

Does DRGs Reform Help to Alleviate the Moral Hazard of Medical Insurance?

—From the Perspective of Game Theory

Lingyao Meng

School of International Economics, Shaanxi International Business College, 35 Uni-unified West Road,
Xixian, Shaanxi, China

milu1049713026@foxmail.com

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Abstract: Using the method of game theory, this paper respectively discusses the moral hazard of the supplier under the medical insurance post payment system and the DRGs payment system. The study found that medical institutions have the motivation to conduct excessive medical treatment, and reducing the review cost of medical insurance institutions, increasing the punishment for excessive medical treatment, and improving the operation efficiency of hospitals will reduce the probability of excessive medical treatment. At the same time, the study found that the use of DRGs medical insurance payment can effectively inhibit the behavior of medical institutions to induce demand and excessive medical treatment. On this basis, some policy suggestions are put forward to control the moral hazard of medical insurance, such as the reform of medical expense payment method, the use of "Internet + medical reform" and the establishment of reasonable review reward and punishment mechanism.

1. Introduction

In recent years, China's health costs have increased rapidly, according to relevant statistics, from 2020 to 2022, the national health expenditure totaled 6,094.8 billion yuan, an increase of 29.4% compared with the previous three years. With the acceleration of the aging process of our population and the decrease of birth rate, the basic medical insurance is facing huge cost pressure due to its long-term low income and high expenditure. In addition, the serious information asymmetry in medical insurance operation leads to adverse selection and moral hazard, which leads to the increase of unreasonable medical expenditure. In order to maximize their own interests, some medical institutions will adopt a series of excessive medical strategies such as inducing patients to stay in hospital, over-checking and prescribing large amounts, and transfer the cost risks in the medical service process to medical insurance institutions, resulting in a waste of medical insurance funds. In response to this phenomenon, the "Regulations on the Supervision and Management of the Use of Medical Security Funds" implemented in May 2021 clearly stipulates the penalties for excessive medical treatment. On the one hand, strengthen the reform of payment methods, so that medical institutions can strengthen the endogenous power of cost control; On the other hand, strengthen the comprehensive supervision and further regulate the medical service behavior of medical institutions.

The national "Twelfth Five-Year Plan" proposes to control the excessive growth of medical expenses by reforming the means of medical insurance payment. On October 24, 2019, the National Healthcare Security Administration held the "Interpretation Meeting of the Technical Specifications and grouping Scheme of the National Trial of Diagnosis Related Groups (DRGs) payment", published the list of 30 pilot cities of DRG payment, and required the simulation operation in 2020. Actual payments will start in 2021. In November of the same year, the Commission for Deepening Overall Reform of the CPC Central Committee deliberated and passed the Opinions on Deepening the Reform of China's Medical security System, establishing an effective and efficient medical insurance payment mechanism, a strict and powerful fund management mechanism, coordinating

the reform of the supply side of medical services and optimizing the public management services of medical security as the key tasks for the continued promotion of medical reform in the following years.

Therefore, in order to further improve China's medical security system, it is an important part of the current medical reform to reform the payment method of medical insurance. At the same time, the problem of medical insurance moral hazard caused by information asymmetry is directly reflected in medical expenses. How to restrain the moral hazard of medical institutions is one of the important issues to ensure the long-term and stable development of medical insurance. It is of great academic value and practical significance to study and correctly understand the relationship between medical insurance payment mode and medical expenses. This paper will study the moral hazard control of medical institutions from the perspective of game theory, and analyze the role of DRGs medical insurance payment mode in mitigating the moral hazard of medical institutions.

2. Domestic and foreign related research review

2.1. Identification of moral hazard in medical insurance

Back in the 1970s, the famous Rand health Insurance experiment demonstrated the existence of moral hazard by studying differences in participants' use of health services. At present, there are few articles about the moral hazard of health system in China, and the research on the measurement of moral hazard basically comes from abroad. Bajariet al. (2006) separated the influence of adverse selection factors in health care from the influence of moral hazard. Through the structural model of health care demand and health insurance, we find strong evidence for moral hazard. ^[1]Marsh (2010) constructed a structural model to separate the influence of adverse selection, and used the discontinuous recovery method to measure moral hazard. ^[2]Liu X et al. (2012) separated moral hazard by dividing patients into three categories (those without supplementary insurance, those who purchased insurance, and those entitled to free insurance), and found that patients of all ages had moral hazard, but the impact of farmers' information asymmetry was not obvious. ^[3]Powell (2014) used quantile estimation of instrumental variables to distinguish moral hazard from adverse selection, and found that for a certain private health insurance, 77% of the extra medical expenditure of the high-payer plan compared with the low-payer plan was due to adverse selection, and the rest was due to moral hazard. ^[4]Domestic scholar Li Ling et al. (2014), by comparing the hospitalization costs of patients with medical insurance and those without medical insurance, found that Chinese patients have the problem of moral hazard, and when the medical insurance compensation rate is increased by about 5%, the corresponding medical and health expenditure will increase by about 7%. ^[5]

2.2. Causes of moral hazard in medical insurance

There is obvious information asymmetry in China's current medical insurance market. The insured and medical institutions are in the position of information superiority and will take a series of behaviors to satisfy their own interests, thus forming moral hazard. If insurance institutions can understand and control medical costs, moral hazard will not arise. However, medical expenses are difficult to control due to uncertainty, particularity of medical market and asymmetric information (Guo Youde, 2011).^[6]

The causes of moral hazard in medical insurance can be divided into three categories according to the subject. First, post-mortem moral hazard exists on the demand side of medical services. When the demand side of medical products is paid by the third party in the consumption of medical services, the demand side has a tendency to over-consume in the whole consumption process, and the amount of medical services consumed by patients is often much higher than the level when they are completely paid by themselves. Due to the lack of cost awareness, patients tend to over-consume, and often have phenomena such as large-scale maintenance of minor diseases, repeated visits, and long-term hospitalization (Huang Feng and Gan Li, 2012).^[7]

Second, there is moral hazard on the part of medical service providers. Medical product

providers use their information advantages and information asymmetry to influence patients' medical consumption behavior and profit from it. Medical information held by both doctors and patients is asymmetrical, and medical service providers may induce patients to overconsume. Research shows that medical service providers are in an information dominant position in the medical insurance relationship, and doctors have the possibility of inducing demand and inhibiting demand (Wang Liyan and Yuan Changhai, 2006).^[8] Evans (1974) pointed out that a large number of medical service demands are actually induced demands of doctors with information advantages.

Third, moral hazard arises from collusion between supply and demand. In this case, both doctors and patients jointly cheat the insurance institution and obtain profits from it when they reach a consensus, which is based on the common interests of doctors and patients. When both sides maximize their own interests, they jointly defraud the medical insurance and obtain profits. Under the third-party payment mechanism, medical insurance institutions are in a position of information weakness, and both doctors and patients may conspire to meet their own interests at the expense of the third-party medical insurance institution, including human prescription, conversion of self-expenses into public expenses, and collusion to extract medical insurance funds (Zhang Fang and Li Yuzhu, 2007).^[9]

2.3. Explanation of the effect of medical insurance payment method on moral hazard

DRGs is divided into several groups related to disease diagnosis according to the severity of the condition of the inpatient, the complexity of the treatment method, the cost of diagnosis and treatment, and the individual factors of the patient, and the price, charge, and payment standard of medical insurance are determined by the group as a unit. An important constraint for medical insurance institutions to formulate the optimal payment method and price level is how to effectively avoid hospital moral hazard under the condition of information asymmetry (Duchuang, 2019).^[10] LAN Yuxi (2005) pointed out that the prepayment system has the nature of hard constraint (medical service providers bear all cost risks), which can encourage medical service providers to take the initiative to reduce medical costs from their own interests, and thus effectively inhibit the occurrence of moral hazard of demand induced by medical service providers.^[11] Ma Benjiang (2007) built a doctor-patient transaction contract design model under the assumption that the treatment results were observable and verifiable, indicating that charging a fixed fee in advance and establishing compensation rules based on the efficacy could solve the problem of physicians' moral hazard.^[12] Most scholars have pointed out that compared with the post-payment system, the prepayment system can effectively control the problem of moral hazard (Yang Yongmei, 2016; Xie Long, 2018; Liu Fucheng, 2019).^[13]

3. Study on moral hazard of medical insurance providers from the perspective of game theory

3.1. The moral hazard of the supplier under the medical insurance post-payment system

(1) Model assumptions

Suppose there are two players in the game: medical institutions and medical insurance institutions, both of which can pursue the maximization of their own interests under the existing conditions.¹ Medical institutions will weigh the benefits of over-treatment against the costs of being examined by the health insurance department to decide whether to proceed with normal treatment or over-treatment. The medical insurance department is the payer of medical insurance, and at the same time, it supervises and manages the behaviors related to medical insurance of medical institutions to ensure that the social benefits brought by medical insurance policies will not be damaged by the bad behaviors of medical institutions. Regulation has a cost, so providers will make decisions about the benefits of regulation versus the costs.

During the game between medical institutions and medical insurance institutions, medical institutions have two choices: normal medical treatment or excessive medical treatment; Medical insurance institutions also have two actions to choose the payment method: adopt the post-payment system and adopt the prepayment system. Hypothesis 1: Medical institutions can obtain N1 income

for normal medical treatment, while excessive medical treatment can obtain D1 income and pay a small amount of extra cost C2 (D1>C2).

Hypothesis 2: The original medical insurance fund of the medical insurance institution is B, which needs to pay the medical insurance fund to the medical institution. When no audit is conducted, the health insurance institution pays all medical expenses to the hospital: N1 for normal medical treatment and N1+D1 for excessive medical treatment. At the time of the audit, the health insurance agency pays the normal medical fees to the hospital: N1 for normal medical treatment and N1 for excessive medical treatment.

Hypothesis 3: Once the medical insurance institution conducts the inspection, it can detect the excessive medical treatment behavior of the medical institution, but it needs to pay the inspection cost C1. If the medical institution has excessive medical treatment, it will be fined $\beta \cdot N1$.

Hypothesis 4: Both medical institutions and regulatory agencies are rational economic people pursuing the maximization of their own interests. Based on the above assumptions, the game payment matrix of medical insurance institutions and medical institutions can be obtained (see Table 1).

Table 1 Game payment matrix under the post-payment system.

		Medical institution	
		Normal treatment	Over-treatment
Medical insurance institution	Examine	B-N ₁ -C ₁ , N ₁	B-C ₁ + $\beta \cdot N1$ -N ₁ , N ₁ (1- β)-C ₂
	Not-Examine	B-N ₁ , N ₁	B-N ₁ -D ₁ , N ₁ +D ₁ -C ₂

3.2. Game outcome

(1) Pure strategy Nash equilibrium

According to the game payment matrix in Table 1, if $B-C1+\beta \cdot N1-N1 \leq B-N1-D1$, that is, $\beta \cdot N1+D1 \leq C1$, there is a pure strategy Nash equilibrium in the game, and the equilibrium is that medical institutions choose excessive medical treatment and medical insurance institutions choose not to review. If $B-C1+\beta \cdot N1-N1 > B-N1-D1$, that is, $\beta \cdot N1+D1 > C1$, the game does not have a pure strategy Nash equilibrium, and can solve a mixed strategy Nash equilibrium.

The pure strategy Nash equilibrium simplifies the game process. Although it is relatively simple and direct, it ignores some realistic conditions and is inconsistent with the goal of improving the efficiency of medical insurance use in China. Therefore, the results of mixed strategy Nash equilibrium are also discussed in this paper.

(2) Mixed strategy Nash equilibrium

Suppose that the probability of the health insurance institution conducting the review is p, and the probability of not conducting the review is 1-p; The probability of over-treatment by the medical institution is q, and the probability of normal treatment is 1-q.

So, the expected utility function of the health care institution is,

$$E_1 = p[(1-q)(B - N_1 - C_1) + q(B - C_1 + \beta \cdot N_1 - N_1)] + (1-p)[(1-q)(B - N_1) + q(B - N_1 - D_1)] \quad (1)$$

E₁-Medical insurance institution

According to the optimization first order condition,

$$\frac{\partial E_1}{\partial p} = \beta \cdot N_1 \cdot q + D_1 \cdot q - C_1 = 0 \quad (2)$$

You may get,

$$q = \frac{C_1}{\beta \cdot N_1 + D_1} \quad (3)$$

The expected utility function of a hospital is,

$$E2 = (1-q)[p \cdot N_1 + (1-p)N_1] + q[p[N_1(1-\beta) - C_2] + (1-p)(N_1 + D_1 - C_2)] \quad (4)$$

E2-Medical institution

According to the optimization first order condition,

$$\frac{\partial E_2}{\partial q} = D_1 - C_2 - \beta \cdot N_1 \cdot p - D_1 \cdot p = 0 \quad (5)$$

You may get,

$$p = \frac{D_1 - C_2}{\beta \cdot N_1 + D_1} \quad (6)$$

Therefore, the equilibrium solution of the mixed strategy Nash equilibrium is $p^* = \frac{D_1 - C_2}{\beta \cdot N_1 + D_1}$, $q^* = \frac{C_1}{\beta \cdot N_1 + D_1}$

It can be seen from the above that C_1 , β , N_1 , D_1 will have an impact on the probability of excessive medical treatment in medical institutions. If it is C_1 reduced, that is, the cost of medical inspection by the medical insurance institution is reduced, then q is reduced, that is, the probability of excessive medical treatment by the medical institution will be reduced. If β increases, that is, the proportion of fines for excessive medical treatment in medical institutions will increase, then q will decrease, that is, the probability of excessive medical treatment in medical institutions will decrease. If N_1 increases, that is, the income of medical institutions increases, then q decreases, that is, the probability of excessive medical treatment by medical institutions will decrease.

From the above, it can be seen that in the game between medical insurance institutions and medical institutions, medical institutions have the motivation to carry out excessive medical treatment. Reducing the review cost of medical insurance institutions, increasing the punishment of excessive medical treatment, and improving the operating efficiency of hospitals will reduce the probability of excessive medical treatment.

3.3. Moral hazard of the supplier under medical insurance DRG payment Suppose

There are two players in the game: medical institutions and medical insurance institutions, both of which can pursue the maximization of their own interests under the existing conditions. Assume that the income of medical institutions for normal medical treatment is N_1 , because the medical insurance adopts DRG payment mode, medical institutions cannot obtain more income for excessive medical treatment, which will only make them pay more costs C_2 . In addition, if excessive medical behavior is audited, it also needs to pay a fine of $\beta \cdot N_1$. Based on the above assumptions, the game payment matrix of medical insurance institutions and medical institutions can be obtained (see Table 2).

Table 2 Game payment matrix of medical institution and medical insurance institution under DRG.

		Medical institution	
		Normal treatment 1-p	Over-treatment p
Medical insurance institution	Examine q	$B - N_1 - C_1, N_1$	$B - C_1 + \beta \cdot N_1 - N_1, N_1(1-\beta) - C_2$
	Not-Examine 1-q	$B - N_1, N_1$	$B - N_1, N_1 - C_2$

When the medical insurance institution does not conduct the review, the medical institution can earn N_1 for normal medical treatment, and $N_1 - C_2$ for excessive medical treatment; When the medical insurance institution conducts the review, the medical institution can receive income N_1 for normal treatment and $N_1(1-\beta) - C_2$ for excessive treatment. Therefore, medical institutions will not choose to over-treat under any circumstances. Static game pure strategy Nash equilibrium is

(unaudited, normal medical). It can be seen that the DRGs medical insurance payment method can effectively restrain the behavior of medical institutions to induce demand and excessive medical treatment.

4. Policy Recommendations

4.1. Reforming the way medical expenses are paid

In the face of the rising medical costs, insurance institutions should explore more reasonable medical expenses payment methods, the original per capita payment, per service item payment, per disease payment, these payment methods have their own advantages and disadvantages. On the basis of the original payment methods, more reasonable methods should be explored, such as exploring the implementation of payment by disease group (DRGs). Insurance institutions should strive to explore and implement, abandon the outdated payment methods, and minimize the probability of the occurrence of moral hazard, which is also an important part of preventing the occurrence of moral hazard.

4.2. Make full use of the "Internet + medical reform" thinking to supervise the medical insurance fund

Information asymmetry is the root cause of moral hazard. The National Healthcare Security Administration needs to use "Internet +" to overcome the problem of information asymmetry in the medical industry, realize online supervision, use the Internet to make medical information as open and transparent as possible, make every link and every project have reasonable evidence, check all materials, and use the Internet to match information. Conduct offline review of problematic projects in a timely manner, prevent the occurrence of moral hazard, and use the thinking of "Internet + medical reform" to minimize information asymmetry and overcome the problem of information gap.

4.3. Give full play to third-party oversight

The third party supervision is a very important role in the supervision of social basic medical insurance. Third party supervision includes supervision by individuals, social organizations and public opinion media. The establishment and improvement of third-party supervision can broaden the supervision channels of social basic medical insurance, so that trade unions, enterprise organizations, public opinion, and the majority of social workers can participate in, so that they can enjoy the rights of social basic medical insurance.

4.4. Medical insurance institutions should establish a reasonable review reward and punishment mechanism

From the point of view of the government or medical insurance institutions, the core measure to control medical insurance costs is to establish a reasonable reward and punishment mechanism. Part of the reason for the over-treatment of designated medical institutions is that the supervision costs of medical insurance institutions are too high. Therefore, medical insurance institutions can establish a complete evaluation system to evaluate medical cost, medical quality, medical management, medical service quality, service attitude and other aspects. Then medical insurance institutions evaluate the results, control the cost of health insurance, and establish economic incentives and rewards and penalties. Reward designated medical institutions that charge reasonable fees and strictly control fees, increase penalties on designated medical institutions that do not strictly control fees, and regulate the behavior of medical providers.

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