**Is Risk Taking or Moral Hazard Beneficial To the Insured and the Society?**

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**Abstract**

In this article, we discuss whether and when the risk taking and moral hazard is beneficial to the insured and to the society as well. We establish models by stochastic optimal control theory. We obtain the optimal levels of risk taking and moral hazard from perspectives of the insured and the society. Finally we make some discussions on insurance, moral hazard and the relationship between them.

**Key words:** risk taking and moral hazard; stochastic optimal control; welfare loss (gain); insurance

**Introduction**

As earlier as 1929, Frank Knight in his long book suggests that perhaps profits in aggregate from risk taking are negative, while negative profit call for explanation as much as positive ones do, it cannot be said that most of the current theories would really seem to have this possibility in mind. In any case, of course, the statistical evidence on the magnitude of pure profits can only be described as negligible.

We argue that the important thing is that if we can distinguish the risk taking behavior which is beneficial from that it is harmful and carry out some intervention to encourage beneficial risk taking and limit harmful risk taking, the final profit will be positive. For example, by rearranging economic structure with insurance we can make risk taking beneficial.

Insurance is usually thought of as a measurement to protect the insured. For example, people who buy natural disaster insurance will get the loss compensation as long as the natural disaster occurs. In addition, the individual insured against usually would have indirect gains in addition to those uninsured, for example, an insured fire would probably entail a gain of credit rating (Arrow (1951) (also Hardy, 1923). However, insurance can encourage risk taking and moral hazard, as Shahar and Logue (2012) said that insurance in moral hazard concept is that insurance can destroy incentives to minimize risk. For example, deposit insurance will encourage the insured banks to take risk and engage in riskier business and insurance allows the insured to take risks they could not previously take. The regulator generally will take measures to try to decrease the risk taking and moral hazard behavior of the banks through regulation of capital and insolvency and so on. Therefore, moral hazard is usually thought of as an undesirable byproduct that is necessary to avoid. However, in some situations, taking risk and moral hazard are beneficial to the insured and to the society as well. For example, people can save time, improve their working efficiency and get some other benefit by taking risk to drive car because they buy car insurance. The enterprise may get more profit by taking more risk in their business due to that they buy the business interruption insurance. People can take a job instead of staying home to take care of the child, planting vegetables in the garden, and living at subsistence level because they buying life insurance. People who buy health care insurance can take more money in their health care than those without health care insurance, so their health can get improvement and their life quality can get promotion. Insurance decreases the constraint and control of the fear to human being and serves the society of human being to open up new areas of actions which might be more risky but very innovative and might be difficult to engage in without insurance. (Lin and Wang, 2015).

In this article, we will show by establishing models that moral hazard and risk taking behavior in some cases is beneficial to the company (the insured) and to the society as well. But excessive risk taking will not beneficial to the insured and even it is harmful to the society.

Before we enter the further discussion, let us define the words of “ risk taking” and “ excessive risk taking”. Risk taking is an action or activity in which someone takes risks to achieve a benefit. Excessive risk taking is an action or activity in which someone takes more risk than he would otherwise in order to achieve a benefit. Excessive risk taking comes at a cost and that cost is absorbed by government and other parties.

**2. Literature Review**

Moral hazard has been an important topic in economics literature. Beginning with Arrow (1963) and Pauly (1968), economists discuss two partial solutions to the problem of moral hazard: (1) incomplete coverage against loss and (2) “observation” by the insurer of the care taken to prevent loss. Shavell (1979) study how to determine exactly when an insurance policy represents a compromise between no coverage and full coverage in the case in which the insurer does not observe care, analysis the choice concerning the timing of observation of care and prove that imperfect information about care is valuable.

Moral hazard in the research of health care insurance especially is an important topic. Rand study：the Health Insurance Experiment (HIE) (Manning et al.,1987 ) which was completed over three decades ago in 1982 found that in health care insurance, there exist over consumption of health service if there is no cost sharing （or lower cost sharing）in insurance so as to increase the cost of health care. They also found that moral hazard would result welfare loss. However, de Meza (1983) argued that “With rare exception of the provision of actuarially fair health insurance tends to substantially increase the demand for medical care by redistributing income from the healthy to the sick. This suggests that previous studies which attribute all the extra demand for medical care to moral hazard effects may overestimate the efficient costs of health care”.

Zweiffl and Manning (2000, chapter 8, P413-414) point out: “ From a normative point of view, moral hazard can be argued to cause a negative externality to the extend that it causes the insurer to increases premium for everyone. Thus, moral hazard should be avoided. However, some amount of moral hazard may be deemed beneficial for two reasons. First, to the extent that physicians wield a collective monopoly, the quality of medical care consumed falls short of the optimum. The increase in quantity caused by the moral hazard effect of health insurance can be efficiency-enhancing in this situation (Crew, 1969). Second, moral hazard may encourage the use of a more cost –effective medical service at the expense of a less cost effective one within an insurance scheme (Pauly and Held, 1990). Thus, the optimal amount of moral hazard is positive rather than zero”.

Nyman (2007) points out that moral hazard in health care insurance sometimes is not welfare loss but welfare gain. He said: “A large portion of moral hazard actually represents health care that ill consumers would not otherwise have access to without the income that is transferred to them through insurance. This is efficient and generates a welfare gain.”

**3. Models**

Before establishing stochastic optimal control model, let us firstly discuss the critical condition the insured takes risk or moral hazard by using a simple example[[1]](#footnote-1). Assume that Mr. A has initial wealth of 16000 dollars and a car worth 4000 dollars, the full damage will occur when the accident happens. Assume that the probability of accident is 0.5 when Mr. A drives his car not carefully and otherwise, the probability of accident is 0.2. Assume that the time cost is x because of careful and slower driving.

Assume that the utility function is the square root of wealth. We can get the rational price of 800 () dollars for carefully driving and 2000 () dollars for not carefully driving.

Then the critical condition for Mr. A to drive car not carefully is



It means that driving car not carefully is beneficial to the insured when the time cost is greater than 1400 dollars, and vise verse.

Therefore, whether an insured taking risk or moral hazard depends on whether it is beneficial to him. In the discussion above, we neglect the expected loss resulting from driving car not carefully, such as the loss due to the increased risk of death or disable because of traffic accident. In the following, we will discuss the optimal condition that risk taking or moral hazard is beneficial to the insured and to the society by stochastic optimal control theory and will overall consider all benefit and loss resulting from risk taking and moral hazard.

Assume that the insurance premium is . Please note that it is important that the insurance premium  should not only include the risk of insured exposure but also includes the moral hazard.

Assume risk taking is only occurred in investment. For example, the insured of deposit insurance will take risk in their investment after purchasing deposit insurance. Assume that the amount of risky assets is  if there exists risk taking in investment and the amount of risky assets is , if there exists excessive risk taking，that is, the amount of risky assets will increase proportion of by excessive risk taking.

Assume that the volatility of claim loss will increase proportion of  and the claim loss increased will be because of the moral hazard after insurance, where  is a constant.

Assume that the increased premium due to moral hazard is expressed as

, (1)

whereis a constant and the premium of risk exposure without considering moral hazard is . Assume that the additional net benefit obtained by the insured because of taking excessive risks and moral hazard are respectively, where  and are constants, and is the external benefit obtained by the insured due to his risk taking or moral hazard behavior, such as the save of time cost or risk management cost etc. Please note here the additional net benefit obtained by the insured does not include the benefit obtained against law.

Then the net profit satisfies with the following stochastic differential equation:

, (2)

where  is the return rate of risky assets,  is risk-free interest rate, is Geometric Brownian Motion with standard deviation , and  is a diffusion process with diffusion coefficient  ， which is the risk not included in insurance but would take place because of the moral hazard of the insured, for example, the death or disable risk of the insured will increase because the insured drives car more quickly, the loss risk of deposit which excesses the upper limit of claim would increase due to the risk taking by the insured and  are two independent stochastic processes.

4. HJB Equation and Optimal Solutions

We formulate the problem of maximizing the expected utility of the terminal wealth of the insurer. Given initial values of time,, the wealth of the insurer, , the objective functional over the class of admissible controls is given by

 (3)

The optimal problem can be expressed as to find the value function and optimal solutions of , which satisfies with

 (4)

It is not difficult to show that is a Markov process. For any twice continuously differential function , where  and denotes the closure of , there exits partial differential operator :

 (5)

It is not difficult to get the following verification theorem.

Theorem 1: Suppose that there exists a function  and a

Markov control such that

1.  for all  and ;

2.  for all ;

1. for all 

Then , and  is an optimal (Markov) control.

In order to obtain the optimal value function and the optimal control, we only need to solve the following HJB equation:

, (6)

To solve the above HJB equation, we use a similar trial function as Mao, et al (2016) to find a solution of the following form.

 , (7)

where is a undetermined function and =0.

Substituting the above trial function into equation (5) yields:

 (8)

By putting  into equation (8) and maximizing over yields the following first order conditions for the maximum point 

 （9）

 （10）

 (11)

By solving system equations of (9) and (10), we get:



(12)

Since taking excessive risk cannot make the insured better off due to the net

benefit obtained by the insured is ,

We have: , (13)

Solving equation (11), we get:

 (14)

The function  is determined by the following differential equation:



(15)

Theorem 2: When the expected utility function of the terminal wealth of the insurer is exponential, the optimal strategy  is given by equations of (13) and (14), and the optimal value function is:

, (16)

where  is given by equation (15).

Since the optimal risky assets after excessive risk taking is 

which is exactly same as that was found out by Merton(1973), that is ,

and since , the optimal strategy for the insured is not to take extra risk in

investment. Therefore, our analysis shows that risk taking is good to the insured and

to the society as well. But extra risk taking cannot make the insured better off and

also it is not beneficial to the society and even harmful to the society.

From equation , we know that higher the return rate of risky

assets( stock), lower the volatility of the return rate of risky assets and less risk

aversion will encourage people to take more risk in their investment and vise verse.

Similarly, from equation ， we know that smaller

underwriting risk and less risk aversion will encourage people to take more risk in the

their insured activity and vise verse.

In the following, we will discuss whether and in what condition, it is optimal and

beneficial for the insured to take moral hazard for underwriting risk under the

situation of fair pricing.

4.1 The situation of fair pricing

4.1.1 Without considering the government's intervention

From equation (14), we know that there exists optimal level of moral hazard, .

When increasing risk taking is beneficial. And vise verse.

From equation (14), we also know that if , that is,,

moral hazard is beneficial to the insured. If pricing is rational, that is, if , the

optimal condition that moral hazard is beneficial to the insured is

 （16）

Or . (17)

It is more than important to notice that if some insured are irrational to take excessive risk, that is, if it results in continuous welfare loss (), the market would not sustain itself in the long run and the government must take some interventions to avoid excessive risk taking under the situation that market mechanism is powerless. In the following, we will discuss the optimal condition that it is beneficial to the society by taking risk under the condition that the government take some interventions.

From inequality (16), we find that the smaller the volatility of risk exposure, the less risk aversion, lower risk-free interest rate, moral hazard will possibly benefit more to the society. And higher benefit the insured obtained from moral hazard will also benefit more to the society. However, the benefit obtained by the insured from moral hazard depends on economic efficiency of the society, productivity level, and capital stock. If you can produce more or if you have a lot of wealth you can take more risk. And the risk-bearing capability of the society also depends on productivity and capital. From equation (16), we can show this since the optimal level of moral hazard  is the increasing function of , which is the benefit obtained by the insured from moral hazard. Also, culture matters, because if other people are more likely to be honest with you, help you when you have problems, you can take more risk.

From equation (16), we also find that the price acts as an important signal in the society about the optimal level of moral hazard. If the price for moral hazard is too cheap, that is, if , the larger the value of , the larger the optimal level of moral hazard, . In this situation, many people will take advantage of this for self –enrichment at the expense of others. Therefore, as illustrated above, when the moral hazard is underpriced, it is not beneficial to the society.

4.1.2 With considering the government's intervention

If the government does not take any costs when the insured obtains the benefit of , then  is also the condition that moral hazard is beneficial to the society. If government takes costs of  for the behavior of moral hazard of the insured (For example, the cost resulting from over consumption of health service or subsides), the benefit to the insured is increased to , then the optimal condition the moral hazard is beneficial to the insured is . Meanwhile, the optimal level of moral hazard is increased to

 (18)

Therefore, increasing the subsides by government would encourage the insured to take more risk. If the benefit obtained by the insured has externality, that is, if it increases benefit of  to the society (such as the improvement of health of labor force because of the subside in health care insurance), then, when , the optimal condition that moral hazard is beneficial to the society is

 (19)

Although subsides will encourage the insured to take more risk, if the benefit obtained by the insured and by the society is greater than the subsides itself, it is still benefit to the society. However, if , (20)

or , (21)

moral hazard is not beneficial or even harmful to the insured and to the society. In this situation, decreasing risk by risk management can benefit to the insured and the society. Let the cost of risk management be , and the benefit obtained or loss decreased is  then the optimal condition that risk management is beneficial to the society is :

. (22)

Or  (23)

Here we assume that the reduced claim loss due to risk management is equal to the reduced premium payment.

4.2 The situation of un-rational pricing

Let us discuss the condition that moral hazard is beneficial to the insured and to the society under the condition of un-rational pricing.

On one hand, if the moral hazard is under- priced, that is, when , that is, the insurance is too cheap, the condition that moral hazard is beneficial to the insured is

. (24)

Or  (25)

Comparing inequality (25) with inequality (17), we know that the insured would take more moral hazard under under-pricing. The net benefit obtained by the insured due to taking risk (moral hazard)  will be greater, if  due to under pricing, However, the equation (25) shows that the optimal value of will be smaller if . Therefore, the insured will take less risk (moral hazard) in the situation of  even under the situation of under-pricing.

Since the insurance company will pay extra claim loss of , the condition that moral hazard is beneficial to the society is

, (26)

and optimal value of  , (27)

where  is the optimal coefficient of risk taking (moral hazard) for underwriting risk for the society. The net benefit obtained by the society due to taking risk (or moral hazard),  will be same as that under the situation of fairly pricing, if , however, the optimal level of risk taking (moral hazard) will be negative if (the net benefit obtained by the insured due to risk taking ( moral hazard) is negative). It means that the insured will take even more less risk than that if . Comparing equation (25) with equation (27), we find that the optimal risk taking level for the society,  is smaller than that for the insured under the situation of under-pricing. Therefore, the government should take some interventions, for example, price regulation to discourage the risk taking (moral hazard) of the insured.

On the other hand, if the moral hazard is overpriced, that is, when , that is, the insurance is too expensive, the condition that moral hazard is beneficial to the insured is same as that under-pricing case (Please see equation (25)). However, the insured would take less risk since the value of is smaller due to .

The optimal risk taking (moral hazard) coefficient of the society,  is same as that under the situation of under-pricing, since the benefit gained by insurer  is just same as that overpaid by the insured due to overpricing[[2]](#footnote-2). Different from the situation of under- pricing, the optimal risk taking (moral hazard) level for the society, is greater than that for the insured under the situation of overpricing. The government should limits the overpricing by insurers and correct the problem of not enough risk taking.

If considering the cost taken by government because of risk taking (moral hazard) of the insured, the analysis is similar to the case under rational pricing. Here we will not repeat it.

On the whole, every risk taking is an economic (real economic) project. The central issue for the society is whether this project has positive or negative economic value. Cost of the risk of the project should be properly calculated. If it is underestimated, losing economic project will be funded. If it is overestimated, fewer economic projects will be funded, but they will be all producing profit. Of the two possibilities, the second one is far, far better, because when you underestimate cost, you lose money, and when you overestimate cost, you get money, although you fund few projects, but you will get less money than that you get if fairly estimating the cost of economic projects. Therefore, what the government should to is to take some interventions and enforce the economic institutions such as insurers to fairly price the risk taking (moral hazard) so as to maximize the social benefit.

**5. An example**

Assume that 

and there is no government intervention. The optimal solutions are listed in Table 1.

**Table 1 The optimal solutions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|  | 2.8370 | 2.9234 | 3.0125 | 3.1042 | 3.1988 | 3.2962 | 3.3966 | 3.5 |
|  | 0.0538 | 0.0859 | 0.1189 | 0.1530 | 0.1881 | 0.2243 | 0.2616 | 0.3 |
|  |  | | | | | | | |

From Table 1, we find that optimal level of moral hazard which maximizes the expected terminal wealth of the insured increases with the time.

**Discussions on insurance and moral hazard**

What is the role of insurance? An article published by Zurich Government and Industry Affair said: “Insurance diminishes the need to avoid risky activity. With insurance, it is therefore natural to expect an increase in risky activities. It could even be said that one of the important economic and social benefit of insurance is the increased potential of individuals to undertake productive but risky business venture. This increase in risk is desirable from the economic point of view”. Nyman (1999) discussed why do people purchase health insurance? He suggested that health insurance is also demanded because it represents a mechanism for gaining access to health care that would otherwise be unaffordable.

On moral hazard, there are generally two kinds of definitions. One (in economic

theory) defines moral hazard as a situation where a party will have a tendency to take risks because the cost that could incur will not be felt by the party. Another defines as the additional insurance purchased which excesses the real value of exposure insured. Nyman (2004) refers the moral hazard of health care insurance as the additional health care that is purchased when persons become insured.

In conventional insurance theory, all of moral hazard is thought of as a bad thing. Insurance companies try their every effort to decrease or even avoid moral hazard. They make several provisions in their insurance contracts to limit the moral hazard of the insured. For example: deductibles, copayment and so on. However, insurance and moral hazard is a couple of twins. Where this is insurance, there is moral hazard. It is impossible and also it is unnecessary to avoid moral hazard completely. And our models show that moral hazard in some conditions is desirable to the insured and to the society as well. Nyman(2004) presents a new theory on moral hazard. He suggests that much of moral hazard is actually efficient. He especially emphasizes that when the care that was deemed to be welfare-decreasing is reclassified as welfare-increasing, health insurance becomes much more valuable to the consumers. He illustrates that the moral hazard in health care insurance sometimes can benefit to the society. The reason is that when the insured buys additional health care insurance he can get higher claim payment in the case of claim event occurs. Therefore, he can get better health care because he can afford higher cost of higher level of health care. It is extremely necessary, especially, when the insured catches the serious illness[[3]](#footnote-3). This is the improvement of society welfare.

The new theory suggests that copayment policy can only on the inefficient moral hazard. But for those which generate welfare gain should be left along or even encouraged. For example, in health care insurance, if the insured catch the serious illness, whose care might also be associated with a great deal of pain and suffering anyway, it makes little sense to apply copayments since he would not stop medication just because he needs to pay part of cost.

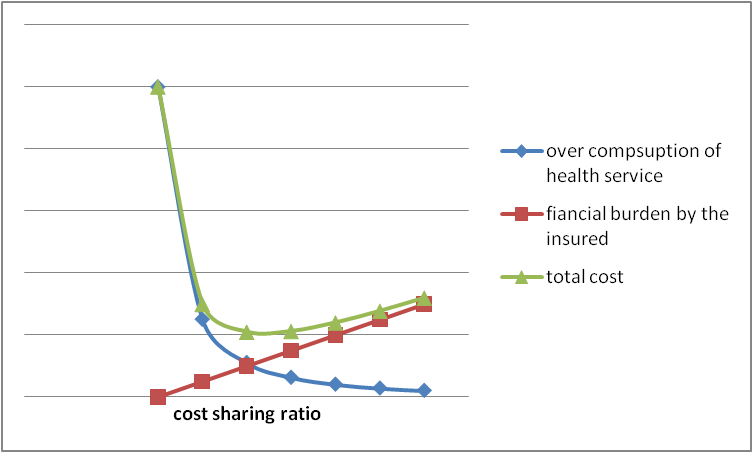
What is important is how the government encourages the risk taking and moral hazard which is beneficial to the society and at the same time limits those which are detrimental to the society. It should diligently follow this: Justice is the constant and perpetual will render to every man his due.

Rational pricing to the moral hazard is one of effective ways to decrease the moral hazard which is detrimental to the society. So, the government should monitor the insurance pricing. Subsidizing insurance premiums is thought of as a way to make the consumer better off but also it is possible to cause excessive moral hazard. Nyman (2004) points out that the subsides that encourage consumers to purchase insurance voluntarily, or a national health insurance program for the entire U.S. population would improve society’s welfare. However, Pauly (1983) point out that to cause too much moral hazard is to subsidize health insurance, as through the tax system. We think that whether subsides is good or bad to the society depends on whether it reduces real income. Although subsides is the payment of the government, if the benefit obtained by the insured from the subsides is larger than the subsides itself, it still improve society’s welfare. Otherwise, subsides would cause negative externality.

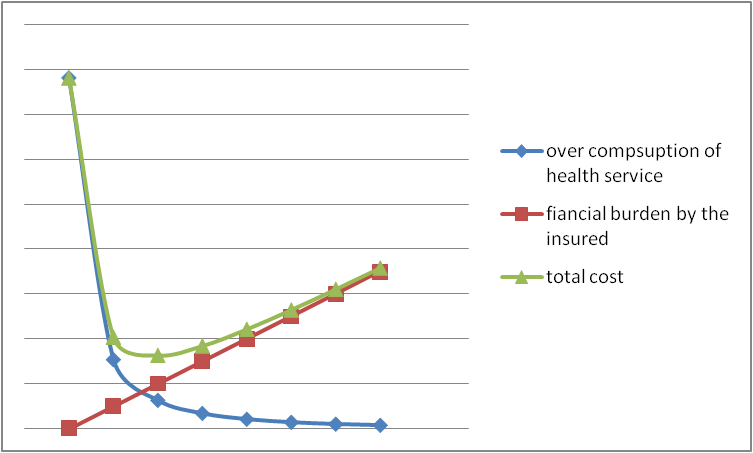
For decreasing moral hazard which is detrimental to insurance companies and to society as well, Shahar and Logue (2012) explore the potential value of insurance as a substitute for government regulation of safety. Insurance companies can take several measures to decrease the moral hazard which is harmful to insurers and to the society as well. For example, copayment, deductibles, upper limits of insurance benefit, premium adjustment to encourage those taking effective prevention measures and punish those with moral hazard which is detrimental to insured and to the society.

It should be noticed that for those moral hazard which is not beneficial to the insurance company but desirable to the insured and to the society, the encouragement by government is important. For example, for serious illness insurance, government can enforce the insurance companies to sell full coverage insurance with lump sum cashier’s check payment when the claim event occurs or to sell insurance with low cost sharing ratio.

Health care insurance is generally thought of as a kind of insurance which is most easy to have moral hazard. Insurance companies are very careful to operate health care insurance. However, the moral hazard of the insured which is usually thought of as harmful to the insurance companies does benefit to the insured and to the society in some situations. For example, visiting doctors more often and pay more medical cost than the insurance company’s expectation is thought of as a moral hazard by the insurance companies, but it may be good to the insured’s health if the treatment of the doctors and the corresponding cost is necessary. Maming (1987) showed that for the poor adults who were with high blood pressure at beginning of the experiment, there was a clinically significant reduction in blood pressure for those in the free plan compared to those in the plans with cost sharing, and the magnitude of this reduction would lower mortality about 10 percent each year among this group, about 6 percent of the whole population. An individual’s health not only has a bearing on his or her well-being, but also on the value of his or her labor to the economy. There exist externalities in the provision of healthcare-that is the social benefit of providing healthcare to an individual often exceeds the private benefit[[4]](#footnote-4). Therefore, developing social insurance of health care is an effective way to increase the supply of health care insurance and improve the health level of the whole population. Meanwhile, the decision makers of health care must equivalence the benefit and loss resulting from any policies they make. For example, for cost sharing policy of health care, higher cost –sharing would decrease the cost due to the over consumption of health service, but it would , on the other hand, increase the financial risk of the insured (Meng, Jia and Yuan, 2011). The decision maker should find an optimal level of cost sharing by balancing the benefit and loss resulting from higher or lower cost sharing. For those with lower risk of diseases, using higher cost sharing policy and limit the over consumption of health service may be a best choice (Figure 1), but for those with higher risk of diseases, it may be better to use lower cost sharing policy and encourage them to use some medical or preventive services by reducing their financial burden (Figure 2). In Social Health Care Insurance of China, the copayment ratio for general illness is much higher than that for serious illness. But the values of copayment ratio for these two sorts are different for different provinces. Here, we use Shanghai as an example to illustrate the difference of copayment ratios for general illness and serious illness. For general illness, the copayment ratio is between 30% to 50% for working force. For the person whose birth date is before 31th December,1955, between 31th December of 1956-1965 and over 31th December of 1965, the copayment ratio is 30%, 40% and 50% respectively and for the retired persons, the copayment ratio is between 20% to 30% depending on which class of the hospitals the patient visits. The higher the class of the hospital, the higher the copayment ratio. However, for serious illness including cancers, uremia and serious mental diseases, the copayment ratio is only 15% for persons whose age is less than retirement age, otherwise, it is only 8%.



**Figure 1 Optimal cost sharing ratio with lower risk deceases**



**Figure 2 Optimal cost sharing ratio with higher risk deceases**

**Conclusions**

In this article, we discuss if and in what condition the risk taking and moral hazard is beneficial to the insured and to the society. We establish models based on stochastic optimal control theory and find optimal level of risk taking and moral hazard and we also make some discussions on the optimal conditions that moral hazard is beneficial to the insured and to the society respectively. Finally, we make discussions on insurance, moral hazard and their relationship by using health care as an example. The results of our discussions indicate that moral hazard in some conditions, is beneficial, however, in other conditions is detrimental to the society. The important thing is that the government should encourage the risk taking and moral hazard which is beneficial to the society and at the same time limits those which are detrimental to the society. Therefore, the paper then can be phrased as guidance for public policy government gets involved and make the insurance more beneficial to the insured and to the society as well.

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1. The example is from Sun (2013, P33). In her book, she assumes =1000 dollars and she gets the conclusion that driving car not carefully is always beneficial to the insured. We here make a different discussion on the condition that driving car not carefully is beneficial to the insured. [↑](#footnote-ref-1)
2. Here we assume that the social benefit is the sum of the benefit obtained by the insured and the insurers. [↑](#footnote-ref-2)
3. Pauly (1983) point out that it is nevertheless true that the relevant theory, empirical evidence, and policy analysis for moral hazard in the case of serious illness has not been developed . This is one of the most serious omissions in the current literature. [↑](#footnote-ref-3)
4. Please see the article titled “ Why is there public provision of health care ?” http://www.parliament.uk/documents/commons/Scrutiny/SU%20Economics%20in%20practice%20-%20healthcare%20(1).pdf [↑](#footnote-ref-4)