710061, China
[b] Department of Global Health and Population, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115, USA
[c] Centre of Health Statistics and Information, Ministry of Health, 1 Xizhimen Nanlu, Beijing 100044, China

ARTICLE INFO

Keywords:
Elasticity of demand
Own-price
Cross-price
Income
Substitute

ABSTRACT

Background: Only limited empirical studies reported own-price elasticity of demand for health care in rural China. Neither research on income elasticity of demand for health care nor cross-price elasticity of demand for inpatient versus outpatient services in rural China has been reported. However, elasticity of demand is informative to evaluate current policy and to guide further policy making.
Objectives: Our study contributes to the literature by estimating three elasticities (i.e., own-price elasticity, cross-price elasticity, and income elasticity of demand for health care based on nationwide-representative data. We aim to answer three empirical questions with regard to health expenditure in rural China: (1) Which service is more sensitive to price change, outpatient or inpatient service? (2) Is outpatient service a substitute or complement to inpatient service? and (3) Does demand for inpatient services grow faster than demand for outpatient services with income growth?
Methods: Based on data from a National Health Services Survey, a Probit regression model with probability of outpatient visit and probability of inpatient visit as dependent variables and a zero-truncated negative binomial regression model with outpatient visits as dependent variable were constructed to isolate the effects of price and income on demand for health care. Both pooled and separated regressions for 2003 and 2008 were conducted with tests of robustness.
Results: Own-price elasticities of demand for first outpatient visit, outpatient visits among users and first inpatient visit are −0.519 [95% confidence interval (−0.703, −0.336)], −0.547 [95% confidence interval (−0.747, −0.347)] and −0.372 [95% confidence interval (−0.517, −0.226)], respectively. Cross-price elasticities of demand for first outpatient visit, outpatient visits among users and first inpatient visit are 0.073 [95% confidence interval (−0.176, 0.322)], 0.308 [95% confidence interval (0.087, 0.528)], and 0.059 [95% confidence interval (−0.085, 0.204)], respectively. Income elasticities of demand for first outpatient visit, outpatient visits among users and first inpatient visit are 0.098 [95% confidence interval (0.018, 0.178)], 0.136 [95% confidence interval (0.028, 0.245)] and 0.521 [95% confidence interval (0.438, 0.605)], respectively. The aforementioned results are in 2008, which hold similar pattern as results in 2003 as well as results from pooled data of two periods.
Conclusion: First, no significant difference is detected between sensitivity of outpatient services and sensitivity of inpatient services, responding to own-price change. Second, inpatient services are substitutes to outpatient services. Third, the growth of inpatient services is faster than the growth in outpatient services in response to income growth. The

* Corresponding author. Tel.: +86 29 82656259; fax: +86 29 82656259.
** Corresponding author. Tel.: +86 10 68792488.
E-mail addresses: zzliang1981@gmail.com (Z. Zhou), ysu@hsph.harvard.edu (Y. Su), gaojm@mail.xjtu.edu.cn (J. Gao), xuling@moh.gov.cn (L. Xu), zhangyg@moh.gov.cn (Y. Zhang).
[1] Zhongliang Zhou and Yanfang Su share first authorship.

0168-8510/$ – see front matter
doi:10.1016/j.healthpol.2011.09.005

major findings from this paper suggest refining insurance policy in rural China. First, from a cost-effectiveness perspective, changing outpatient price is at least as effective as changing inpatient price to adjust demand of health care. Second, the current national guideline of healthcare reform to increase the reimbursement rate for inpatient services will crowd out outpatient services; however, we have no evidence about the change in demand for inpatient service if insurance covers outpatient services. Third, a referral system and gatekeeping system should be established to guide rural patients to utilize outpatient service.

1. Introduction

The target of the New Cooperative Medical Scheme (NCMS) was to protect patients against catastrophic inpatient expenses under the rationale that most households generally were able to afford the expenses of minor illness. For the insured, a proportion of inpatient expense was reimbursed by NCMS; however, the expense for outpatient service was mainly from out-of-pocket payment or the family savings accounts. After NCMS was implemented in 2004, it has been developed so fast that more than 96% of the rural residents were covered by it in 2010 [1]. Given that inpatient services have been less expensive under NCMS, the rationale of NCMS was critiqued by Yip and Hsiao in that it failed to address a major cause of medical impoverishment, i.e., relatively expensive outpatient services for chronic conditions [2]. In order to further current understanding about the relationship between inpatient and outpatient services, which have been dramatically reshaped by NCMS, the new estimates of elasticity of demand for healthcare are necessary to uncover structural changes of healthcare utilization in rural China.

The puzzle in rural China is unbalanced change in outpatient versus inpatient service after implementing NCMS. From 2003 to 2008, outpatient visits per capita slightly increased by 9.2%; by contrast, inpatient visits per capita dramatically increased by 100% [3]. Price and income are two determinants of demand for health care [4,5]. However, the statistics about price or income alone are not informative enough to solve this puzzle. For instance, outpatient cost per visit and inpatient cost per visit increased at a parallel rate, by 40.6% and 39.1%, respectively. Meanwhile, income per capita increased by 72.7% from 2003 to 2008 [6,7]. Given that the increase in demand for health care is due to the joint effect of income and medical price, we propose to establish regression models to isolate the effect of income or price on demand for health care, and further estimate the elasticity of demand to signal the pattern of health expenditure.

Elasticity of demand measures the responsiveness of demand for health care to changes in price or income. Even though theories in economics generally suggest the rules to distinguish inferior goods from normal goods as well as necessary goods from luxury goods, whether demand for health care is elastic is an empirical question [8]. In the US, results about elasticity of demand for health care are well-documented. The income elasticity was 0.2 or less in a health insurance experiment as well as in other observational studies [9]. Through Scitovsky and Snyder's [10] field experiment, own-price elasticity of physician visits was −0.14; Cherkin et al. [11] found it to be −0.04 in another experiment. The value of elasticity varies according to time change, difference in sampled population, and even the distinction between point elasticity and arc elasticity. For instance, studies showed that elasticity of physician visits based on net prices ranged between −0.15 and −0.20 [12] or between −0.16 and −0.35 [13]. In short, estimation of elasticity only explains the local effects for a specific population at a specific time [14]. However, the estimates of elasticity in all above-mentioned studies reveal the same message for policy making that the demand for physician visits is inelastic in response to income or price.

Furthermore, not only own-price but also price of relative goods impact on demand for health care, and this impact could be captured by different types of elasticity [15,16]. For instance, cross-price elasticity reveals whether outpatient and inpatient services are substitutive to each other [8]. Manning et al. indicated that inpatient and outpatient services were with negative cross-price elasticity in field experiment design [17], which means that those two services are complements and explains the phenomenon that the increase in outpatient service goes along with the increase in inpatient service under a referral system. However, studies also found that outpatient service was substitutive [18,19] or not related [20,10] without referral systems. Overall, cross-price elasticity is conditional on existence of a referral system.

More importantly, elasticity of demand should be estimated at an appropriate level to address specific issues as empirical studies show that the values of elasticity are positively related to the levels of estimation. For instance, in Getzen's paper in 2000, he summarized 45 studies from the 1960s to 1990s to demonstrate a clear pattern of income elasticity at micro (individual), intermediate (regions), and macro (nations) levels. Getzen concluded that healthcare was an individual necessity but a national luxury in applying multilevel decision models to the analysis of healthcare expenditures [21].

However, in developing countries, the results about elasticity of demand for health care are less-documented and even mixed. Lavy and Quigley indicated elastic demand for health care in Ghana [22]; Sauerborn et al. found overall inelastic demand for health care (−0.79) but elastic demand in subgroups such as infants, children, and lowest income quantile (−3.6, −1.7, and −1.4, respectively) in Burkina Faso [23]. In 1989, the field experiment conducted by Li and Yang in two counties (Meishan and Jianyang) in Sichuan province in China indicated elastic outpatient but inelastic inpatient services [24]. More specifically, price elasticity of outpatient service was −1.66 in township hospitals and −1.13 in village clinics; and the price elasticity of

inpatient service was −0.33 in county hospitals and −0.44 in township hospitals. Employing data from another field experiment in Shaanxi province in China, Zhou et al. also showed elastic outpatient service with price elasticity of demand for outpatient visits in villages being −1.5 [25]. Both field experiments, which are limited to one or two counties, have strength in internal validity but shortcoming in external validity. Furthermore, Li et al.'s study was conducted 20 years ago and lacks the power to predict current consumer behavior due to time-varied factors such as systematic health care reform.

To our knowledge, there are only several above-mentioned empirical researches on own-price elasticity of demand for health care in rural China. Neither research on income elasticity of demand for health care nor cross-price elasticity of demand for inpatient versus outpatient services in rural China has been reported. Our study contributes to the literature by estimating three elasticities (i.e., own-price elasticity, cross-price elasticity, and income elasticity of demand for health care) at an individual level based on nationwide-representative data.

This paper aims to answer three empirical questions with regard to healthcare utilizations in rural China: (1) Which service is more sensitive to price change, outpatient or inpatient service? (2) Is outpatient service substitutive or complementary to inpatient service? and (3) Does demand for inpatient services grow faster than demand for outpatient services with the same income growth? First, we introduce data collection methods, dependent variables, independent variables, and covariates. Then we specify regression models, because estimation of elasticity is based on holding all other determinants of demand constant [26]. Both pooled and separated regressions for 2003 and 2008 were conducted with tests of robustness. Next, we interpret the results and we further the discussion by pointing out limitations in this study design. Finally, this paper concludes with policy implications of our findings.

2. Materials and methods

2.1. The data

In order to address the puzzle of unbalanced growth in inpatient and outpatient services, we obtained access to the raw data set, National Health Services Survey (NHSS), from which the summary statistics we mentioned at the beginning of this paper were generated by the Center for Health Statistics and Information, Ministry of Health. Through a four-stage stratified sampling procedure, samples are randomly selected for household survey in NHSS and we focus on the rural component of the dataset. In the first stage, 65 rural counties were randomly selected. In the second stage, 5 townships in each county were randomly chosen. In the third stage, 2 villages in each township were randomly selected. Finally, around 60 households were chosen in each village. The counties, towns, and villages selected in 2003 remained the same as those in 2008; however, households in 2003 were different from those in 2008. Therefore, NHSS is panel data at village or upper levels but only repeated cross-sectional data at individual level. The total number of rural households sampled in 2003 and 2008 were 38,955 and 38,970, respectively. Only people who were 15 years old and older were included in this study and the numbers of these individuals are 109,224 in 2003 and 104,271 in 2008. The average individuals over 15 years old (i.e., 2.8 in 2003 and 2.67 in 2008) indicated slightly difference in demographic characteristics in two years, which we will address in calculating per capita consumption expenditure (Table 1).

Table 1
Data collection strategy in 2003 and 2008.

Stratification	2003	2008
County	65	65
Town	325	325
Village	650	650
Household	38,955	38,970
Individual (≥15)	109,224	104,271

Resource: National Health Services Survey, 2003 and 2008.

In the household survey, the questionnaire included variables on demographics, socio-economic variables, insurance characteristics, health status, outpatient service utilization and inpatient service utilization. Cross-sectional data from the year of 2003 and 2008 are analyzed through pooled and separated regressions.

2.2. The dependent variables

The dependent variables include probability of outpatient visit, outpatient visits among users and probability of inpatient visit. The probability of outpatient visit refers to the probability of using outpatient service in last two weeks, which is based on the question in questionnaire "did you visit a doctor in the past two weeks". Outpatient visits refer to the number of outpatient visits among patients who have utilized the outpatient service in last two weeks, which is based on the question in questionnaire "how many times did you visit with a doctor in the past two weeks". From 2003 to 2008, the probability of outpatient visit increased from 7.90% to 8.47%, with growth rate at 7.22%, while the average number of outpatient visits among users decreased from 1.85 to 1.80 (see Table 2). The probability of inpatient visit means the probability of using inpatient service in the previous year, which is based on the question "have you been hospitalized in the past year". Compared with outpatient care, the probability of inpatient visit increased greatly from 3.32% to 6.11%, with growth rate at 84%.

2.3. The independent variables

Price of healthcare refers to out-of-pocket payment, which directly impacts the demand of healthcare. We only include direct medical expenditure but do not include the indirect costs such as transportation cost or opportunity costs in our price variables.

For outpatient services, the payment from family savings account is considered to be equivalent to out-of-pocket payment. As there was no reimbursement for outpatient visits in most counties before 2009, outpatient price is measured by the total outpatient expenses per visit, which is calculated through dividing total outpatient

Table 2
Description of variables in the year of 2003 and 2008 (Percentage/means).

Variable	Description	2003	2008
Dependent variables			
Probability of outpatient visit	The probability of utilizing outpatient service in past two weeks	7.90	8.47
Outpatient visits among users	The number of outpatient visits in the past two weeks for those who utilized outpatient services	1.85	1.80
Probability of inpatient visit	The probability of utilizing inpatient service in the past year	3.32	6.11
Independent variables			
Outpatient price (RMB)	Median price of outpatient service (out of pocket). Natural log of outpatient price is introduced in regression models	39	71
Inpatient price (RMB)	Median price of inpatient service (out of pocket). Natural log of inpatient price is introduced in regression models	1409	1414
Income (RMB)	Consumption expenditure per capita. Natural log of income is introduced in regression models	1774	3064
Other covariates			
The year of 2008	1 if year of 2008, 0 if year of 2003	0	1
Year*outpatient price	Interaction between the year of 2008 and the log of outpatient price	–	–
Year*inpatient price	Interaction between the year of 2008 and the log of inpatient price	–	–
Year*income	Interaction between the year of 2008 and the log of income	–	–
Male	1 if male, 0 if female	50.32	49.63
Age 65+	1 if age between 65 and above, 0 otherwise	10.61	12.47
Married	1 if married, 0 if unmarried	74.74	75.36
Illiterate	1 if illiterate, 0 otherwise	22.94	19.06
Farmer	1 if farmer, 0 if not famer	72.43	63.78
NCMS	1 if covered by NCMS, 0 otherwise	0	90.22
Chronic disease	1 if chronic disease, 0 otherwise	13.42	18.00
Distance to the nearest healthcare provider (min)	Mean time of reaching the nearest medical institution. Natural log of time is introduced in regression models	14.35	13.78
Eastern region	1 if eastern region, 0 otherwise. Omitted group	32.22	32.69
Central region	1 if central region, 0 otherwise	27.62	27.38
Western region	1 if western region, 0 otherwise	40.16	39.93

Resource: National Health Services Survey, 2003 and 2008.

expenses in the past two weeks by number of visits in the past two weeks. According to questions in questionnaire are "how much did you spend for outpatient services in the past two weeks" and "how many times did you visit with a doctor in the past two weeks". For inpatient services, out-of-pocket payment is calculated through subtracting the total inpatient expenses by the reimbursed. According to questions in questionnaire are "how much did you spend for inpatient services in the past year" and "how much did you get reimbursed in the past year". As NCMS is community-based insurance with pooling at county level, out-of-pocket payments for inpatient services vary due to different reimbursement policies from county to county.

Considering that price of healthcare is ex-post and endogenous to healthcare utilization at individual level, we apply the medians of outpatient expenses per visit as well as inpatient expenses per visit at county level as the proxy of the perceived prices of healthcare in each county. Another alternative to measure the expected price is the weighted average of healthcare expense; however, the healthcare expenses are skewed to the right and the medians are better than the means to avoid the influence of the extreme values at the right tails. Table 2 shows that, from 2003 to 2008, the average of out-of-pocket payment for outpatient and inpatient services increased by 82.1% and by 0.4%, respectively. The major medical cost was buried by individuals for outpatient services but through NCMS inpatient services were reimbursed to lower the private cost.

Income is measured by self-reported annual consumption expenditure per capita rather than by self-reported income because income is more likely to be misreported [27,28]. The total annual consumption expenditure in each household was asked in the health services survey, which was broken down into expenditure for food and other daily necessities, transportation, housing and utilities, education, healthcare, recreation, entertainment, etc. Theoretically speaking, healthcare expenditure is endogenous to the demand for healthcare and it is safe to exclude healthcare expenditure from total consumption expenditure. Nonetheless, this exclusion is a trade-off because healthcare expenditure crowds out other expenditure. Therefore, other expenditures might be higher in the absence of healthcare expenditure, and overall the total expenditure might remain most the same. Empirically, we test both approaches to generate the variable of income and we have not found significant difference in final results among those two ways. The concern of endogeneity could be partially solved by controlling for health status. We argue that, for individuals with the same health status, higher purchase power for healthcare represents higher living standard.

However, although household consumption expenditure is a convenient measure of living standard, it ignores household size and demographic composition. We calculate per capita consumption expenditure through dividing household expenditure by the number of adult equivalents (AE) in the household.

AE is estimated through

$$AE = (A + mK)^b \quad (1)$$

Where A is the number of adults in the household, K is the number of children, m is the "cost of children," and b reflects the degree of economies of scale.

A and K is directly obtained from the questionnaire, in which adults is defined as individuals with age equal to or greater than 18. Meanwhile, we apply the estimates of m and b from O'Donnell et al. We use 0.3 for m and 0.75 for b, given that food accounts for a large proportion of total consumption, and economies of scale are relatively limited due to lack of goods and services that are consumed by the household with public goods characteristics [29]. After adjusting the consumption expenditure per capita by using consumer price index in 2008 to be comparable with that in 2003, the consumption expenditure per capita in 2003 and 2008 were 1774 Yuan and 3064 Yuan, respectively, and the growth rate was 72.7%.

2.4. Other variables

In order to draw a ceteris paribus conclusion about medical price and income effect, the study controls for "year effect" [30] and a number of individual and community variables, which are described in Table 2. "Year effect" refers to the aggregate effect of unobserved factors from the year of 2003–2008 that affect demand for health care. We also add interaction terms between "the year of 2008" and three independent variables to detect the difference of effects among the two periods. Individual variables include gender, age, marital status, education, occupational status, health insurance schemes, and health status. Community variables include distance from the nearest health care provider and a regional dummy variable and. Distance from the nearest health care provider is measured by minutes the residents spent to get to the nearest medical institution. Due to economic, geographical and cultural variations within the country, China is divided into three parts, namely eastern region, central region, and western region.

2.5. The model

Newhouse and Phelps used a two-stage least squares (TSLS) model to estimate the price elasticity of demand for health care, in which demand is measured by probability of inpatient use, length of stay in hospital, probability of outpatient use and outpatient visits among users [31]. In this study, we use different models according to data characteristics. For outpatient service, two models are employed to estimate the effects on outpatient care demand. First, as the utilization of outpatient visit is a binary response, Probit regression model is used with the probability of outpatient visit as the dependent variable [32]. Second, as the number of visits for patients who have utilized outpatient services is count data with the exclusion of zero, the zero-truncated negative binomial (ZTNB) regression model is used with outpatient visits as the dependent variable [33]. For inpatient service, as very few people are hospitalized for more than one time within one year in Chinese rural areas, we only use Probit model to test the effect on the probability of inpatient visit.

Clustered standard errors are applied in regressions for two reasons. First, outpatient price and inpatient price are estimated at county level through calculating the medians of out-of-pocket payment for outpatient and inpatient services in each county. More specifically, 130 observations of outpatient prices (i.e., 65 counties in 2003 and 65 counties in 2008) are generated in two periods. Second, NCMS as a community-based insurance is pooled at county level. The individuals in the same county are treated by the same insurance scheme. Therefore, individual standard errors are independent and should be clustered at the county level [34].

2.5.1. Pooled regression

We use an unrestricted model for the pooled data.

$$H_{it} = \alpha_{03} + \theta_{08} + \beta \cdot OP_{i03} + \gamma \cdot IP_{i03} + \delta \cdot IN_{i03} + \rho \cdot \theta_{08} \cdot OP_{i03} + \sigma \cdot \theta_{08} \cdot IP_{i03} + \tau \cdot \theta_{08} \cdot IN_{i03} + \pi \cdot X_{i03} + \varepsilon \quad (2)$$

Where H is the dependent variables, i.e., probability of outpatient visit, outpatient visits among users, and probability of inpatient visit; a_{03} is the intercept for the year of 2003; θ_{08} is the deviation of the intercept in 2008 from the baseline intercept (2003); β, γ, and δ are the slopes of the logarithms of outpatient price, inpatient price, and income in 2003; ρ, σ, and τ are the deviations of the slope of the logarithms of outpatient price, inpatient price, and income in 2008 from that slope in 2003; X represents control variables, such as gender, age, marriage, etc.; π is the coefficients for control variables; and ε is the residual term.

2.5.2. Test of robustness

We could test stability of parameters through two hypotheses for the pooled regression.

Hypothesis I. The intercept in the year of 2003 is the same as that in 2008, which is tested by whether θ_{08} is significantly different from zero.

Hypothesis II. The slopes of independent variables in 2003 are the same as those in 2008, which is tested by whether the coefficients of interaction terms, i.e., ρ, σ, and τ, are significantly different from zero.

The joint test of these two hypotheses is Chow test with the null that the parameters of independent variables and the intercepts are the same in 2003 and 2008. In other words, deviations of the slopes and intercept are not statistically discernible from zero. Rejection of the null suggests that data in the year of 2003 do not share the same intercept or slopes with data in the year of 2008. However, we do not apply standard Chow test. Alternatively, we focus on the second hypothesis about coefficients of interaction terms to further the test whether elasticities in 2008 are significantly different from those in 2003.

Among 9 coefficients of interaction terms in Table 3, two coefficients suggest rejecting the null in Hypothesis II. In ZTNB regression, the coefficient of interaction term between year dummy and outpatient price (−0.249) is significantly different from zero with 95% of confidence. Meanwhile, in Probit regression with probability of inpatient visit as the dependent variable, the coefficient of interaction term between year dummy and income

Table 3
The estimated coefficients of regression models for pooled data.

	Outpatient care		Prob. of inpatient visit (Probit model)
	Prob. of outpatient visit (Probit model)	Outpatient visits among users (ZTNB model)	
Log of outpatient price	−0.209(0.034)***	−0.230(0.070)**	0.064(0.043)
Log of inpatient price	0.088 (0.040)**	0.151 (0.108)	−0.163 (0.061)***
Log of income	0.061 (0.021)***	0.103 (0.037)***	0.323 (0.023)***
The year of 2008	0.810 (0.448)**	0.347 (0.920)	0.747 (0.440)*
Year* outpatient price	−0.041 (0.051)	−0.249 (0.110)**	−0.027 (0.046)
Year* inpatient price	−0.069 (0.066)	0.089 (0.133)	−0.017 (0.066)
Year* income	−0.019 (0.027)	0.012 (0.052)	−0.072 (0.027)**
Male	−0.072 (0.010)***	−0.015 (0.028)	−0.215 (0.014)***
Age 65+	0.138 (0.019)***	0.054 (0.043)	0.202 (0.023)***
Married	0.135 (0.014)***	−0.036 (0.037)	0.258 (0.019)***
Illiterate	0.119 (0.014)***	0.063 (0.038)*	−0.078 (0.021)***
Farmer	0.086 (0.015)***	0.010 (0.041)	0.039 (0.016)**
NCMS	0.081 (0.037)**	−0.059 (0.089)	0.100 (0.035)***
Chronic disease	1.050 (0.028)***	0.060 (0.036)*	0.683 (0.037)***
Log of distance	0.002(0.010)	−0.070 (0.031)**	0.017 (0.010)*
Central region	0.021 (0.043)	−0.018 (0.107)	0.085 (0.042)**
Western region	0.095 (0.056)*	0.128 (0.116)	0.131 (0.043)***
Constant	−2.246 (0.332)***	−1.249 (0.798)	−3.692 (0.452)***
Wald χ^2	2018.93	131.32	2676.06
Prob > χ^2	<0.0001	<0.0001	<0.0001
R^2	0.1346	–	0.096
Sample size	211,184	17,293	211,184

Note: For outpatient care, Probit regression model is used with probability of outpatient visit as the dependent variable and ZTNB model is used with outpatient visits among users as the dependent variable; for inpatient care, Probit regression model is used with probability of inpatient visit as the dependent variable. Standard errors are in parentheses, which are clustered at county level.

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

(−0.072) is also significantly different from zero at 95% confidence level. The results from regressions indicate that the impact of outpatient price on outpatient visits among users in 2003 is different from that in 2008, and the impact of income on probability of inpatient visit in 2003 is also different from that in 2008. Therefore, we cannot pool the data to estimate those two impacts; however, the legitimacy to pool the data to estimate the other 7 coefficients is established through hypothesis tests.

2.5.3. Separated regressions in 2003 and 2008

After testing parameter stability, we decide to run separate regressions for data in 2003 and 2008 to estimate the impact of outpatient price on outpatient visits among users as well as the impact of income on probability of inpatient visit.

The separated regression models are as the following:

$$H_{i03} = \alpha_{03} + \beta|OP_{i03} + \gamma|IP_{i03} + \delta|IN_{i03} + \pi|X_{i03} + \varepsilon \quad (3)$$

$$H_{i08} = \alpha_{08} + \beta|OP_{i08} + \gamma|IP_{i08} + \delta|IN_{i08} + \pi|X_{i08} + \varepsilon \quad (4)$$

Tables 4 and 5 show the impact of own-price, cross-price, and income on demand of health care, after controlling for other listed variables in 2003 and 2008.

We conduct *t*-tests for the coefficients in 2003 against those in 2008. For example, we test whether the impact of outpatient price on outpatient visits among users in 2003 is significantly distinctive from that in 2008. The results suggest the impacts of outpatient price on outpatient visits among users and the impacts of income on probability of inpatient visit are statistically different in 2003 and 2008, which echoes the test of Hypothesis II in analyzing the pooled data. In short, the results from *t*-test in pooled and separated regressions are consistent with each other.

3. Results on elasticity of demand for healthcare

Elasticity of demand is calculated as the ratio of the percentage change in demand to the percentage change in income. We take the natural logarithms of independent variables in ZTNB model and the coefficients from regression could be directly read as elasticity. More specifically, for the residents who have utilized outpatient service, the estimated coefficients of natural logarithms of outpatient price, inpatient price and income from ZTNB model are the elasticities of demand for outpatient visits in response to the change in outpatient price, inpatient price and income [33].

However, elasticity cannot be read directly from coefficients in Probit model. Accordingly, the estimated results from Probit models could be transferred into elasticity of demand measured by probability of outpatient visit and probability of inpatient visit through the following calculation [32]:

$$\varepsilon_V = \frac{\phi(\alpha' z_i)\alpha_V}{\Phi(\alpha' z_i)} \quad (5)$$

Table 4
The estimated coefficients of regression models (the year of 2003).

	Outpatient care		Prob. of inpatient visit (Probit model)
	Prob. of outpatient visit (Probit model)	Outpatient visits among users (ZTNB model)	
Log of outpatient price	−0.209 (0.034)***	−0.211 (0.063)***	0.065 (0.042)
Log of inpatient price	0.082 (0.042)**	0.118 (0.104)	−0.152 (0.060)**
Log of income	0.051 (0.020)***	0.077 (0.033)**	0.324 (0.022)***
Male	−0.057 (0.015)***	−0.024 (0.033)	−0.207 (0.021)***
Age 65+	0.103 (0.026)***	0.037 (0.053)	0.106 (0.035)***
Married	0.141 (0.018)***	0.017 (0.047)	0.232 (0.023)***
Illiterate	0.111 (0.019)***	0.072 (0.046)	−0.086 (0.027)***
Farmer	0.087 (0.021)***	−0.025 (0.051)	0.090 (0.026)***
Chronic disease	1.105 (0.037)***	−0.011 (0.037)	0.732 (0.044)***
Log of distance	0.002 (0.014)	−0.093 (0.036)***	0.031 (0.015)**
Central region	−0.054 (0.049)	−0.136 (0.099)	0.009 (0.047)
Western region	0.065 (0.055)	0.058 (0.101)	0.117 (0.040)***
Constant	−2.131 (0.348)***	−0.533 (0.762)	−3.812 (0.437)***
Wald χ^2	1280.04	41.03	1294.49
Prob > χ^2	<0.0001	<0.0001	<0.0001
R^2	0.1378	–	0.096
Sample size	107,643	8520	107,643

Note: The control variable NCMS is excluded in this regression as the majority was not covered by NCSM in 2003 (Please refer to the summary statistics in Table 2).
** Significant at 5%.
*** Significant at 1%.

Where ε_V is the elasticity of demand with respect to factor V (outpatient price, inpatient price and income), α_V is the coefficient of the natural log of variable V, $\phi(\alpha' z_i)$ is the probability density function of the standard normal variable estimated at the means of the regressors, and $\Phi(\alpha' z_i)$ is the cumulative probability function.

Table 6 shows the own-price, cross-price, and income elasticities of demand for health care for the year of 2003, the year of 2008, and the pooled data. Even though numeric values of estimated elasticities are all presented in Table 6, we emphasize the implicit information delivered through the patterns in three groups of elasticities.

3.1. Own-price elasticity

All own-price elasticities are significant, negative and less than 1 in absolute values. For outpatient services in 2003, the probability of outpatient visits decreases by 41.4% if outpatient price is increased by 100%; outpatient visits among users decrease by 21.1% if outpatient price is doubled. In 2008, the probability of outpatient visits decreases by 51.9% if outpatient price is increased by 100%; outpatient visits among users decrease by 54.7% if outpatient price is doubled. From point estimate, it means that the utilization of the first outpatient visit is more sensitive to price change,

Table 5
The estimated coefficients of regression models (the year of 2008).

	Outpatient care		
	Prob. of outpatient visit (Probit model)	Outpatient visits among users (ZTNB model)	Prob. of inpatient visit (Probit model)
Log of outpatient price	−0.265 (0.048)***	−0.547 (0.102)***	0.029 (0.036)
Log of inpatient price	0.037 (0.065)	0.308 (0.113)***	−0.180 (0.036)***
Log of income	0.050 (0.021)**	0.136 (0.056)**	0.252 (0.021)***
Male	−0.087 (0.014)***	−0.009 (0.042)	−0.218 (0.017)***
Age 65+	0.171 (0.026)***	0.072 (0.057)	0.256 (0.027)***
Married	0.127 (0.022)***	−0.097 (0.052)*	0.275 (0.026)***
Illiterate	0.126 (0.024)***	0.051 (0.049)	−0.072 (0.025)***
Farmer	0.090 (0.024)***	0.057 (0.063)	0.013 (0.020)
NCMS	0.078 (0.038)**	−0.077 (0.091)	0.110 (0.035)***
Chronic disease	0.999 (0.035)***	0.146 (0.057)**	0.650 (0.040)***
Log of distance	0.001 (0.016)	−0.045 (0.048)	0.004 (0.013)
Central region	0.105 (0.065)	0.137 (0.144)	0.139 (0.050)***
Western region	0.133 (0.075)*	0.216 (0.154)	0.147 (0.054)***
Constant	−1.578 (0.447)***	−1.762 (0.854)**	−2.915 (0.264)***
Wald χ^2	1310.36	73.06	1341.95
Prob > χ^2	<0.0001	<0.0001	<0.0001
R^2	0.1325	–	0.0801
Sample size	103,541	8773	103,541

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 6
The individual-level elasticities of demand for outpatient and inpatient services.

	Outpatient price	Inpatient price	Income
The year of 2003			
Probability of outpatient visit	**−0.414 (−0.545, −0.284)**	0.163 (−0.001, 0.327)	**0.102 (0.026, 0.179)**
Outpatient visits among users	**−0.211 (−0.335, −0.087)**	0.118 (−0.085, 0.321)	**0.077 (0.013, 0.142)**
Probability of inpatient visit	0.152 (−0.042, 0.347)	**−0.357 (−0.633, −0.080)**	**0.762 (0.659, 0.865)**
The year of 2008			
Probability of outpatient visit	**−0.519 (−0.703, −0.336)**	0.073 (−0.176, 0.322)	**0.098 (0.018, 0.178)**
Outpatient visits among users	**−0.547 (-0.747, −0.347)**	**0.308 (0.087, 0.528)**	**0.136 (0.028, 0.245)**
Probability of inpatient visit	0.059 (−0.085, 0.204)	**−0.372 (−0.517, −0.226)**	**0.521 (0.438, 0.605)**
Pooled regression			
Probability of outpatient visit	**−0.408 (−0.537, −0.279)**	**0.171 (0.017, 0.326)**	**0.118 (0.039, 0.197)**
Outpatient visits among users	**NA**	0.151 (−0.061, 0.362)	**0.103 (0.031, 0.175)**
Probability of inpatient visit	0.134 (−0.041, 0.309)	**−0.339 (−0.588, −0.089)**	**NA**

Note: 95% confidence intervals are provided in parentheses. The bolded parameters are significantly different from zero with 95% of confidence, while others are insignificantly different from zero. For pooled data, we denote two elasticities as "NA" because we cannot estimate those two parameters through pooled data. Accordingly, in separated regressions, the confidence intervals of −0.211 and −0.547 are not overlapped; meanwhile, the confidence intervals of 0.762 and 0.521 are not overlapped.

compared with sequential utilization of outpatient visits among users in 2003; vice versa in 2008. However, neither the difference between the values of elasticity −0.414 and −0.211 nor the difference between the values of elasticity −0.519 and −0.547 is statistically significant in *t*-test. Therefore, we conclude that own-price elasticity for the first outpatient visit is not significantly different from that for outpatient visits among users in 2003, which is the same for 2008. Meanwhile, own-price elasticity of outpatient visits among users in 2003 (−0.211) is significantly different from that in 2008 (−0.547) in *t*-test. For inpatient service, the probability of inpatient visit decreases by 35.7% in 2003 and 37.2% in 2008 if inpatient price is doubled. However, they are not significantly different from each other.

3.2. Cross-price elasticity

Among 9 cross-price elasticities in 2003 and 2008, only two are significant at 95% confidence level. Both of them (0.308 and 0.171) are positive, which means outpatient services are substitutes to inpatient services. Besides that, no dependent variable responds to change in inpatient price. For instance, in 2008, probability of outpatient visit does not respond to change in inpatient price; however, outpatient visits among users decrease by 30.8%, if inpatient price is reduced by 100%. It means users of outpatient services are more sensitive than the general mass to the change in inpatient price in 2008.

3.3. Income elasticity

All income elasticities are significant, positive, and with absolute values less than 1. For outpatient services in 2003, probability of outpatient visit increases by 10.2% if income is doubled; outpatient visit among users increases by 7.7% in this case. In 2008, probability of outpatient visit increases by 9.8% if income is doubled; outpatient visit among users increases by 13.6% in this case. However, neither the difference between the values of elasticity −0.102 and −0.077 nor the difference between the values of elasticity −0.098 and −0.136 is statistically significant in *t*-test. For inpatient services, probability of inpatient visit increases 76.2% in 2003 and 52.1% in 2008, when income is doubled. The results indicate that, when income is doubled, the growth rate in first inpatient visit (76.2%) is 7.5 times greater than first outpatient visit (10.2%) in 2003, holding other factors (e.g., price of outpatient service, price of inpatient service) constant. Meanwhile, the growth rate in first inpatient visit (52.1%) is 5.3 times greater than first outpatient visit (9.8%) in 2008, holding other factors constant.

4. Discussion

In this section, we discuss four points with regard to endogeneity of price, selection of models, characteristics of dependent variables, and characteristics of cross-sectional data. We further the discussion by pointing out limitations in this study.

First, one of the key efforts in our study is to deal with endogeneity of price. To evaluate the elasticity, the price should be ex-ante or patients are price takers. However, the medical cost for each individual occurs in an ex-post manner. In other words, utilization of healthcare by each individual impacts his or her medical cost. Thus, it is problematic to take medical costs from individuals as the independent variable. We take the medians of medical cost per visit in each county as the proxy of the perceived price of healthcare. Intuitively, patients' demand for healthcare is affected by the perceived price; in turn, individual demand for healthcare has almost no power to impact the median of medical cost per visit given large sample size in each county. It is the most feasible approach we could take in the empirical estimation of elasticity of demand for healthcare in rural China to enhance exogeneity of price. Furthermore, even though price is constructed at the county level, we are still aware of other sources of confounders from both demand and supply sides, such as differences in the adaptation of new technology or NCMS policies at county level. For instance, adaptation of new technology will bias up the impact of price on demand for healthcare.

Second, Newhouse and Phelps recommended that the elasticity of total outpatient visits could be calculated by adding up the elasticity of demand measured by probability of outpatient visit and the elasticity of demand for

outpatient visits among the outpatient service users [31]. In our analysis, we did not take this approach due to results from data analysis. As we stated in the section about models, we used both Probit and ZTNB models for outpatient services; however, we only used Probit model for inpatient services. The major reason is lack of variation in dependent variable (inpatient visits) to make convergent regression in ZTNB model. Accordingly, in Table 6, we did not report the elasticity of demand for inpatient visits among users. Finally, we conduct comparison of elasticities between probabilities of outpatient visit and inpatient visit, both of which are based on Probit model.

Third, in pooled regression, the elasticity of first outpatient visit is calculated from all samples with 211,184 sample size; however, the elasticity of outpatient visits among users is calculated from restricted samples with 17,293 sample size, which is conditional on utilization of outpatient services. Equivalent explanations apply to separated regressions in 2003 and 2008. The interpretations of those two elasticities refer to different sets of heterogeneous population. Therefore, we focus on interpreting the comparable results from the analysis of full samples.

Fourth, we pool the data from 2003 and 2008 in order to enhance the variation of median price for healthcare. However, the strategy of pooling data cannot apply to estimate all elasticities. Therefore, we run separate regressions for each year as well. It is of importance to emphasize that comparisons between two years are not informative for policy making as it is cross-sectional data rather than panel data at an individual level. The elasticities in 2003 or 2008 shed light on policy implications in that specific year and the elasticities from pooled data suggest the relationships between price, income and demand for healthcare at an average sense, which is less intuitive for policy implications. Furthermore, comparison between elasticity of first outpatient visit and elasticity from first inpatient visit cannot solve the puzzle about unbalanced utilization of health care measured by total visits. Despite this distinction, the results from this study are sufficient to answer three questions addressed at the introduction section.

There are several limitations in our analysis. First, we use the median medical cost per visit at county level and we cannot address the variation within county. Neither can we compare our results with the results from Li et al. and Zhou et al., which explored the variation at town or village levels. Second, we use self-reported consumption expenditure to proxy income, which could be improved in further study with better data on income. Third, our study is restricted to population above 15 years old; therefore, we had no information with regard to health expenditure pattern for infants or children under 15. Further studies could pay more attention to within-county or subgroup analysis.

5. Conclusion

How does elasticity signal about healthcare utilization in rural China? The main findings from this paper are summarized as the following.

First, no significant difference is detected between sensitivity of outpatient services and sensitivity of inpatient services, responding to own-price change. The point estimates of own-price elasticity indicate that outpatient services are more sensitive than inpatient services to price change. Furthermore, as price ratio (i.e., outpatient price over inpatient price) increases, the share of outpatient service in total health expenditure sensitively drops. However, if we take confidence intervals into account, the difference between outpatient and inpatient services vanishes. This conclusion holds for the year of 2003, the year of 2008, as well as the pooled data.

Second, inpatient services are substitutes to outpatient services. More specifically, outpatient visits among users decrease by 30.8%, if inpatient price is reduced by 100%. Meanwhile, cross-elasticity from pooled data indicates that the first outpatient visit decreases by 17.1%, if inpatient price is reduced by 100%. It means the decrease of out-of-pocket payment, which is measured by inpatient price in our model, reduced outpatient visits among users as well as the general mass. In NCMS, only inpatient service is covered by insurance, the relative price for inpatient service was reduced through reimbursement and patients were incentivized to use less basic medical service and more hospital service. This health care expenditure pattern not only financially increases the probability of patients' medical impoverishment but also physically increases the probability of accumulating minor illness to catastrophic conditions. This conclusion only holds with regard to the impact of inpatient price on outpatient services for the year of 2008 and the pooled data.

Third, the income elasticity indicates that the growth of inpatient services is faster than the growth in outpatient services in response to income growth; this conclusion is drawn from comparing income elasticities of the first outpatient visit versus the first inpatient visit. Theoretically, for the people under full insurance or with free access to health care, the effect of income on the demand for health care should be small [15]. However, under partial insurance such as NCMS, income elasticity is smaller for uninsured services and greater for reimbursed services. Income growth leads to around 6.4-time increase in inpatient service compared with outpatient service, which reveals patients' preference for inpatient service over outpatient service and partially explains the unbalanced change between those two counterparts. This conclusion holds for the year of 2003, the year of 2008, as well as the pooled data.

The evidence from 2003 is not adequate to support any conclusion on NCMS as the majority did not have health insurance at that time, which was mentioned in Table 2. However, the findings from the year of 2008 suggest refining NCMS policy in China.

The NCMS implemented in 2004 has a significant impact on the results in 2008, because insuring people increases the demand for treatments (Tables 3 and 5). Given that one of the initial goals of NCMS is achieved to make inpatient services less expensive, which is indicated in Table 2, we offer recommendations to address unbalanced change of inpatient versus outpatient services in rural China. First, from a cost-effectiveness perspective, changing outpatient price is at least as effective as changing inpatient price to adjust demand of health care, if effectiveness is measured by the probability of seeking healthcare when it is in

need. Given the increase in government subsidy for NCMS, it is reasonable to allocate funding to include outpatient services in risk pooling, which would finally reduce out-of-pocket payment and increase utilization of outpatient services, especially for patients with chronic conditions. Similar effect will occur through pooling funding in family savings account for outpatient services to reduce patient delay in seeking outpatient services due to financial concerns. Second, the current national guideline for healthcare reform to increase the reimbursement rate for inpatient services will crowd out outpatient services. Each county should estimate how much outpatient services would be crowded out if reimbursement rate for inpatient services is increased according to the results of cross-price elasticities of demand for outpatient services. Unluckily, we have no evidence regarding the change in demand for inpatient services in case NCMS covers outpatient services to reduce out-of-pocket payment because of insignificant estimations of related cross-price elasticities. Last but not the least, patients' preference for inpatient service over outpatient service should be reshaped; otherwise, as income grows in rural China, the unbalanced growth in inpatient and outpatient services would even more deepen. Referral system and gate-keeping system should be established to adjust patients' preference. Discriminative reimbursement policies could be set in NCMS to highlight the essential role of gate-keeping and referring.

Conflict of interests

The authors declare that they have no conflict of interests.

Contributions

Z.Z., Y.S., J.G., L.X., and Y.Z. designed this study. L.X. and Y.Z. acquired data and provided administrative and technical support for this study. Z.Z. and Y.S. analyzed the data and J.G. provided statistical expertise. Z.Z. and Y.S. drafted the manuscript. Z.Z., Y.S., J.G., L.X., and Y.Z. critically revised the manuscript and approved the final version of this paper. Z.Z. and Y.S. share first authorship as both of them equally contribute to the full paper.

Acknowledgments

We are thankful to the Center for Health Statistics and Information of Chinese Health Ministry (CHSI) for the data. We are also indebted to China Medical Board of New York Inc. (CMB), Fairbank Center for Chinese Studies at Harvard for Desmond and Whitney Shum Fellowship, and CHSI for financial support.

References

[1] Center for Health Statistics and Information of MOH. Statistics report of Chinese health service development, 2010. Available at: http://www.moh.gov.cn. Accessed 29 April 2011.
[2] Yip W, Hsiao W. Non evidence-based policy: How effective is China's New Cooperative Medical Scheme in reducing medical impoverishment? Social Science & Medicine 2009;68(2):201–9.
[3] Center for Health Statistics and Information of MOH. Analysis report of the National Health Services Survey in China, 2003 and 2008. Accessed 21 September 2011 at: http://www.moh.gov.cn; 2010.
[4] World Health Organization representative in China and the Development Research Center of State Council China: medical health, poverty and economic development, Beijing; 2006.
[5] Tang X, Zhang J. Analysis on the utilization and influence factors of the outpatient service of rural residents in four counties. Modern Preventive Medicine 2009;(7):1255–7.
[6] National Bureau of Statistics of China. Statistical bulletin of national economy and social development in 2003. Available at: http://www.stats.gov.cn; 2003.
[7] National Bureau of Statistics of China. Statistical bulletin of national economy and social development in 2008. Available at: http://www.stats.gov.cn; 2008.
[8] Ringel JS, Hosek SD, Vollaard BA, Mahnovski S. The elasticity of demand for health care: a review of the literature and its application to the military health system. Santa Monica, CA: Rand; 2002.
[9] Holmer M. Tax policy and the demand for health insurance. Journal of Health Economics 1984;3(3):203–21.
[10] Scitovsky AA, Snyder NM. Effect of coinsurance on use of physician services. Social Security Bulletin 1972;35(6):3–19.
[11] Cherkin DC, Grothaus L, Wagner EH. The effect of office visit copayments on preventive care services in an HMO. Inquiry 1989;27(1):24–38.
[12] Fuchs VR, Kramer MJ. Determinants of expenditures for physicians' services in the United States, 1948–1968. NY: National Bureau of Economic Research; 1972.
[13] Wedig GJ. Health status and the demand for health. Results on price elasticities. Journal of Health Economics 1998;7(2):151–63.
[14] Deaton A. Estimation of own- and cross-price elasticities from household survey data. Journal of Econometrics 1987;36(1–2):7–30.
[15] Phelps CE. Health Economics. NY: HarperCollins; 1992.
[16] Di Matteo L. The income elasticity of health care spending, a comparison of parametric and nonparametric approaches. European Journal of Health Economics 2003;4(1):20–9.
[17] Manning WG, Newhouse JP, Duan N, Keeler EB, Leibowitz A. Health insurance and the demand for medical care: evidence from a randomized experiment. American Economic Review 1987;77(3):251–77.
[18] Davis K, Russell LB. The substitution of hospital outpatient care for inpatient care. Review of Economics and Statistics 1972;54:109–20.
[19] Gold M. The Demand for Hospital Outpatient Services. Health Service Research 1984;19:384–412.
[20] Freiberg L, Scutchfield FD. Insurance and the demand for hospital care: an examination of the moral hazard. Inquity 1976;13:54–60.
[21] Getzen T. Health care is an individual necessity and a national luxury: applying multilevel decision models to the analysis of health care expenditures. Journal of Health Economics 2000;19(2):259–70.
[22] Lavy V, Quigley JM. Willingness to pay for the quality and intensity of medical care: low-income households in Ghana. Washington, DC: World Bank; 1993.
[23] Sauerborn R, Nougtara A, Latimer E. The elasticity of demand for health care in Burkina Faso: differences across age and income groups. Health Policy and Planning 1994;9(2):185–92.
[24] Li L, Yang S, Lui G, Cretin S. Forecast model for medical expenses and insurance factor analysis. Chinese Health Service Management 1994;5:235–40.
[25] Zhou Z, Gao J, Xue Q, Yang X, Yan J. Effects of Rural Mutual Health Care on outpatient service utilization in Chinese village medical institutions: evidence from panel data. Health Economics 2009;18 (Suppl. 2):S129–36.
[26] Png I, Lehman D. Managerial economics. Malden, MA: Blackwell; 2002.
[27] Wang H, Zhang L, Hsiao W. Ill health and its potential influence on household consumptions in rural China. Health Policy 2006;78:167–77.
[28] Meyer BD, Sullivan JX. Measuring the well-being of the poor using income and consumption. Journal of Human Resources 2003;v38:1180–220.
[29] O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Analyzing health equity using household data: a guide to techniques and their implementation. Washington, DC: World Bank; 2008.
[30] Ekman B. The impact of health insurance on outpatient utilization and expenditure: evidence from one middle-income country using national household survey data. Health Research Policy and Systems 2007;5:6.
[31] Newhouse JP, Phelps CE. New estimates of price and income elasticities. In: Rosett R, editor. The role of health insurance in the health services sector. NY: National Bureau of Economic Research; 1976.

[32] Ogloblin C, Brock G. Smoking in Russia: the 'Marlboro Man' rides but without 'Virginia Slims' for now. Comparative Economic Studies 2003;45(1):87–103.
[33] Sheu ML, Hu TW, Keeler TE, Ong M, Sung HY. The effect of a major cigarette price change on smoking behavior in California: a zero-inflated negative binomial model. Health Economics 2004;13(8):781–91.
[34] Moulton BR. An illustration of a pitfall in estimating the effects of aggregate variables on micro units. The Review of Economics and Statistics 1990;72(2):334–8.