The Relationship Between the Basic Medical Insurance and the Commercial Medical Insurance in the Old Age Security in China

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Abstract

It is very significant to explore the interacting relationship between the basic medical insurance and commercial medical insurance for improving the medical security system. Based on the analytical framework of expected utility theory, by analyzing the model of insurance demand theory, this article shows following: the interacting relationship between the basic medical insurance and commercial medical insurance is either "Complementary Effect " or "Crowd-out Effect". The dominant relationship is decided is depend on the probability of illness in the elderly and the setting rate of basic medical insurance reimbursement. When both medical insurances coexist, if both price and quantity of commercial medical insurance reach the optimum point, the expect utility of the medical security for the aged will maximize.

Key words: Expected utility; Crowding out effect; Complementary effect

INTRODUCTION

In the past five years, the construction of elderly medical security has obtained the remarkable achievement. By the end of 2011 (K. N. Rask & K. J. Rask, 2000), the both percentages of elderly people with basic insurance in city and rural were respectively 74.1% and 44.7%, a problem of "a sense of security" for elderly people were improved greatly. However, as one of the two mighty pillars in medical security system, the basic insurance is limited to its strength security and quality guarantee by nonprofit nature and spread ability. The current phenomenon of "poverty due to illness" from elderly people frequently happens and proves the limits of basic insurance. Simplex basic medical insurance system has already not satisfied the increasing requirements of the medical insurance for elderly people. To solve the "demand beyond the basic medical security", we should devote more efforts to develop the commercial medical insurance system, and this is only one channel to achieve the major goal of "healthy aging" from the World Health Organization (WHO).

1. SUMMARIES

Foreign scholars have done a lot of researches to study the relationship between the basic medical insurance and the commercial medical insurance, and the results of researches tend to belief of " free medical resources have a negative impact on private medical insurance". For instance, Rask and Rask (2000) find that public medical care has a crowded-out effect on the private insurance in the middle and lower income group. Herring (2005) proves that the existence of the charity medical care impedes the purchase behavior of insurance in the local low-income group. Lo Sasso and Meyer (2006) find the Crowd-out Effect is apparent in the two age groups. Qin (2010) verifies that the density of all kinds of Healthcare Safety Network is positively related to the scale of Crowd-out Effect. But unfortunately, the studies above are questioned by other scholars in a certain degree and have failed to reach a consensus. For instance, both studies of Shore－Sheppard (2005) and Thorpe and Florence (1998) show that the public insurance does not

have significant crowd-out effect on commercial medical insurance.

On the contrary, there are few domestic researches on this issue. The reasons are two. On the one hand, as the medical security system is still under construction, the basic medical insurance and commercial medical insurance are lack of coordination with each other in the practice. For instance, only few insurance companies introduce the elderly medical insurance and put it as a gift of bundle sales. On the other hand, the researches are lack of supports from relevant theories and current medical security researches only focus on the improvement of the basic medical insurance system, funding rising and the construction of a network system. From both medical insurance in the role of the medical insurance system, although there are two main type of medical insurances which support the system, the basic medical insurance obtains more preferential polices and well development due to its universality. The commercial medical insurance faces many challenges in development as its nature is market oriented. Moreover,the supplementary role of commercial medical insurance is ranked after basic medical insurance and it is situated in the third layer of medical security system. This is why the basic medical insurance can possibly substitute or impede the commercial medical insurance.

Above all, emphasis on research of the relationship between the basic medical insurance and commercial medical insurance is very significant to the improvement of the medical security system and the development of commercial medical insurance. On the basis of summary above, with the model of insurance demand theory from Ehrlich and Becker (1972) study, this article aims to build up a utility function model which is able to offer the theoretical support the practical works by analyzing the mechanism and degree of mutual effect on the basic medical insurance and commercial medical insurance.

2. CONSTRUCTOR OF MODEL

The model from this article is developed on the basis of "state preference" Model. We assume the following conditions: First of all, the elderly obtain the medical insurances which mainly consists of basic medical insurance and commercial medical insurance, and the commercial medical insurance is additional insurance of basic medical insurance. Reimbursement of insurance should obey the following principle: The reimbursement should be firstly done in the scope of basic medical insurance, and the rest of unfinished part should be done

with commercial medical insurance. Meanwhile, ignore the exemption and starting point for reimbursement.

Secondly, we assume here are two states of the world (1, 0) with two utility functions (U_1, U_0) for elderly: One state of the world 1 is healthy life; another state of the world 0 is unhealthy life. The income endowment of elderly with healthy life is given with certainly by I_1^e and that is total income for elderly as well. I_0^e is the income endowment of elderly with unhealthy life and it is the total income I_1^e deducted by prospective loss from unhealthy life. If P is probability of unhealthy life, θ is prospective loss from unhealthy life, α is the reimbursement rate of basic medical insurance, $f(\theta,\alpha)$ is the utility function for the cost of basic medical insurance, and if there is no commercial medical insurance $f'_\alpha > 0$, the utility function endowment of elderly is:

$$U = (1-p) \cdot U_1(I_1^e) + p \cdot U_0(I_1^e - f(\theta,\alpha)). \tag{1}$$

Assume that the general characteristics of utility function are follows: (i) Continous and differentiable. (ii) Monotonic, namely the first derivative is greater than zero, $U'' < 0$. (iii) Diminishing marginal utility, namely the second derivation is less than zero.

Thirdly, the different purchaser gets different price and reimbursement rate for different insurance in different time. But for the elderly, since the probability of unhealthy life and the loss magnitude is relatively consistent, we will not consider the difference from types of insurance as well as the difference from types and compensation way of commercial insurance. We assume the β is reimbursement rate of commercial medical insurance, $g(\theta,1-\alpha,\beta)$ is cost function of commercial insurance, it implies that the rest cost of basic medical insurance $(1-\alpha)$ is reimbursed from commercial medical insurance. The marginal cost of the reimbursement rate of basic insurance α is diminishing $g'_\alpha < 0$, the marginal cost of the reimbursement rate of commercial insurance α is increasing. The individual expenditure equals to total expenditure minus both cost of basic medical insurance and commercial medical insurance. $G=\theta-f(\theta,\alpha)-g(\theta,1-\alpha,\beta)$. If the elderly continue to purchase commercial insurance by themselves, the form of cost for the elderly is following: π is the price of insurance, it equals to the ratio of marginal income in two states of word (0,1) $\pi = -\dfrac{dI_1}{dI_0} = -\dfrac{I_1 - I_1^e}{I_0 - I_0^e}$:..., I_1, I_0 is actual income, $I_1,-I_1^e$, is risk cost, s is the amount of insurance purchase in state 0 can be calculated as the difference between the actual and endowed income $s=I_0-I_0^e$. So the purchase function of commercial insurance is $I_1-I_1^e=s\pi$ and the expected utility function is

$$U = (1-p) \cdot U_1(I_1^e - s\pi) + p \cdot U_0(I_1^e - f(\theta,\alpha) - g(\theta,1-\alpha,\beta) + s). \tag{2}$$

At last, utility function for the elderly who have purchased the commercial insurance is:

$$\text{Max}(U) = \text{Max}[(1-p) \cdot U_1(I_1^e - s\pi) + p \cdot U_0(I_1^e - f(\theta,\alpha) - g(\theta,1-\alpha,\beta) + s)]. \tag{3}$$

3. THE ANALYSIS

3.1 Basic

(a) The optimal price of commercial insurance π^* and optimal purchases of commercial insurance s^* Get the first-order derivative of s in Function (3) and make it equal to zero:

$$\frac{\mathrm{d}U}{\mathrm{d}s} = (1-p) \cdot U_{1s}' \cdot (-\pi) + p \cdot U_{0s}' \quad . \tag{4}$$

The optimal condition of first-order derivative is

$$\pi_0 = \frac{p \cdot U_0'}{(1-p) \cdot U_1'} \quad .$$

Get the second-order derivative of s $\frac{\mathrm{d}^2 U}{\mathrm{d}s^2}$:

$$\frac{\mathrm{d}^2 U}{\mathrm{d}s^2} = \pi^2 \cdot (1-p) \cdot U_1'' + p \cdot U_0'' \quad . \tag{5}$$

Because of $U_1'' < 0$ and $U_0'' < 0$, the $\frac{\mathrm{d}^2 U}{\mathrm{d}s^2} < 0$, the utility function is convex to the origin. The stagnation point

is best solution $\pi^* = \frac{p \cdot U_0'}{(1-p) \cdot U_1'}$, meanwhile the optimal purchase of commercial insurance is s^*.

Time $\frac{1-p}{p}$ both sides of Equation (5):

$$\bar{\pi}^* = \frac{1-p}{p} \pi^* = \frac{U_0'}{U_1'} \quad . \tag{6}$$

$\bar{\pi}^*$ is called as the optimal fair price of insurance, it is equal to optimal insurance price timed by the coefficient of actual insurance price. The meaning of Equation (6) is that optimal fair price of insurance is the result of marginal utility of income in the world of state 0 divided by marginal utility of income in the world of state 1. If $p \in [\frac{1}{2}, 1]$, then $\bar{\pi}^* > \pi^*$. On the contrary, if $p \in [0, \frac{1}{2}]$, then $\bar{\pi}^* < \pi^*$. As shown in graph 1, the π in left side of Equation (4) is the slope of line AB for revenue budget, right side of equation is the slope of both indifference curve L_1 and L_2.
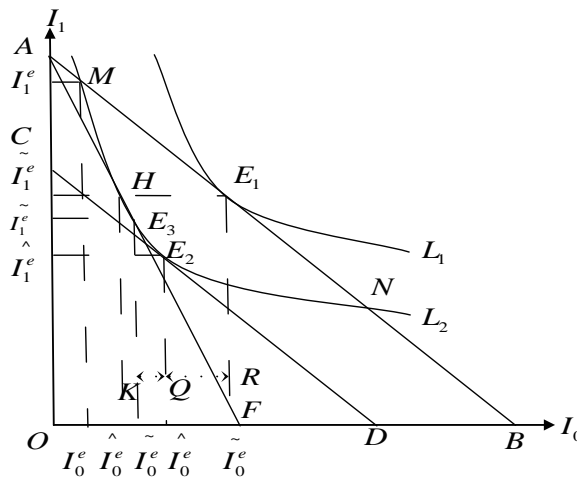

Figure 1
Effect Function
Note. I_0 is the income in the state 0, I_1 is the income in the state 1; L_1 and L_2 are indifference curves; *AB* and *CD*.

AB is the tangent line of curve L_1 and the tangent point E_1 is the optimal fair price $\bar{\pi}^*$ of π. Meanwhile, the slopes of both curve are same, the optimal expected incomes for combination of basic medical insurance and commercial medical insurance is ($\tilde{I}_1^e$, $\tilde{I}_0^e$), the utility of medical insurance for the elderly is maximum. If there is not any change on the expected income $\tilde{I}_1^e$ in a healthy state, H point is a tangent point where the non maximum utility of insurance income portfolio is ($\tilde{I}_1^e, \hat{I}_0^e$). In order to obtain the maximized effectiveness, the purchase of commercial insurance should be increased and enable the respected income in the unhealthy state reach to $\tilde{I}_0^e$ which is in the

state of equilibrium. The increment of insurance purchases is $\Delta s = \tilde{I}_0^e - \hat{I}_0^e > 0$.

(b) When indifference curve is moved from L_1 to L_2, if keep the original budget revenue line, the two curves will intersect at point M and the fair price of insurance will be $\bar{\pi}_M^*$. Obviously, the elderly will revalue the risks and returns in the state 1. (i) If the price of insurance is optimized at this time, the elderly will purchase commercial insurance in any case because the utility of insurance is much more than the cost of insurance purchase. (ii) If the price position of insurance is not optimal at this time, the elderly will behave in the perspective of risk preference. Risk Averters from the elderly will rise their expected utility by moving

the indifference curve from L_2 to L_1 and obtain the equilibrium point E_1. In this case, the purchase of insurance will increase ($\Delta s = \tilde{I}_0^e - I_0^e > 0$), the increment of income in healthy state is $\Delta I = I_1^e - \tilde{I}_1^e$. The risk seeker from the elderly will decrease their expected utility by moving the budget revenue line from *AB* to *CD* and obtain a new equilibrium point E_2. in this case, the optimal Porfit of expected income is ($\tilde{I}_1^e, \hat{I}_0^e$). The purchase of insurance will decrease $\Delta s = \tilde{I}_0^e - \hat{I}_0^e < 0$, the cost of risk will increase, the expected income in the healthy state will reduce $\Delta I_1 = \tilde{I}_1^e - \hat{I}_1^e < 0$.

2.2 Substitution Effect for Basic Medical Insurance and Commercial Medical Insurance

Get the first-order derivative of α in Function (3) :

$$\frac{dU}{d\alpha} = p \cdot U_0^{''} \cdot (g_\alpha^{'} - f_\alpha^{'}). \quad (7)$$

Get the second-order derivative of α:

$$\frac{d^2U}{d\alpha^2} = p \cdot (U_1^{''} \cdot (g_\alpha^{'} - f_\alpha^{'})^2 + U_0^{'} \cdot (f_\alpha^{''} - g_\alpha^{''})) . \quad (8)$$

As $\frac{d^2U}{d\alpha^2} < 0$, and , therefore and . If we completely differentiate the optimal condition of first-order derivative , we will get the optimal insurance purchase with optimal insurance price:

$$\frac{ds}{d\alpha} = \frac{p \cdot U_0^{''} \cdot (g_\alpha^{'} - f_\alpha^{'})}{p \cdot U_0^{'} + \pi^2 \cdot (1-p) \cdot U_1^{''}}. \quad (7)$$

In the Equation (7), as $U_0^{''}$, $U_1^{''}$ less than 0 and , therefore $\frac{ds}{d\alpha} < 0$. In this case, the fair price of insurance which is not the optimal is , the probability of elderly sickness is . So the two above is mutually alternative and there is crowding out effect: The higher the reimbursement rate of basic medical insurance is, the less the purchase of commercial insurance. On the contrary, the lower the reimbursement rate of basic medical insurance is, the more the purchase of commercial insurance is. That is showed as the line *KQ* in the graph 1. As the condition of maximizing utility is to change the expected income in the unhealthy state, the budget revenue line should be moved from *AB* to *AF*, and the equilibrium point will be changed from E_1 to E_3. in this case, the purchase of insurance is decrease($\Delta s = \tilde{I}_0^e - \hat{I}_0^e < 0$) and the expected income in the unhealthy state is decrease. Meanwhile, the risk of cost

will increase($\Delta I_1 = \tilde{I}_1^e - \hat{I}_1^e < 0$). So it shows following points: (i) once the reimbursement of basic medical insurance is increase, it is equivalent to raise the shadow price of commercial insurance and the purchase of commercial medical insurance reduce. (ii) When the elderly is in the unhealthy state, the expenditure of basic medical insurance is increasing and the expenditure of commercial medical insurance is decreasing. However, the increase of the expenditure from basic medical insurance can not make up for the decline of expenditure from commercial medical insurance, the difference between these two expenditures will be afforded by the elderly. So the reality is the medical expenditure increases and the expected utility reduces.

3.3 Complementary Relationship Between the Basic Medical Insurance and the Commercial Medical Insurance

If divide the Equation (7) by Equation (4), the result will be the degree of influence from basic medical insurance on purchase of commercial insurance:

$$\frac{ds}{d\alpha} = \frac{p \cdot U_0^{'} \cdot (g_\alpha^{'} - f_\alpha^{'})}{p \cdot U_0^{'} - \pi \cdot (1-p) \cdot U^{'}}. \quad (9)$$

As $U_0^{''}$ more than 0 and , in order to make $\frac{ds}{d\alpha} > 0$, should make . In this case, the fair price of insurance which is not the optimal is ,the probability of elderly sickness is .So the two above is mutually complementary and there is income effect: the higher the reimbursement rate of basic medical insurance is, the more the purchase of commercial insurance. That is showed as the line *QR* in the graph 1. Assume that the initial equilibrium point is E_2, the condition of maximizing utility is to change the expected income in the both unhealthy state and healthy state at same time, the budget revenue line should be moved from *CD* to *AB*, and the equilibrium point will be changed from E_2 to E_1. the elderly will increase the purchase of medical insurance and the expected utility will increase from L_2 to L_1. In this case, the purchase of insurance is increase ($\Delta s = \tilde{I}_0^e - \hat{I}_0^e > 0$) and the risk of cost will decrease ($\Delta I_1 = \tilde{I}_1^e - \hat{I}_1^e > 0$). In the interval ($E_2, E_1$), it shows following points: (i) Once the basic medical insurance is complementary with the commercial medical insurance, the reimbursement of basic medical insurance is increase, and the purchase of commercial medical insurance is increase. So the investment in the purchase of commercial medical insurance will make the elderly feel 'double security'. (ii) Although the increased reimbursement of basic medical insurance raises the shadow price of commercial insurance and the purchase

of commercial medical insurance reduce, the increased income of commercial medical insurance exceed highly than the increased price, the elderly will feel the increase of utility.

3.4 The Relationship Between the Two Types of Insurance Reimbursement

3.4.1 The Reimbursement Rate of Commercial Insurance β

Get the first-order derivative of β in Equation (3):

$$\frac{\mathrm{d}U}{\mathrm{d}\beta} = -p \cdot U_0' \cdot g_r'. \tag{10}$$

As   ,   ,   , there is no stationary point and this function is increasing function. Continually get the second-order derivative of β:

$$\frac{\mathrm{d}^2U}{\mathrm{d}\beta^2} = p \cdot (U_0'' \cdot (g_\beta')^2 + U_0' \cdot g. \tag{11}$$

As   ,   ,   , the   . The function is a convex function; there is no maximum point but extreme point. If make   , it should get   .

There is a suboptimal reimbursement rate for the payment function, which is equal to the marginal utility divided by the rate of change of marginal utility in the unhealthy state. Meanwhile the suboptimal reimbursement rate is the inflection point as well. In the interval   , the utility function is convex. At the inflection point, the utility function changes with the change of reimbursement rate of commercial insurance, so there is no optimal solution of the reimbursement rate of commercial insurance. In the interval   , the expected utility increases with the increased reimbursement rate of commercial insurance. In the interval which is larger than   , the expected utility decreases with the increased reimbursement rate of commercial insurance.

3.4.2 Interrelationship

If divide the Equation (7) by Equation (4), the result is :

$$\frac{\mathrm{d}\beta}{\mathrm{d}\alpha} = -\frac{g_\alpha' - f_\alpha'}{g_\beta'}. \tag{12}$$

As   ,   , so $\frac{\mathrm{d}}{\mathrm{d}}$. So the two above is mutually complementary. The implication is that when the reimbursement rate of basic medical insurance increases, the commercial medical insurance is in danger of being crowed out. The best way to reduce the risk is only be taken with 'following strategy', that is to offset the negative impact from the increased reimbursement rate of the basic medical

insurance by raising the reimbursement rate of commercial insurance. Therefore, the basic medical insurance can not completely replace the commercial medical insurance, but the partially crowed out of commercial insurance.

CONCLUSION

To conclude, when the basic medical insurance and commercial medical insurance coexist, if there is an optimal price and optimal purchase for commercial medical insurance, the utility of elderly medical security is maximized. (i) The optimal price is the ratio of utility of marginal income in unhealthy life and healthy life. (ii) When the utility is not maximized, there are two ways to maximize the utility: One is to directly increase the purchases of commercial insurance; another is to assess risk and income after reduce budget revenue, and indirectly adjust the purchase of insurance. The success of second way is depending on the preference of risk from the elderly. The elderly who is a risk avoider will gain more expected utility by increasing the insurance purchases. The elderly who prefers the risk will reduce the budget revenue and decrease the insurance purchase.

When the probability of unhealthy life for the elderly is $p > \frac{1}{2}$, commercial medical insurance produces a crowding out effect on basic medical insurance. One the one hand, the higher the reimbursement rate of basic medical insurance is, the less the commercial insurance purchase is. On the contrary, the lower the reimbursement rate of basic medical insurance is, the more the commercial insurance purchase is. On the other hand, this crowding out effect does not completely crowd out all but partially crowd out. (i) When the reimbursement of basic medical insurance increases, in order to continue to stay in the market, the reimbursement commercial medical insurance will increase as well. (ii) There is no optimal solution for the reimbursement of commercial medical insurance but only sub-optimal solution. When the reimbursement rate is over the sub-optimal solution, the expected utility of the elderly will decrease follow the increase of reimbursement rate, namely the marginal utility will change from increase to decrease.

When the probability of unhealthy life for the elderly is $p < \frac{1}{2}$, the complementary relationship between the basic medical insurance and commercial medical insurance will enhance the expected utility of the elderly. Because on the basis of the fairly optimal price, the increase of reimbursement rate of basic medical insurance will increase the purchases of commercial insurance. At this time, that will offer the feeling of "belt and braces" to elderly. Although, the shadow price of commercial insurance is increase, the increased amount of price is much less than the increased amount of income and the utility is enlarged.

As at the beginning of model setting, we will not consider the difference from types and compensation way of commercial insurance and also ignore the exemption and starting point for reimbursement; this article may miss out some meaningful conclusion and need further researches to improve it.

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