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Mathematical Modeling of Moral Hazard in Healthcare and Empirical Evidence in China

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Abstract

With rapid growing cost and lower efficiency of the whole healthcare system, various problems arise in the fairness, efficiency and accessibility of China's current healthcare system, which became the focus of government' priority in reform of fiscal expenditure. Moral hazard is regarded as the main reason of the unavailability of health services, and the main research question of the paper is to find out the factors that may cause the systematic low efficiency. This article analyses the possible moral hazard tendency of health care and conducts the empirical analysis with the survey data. Based on the theoretical model and empirical analysis, this paper proposes policy advice to improve efficiency of health care financing and to avoid moral hazard in the health care field, the aim of which is to provide policy options in the forthcoming health care reform and provide useful suggestions and possible strategies.

Key words: Inefficiency, Healthcare Expenditure, Moral Hazard, China

Introduction

In the healthcare system, the most important link of health care expenditure and the degree of moral hazard is the payment method of health care provider and consumer. This paper utilizes the principal-agent analysis and utility function analysis, together with limited dependent variable econometric analysis to evaluate performance. It also analyses policy design to control moral hazard from the demand side, including the use of a co-payment system, savings accounts, and pre-payment of fixed amount to the providers of health care services within a fixed period of time, which encourages consumers to choose different packages of low-cost health care services, government information regulation and so on. Then, the paper concludes on the main factors which determine the level of moral hazard from the demand side, including the residents smoking behaviour, distance to health care institutions, exercise rate, exercise time and the initiative to obtain health care knowledge and their proportion of spending. Considering the features in the health care system, the research is designed a simple theoretical model and started the theoretical analysis from the assumption of rational consumers. The basic aim of this model is to verify the various changeable relationships between the level of consumers' utility, health care expenditure and medical treatment processes. The second aim is to explore the potential relationship between customers' behaviour and the health care financing model, mainly the relationship between personal efforts in preventing disease and health care financing. When facing risks, consumers are rational and risk-averse and make their optimal choice under the constraint condition. The model assumed two different conditions: sick or not sick. The possibility of being sick is up to a consumer's health state and his or her efforts in preventing disease. The analysis commenced with the optimization problem under the constraint condition. The objective function and constraints are ascertained to identify the condition for optimization and probe the importance of different variables and make a theoretical analysis.

Mathematical Modelling and Research Methods. Reduction of consumer utility brought about by illness is determined by direct expense and income loss in work. Another significant hypothesis of the model is asymmetric information, which means that institutions cannot detect the consumer's potential health condition and the level of their efforts in preventing disease. Therefore, in the two different conditions, the cost of health care is respectively:

$H_0 = 0$ if not sick,

$H_1 > 0$ if sick,

The level of consumer's efforts in preventing disease, e, determines the possibility function P of being sick. The assumption is that the higher level of effort in preventing disease, lower possibility of being sick for consumers. $P(e)$ can be defined as the possibility function of effort in preventing disease. So if we regard e as a continuous variable and $e > 0$, then $P(e)$ is a continuous and strictly convex function.

$\frac{\partial P_1(e)}{\partial e} = P_1'(e) < 0;\ \frac{\partial^2 P_1(e)}{\partial e^2} = P_1''(e) > 0,$ that is, $P' < 0;\ P'' > 0$ If $P_1(e)$ and $P_0(e)$ signify the possibility of being sick and not being sick respectively, then the function of shared medical expenses can be defined as:

$$S(H_1) = \begin{cases} \sigma H_1 & \text{if} \quad H_1 < \theta \\ \theta & \text{other conditions} \end{cases}$$

In the function, θ refers to the maximum expense that consumers can afford, σ refers to the ratio of personally payment of consumers, H_1 refers to the actual medical expenses. Consumer's opportunity cost function can be expressed as $C(w,t) = wt$, w means the salary of consumer, t means time cost of consumer's sickness. Assuming that W_0 is the wealth endowment level of consumer at the initial stage and under the condition that no consumer being sick, and it's level is $NW_0 = W_0 - \rho$, ρ means cost of participating health care system. Then when a consumer is sick, his level can be expressed as:

$$NW_1 = \begin{cases} W_0 - \rho - e - \sigma H_1 - wt & \text{if } \sigma H_1 < \theta \\ W_0 - \rho - e - \theta - wt & \text{other conditions} \end{cases}$$

Derivation of the utility function must be based on the following assumptions. First, the consumer's behaviour utility should be mutually independent. Second, the consumer's effort level in preventing disease and the occurrence of disease should be independent factors. From the intuitive view, the effort level often appears before the disease happens and it is natural to assume the independence of these two variables. However, this assumption should be adjusted if we conduct comparative static or dynamic analysis. Third, Arnott and Stiglitz (1988, 1991) assumed that consumer's effort level could cause reduction of utility, $U_1(e) = U_2(e) = e$, but it contradicted to the earlier assumption of risk-averse for consumers. Then, this assumption can be modified to $U_1(e) = U_2(e) = U_e(e)$.
With these hypotheses, consumers choose to prevent disease and reach their maximum utility. Utility function and endowment function are mutually independent, so the expected utility function can be expressed by the sum of endowment function and utility function of prevention level:

$$EU(u) = P_1(e)\,U_1(NW_1) + [1 - P_1(e)]\,U_0(NW_0) + U_e(e) \quad (1)$$

With the condition of $U_1', U_0' > 0;\ U_1'', U_0'' < 0$;Utility function U_e satisfies: $U_e(0) = 0;\ U_e'(e) < 0$, but the signal U_e'' is not known and it's defined by the correlation between the rising tendency of cost that consumer used to prevent disease and reduction of utility brought by each unit of e.

In all the exogenous variables $(H_1, NW_0, \rho, w, t, \sigma, \theta)$ of this model, the maximum ratio of consumers' payment σ and the maximum cost that consumers can afford θ are critical measurement for the level of consumer's moral hazard. Consumer can choose effort level to maximize the expected utility and the first-order condition of the best EU is:

$$P_1'U_1(NW_1) - P_1'U_0(NW_0) + U_e'(e) = 0 \quad (2)$$

It can be simplified as : $P_1'(U_1 - U_0) = -U_e'$, consumer's net wealth is larger in the no illness condition, $U_1 < U_0$, and $P_1' < 0$. The left side of the equation is positive, which means the extra effort of prevention reduced the possibility of disease utility (U_1) , and then reduced the cost of expected utility. The right side of the equation is also positive, which means that marginal cost of prevention. The second order condition to achieve best EU is:

$$\frac{\partial^2 EU}{\partial e^2} = P_1''(U_1 - U_0) + U_e'' < 0 \quad (3)$$

To focus analysis on the influence of σ , we can acquire the partial derivative $\partial\sigma$ from (2):

$$\frac{\partial e}{\partial \sigma} = \begin{cases} \dfrac{P_1' U_1' H_1}{\partial^2 EU / \partial e^2} > 0 & ,if\ \sigma H_1 < \theta \\ 0 & other\ conditions \end{cases}$$

When $\sigma H_1 < \theta$, $d\sigma$ is positive number, and under other conditions, $d\sigma$ is zero. In the former case, when consumers' actual cost in illness is lower than the highest they can afford, the rising rate of maximum patient payment leads to the higher consumer disease prevention efforts. But in the latter, when cumulative sick payment is more than the affordable maximum amount, which means the consumers' payment rate is 1, the prevention effort is unchangeable in this condition.

When $\sigma H_1 < \theta$, σ is exogenous variable comparing to $U_e'(e)$. So the change of σ will not influence marginal utility, but it will have effect on $P_1'(U_1 - U_0)$ and make it increase no matter what e is and then make e higher in the equilibrium. When $\sigma H_1 \geq \theta$, σ does no influence on the two sides of the equation in first-order condition, so equilibrium level will not change.
The formulas derivation and the analysis of economic significance of other variables (θ; H_1) in medical expense shared function and w, t in opportunity cost function are similar with the analysis of σ, because they are all the variables of utility function $U_1(NW_1)$. And increase of these variables will lead to a higher e in equilibrium. The derivation of these variables in first-order is showing in the following Table Ⅰ.
The initial wealth endowment level of consumers is W_0 and expense in health care ρ are two variables in utility function $U_1(NW_1), U_0(NW_0)$. The difference between them is that the former one is positive correlated while the other one is negative correlated. According to the first-order condition of the derivation of ρ :

$$\frac{\partial e}{\partial \rho} = \frac{P_1'[U_1'(NW_1) - U_0'(NW_0)]}{P_1'[U_1'(NW_1) - U_0'(NW_0)] + U_e''(e)} = \frac{P_1'[U_1'(NW_1) - U_0'(NW_0)]}{\partial^2 EU / \partial e^2} > 0 \quad (4)$$

Because of the law of diminishing marginal utility, in $U_1(NW_1) < U_0(NW_0), U_1'(NW_1) > U_0'(NW_0)$, numerator and denominator are negative numbers. The higher cost consumers are required to pay in health care, the higher level of prevention efforts. Increase of ρ can lead to reduction of utility function $U_1(NW_1)$; $U_0(NW_0)$ and then make a higher e.

Table Ⅰ
Partial derivatives of variables in related functions

Variables	First-order partial derivatives
θ	$\frac{\partial e}{\partial \theta} = \begin{cases} 0, & \sigma H_1 < \theta \\ \frac{P_1' U_1'(NW_1)}{\partial^2 EU / \partial e^2} > 0, & \text{other conditions} \end{cases}$
H_1	$\frac{\partial e}{\partial H_1} = \begin{cases} \frac{P_1' U_1'(NW_1)\sigma}{\partial^2 EU / \partial e^2} > 0, & \sigma H_1 < \theta \\ 0, & \text{other conditions} \end{cases}$
W	$\frac{\partial e}{\partial w} = \frac{P_1' U_1'(NW_1) t}{\partial^2 EU / \partial e^2} > 0$
T	$\frac{\partial e}{\partial t} = \frac{P_1' U_1'(NW_1) w}{\partial^2 EU / \partial e^2} > 0$

Analysis of W_0 can refer to the above analysis. But W_0 is negatively correlated with the utility function, which is different from the former. The first-order partial derivatives condition of W_0 is:

$$\frac{\partial e}{\partial W_0} = -\frac{P_1'[U_1'(NW_1) - U_0'(NW_0)]}{\partial^2 EU / \partial e^2} < 0 \quad (5)$$

The result of analysis is consistent with the result gained from intuitive analysis: the consumers who own more initial wealth are more likely to take part in the exercise, pay more attention to diet, have more food supplements and smoke less. But as the empirical results of Grossman (2006) show, people of higher income drink more and take less measures to prevent disease. So the derivation here only can be applied to the analysis of the non-monetary preventive measures. In the previous analysis, utility function of prevention efforts level is separated with income utility function. And those variables that are negative with income utility function can also lead to reduction of prevention efforts level.

The purpose of the empirical analysis is to verify the above assumptions. Because individual variables in former analyses are difficult to express in numbers, most of the proxy variables in the analysis are based on discrete variables, especially the dependent variable such as the self-reported health status. The main empirical methods of this part are discrete choice models, such as Logit model, Probit model and OLS methods. If the model specification is Logit, F represents distribution function, then:

$$y_i = m, \quad \tau_{m-1} \le y_i^* < \tau_m , \quad m = 1 \dots J \qquad (6)$$

Regression model can be expressed as:

$$y_i^* = h\big(P(y_i \le 1\ |x_i)\big) = \alpha_j + \sum_{i=0}^{n} \beta_i\, x_i + \epsilon_i \qquad (7)$$

And in it,

$$h\big(P(y_i \le 1\ |x_i)\big) = \log \frac{P(y_i \le 1\ |x_i)}{1 - P(y_i \le 1\ |x_i)} \qquad (8)$$

If the specification is a Probit model,

$$P(y_i \le 1\ |x_i) = \int_{-\infty}^{\alpha+\beta x_i} (2\pi)^{-1/2} \exp\left[\frac{-t^2}{2}\right] dt \qquad (9)$$

Supposing that response of interviewees are obtained in order: 1, 2, 3, … J, then the model can be expressed as:

$$P(y_i = j\ |x_i) = \begin{cases} F(\alpha_1 + \beta x_i) & j = 1 \\ F(\alpha_j + \beta x_i) - F(\alpha_{j-1} + \beta x_i) & 1 < j \le J - 1 \\ 1 - F(\alpha_{j-1} + \beta x_i) & j = J \end{cases} \qquad (10)$$

In the two functions above, the partial derivative analysis of variables is the constant coefficient we estimated if probability function is linear. The partial derivative of probability function can be expressed as:

$$\frac{\partial P(y_i \le j\ |x_i)}{\partial x_{ki}} = \frac{\partial F(\alpha_j + \beta' x_i)}{\partial x_{ki}} = \beta_k f\,(\alpha_j + \beta' x_i) \qquad (11)$$

In this equation, f(x) is the probability density function. The computation of explanatory variables in different level of partial derivatives can estimate what influences the change of range will bring to the probability likelihood of the result. When the i_{th} variable is valued as j, the partial derivative of probability can be expressed as:

$$\frac{\partial P(H_{it} = j\ |x_i)}{\partial x_i} = \begin{cases} \beta_k f\,(\alpha_j + \beta' x_i) & j = 1 \\ \beta_k f\,(\alpha_j + \beta' x_i) - \beta_k f\,(\alpha_{j-1} + \beta' x_i) & 1 < j \le J - 1 \\ -\beta_k f\,(\alpha_{j-1} + \beta' x_i) & j = J \end{cases} \qquad (12)$$

In addition, in order to analyse the relationship between the moral hazard of consumers' prevention and other explanatory variables, the research also utilizes OLS estimation of multivariate regression models. Strictly speaking, behaviours of personal moral hazard are hard to measure, such as personal efforts in keeping good health. Variables used here are proxy variables. The first type is physical and mental health variables (including HS and NWR) and the second type is effort level variables in keeping fit (including SMR, SMA and PSM). The third type is health care behaviour variables (EXR, FEX, TEX and OTK). Different regression methods are applied in the latter analysis due to the distinctive value types.

The sample data comes from the fifth national health services survey in 2013. The objects of the family health survey are permanent residents of the national sample households in China. The sampling method is multi-stage stratified cluster random sampling. Variables consist of the following items in Table Ⅱ:

Table Ⅱ

Variable settings of consumer moral hazard selection model

Variables	Description
HS	Self-reported health status of the old
NWR	Proportion of poor spirit condition
SMR	Smoking rate
SMA	Smoking amount
PSM	Rate of quitting smoking
DRR	Rate of regular drinking

YDR	Years of drinking
EXR	Rate of doing exercise
FEX	Frequency of exercise each week
TEX	Exercise time each week
OTK	Rate of people who acquire health knowledge initiatively
MEX	Maximum of average medical costs
SELF	Ration of the patient's self-payment
INCOME	Annual income per person
OPR	Outpatient rate in two weeks
WAIT	Satisfaction rate when waiting for doctor
TRVL	Satisfaction rate of time on road
SATR	Satisfaction rate of the first time with doctor

National health services survey offered disposal data and the local data, and there are also many variables which are not proper for the analysis of this model. After restructuring and sorting, variables in Table II can represent consumers' behaviour variables in a large degree.

In this model, HS and NWR are variables to describe people's physical and mental health status in the survey. They represent the self-reported health status and the amount of sickness respectively. The measure of variables refers to the WHO's definition of health, that is, "Health is not only the status with no illness, but keeping a perfect condition both in body and spirit". Also, health consists of motility, self-care ability, pain and discomfort, cognitive competence, eyesight, sleep and energy, and emotion. Self-evaluation in the health survey adopts a discrete variable multivariate selection model, and self-evaluation is allocated into different levels. The health status of self-awareness in the cities is poorer than respondents in the countryside, which may result from the higher urban population ages. Citizens' education level is higher than people in countryside. Ratio variable is adopted to describe the situation in physical and mental status. In gender, the rate of females in poor status in different areas is higher than males. This type of variable is the focus in empirical examination, because the model mainly discusses the relationship between health status and health behaviour of people in survey.

Another type of dependent variable is personal healthy habits, which can be expressed as some efforts in keeping fit. This mainly discusses the issue of smoking and drinking. Main variables of smoking status consist of SMR, SMA and PSM, which respectively represent smoking rate of the old, smoking amount and rate of quitting. Main variables of drinking status consist of DRR and YDR, which represent the rate of often drinking and years of drinking respectively. The overall trend is that the smoking rate decreases while smoking amount and degree are higher. In the investigating process, drinking habits and occasional drinking are separated and there is analysis for people who have drinking habits. These drinkers' average years of drinking are 22 and there is little difference between urban and rural areas.

Other variables can be divided into three types. The first type is personal health care behaviour, including EXR (exercise rate), FEX (exercise times each week), TEX (exercise time each week) and OTK (rate of acquiring health care knowledge by self). The second type is related to health care spending, including MEX (maximum of average health care cost of the old), SELF (rate of self-payment of medical cost) and INCOME (annual income per capita). The third type is the response to medical service of aging population, including OPR (outpatient rate in two weeks), WAIT (dissatisfaction rate when waiting for doctor), TRVL (dissatisfaction rate of time in road), SATR (satisfaction rate of the first time with doctor) and OBSER (number of sickness).

Empirical Results and Discussion. In an empirical model, dependent variable mainly measures the consumer's moral hazard behaviour in health care. Because it is difficult to measure directly, three types of proxy variables are presented in detailed descriptions. Dependent variables mainly consist of variables related to health care expense (including MEX, SELF and INCOME) and variables of response to medical service of aging population (including OPR, WAIT, TRVL, SATR) and OBSER (number of cases). Some variables original data are transformed. There are two forms of MEX in the investigation. One is the largest portion of expense during outpatient and hospitalization and the other is the rate of medical expense in family costs. Two kinds of data are compared and the smaller value is chosen. Rate of self-payment (SELF) is the rate of capital can be offered after handling all kinds of health care methods and total expense (including outpatient, hospitalization, and buying drugs by oneself) in the medical process. Then the rate of expense paid by the consumer themselves is calculated. Due to the limitations of the survey data, the exact amount of self-paid expense cannot be obtained. To make up for the limitations, the study provides the satisfaction of consumers of the medical service as the proxy variable, including WAIT (dissatisfaction rate when waiting for doctor), TRVL (dissatisfaction rate of time in road) and SATR (satisfaction rate of the first time with doctor).

In the data, if the dependent variable is descriptive or proportional data, especially when proxy variables are utilized to measure respondent's ordinal results, the Order Logit Model must be utilized. This type of model may overcome some disadvantages of a standard linear regression model, but what is different from other normal models is that it should be cautious in interpreting the estimated result. To show these changes, calculation of partial derivative of nonlinear probability function is contained in latter result table and its number is in the item "change of probability". Then the basic function of regression model can be expressed as:

$$h(P(y_i \le j \mid x_i)) = \alpha_j + \beta_1 OTK + \beta_2 MEX + \beta_3 SELF + \beta_4 INCOME$$
$$+ \beta_1 OPR + \beta_1 WAIT + \beta_1 TRVL + \beta_1 SATR + \varepsilon, 1 \le j \le J-1 \quad (13)$$

In the survey data, overall evaluation of physical status made by respondents themselves is evaluation after considering body, mental status and other various factors. It has rank correlation and every rank is in different rate. In the empirical model above, it adopts Ordinal process of regression and the primary result is shown in Table Ⅲ.

The results show that MEX, OPR, WAIT and TRVL are significant when statistical level is 10% and it is accord with the degree of importance and expected direction of influence. This result also supports the former assumption that the largest medical expense has an inverse correlation with personal health status. At the same time, due to the system problems of medical financing, consumers avoid normal medical needs for various reasons to worsen their health status. In addition, time for medical service and distance of medical area may also make consumers reduce the frequency of going to hospital, which also lead to a lower health status.

Table Ⅲ

Estimated result of self-reported health status (HS) of aging population

Dependent variables: HS self-reported health status				Standard evaluation fitting in model			
variable	Coeff.	S.D.	Change of probability*	Evaluation criterion	intercept	Final model	Chi-square
OTK	0.013	0.013	---	-2Log L	843.056	804.298	38. 758 **
MEX	-0.010	0.003	0.00336	Pearson	N/A	N/A	8441.485
SELF	-0.002	0.008	---	Deviance	N/A	N/A	804.298
INCOME	0.000	0.000	---				
OPR	-0.009	0.003	0.003024	Pseudo R-square			
WAIT	-0.171	0.051	0.057456	Cox and Snell	0.335		
TRVL	-0.152	0.078	0.051072	Nagelkerke	0.335		
SATR	0.005	0.011	---	McFadden	0.046		

--- Means that coefficient is not significant under the statistical level 0.1.

** Means that statistical magnitude is significant under the statistical level 0.01.

*Means the cumulative density of partial derivative.

Table Ⅳ

Estimated results of cases (NWR) of the aging population

Dependent variable ： NWR				Model fitting standard evaluation	
concomitant	Coeff.	S.D.	Coeff/S.E	Evaluation criterion	Chi-square
OTK	-0.00066	0.00026	-2.58790	Pearson	2263.395
MEX	0.00025	0.00006	4.01292	Result of Pearson test of goodness of fit shows that model fitting is good. Due to the test result is statistically significant (the number of P is larger than assumed 0.15), so when credibility interval is calculated, it had heterogeneity correction.	
SELF	0.00008	0.00016	0.50863		
INCOME	-0.00001	0.0000	-2.64898		
OPR	0.00195	0.00006	33.79909	Regression equation of the model can be expressed as: Prob（p）=-1.04626-0.00066OTK+0.00025MEX+0.00008SELF-0.0001INCOME+0.00195OPR+0.00154WAIT-0.01312TRVL-0.00238SATR	
WAIT	0.00154	0.00101	1.52466		
TRVL	-0.01312	0.00152	-8.65905		
SATR	-0.00238	0.00022	-10.67526		
intercept	-1.04626	0.03655	-28.62835		

From the whole model, data aggregation and the likelihood ratio test for the model indicates that the model is meaningful. Goodness-of-fit Pearson and Deviation test also show that fitness of the model is good. Every variable passes Wald test and the results are significant, Table Ⅲ shows the variations of probability. And explained, consumers' largest medical expense, outpatient rate in two weeks and satisfactory waiting time and distance have significant influence on their own health evaluation and this influence in the model is shown through the increase of probability in health evaluation. A 1% change of a statistically significant standard deviation can lead to a related change of probability in health evaluation of consumers.

In order to study the relationship between variables in medical financing system and the possibility of being sick together with other related variables, Table Ⅳ adopted Probit fitting regression model to analyse the relationship between expected numbers and real numbers of illness. Actually, variables in the table are called as concomitant variables, that is irritating condition factors. The result shows that the model of 18 iterations gained the best result and the regression equation is listed in the table. The regression results show observed values and expected values, and gave related residuals and probabilities.
Figure I shows the response curve of Probit function under the premise that MEX is the only covariate, that is, different maximum medical expense values correspond to related probability scatters.

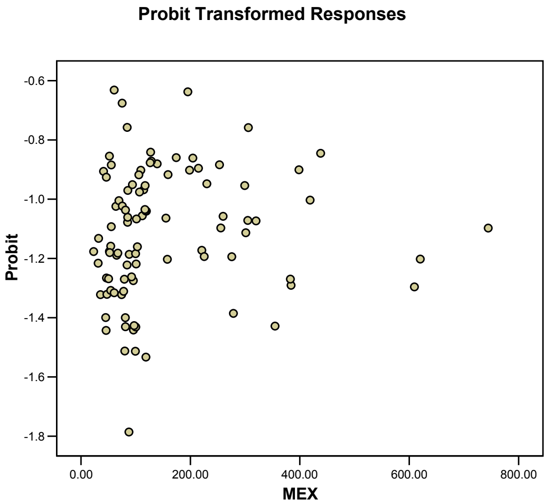

Figure Ⅰ
Scatter diagram of the maximum expense in the Probit regression

From Table Ⅴ, medical cost has a close relationship with smoking rate (the proportion of the population that smokes) and smoking amount (individual's volume of smoking), which means that higher the cost, the greater possibility that people may restrict smoking behaviour. At the same time, rate of quitting smoking has a significant relationship with the proportion of self-payment, which means that self-funded medical cost is an important consideration in respondents' decisions to quit smoking. Income level has an insignificant influence on smoking condition, which means that people in different income levels are likely to form a smoking habit. In addition, smoking rate, smoking amount and cases of illness have a strong positive correlation relationship and it means that smoking can weaken the body function and make it easier for the person to be sick. Moreover, distance of medical institution is also a statistically significant variable. A possible explanation for this is that areas with few medical institutions provide less education about smoking harm, which leads to less knowledge, especially in the vast rural areas. In order to reduce total medical cost, education for prevention of smoking may be more effective for controlling expense than treating residual illness. A certain degree of cost sharing by consumers may influence their smoking behaviours.
Table Ⅴ
Estimated results of related variables in smoking status of aging population

	Smoking rate（SMR）		Smoking amount（SMA）	
variable	Coeff.	T stat	Coeff.	T stat
MEX	-0.002	-1.823	-0.002	-3.276
SELF	---	---	---	---
INCOME	---	---	---	---
OPR	---	---	0.003	1.801
WAIT	---	---	---	---
TRVL	0.422	1.775	---	---
SATR	---	---	0.022	3.059
OBSER	-0.006	-3.026	-0.002	-4.369
Intercept	33.547	5.511	18.923	14.621
R square	0.390		0.546	

F value	1.932	4.571

--- Means the coefficient is not significant under the statistical level 0.1.

From Table Ⅵ, the drinking status of aging population is similar to smoking status. Rate of regular drinking and drinking years have a significant relationship with the maximum medical expense. The drinking behaviour is related with the affordability of the population and this positive correlation infers that people with higher income may be more likely to drink. But it can also be passive. Drinking is a kind of communicating method in China and many people with high income form the drinking habit passively when they host a dinner with customers or other people. Similarly, excessive alcohol consumption can cause the deterioration of the health status, so variables (drinking rate and drinking years) of drinking status also have significant negative relation with cases of illness. Improper drinking no matter what the cause will lead to the deterioration of health status. Moreover, satisfaction of consumers is positively related with drinking variables, because problems caused by drinking often require emergency treatment, which must be handled immediately, which usually makes consumers feel satisfied with the treatment of medical institution.

TableⅥ

Estimated results of related variables in drinking status of aging population

	Rate of frequent drinking（DDR）		Drinking years（YDR）	
variable	Coeff.	T stat	Coeff.	T stat
MEX	-0.016	-1.982	0.003	2.510
SELF	---	---	---	---
INCOME	0.001	1.665	---	---
OPR	---	---	---	---
WAIT	---	---	---	---
TRVL	0.434	2.070	0.338	2.470
SATR	0.070	2.333	0.043	2.182
OBSER	0.007	-3.972	0.006	-4.924
Intercept	15.136	5.364	25.520	7.288
R square	0.470		0.538	
F value	3.044		4.370	

--- Means the coefficient is not significant under the statistical level 0.1.

Generally, “active exercise” of an aging population is the highest in city and lower in the smaller cities and rural areas; it trends down along with the social economy. So we can learn that people of exercise more in the city than in rural areas. From Table Ⅶ there is little correlation between medical expense of aging population and variables of health care behaviours like active exercise, which are statistically insignificant. However, the relationships between exercise rate, exercise time and rate of actively acquiring knowledge of health care have a strong correlation. When the rate of self-payment is higher, patients are more inclined to avoid being sick through undertaking active exercise. Moreover, four variables all showed that people might undertake active health care behaviours to avoid seeking medical advice due to the long distance to the medical institutions, because all these variables had a negative correlation with time spent on the way to the medical institutions. At the same time, these variables also showed that people had dissatisfaction in varying degrees and they chose active prevention to avoid the possibility of going to hospital.

Table Ⅶ

Estimated results of related variables (EXR, FEX, TEX, OTK)
in personal health care behavior of aging population

	Exercise rate（EXR）		Exercise times each week（FEX）		Exercise time each week（TEX）		Acquiring health care knowledge（OTK）	
variable	Coeff.	T stat	Coeff.	T stat	Coeff.	T stat	Coeff.	T stat
MEX	---	---	---	---	---	---	---	---
SELF	-0.067	-1.685	---	---	-0.043	-2.006	0.087	2.260
INCOME	0.002	2.149	---	---	0.002	1.977	0.004	2.273
OPR	---	---	---	---	---	---	---	---
WAIT	0.604	2.544	---	---	---	---	---	---
TRVL	-1.028	-2.655	-0.157	-3.667	-0.690	-1.663	-1.131	-1.690
SATR	-0.188	-3.368	---	---	-0.104	-1.734	-0.183	-1.904
OBSER	---	---	---	---	---	---	---	---

Intercept	29.391	2.964	6.543	1.095	50.575	4.750	54.483	3.180
R square	0.857		0.520		0.740		0.700	
F value	29.689		3.991		13.001		10.328	

--- Means the coefficient is not significant under the statistical level 0.1.

Conclusion

The basic conclusion of demand-side moral hazard is: appropriate insurance level should be chosen, and the government should establish broader coverage and a multi-level healthcare system, which may control the behavioural tendencies of moral hazard. The paper utilizes the principal-agent analysis and utility function analysis, together with limited dependent variable econometric analysis. The use of co-payment system, savings accounts, and pre-payment of fixed amount to the providers of health care services within a fixed period of time, which encourage consumers to choose different packages of low-cost health care services, government information monitoring and so on. The main factors to determine the level of moral hazard from the demand side are the residents of smoking behaviour, distance to health care institutions, exercise rate, exercise time and the initiative taken to obtain health care knowledge and their own expense ratio and proportion. Effective medical costs sharing system and reasonable coinsurance rate should be established. In some degree, this measure will help to reduce the information asymmetry and assist all parties in the awareness of their real options.

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