Purchasing and selling mode in pharmaceutical industry in China
-A case study on the Introduction of Direct Supply Mode in Hubei Zhongshan hospital

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Abstract

Expensive medicine cost is always a thorny livelihood problem that most people complain about in China. From pharmaceutical factories to consumers, medicines prices increases several times during the circulation. Due to this situation, many hospitals launched different pattern of purchasing and selling medicines to decrease patients’ drug costs. Among them, the uniform bidding mode is the mode most commonly used by state-operated institutions in China. However, as a typical innovation pattern of purchasing and selling medicines, the drug direct supply mode launched by Hubei Zhongshan Hospital has achieved remarkable progress.

In this thesis, I intend to analyze these two modes and compare the performance of them to give some suggestions for future medical reform. The unified bidding mode achieved a win-win-win between pharmaceutical suppliers, medical institutions and patients. The direct supply mode compressed intermediate circulations to transfer multilayer wholesalers' profits to the patients to reduce their burden of medicine costs. However, the introduction of this purchasing mode may lead to market concentration which may influence prices in the longer run. For future medical reform, in the long run, the key is the separation of medical services and pharmaceutical sales. However, from a short-term perspective, direct supply mode can be adopted to solve the core issue of excessive price-adding in medicine circulations.

Key-words: medicine price, purchasing and selling medicines, uniform bidding mode, direct supply mode, Zhongshan Hospital
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Chapter 1 Introduction

1.1 Background of the Problem

As one of the fast-growing economies, China has developed with high speed for over thirty years. However, the average growth rate of pharmaceutical industry in China is more than twice of that in GDP (Pharma China, 2011). The pharmaceutical industry in China is facing both rigid challenges and significant development opportunities. The Chinese drug supply system has experienced several stages, from the stage of high degree of planning management in the early years of the new nation, then gradually liberalized to a monopoly supply stage in the 1980s, and finally to the current stages of self-regulation by the market. Although the Chinese government has been committed to regulate pharmaceutical industry in recent years, expensive medical cost is still a thorny livelihood problem that most people complain about, and medicine costs contribute for a large proportion.

In recent years, Chinese National Development and Reform Commission adopted a series of measures to reduce drug prices but the effects are small. The reasons for rapid growth of drug costs not only include some reasonable factors such as population aging, spectrum of disease changes, the rise of chronic diseases and increase in manufacturing costs, but also include many unreasonable factors such as that drug price compensation mechanism in the hospital is not perfect. In addition, the phenomenon of “revenues from prescription medication” has become a hidden rule in current health care system in China (Zhang, 2010). From pharmaceutical factories to consumers, medicines prices increase several times during the circulation, resulting in a high level. According to the statistics, China has 18 thousands state-operated hospitals, 140 thousand retail pharmacies, but 85% of medicines are sold to the patients through the pharmacy of hospitals (Database of authorial Chinese economic data by National Bureau of Statistics, 2011). However, the medicines’ prices in pharmacy of hospitals are usually higher than that in retail pharmacies, the main reason was that the average markups in the sales circulation which through hospitals were very high, and hospital account for a large proportion (average 20%-25%) (Lee, 2009). Due to this situation, many hospitals launched different patterns of purchasing and selling medicines in order to reduce the drug price and decrease patients’ drug costs. As a typical innovation pattern of purchasing and selling medicines, the drug direct supply mode which launched by Hubei Zhongshan Hospital has achieved remarkable progress.

1.2 Purpose of the Study

With the rapid development of the pharmaceutical industry, many economists began to pay their attention to analyze the economic phenomenon occurred in pharmaceutical industry and study the law of its development. At present, some Chinese researchers have performed a lot of studies about Chinese pharmaceutical industry. Most of the studies focus on how to reduce the expensive drug price.
However, they generally reached the results almost from the policy respect. For the research of purchasing and selling pattern of medicines, there are relatively fewer studies and lack a systematic discussion from the pharmaceutical economic point of view and also there is no large statistical investigation in this field.

Therefore, in this study, I analyze two patterns of purchasing and selling medicines. Firstly, I use the theory of pharmaceutical economics to analyze uniform bidding mode and figure out why this mode can reduce the price of medicines. Then, an empirical analysis on direct supply mode is provided. I collect data and compare the situation before and after the implementation of this mode to evaluate the new system. In order to get a deeper understanding of the new system I also conduct semi-structured interviews with patients and a doctor at Zhongshan Hospital. The results of this thesis could help medical institutions know how to optimize the purchasing and selling mode of medicines to reduce the price of medicines, thereby reducing the burden of their patients.

1.3 Outline of the Study

The structure of this paper is organized as follows: Chapter 2 reviews the previous literature and theoretical foundation on purchasing and selling pattern in pharmaceutical industry, which are basis for the later empirical analysis. In Chapter 3 the hypothesis are brought up and Bayesian game theory is applied to analysis the uniform bidding mode of medicines in China. Chapter 4 states the empirical analysis on the direct supply mode carried out in Hubei Zhongshan hospital. A semi-structured interview with the doctor and the patients will be represented. This is the core of this thesis. Chapter 5 is the comparison of two modes and suggestions.
Chapter 2 Literature Review

2.1 The characteristics of medicines and its pricing

2.1.1 Classification of medicines

Medicines, refers to a special and important medical substance intended for use in prevention, diagnosis and treatment of human diseases, and it has provided indications or functions, usage and dosage (US Federal Food, Drug, and Cosmetic Act, SEC. 210., 2008). Different medicines should take different mode of purchasing and selling. Hence, before studying the purchasing and selling mode of medicines, having a clear idea of classification of medicines is very significant.

At present, the internationally recognized drug classification classifying the drugs into two major categories: non-prescription medication and prescription medication, which based on the variety, indications, specifications, dosage and route of administration of the medicines. Prescription drugs mainly include the following three categories: (1) New listed drugs, its efficacy and side effects require further observation; (2) Dependence-producing drugs, such as hypnotics and narcotic analgesics; (3) Drugs which used under the guidance of a doctor.

Huge and complex categories of drugs, special storage requirements of each drug and different requirements of transport determine the purchasing and selling mode of drugs are different from that of other commodities (Rønning, Blix, Harbø and Strøm 2000).

In order to study the mode of purchasing and selling of medicines, medicines can be classified into the following three categories. The first category is oral medications and drugs for external use, of which the side effect is moderate. These medicines can be purchased by doctor’s prescription and also can be purchased from the pharmacies. The second category is injections, however it needs the decision made by doctor. The prices of drugs are relatively high, and the drugs are mainly used in the hospitals. The third category is non-prescription drugs which are mainly various external used and oral medications. The risk of use is relatively low. They can be usually purchased in pharmacies and usually with a relatively cheap price.

2.1.2 The characteristics of medicines

Medicine is different from any other commodity. It has some characteristics, mainly in the following three aspects:

1 Medicine is directly related to the safety of people's lives, therefore, its quality must be ensured.

2 Medicine is not an independent commodity. Patients must first be examined by a doctor who provide a diagnosis, and then, use the drugs under the guidance of the doctor.
3 Medicine has huge and complex categories. In China, there are more than 5000 kinds of Chinese preparation medicines and more than 4000 kinds of Western medicines. (US Federal Food, Drug, and Cosmetic Act, SEC. 210., 2008)

2.1.2 Pricing of medicines in China

Due to the special nature of medicines, there are some factors needed to be considered when pricing medicines. Price elasticity of demand (PED or Ed) is a measure used in economics to reflect the sensitivity of the quantity demanded of a commodity to a change in its price (Krugman; Wells, 2009). The medicine is a necessary commodity. Its $-1 < PED < 0$, that means it has a inelastic or relatively inelastic demand (Parkin; Powell; Matthews, 2002). However, if there is a similar alternative drug, the demands are often elastic or relatively elastic. Because if the prices of the drug A has rose patients can replace it with the similar drug B, in this situation, the demands are quite elastic.

According to the Chinese law, the Chinese government set uniform prices nationwide on the medicines which are included in the Medicare Reimbursement List and other medicines which with a certain monopoly or particularity such as patented and innovative drugs, narcotic and psychotropic drugs, contraceptives and EPI drugs. (Chen and Shen, 2008) However, the medicines which are not included in the Medicare Reimbursement List are independent pricing by pharmaceutical enterprises (Zhou and Zhang, 2001). The principles of government pricing emphasized the relationship between supply and demand and compensating for the reasonable cost of production and management. But in its execution, it the phenomenon of "price reverse adjustment" would happen, it means a large number of drugs which with high quality and low price has no one want to produce because the low profit. (Chen and Shen, 2008) However, if considered the clinical value of the drug into the factors of pricing, the effectiveness of medicines, their security and other factors cannot be ignored. In addition, drug pricing would also affected by other factors, such as the degree of innovation, costs of production and operation, market supply and demand, the international comparison of reference and other factors.

2.2 Previous studies on purchasing and selling patterns of medicines in China

Expensive price of medicines is a complex issue which involves many long standing problems in the pharmaceutical system, such as disordered pharmaceutical distribution system, monopoly operation of the hospital and faultiness in medical compensation mechanism, etc. However, one of the most important reason is that medicines went through from pharmaceutical factories to consumers would experienced several times of price increase during the circulation. How to regulate the medicine circulation system and find a suitable purchasing and selling pattern of medicines for China is at the heart of the matter. There are a large number of scholars which have conducted research on the current situation and problems of drug
purchasing and selling mode, and put forward relevant proposals for reform.

Zhong (2010) pointed out that the excessive number of pharmaceutical factories and their individual differences imply that it is difficult to form economies of scale. The prices of medicines which are priced by the government are artificially high. At the same time, the independent pricing medicines are existing tendency of monopoly. In addition, unhealthy competition in pharmaceutical industry also raised the manufacturing cost of medicines, resulting in a high level of ex-factory price (Zhong (2010). Due to the cumbersome links in the drug marketing and price adding during the circulation, the medicines price to the final consumers is almost the price ceiling which has been stipulated by the State. Zhong (2010) believed that the phenomenon of “revenues from prescription medication” is the critical issue which caused the price of medicines is artificially high. To solve these problems, Zhong (2010) proposed to take the general distribution mode to reduce transaction costs. Moreover, he claimed that establishing the reaction mechanism of drug prices management is also needed. To government pricing medicines, the pricing department should timely adjust the medicines prices according to the production costs, market supply and demand and the actual circulation rate. To independent pricing medicines, manufacturers should timely adjust their retail prices base on their production costs and the changes of market supply and demand.

Fu (2007) mentioned that the artificially high price of medicines in China can be explained by the current irrational structure of medicine distribution channels. The multi-layer structure is not conducive to improve the efficiency of medicines distribution and against to form the competitive advantage of price. She also stated that the market concentration of pharmaceutical enterprises in China is low, thus decreased the enterprises’ advantage of negotiate with medical institutions. Therefore, it reinforced the monopoly position of the medical institutions. In addition, Fu (2007) thought that medical institutions have the right to prescribe and the exclusive rights to sell medicines, and owing to the asymmetric information between doctors and patients, patients lost the right of free choice which is different with general merchandise consumer. On the basis of these studies, Fu (2007) propose a new vision on the medicines purchasing and selling patterns: First, pharmaceutical enterprises should implement vertical integration strategy to achieve the scale of management and improve the ability of negotiate with medical institutions. Second, changes in the existing logistics model, from the original multi-layer model which run through wholesale enterprise, retail pharmacies or hospital pharmacies change into a modern logistics distribution system which uses the supply chain structure to reduce the circulation. Third, establish a hospital compensation mechanism to achieve the implementation of separation of the medical institutions and pharmacies, thereby reducing the dependence on drug income in hospitals.

Miao and Ye (2009) compared five medicine circulation patterns and found that large pharmaceutical manufacturers, especially which with a strong capital and abundant
technical strength can build logistics and distribution network by themselves or develop the third-party logistics. Miao and Ye (2009) believed that for most pharmaceutical manufacturers, it is better to use the logistics platform which is built by pharmaceutical distribution enterprises and they also pointed out that wholesale pharmaceutical enterprises have all the qualifications to provide third-party logistics services.

Ma (2010) indicates that the expense ratio of wholesale pharmaceutical enterprises stays at a high level and their profitability is still low. On the other hand, the amount of the pharmaceutical retail enterprises is not sufficient for the current pharmaceutical market and due to inadequate investigation of capacity gaps between urban and rural residents' consumption of medicines, the distribution of pharmaceutical retail enterprises is also irrational. In recent years, local protectionism and an imperfect social security system results in that the pharmaceutical companies cannot achieve the scale of operation.

Gao (2007) analyzes current pharmaceutical distribution models and found that disordered pharmaceutical distribution market made the cost of distribution is relatively high. Gao makes the following recommendations: to accelerate the pharmaceutical distribution market reform; to implement the separate accounting and management between medicines and medical services.

After analyzing the current medicine marketing mode, Yun (2011) raised some suggestions for the new reformation of medicines marketing mode. He pointed out that the key of reforming the marketing mode is the separation of medical institutions and pharmacy. Training professional licensed pharmacists becomes especially important. In addition, Yun (2011) also thought that refusing the local protectionism is the premise of reforming medicines marketing pattern.

Chen (2007) conducts a survey about the Chinese medical market and analyzed the reasons for the artificially high price of medicines. He concludes that the industry concentration is low, the supply chain is disordered and that government’s investment in hospital decreased in these years. The main reason for artificially high price is an irrational compensation mechanism in hospital. In order to control medicines price, Chen (2007) suggests that government should reinforce their obligation to help build healthy medical market and the medicines distribution enterprises must reduce links in medicines circulation and develop modern logistics for the whole medicine distribution process.

To sum up these scholars’ studies on purchasing and selling pattern of medicines in China, there are three aspects mainly discussed. From the aspect of pharmaceutical enterprises, low market concentration caused that it is difficult to achieve economies of scale; disordered supply chain and multi-layer structure of distribution channels made enterprises lose their comparative advantage in price reduction. From the aspect
of medical institutions, lack of good compensation mechanism and the phenomenon of “revenues from prescription medication” in hospitals brought artificially high price of medicines; owing to the asymmetric information between doctors and patients, patients lost the right of free choice. Hence, separating medical institutions and pharmacy and training professional licensed pharmacists become extremely important. From the aspect of government, government’s investment in medical institutions in these years decreased and the supervision of the relevant government departments is still missing. The main recommendations are to increase the medical industry investment and promote medical system reform.

2.3 Previous studies on medicines purchasing and selling pattern abroad

Chinese medicines purchasing and selling mode is currently undergoing a period of reform and it change gradually from the stage of planning management to self regulating by market. Moreover, medicines purchasing and selling model in other developed countries has gone through a long time process of reform. Their models have been improved. Hence, it is worth study these reforms and adopts of applicable measures in the future Chinese reform of the system. Many scholars (Davidson and Greblov, 2011; Pill, 2005; Arrow, 2010; Leonie, 2009; Jacqueline, 2007) have studied medicines purchasing and selling mode in some foreign countries and compared with the domestic mode. These studies summarize the major foreign drug supply system for the following types:

1 Central Storehouse System: It is a traditional drug supply system, funding for medicine procurement, medicine purchasing and distribution are all performed by the Central Drug Administration. This government sector is the owner, investor and manager of the supply system, and the funding sources of the medicines are treasury funding or donor funds.

2 Private Supply System: It refers to a system were the government does not provide any medicines to medical institutions. Medicines are entirely supplied by retail pharmacies.

3 Self-supply System: Medicines are entirely supplied by bulk procurement agencies which are responsible for the quality, storage, distribution and financial management of medicines.

4 Distributor System: It evolved from direct delivery system. First, the public procurement department of the government selected the distributor by a public bidding, and then signed two contracts with the winner. One contractor should negotiate with the supplier about the source of supply and price of each drug. The rest is signing a delivery contract with a single distributor, the distributor is responsible for the medicines delivery.

5 Direct Supply System: The medicines procurement department of government selects drug prices and suppliers by public bidding. Medicines are directly supplied to all levels of medical reserve station and major medical institution by the winning bidder.
The following describes the medicine supply system in five countries. I chose the United States, Sweden, Japan, the United Kingdom and Germany as examples. They are all among the world's more developed countries and their pharmaceutical supply systems are relatively mature. China can learn from the experiences of these countries to tackle the problems in medicine supply system.

**A. Pharmaceutical sales mode in the United States**

The U.S. pharmaceutical market is highly concentrated. The number of large pharmaceutical companies or enterprises is less than one hundred, and the first three ones sales accounted for 95 percentages of total U.S. sales. (Davidson and Greblon, 2011) Conventional medicine in the United States is generally just go through two links in the process of sales, first, from drug manufacturers to wholesale companies; and then to the retail enterprises. The cooperation relationship between wholesalers and hospitals, wholesalers and retail pharmacies are fixed. Once the hospital, chain pharmacies and retail pharmacies pick a wholesaler, they generally do not purchase from other wholesalers (Pill, 2005).

This mode has some advantages: the links are less in the process of sales which reduce the cost of circulation; the transit time is short, thereby accelerating the speed of delivery and improves the efficiency of distribution. Moreover, coupled with good U.S. pharmaceutical industry logistics services, the efficiency of transportation from drug manufacturers to retail customers is further improved.

In addition, the large wholesalers would offer their customers a variety of convenient intermediary services. One of the most important distribution services is called "the Storehouse to the Storehouse". It means the wholesalers are responsible for the transportation services from pharmaceutical manufacturers to the end retailers. They first purchase medicines from the pharmaceutical manufacturers, and then the medicines would be sent directly to the storeroom of the chain pharmacies or hospitals. Another important one is called “Direct transportation” service. In this business, the wholesalers are responsible for ordering and paying the prepayments to the manufacturer, and the medicines do no longer stay in the wholesale warehouse but just directly sent from the manufacturer to large retail customers.
In the U.S., from the point of view of the consumer purchase channels of medicines, pharmaceutical retail sector is the main channel, independent pharmacies and chain pharmacies accounted for 60% of the market share while public hospitals, private hospitals, clinics, long-term care wards, family wards and other medical institutions hold 26% market share. Besides, the other market share is took up by a newly developing channel -- "mail-order". (Davidson and Greblov, 2011) From the beginning of 20th century, a kind of Group Purchasing Organization (GPO) appeared in the United States. These GPOs gathered purchases of a certain number of hospitals, and then negotiated purchase prices with suppliers. After that, those hospitals which have been organized by the GPO could purchase needed items directly from the manufacturer under the agreement price (Pill, 2005).

**B. Pharmaceutical sales mode in Sweden**

Sweden is a welfare state, in order to save medical expenses and improve social welfare, they established pharmacy companies in the mid-1960s and implement the chain pattern to sell medicines (Su, 2012). In Sweden, all the pharmacies in hospital are owned by pharmacy companies, at the same time, the work of supplying medicines and negotiating and signing the medicine supply agreement with pharmaceutical manufacturers are all unified managed by the pharmacy companies. It should be said that Sweden implemented a more thorough “SDP” (Separation of Dispensing from Prescription). People can buy common medicines in pharmacies, but the special medicine must hold a doctor's prescription. (Wang, 2011)

Moreover, since July 1st 2009, the Sweden implemented deregulated policy to their pharmacy monopoly, which lead to greater competition between pharmacies and a downward pressure on the price of pharmaceuticals (Löhmus and Thorell, 2010) Apoteket is a key competitor which has one third of pharmacies under state ownership.
And the other two leading pharmacy chains are Apoteket Hjärtat and Kronans Droghandel. The number of pharmacies is continued to rise rapidly in 2011, and then slowed down and stabilized from 2012 (Espicom Business Intelligence Ltd, 2012).

C. Pharmaceutical sales mode in Japan

Medicines in Japan are mainly distributed through drug wholesalers, in their pharmaceutical market, the wholesalers sales accounted for 99% of the total sales while only 1% of the pharmaceutical market share was held by pharmaceutical manufacturers. (Arrow, 2010) Medical institution is the major drug sales channel in Japan. Japanese pharmaceutical manufacturing companies would employ medical representatives who are responsible for their medicine sales. Medical representatives provide information of the effectiveness and adverse reactions of medicines to doctors and pharmacists, and then get the feedback from them. Therefore, compared to the doctors in Europe or in the United States, Japanese doctors are more authoritative in their selection of pharmaceutical brands and prescription and choosing medicines brand. The relationship between marketing PR of medical representatives and pharmaceutical sales is more direct in Japan compared to Europe. The number of drug wholesalers in Japan is huge, no one has the ability to operate across the country or wholesale all the products from all the pharmaceutical manufacturers. (Yamahita, 1995) Therefore, there is a network relationship between Japanese pharmaceutical manufacturers and wholesale enterprises.

In addition, wholesalers are also like intermediaries of the pharmaceutical manufacturers, it bears a number of other functions, such as charge accounts and credit management. Due to the supply and temporary pay commercial activities between pharmaceutical wholesalers and pharmaceutical institutions, the time of collection of costs is often extended, the rebate costs has been included when pricing the medicines. The medical institutions purchase medicines at low prices then sold at high prices the differences between selling price and the actual purchasing costs as the income of medical institutions. Hence, the competition in the Japanese pharmaceutical market is mainly from the rebates and extra services fees.

D. Pharmaceutical sales mode in the UK

The United Kingdom enacted the National Health Service Act in 1948, and then it began to implement government management and provide health services. The British pharmaceutical market is a monopsony market, but the government’s monopoly purchasing power is limited. First of all, in the British primary care market, there are many pharmacies act as a contract supplier. Secondly, the government cannot suppress the needs of the community, and on the contrary, they must meet the demand of medicines, it cannot be out of stock (Leonie, 2009). Medicines in the UK are free, but patients have to pay for prescription. Because the market space can only accommodate a limited number of long-term wholesale enterprises, the economies of scale would inhibit the development of a fully competitive wholesale market. There are only three national wholesalers in the UK: Phoenix, Unichem and AAH. Britain
has 12,000 pharmacies, their trend of linked together is very clear. About 6500 pharmacies belong to five pharmaceutical supply chains, and one of the biggest pharmaceutical supply chains is a long-term national wholesaler. (UK Pharmaceutical Industry Report, 2009-2010) Under the target of ensuring the care service levels and qualities, the minimization of cost is a basic objective of the UK Department of Health. The British pharmaceutical distribution system is very modern and efficient, long-term wholesales deliver medicines to pharmacies three times a day to ensure the supply of medicines. Long-term wholesalers need to build very expensive infrastructure construction, and they have to invest in the storage of commonly prescribed medicines. However, because the pressure of the three times daily distribution, the long-term wholesalers take large-scale purchase and distribution.

E. Pharmaceutical sales mode in Germany

The degree of concentration of the pharmaceutical distribution market in Germany was relatively high. The sales of top three pharmaceutical wholesales in German accounted for 65 percents of total sales (Jacqueline, 2007). The main channel for patients to purchase medicines is pharmacies. About the medicines distribution channels, 85% of medicines sold through pharmacies, most of which are prescription medication and can be reimbursed non-prescription medication, and the rest of the medicines sold by supermarket. German drug prices are basically fixed; there is no competition regarding the price between pharmacies. In the circulation of medicines, professional pharmacists are served in order to ensure the safety of the pharmaceutical distribution process. The medicines enter the market only through the logistics system, if not or the medicines are not implemented standardized production and packaging, they cannot enter the system. This is how they guarantee the safety of medicines in their circulation.

From the above brief descriptions on medicine distribution network in these five countries, there are something worth learning. To sum up, except Japan, the pharmaceutical distribution markets in these countries are all with a high degree of concentration. In the United States, the large wholesaler’s intermediary services can give us some inspiration. The direct supply mode which mainly study in this thesis has some similarities with such services. In the Sweden, its thorough separation of dispensing from prescription is worth learning, specifically, how to implemented in practice and achieve the goals of separating dispensing from prescription need to be studied and thought about. Although Japanese and Chinese medicine distribution network are similar: the less concentration market and also the medicine representatives for medicine sales, their good method of pricing the medicine can be used as a source of reference. In the United Kingdom, the government intervenes regarding the pricing of drugs. The payment method of medicine expenses are worth exploring as well. In the German mode, the most worth learning is their ways of guaranteeing the safety of medicines in the circulation.
2.4 Theories for establishing purchasing and selling patterns of medicines

How to build a suitable drug purchase and sale mode for China is a comprehensive issue which related to the social security system, medical system, the government regulation system and distribution system. Some questions like: “how many links should be set in the circulation seems to be reasonable?” or “how to arrange the institution for every aspect?” are hard to give a simple answer. These issues are needed to analyze from the fundamental principles of economics. In this thesis, I prepare to first analyze the game relationship between the stakeholders in the different modes of purchasing and selling medicines in China. Then I analyze the amount of the transaction costs according to the cost-benefit theory of economics. In the analysis of the process of purchasing and selling medicines, how to avoid the phenomenon of rent-seeking and how to set up a principal-agent relationship is particularly important. Finally, designing an efficient institutional arrangement to solve the problems in the mode of purchasing and selling medicines, and form a virtuous circle. Hence, before studying the drug purchase and sale mode, having a brief review on transaction cost theory, contract theory, rent-seeking theory, game theory, moral hazard and institutional economics is necessary for building a suitable drug purchase and sale mode for China.

The concept of *transaction costs* was first introduced by Nobel laureate Ronald Harry Coase (1937) in his article "The Nature of the Firm" to explain the nature and limits of firms. Coase (1937) noted, transaction costs should include search and information costs, bargaining costs, keeping trade secrets, and policing and enforcement costs. Cheung (1978) gave the following definition for transaction cost in 1987: “A transaction cost is a cost incurred in making an economic exchange.” Transaction costs are mainly constituted by the search costs, negotiation costs, contract costs and supervision costs. In order to reduce transaction costs, enterprises can use the capital management as: acquisition, merger and reorganization to achieve market internalization which changed cross-border transactions into internal transactions, and to eliminate the risk arising from uncertainty in the market. According to the theory of transaction costs, a good pattern of purchasing and selling medicines should reduce transaction costs, and shorten the difference between patients’ medicine expenses and pharmaceutical manufacturing costs. At the same time, it can also achieve the goal of maximizing the income of hospital and pharmaceutical company.

Subsequently, the transaction costs theory was further improved by Demsetz (1967, 1972) and Williamson (1971, 1979) and other scholars. Principal-agent relationships are the outcome of highly developed economies and arising out of the separation of the ownership and operation of corporation. It is the results of the social division of labor. In the contract theory, the principal agent relationship is a very important object of research, and actually it is a contractual relationship. The neo-classical contracts
are incomplete long-term contract. Among them, there are third parties involved to resolve the dispute and in order to achieve the flexibility of the contract, but the initial contract would not be changed. However, in this thesis, there are many relational contracts which need to be investigated. They are negotiated by hospital and medicine supplier and generally are long-term and complex contracts, but effectively reduce the transaction costs in the formal contract execution.

The phrase *rent-seeking* itself, was first put forward as the economic category in 1974 by the U.S. economist Anne Krueger (1974). In economics, the word "rent" refers to a payment to a factor of production in excess of that which is needed to keep it employed in its current use. If people are to pursue the vested interests of socio-economic, the nature of their activities is changed into "rent-seeking". Rent-seeking theory has a very wide range of applications in the field of political science, administrative science, sociology and law. Buchanan (1988) has an outstanding contribution to the rent-seeking theory. Buchanan’s rent-seeking theories mainly investigate the conditions of rent-seeking, and discuss three levels of rent-seeking, political allocation and rent-seeking. Rent-seeking condition is the existence of institution or policy which restricts market entry or market competition. It is often associated with the intervention of government privileges. (Buchanan, Tollison, Tullock, 1988) For example, under the uniform bidding mode, the competition mechanism was introduced to rectify the order of the medicines circulation and lower prices of medicines. But the pharmaceutical entrepreneurs find that it is difficult to seek profit, so they turn to rent-seeking activities to obtain additional revenue. As a result, black-box operations began to appear in the tender exercise.

*Game theory* is "a method of studying strategic decision making. More formally, it is the study of mathematical models of conflict and cooperation between intelligent rational decision-makers" (Myerson, 1991). It is a branch of Applied Mathematics; the analysis methods of game theory are totally same with other mathematical tools which are used to analyze the socio-economic phenomena. Osborne (2005) classified games into cooperative game and non-cooperative games. The difference between cooperative game and non-cooperative game is whether there is a binding agreement between the parties, and if so, it is a cooperative game. From the aspect of the behavior, over time game theory is classified into two categories. Here I only discuss the static game, which means in the game process implies that, the participants make the decision at the same time or not, due to information asymmetry, the second actors do not know what specific acts that the first actors would take. According to the participants’ information mastery on other participants, it will be classified into complete information game or incomplete information game. In the analysis of uniform bidding mode, I will use the incomplete information game model. Game theory plays a very important role in guiding the study of the competitive relationship between different stakeholders. In the study of purchasing and selling patterns of medicines, we can find that pharmaceutical enterprises and circulation enterprises always use the particularity of medicines to form a price alliance, to achieve the
purpose of raising the price of medicines. Hence, in order to reduce the price of medicines, a tendering mechanism can be adopted to break this price alliance.

*Moral hazard,* refer to a situation where there is a tendency to take undue risks because the costs are not borne by the party taking the risk (Arrow, 2010). Due to the complexity of the health care market, there is a serious information asymmetry between doctors and patients. The moral hazard of patients is usually achieved by the medical staff. Therefore, in the case of asymmetric information, moral hazard generated by the medical staff is worth to be studied. In the medical procedures, the moral hazard problems of medical staffs are as follows: To pursue the maximizing of benefits, the doctors tend to provide more medical services and medicines which exceed the needs of patients, such as large prescription and unnecessary tests. To the maximum extent to reduce their own responsibility and avoid medical disputes, the doctors generally take "protective health care" which miss the best timing of treatment. In this thesis, the conception of “revenue from prescription” comes from the first situation. In order to raise the market share, the pharmaceutical companies will send the medicine representatives to market their products with doctors. If the doctors prescribe their medicines, they will get a rebate from the medicine representatives and those rebates are actually bear by the patients. In addition, the more expansive the more rebate and these rebates account a large proportion in the doctors’ income, so the doctors have a big motivation to prescribe these expansive medicines. Hence, the “revenues from prescription” gradually become a hidden rule in the hospital.

*Institution* is used to reduce the uncertainty in the environment, protect the property rights, reduce transaction costs and promote productive activities by developing a series of rules of the game to limit the space of people's behavior and constrain the relationship between the social behaviors of the individual. North (1994) defined institution as a series of rules, order, ethical conducts and ethical norms. It is designed to bind individual behavior which in order to pursue the main welfare and the interests of utility maximization. (North, 1994) To sum up, the institutions have the following functions: first, lower transaction costs, create conditions for the realization of cooperation, and help the cooperation to be carried out smoothly. In addition, they provide incentives mechanism, and provide information to reduce the externality. Institutional theory emphasizes that the institution of property rights is an important driving force for resource allocation, factor development, allocate efficiency and economic growth. (Davis and North, 1970) Institutional change is a process of a system substitution, exchange and conversion. Whether institutional change can occur, it affected by many factors. Liu (1989) used the theory of institutional change in the western economics and made Mandatory institutional change model. He (Liu, 1989) thought that there are two kinds of phenomenon of path dependence exist in institutional change. The first one is that economic and political institution changes along the original path, the economic and political institutions will enter into a virtuous cycle and optimize rapidly, which is called "path dependence I.” The second one is follow the original error path, locked in a state of inefficient, which is called
"path dependence II ". (Liu, 1989)

Institutional economics theory has played an important role in the study of purchasing and selling mode of medicines in China. First of all, purchasing and selling model itself is an institutional arrangement. Under this arrangement, it will have the specific transaction costs and incentive mechanism. If this arrangement does not have the function of reducing transaction costs, then gradually increasing transaction costs will impede the specialization and division of labor in the purchasing and selling medicines. However, through an institutional innovation, specifically, a new arrangement of purchasing and selling of medicines can reduce the transaction costs, and reduce the difference between personal income and social benefits which will improve efficiency. Therefore, the problem of expensive drug price can be solved. However, accompanied with institutional change, there are induced changes and force changes. When it enters the " path dependence I ", A good drug purchasing and selling model will develop and enter a state of virtuous cycle, and if it goes into the " path dependence II " and locked in a state of inefficient, it is necessary to implement the mandatory changes to break the lock state from the outside, and these need reform of health care.
Chapter 3 Uniform Bidding Mode

3.1 Uniform bidding mode

Due to a growing number of problems caused by decentralized procurement, a great deal of attention of society has been paid to finding a better mode of procurement for pharmaceutical industry. Since July 1999, the Chinese Food and Drug Administration put forward the suggestion of implementing the uniform bidding mode of medicines in China. In February 2000, according to the Bidding Law, the State Council explored the corresponding legal responsibility of parties in the bidding and proposed the specific solution to regulate the uniform bidding and purchasing drugs (Feng, 2001). After that, the uniform bidding mode of medicines began to be carried out by state-operated medical institutions across the country.

In the uniform bidding mode, the government is the organizer of the tendering mechanism (Feng, 2001). The hospital is the tendered and the supplier of the medicines is the Bidder, they are both direct stakeholders. The benefits of hospitals are the cost saving through uniform bidding, that is, the differences of cost between the traditional procurement mode and uniform bidding mode. The Figure 3.1 shows the process of uniform bidding mode.

![Figure 3.1: The process of uniform bidding mode.](image)

3.2 The uniform bidding mechanism analysis

In the actual implementation of the uniform bidding mode, the sealed bid auction model is adopted. The model has the following basic characteristics (Athey, Levin and Seira, 2004):

1. Tenders are filed under seal;
2. The opening time is uniform and notarized;
3. Set Price as the main decision variables, the lowest price wins the bid; if they all bid at a same price, random selecting by the tenderee to decide who won the bid.

In order to illustrate the roles of stakeholders and final interest distribution in a
uniform bidding, I assume that there are n bidders involved in uniform bidding. Their supply costs are $c_i (i=1, 2 \ldots n)$. Therefore, if bidder $i (i=1, 2)$ win the bid by a price $P_i$, his income should be $P_i - c_i$. Based on the above information, it is not difficult to launch the bidder $i$'s payoff function as follow:

$$\pi_i = \pi_i(P_i, P_j, c_i, c_j) = \begin{cases} 
P_i - c_i, & \text{when } P_i < P_j; \\
(P_i - c_i) / n, & \text{when } P_i = P_j; \\
0, & \text{when } P_i > P_j.
\end{cases} \quad (3.1)$$

Note: In the formula (3.1), $i, j = 1, 2, \ldots, n; i \neq j$.

According to the Nash theorem, if a game with a finite set of actions, at least one Nash Equilibrium must exist in such a game (Nash, 1951). Hence, as a finite game, the sealed bid auction model would at last have one Nash Equilibrium. However, only base on existing conditions, it will be very difficult to solve the case of n bidders. In game theory, there is a “symmetric Bayesian Nash equilibrium game” model, which assumes that each participants will have a same type of strategy, at this point, the optimal strategy function for each bidder will be the same, differing only in their costs (Ozdaglar, 2010). This assumption can make the problem simplified, solving process can be continued. Moreover, it is not difficult to find that under this assumption, the optimal bidding price of bidder with higher costs will be strictly greater than the optimal strategy of lower-cost bidder. Hence, the optimal strategy $P^*(c_i)$ solves:

$$\max \left[ (P_i - c_i)p(P_i = c_j) + \frac{1}{n} (P_i - c_i)p(P_i = P_j) \right] \quad (3.2)$$

According to the method of solving the full differential equation, we can obtain the optimal strategy $P^*(c)$ is:

$$P^*(c) = \frac{n-1}{n} c + \frac{1}{n}$$

The detailed calculation of optimal bidding price can be found in Appendix A. It is not difficult to find that $P^*(c)$ increased with the increase of n, in particular, when $n \to \infty$, $P^* \to c$. That means in the uniform bidding mechanism, the more bidders participate in the bidding, the less money that hospital needs to pay. Hence, the hospital will expect that more bidders can participate in the bidding, and the uniform bidding mode provides a good platform to attract more bidders. Through the uniform bidding game, the supplier with a lower cost will win the bid and get the medicine supply contract. The lowest-priced supplier supplanted higher-priced supplier, low price strategy is beneficial for suppliers. It achieve the goal of maximize the total benefits. On the other hand, the hospital can also benefit from the uniform bidding game. However, hospitals' price-adding space is only 15% of the purchase price, so through this pathway, the interests of the medical institutions from the uniform bidding are actually transferred to patients. Therefore, the unified bidding is actually compressed complex interest chain of medicines which from the manufacturer to the hospital and then to patients.
Moreover, in the actual implementation of uniform bidding mode, it is a repeated game, the hospital will selected the supplier year by year. But after a few years, they will identify a supplier for a particular drug supply, and a long-term cooperation contract will be signed. In addition, using a back stepping method, we can find that if the time of game repeated is limited and there exists a unique Nash equilibrium in the one-time stage game, the equilibrium solution at each stage of the repeated game are all the same with this Nash equilibrium solution in the one-time stage game. (Xiang, 2000) That means in the time limited repeated game, all participants will still choose the dominant strategy, so that the probability of win the bid with high price is eliminated. Hence, the above result is also effective in the actual implementation of uniform bidding mode.

3.3 The problems in uniform bidding mode

Uniform bidding of medicines has implemented more than 10 years in China, but it did not form a mature pattern. Although excessive growth trend of medicine prices and medical expenses get some control, the growth rate of medical expenses was still more than that in GDP over the same period in recent years. The uniform bidding system needs to be improved, there is some problems worth to be analyzed.

A. The passive attitude of medical institutions

On the one hand, due to interest chain in the field of purchasing and selling medicines and long-term lack in national investment, the situation of "to increase the revenue of hospital by excessive sales of medicines" made medical institutions lack the motivation to self-organized, and actively participate in the uniform bidding and centralized procurement of medicines. Some medical institutions take the negative attitude and even do everything possible to find an excuse to refuse to participate in the work of uniform bidding and centralized procurement of medicines. It makes the implementation of uniform bidding and centralized procurement of medicines hindered by a very large internal resistance. In addition, after uniform bidding, some hospitals less prescribe or even did not prescribe the bid winner medicines. The uniform bidding and centralized procurement of medicines is facing an embarrassing situation.

On the other hand, after taking a uniform bidding and centralized procurement, government usually stipulate price-adding space -- only 15% of the purchase price as hospital income. Medical institutions are more willing to choose high-priced drugs in the clinical treatment, which increase the average price of the actual medication and make patients bear a higher health care expenses. Hence, in many places, the patient did not enjoy the benefits from the uniform bidding and centralized procurement. It is difficult to solve the problem of "expensive medicine price" effectively. In theory, the uniform bidding and centralized procurement can reduce the purchase price and the purchaser -- hospitals can benefit from it. However, the policy “only 15% of the purchase price as hospital income” make the interests of hospital is damaged. This is why the medical institutions to take a negative attitude towards the uniform bidding.
and centralized procurement of medicines. At the local level, the uniform bidding and centralized procurement of medicines is difficult to get the effective implementation. Analyzing the causes and finding the solution is the inevitable way to promote the uniform bidding and centralized procurement mode.

**B. The interests of pharmaceutical companies cannot be guaranteed**

Pharmaceutical companies, especially with a small scale, had a negative attitude to the uniform bidding and centralized procurement of medicines. Even in some cities, in order to avoid bidding affect their medicines prices in the neighboring city, some pharmaceutical companies do not participate in the tender. In this sense, the promotion of the uniform bidding and centralized procurement of medicines in the provincial regions has a positive and practical significance. The reason for these phenomena is that the uniform bidding and centralized procurement are disconnected in the current system. The production company won the bid does not mean obtain the sale or the market, it still needed to do a lot of public relations and marketing. Therefore, it should improve the medicine procurement system and explore the implementation of "single source procurement".

**C. Large preliminary investigation work on pharmaceutical quality**

Although the uniform bidding mode indeed compress the price of medicines through a tendering mechanism, in the actual implementation, the quality of medicines should also to be considered. The medicines with lowest prices cannot guarantee a good quality. Only pursue on reducing the price of medicine but ignore the quality of drugs can not be a good pattern for purchasing and selling medicines. In addition, as we know, medicines of different brands have different quality that means we cannot simply determine whether the two drugs completely homogeneous only by their medicinal ingredient. It also makes stringent requirements on the ability of medicine inspection agency and pharmacists to judge the quality of medicines. In particular, the unified bidding of medicines is often not only for one type of medicines, but also involve a lot of different kinds of medicines and often up to thousands of categories. In order to make the uniform bidding carried out smoothly, the preliminary investigation work on pharmaceutical quality seems to be essential. Of course, this large preliminary investigation work on pharmaceutical quality will also bring a huge investigation costs.

**D. A huge tendering costs cannot be ignored**

As we have discussed above, the more times repeated tender the more motivated to drive bidders to lower the bidding prices and at the same time, the success bidder will also improve more on the service after the tender. In this way, the hospital will increase time of repeated tender to compress the price of medicines and get better service of suppliers. As the price, in order to hold time and time tenders, the hospital will also spent more money on training a group of professional tender personnel or hiring a tendering agency. Newly forming a group of professional tender personnel need to invest a certain amount of time and human capital, but hiring a tendering agency to charge the tenders will also bring a huge amount costs on intermediary services. These have increased the tendering expenditures of the hospital.
Chapter 4 Direct Supply Mode

The incomplete substitutable and professional natures of medicines made a profound impact on its distribution channels and patterns. According to the theory of price elasticity, the price elasticity of demand of medicines is relatively low. In general, the patients will completely obey professional and authoritative advice of doctors, so they will not reduce the dosage of medicine or do not take the medicines which doctor recommended just because of the high drug prices. Therefore, there is a serious information asymmetry between patients and doctors. Driven by the interests and having the absolute position of authority, doctors have the motive to prescribe the expensive prescription medication. In the present Chinese health care system, the main income of medical institutions is earned by providing medical services and selling medicines. For their own interests, medical institutions would create additional demand which leads to over-treatment. From the respect of supply side, the number of pharmaceutical companies in China expanded from 1833 in 1951 to nearly ten thousand now (Ministry of Commerce of the People's Republic of China, 2011). The gross margin of pharmaceutical wholesale is much higher than that in pharmaceutical manufacturing industry. The high profits attract a large number of non-professional companies to enter this field. At present, there are more than 13,000 pharmaceutical wholesale companies and more than 360,000 pharmaceutical retail enterprises in China (Ministry of Commerce of the People's Republic of China, 2011). It can be seen, from the source to the terminal, there are many problems in the field of purchasing and selling medicines in China.

The uniform bidding mode aims to introduce a competitive mechanism to regulate the production and circulation of medicines and reduce medicines prices. But this mode increased the burden of pharmaceutical manufacturers, resulting in new rent-seeking behaviors, and black-box operations in the tender process. Although the uniform bidding mode has achieved a certain effect, it did not cause a serious impact on the medicines with artificially high prices. We can see from the figure 4.1, under traditional medicine circulation model, the medicines experience several times of circulation and their prices have go up during every circulation. After the final 15% price-adding by hospitals, the price of medicines which burdened by patients has reached a high level.
Therefore, if we try to reduce the circulations of medicines, the problem of expensive drug price can be solved, so the direct supply mode may be a better choice. We can see from the figure 4.2, under direct supply mode, the medicines are directly sent from the manufacturers to medical institutions. It minimizes the intermediate links in the circulation of pharmaceuticals.

4.1 The Direct Supply Mode in Zhongshan

Before taking the direct supply mode, the phenomenon of “revenues from prescription medication” in Zhongshan Hospital was very serious. In order to reduce medicine expenditures of their patients and curb the commercial briberies in the hospital, the head of the hospital Doctor Song has proposed to launch the direct supply mode in Zhongshan hospital. The proposal has been quickly approved by the relevant
department of government. Since February 2010, Zhongshan Hospital began to take direct supply mode to purchase and sell their medicines and it has become the first medicines direct supply pilot hospitals in China.

The specific practices of direct supply mode in Zhongshan were first to, select a large pharmaceutical wholesale enterprise through a public tender, and then this pharmaceutical wholesaler bear the responsibility for the supply of medicines in hospital. The medicines were wholesaled directly from pharmaceutical manufacturers and then sent to the hospital. It is very effective to get rid of the profits of wholesalers in the medicines circulation and reduce the cost of medical institutions in the purchasing of medicines, thereby reducing the patients' medication expenses. The figure 4.3 shows the process of the mode.

![Figure 4.3: The direct supply mode in Zhongshan Hospital](image_url)

Strictly speaking, the current direct supply mode in Zhongshan is not the direct supply mode in the true sense which medicines are sold directly by pharmaceutical manufacturers to the medical institutions. The reason is that the current Chinese pharmaceutical distribution market does not have such conditions for direct supply mode. If the hospital faced the pharmaceutical companies directly, they would spend more money on searching costs and negotiation costs, and result in a higher transaction cost, ultimately counterproductive. However, choosing a large pharmaceutical wholesale enterprise as a transit hub between pharmaceutical manufacturers and hospital, the hospital would have a more economical channel to purchase, transport and distribution medicines. This kind of pharmaceutical agent wholesalers can reduce the burden of the medical institutions, and play an important role in distribution of medicines, collecting price information, price negotiations and reducing transaction costs.

In addition, Zhongshan Hospital also set a number of details to improve the entire direct supply mode. The main measures are as follows:

**1 Provide medicines catalog of direct supply**

The core of this measure is "one medicine with more than two choices". That is the hospital provides more than two brands of medicines with same compositions for doctor to choose and one of the medicine should be the original research. If one
species of drugs has no original research drugs, it must include a well-known brand of medicine.

2 Strictly control prices of medicines
In order to ensure the medicine prices are significantly reduced after adopting the direct supply mode, the hospital proposes some requirements to pharmaceutical wholesaler. Drug prices of direct supply company must be lower than the current bid price and the gross margin of drugs was controlled within 3%; imports and original research drug prices must be lower than that in the same level of hospitals, generic drugs prices shall not exceed that in cheap pharmacies; in addition, the prices of medicines should be made timely adjustments with government's command. In accordance with state regulations, the hospital took 15% as the mark-up margin rate on the basis of purchase price.

3 Regulate the behavior of doctors
The hospital strengthened the management of medications and implemented four hierarchies of management for using antibiotics. They ask doctors to prescribe medication in strict accordance with the medicines catalog of direct supply, and offenders shall be severely punished. The offenders will be downgraded or suspended their right to prescribe. More explicitly speaking, the hospital set several rules to regulate the behavior of doctors. The doctors cannot use their professional advantage to seek illegitimate interests, such as asking for property from their patients or taking any kind of commissions from the pharmaceutical representatives. Meanwhile, the Zhongshan hospital established an evaluation system for patients to evaluate the doctors. They will rate every doctor in accordance with the collected evaluations in every month, and the excellent ones will get a special bonus.

4 Establish the compensation mechanisms
The implementation of the drug direct supply would make hospital's medicine income substantially reduced. In order to ensure the operation of the hospital, the Government offered a 500 million yuan research subsidy to the hospital, and also provided one million yuan as special funds. According to the technical level of doctors, the hospital promised more than 350 doctors to issue a "risk allowance". At the same time, the hospital accept the business none other of the direct supply companies. The direct supply companies provide 10% of drug sales as donations to the hospital.
4.2 The empirical findings

4.2.1 The medical expenses per capita in the out-patient and in-patient declined

<table>
<thead>
<tr>
<th>Period</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of outpatients</td>
<td>472469</td>
<td>445498</td>
</tr>
<tr>
<td>The medical expenses per capita in the out-patient</td>
<td>78.64</td>
<td>61.35</td>
</tr>
<tr>
<td>The number of patients discharged</td>
<td>24014</td>
<td>28835</td>
</tr>
<tr>
<td>The medical expenses per bed per day in the in-patient</td>
<td>167.80</td>
<td>125.09</td>
</tr>
<tr>
<td>The medical expenses per capita in the in-patient</td>
<td>2751.44</td>
<td>1496.74</td>
</tr>
</tbody>
</table>

Table 4.1: The income situation of Zhongshan hospital before and after introducing the direct supply mode (The annual accounting statements of Hubei Zhongshan Hospital, 2009~2011)

Table 4.1 lists the data of outpatient and inpatient medical expenses per capita before and after the implementation of direct supply mode in three years. All the data about the medicine expenses have been adjusted by the inflation. The inflation rate in the period 2010.2.1-2011.1.31 is 3.485% and the inflation rate in the period 2010.2.1-2011.1.31 is 5.494% (Organization for Economic Cooperation and Development). The limitation of this study is that I cannot control for the fact that the severances of the patients treated may vary. In some years the hospital would happen to have very few patients with very “expensive decease”. It can be seen that the number of outpatient and inpatient increased steadily. After the implementation of direct supply mode, the medical expenses per capita in the out-patient and in-patient was significantly lower than before. Especially in the first year of implementing direct supply mode, the medical expenses per capita in the out-patient decreased by 17.29 yuan, a drop of 21.99 percent, the medical expenses per capita in the in-patient fell by 1254.7 yuan, a decline of 45.60%. In the second year of implementing direct supply mode, still using the data in 2009 as base, the medical expenses per capita in the out-patient declined by 5.12 yuan, a drop of 6.51 percent, the medical expenses per capita in the in-patient drop off by 850.92 yuan, a decline of 30.93%. Compared with the first year, the change of medical expenses in the second year is less than the first year but the medical expenses are still below the prior year before the implementation
of the direct supply mode. Hence, in the actual implementation, the direct supply mode has achieved the goal of reducing medicine expenses of patients.

Figure 4.4: The income situation of Zhongshan hospital before and after introducing the direct supply mode (The annual accounting statements of Hubei Zhongshan Hospital, 2009~2011)

Figure 4.4 can be more intuitive to show the change in the medical expenses per capita before and after introducing the direct supply mode. In the first year of implementing direct supply mode, the medical expenses per capita in Zhongshan hospital experienced a sharp decline, and rebounded in the second year, but still lower than the level prior to the implementation of the drugs direct supply. However, in the first year, the decline in the medical expenses per capita in the out-patient is less than that in the in-patient, while the rebounded in the medical expenses per capita in the out-patient is much more than that in the in-patient. This shows the impact of direct supply mode on reducing the medical expenses per capita in the in-patient is more pronounced and more effective. Since the implementation of direct supply pattern, the goal of reducing medical expenses per capita in Zhongshan hospital has successfully been achieved which fully reflects the powerful role of direct supply mode.

### 4.2.2 Longitudinal comparison of the other indicators

The table 4.2 shows the structure of the income (in millions) in Zhongshan hospital in 2008 and 2009, before taking the direct supply mode.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Revenue</th>
<th>Medical Income</th>
<th>Medicine Income</th>
<th>Other Income</th>
<th>Financial Assistance Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>79.93</td>
<td>42.53</td>
<td>28.99</td>
<td>3.04</td>
<td>5.37</td>
</tr>
<tr>
<td>2009</td>
<td>119.51</td>
<td>58.77</td>
<td>47.18</td>
<td>6.88</td>
<td>6.68</td>
</tr>
</tbody>
</table>

Table 4.2: The structure of the income (in millions) in Zhongshan hospital in 2008 and
2009 (The annual accounting statements of Hubei Zhongshan Hospital, 2008 and 2009)

All the data in the table 4.2 have also been adjusted by the inflation and also have the some limitations with the reasons we have discussed in the above analysis. The inflation rate in 2008 is 5.903% (Organization for Economic Cooperation and Development). The data indicates the government increased the government financial assistance in the Zhongshan Hospital, for about 1.31 million yuan from 2008 to 2009. But the proportion of the total income of the hospital is decreased from 6.7% to 5.6%. Although the medical income increased by 16.24 million yuan, the income share dropped from 53.1% to 49%. The medicine income rose by 18.2 million yuan, and its income share remained at around 40%. However, the other income increased rapidly and accounted for 5.8%. This was mainly the increase in the sponsorship fee income and housing funding income. From the point of view of structure of total income, the growth of medicine income is relatively stable. From 2008 to 2009, the average mark-up rates of medicines in Zhongshan hospital rose from 23.8% to 27%. Thus, the mark-up rate is higher than 15% which is stipulated by the state compensation ratio. It shows that the hospitals hope to get a better return by increasing the mark-up rates of medicines. Medicine income is the important source of the hospital total revenue.

<table>
<thead>
<tr>
<th>Period</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2009.2.1-2010.1.31</td>
<td>2010.2.1-2011.1.31</td>
</tr>
<tr>
<td>Medical Income (in millions)</td>
<td>60.28</td>
<td>79.98</td>
</tr>
<tr>
<td>Medicine Income (in millions)</td>
<td>46.52</td>
<td>34.00</td>
</tr>
<tr>
<td>Other Income (in millions)</td>
<td>6.07</td>
<td>5.82</td>
</tr>
<tr>
<td>Total income (in millions)</td>
<td>112.87</td>
<td>119.8</td>
</tr>
</tbody>
</table>

Table 4.3: The structure of the income in Zhongshan hospital before and after introducing the direct supply mode (The annual accounting statements of Hubei Zhongshan Hospital, 2009~2011)

Table 4.3 gives the other indicators before and after introducing the direct supply mode in Zhongshan hospital. Through analyzed the data, it cannot be difficult to find that the direct supply mode reduced the medicine price and eased the burden of patients. All the data in table 4.3 have also been adjusted by the inflation and also have the same limitations with the reasons we have discussed in the above analysis. From table 4.3, it can be seen that before introducing the direct supply mode, the proportion of medicine income is: \[ \frac{\text{Medicine income}}{\text{Total income}} = \frac{46.52}{112.87} \times 100\% = 41.22\% \].
The proportion of medical income is: \[
\frac{\text{Medical income}}{\text{Total income}} = \frac{60.28}{112.87} \times 100\% = 53.41\%
\]

However, if we use the same calculation method, it is not difficult to find that in the period of 2010.2.1-2011.1.31 and in the period of 2011.2.1-2012.1.31, the proportion of medicine income is 28.38% and 27.01%, respectively. Similarly, the proportions of medical income in the period of 2010.2.1-2011.1.31 and in the period of 2011.2.1-2012.1.31 are 66.76% and 68.43%, respectively. The proportion of medicine income in the total revenue declined while the medical income increased after the implementation of direct supply mode. Since February 2010, the proportion of medicine income continually decreased from 41.22% to 27.01%, medicine income is no longer account for a large proportion of the total income. Moreover, the proportion of medicine income dropped by 41.22%−27.01%=14.21%. This figure shows that through adopting the direct supply mode, the Zhongshan Hospital achieved the purpose of reducing medicine expenses of patients by controlling drug prices.

Antibiotics are the most widely used drugs in clinical use in China. Its largest consumption made it has the highest proportion of medication expenditures. But along with the excessive use of antibiotics, the patients may suffer from enhanced bacterial resistance and more drug reaction problems. However, there are many types of antibiotics in the Chinese pharmaceutical market, new drugs and expensive drugs continue to emerge. For driven by profit and lack of expertise, the doctors over-reliance on prescribing antibiotics. According to statistics, due to the overuse of antibiotics, unreasonable medical expenses grew by 80 billion yuan each year in China.

![Figure 4.5: The proportion of medicine Income in the total revenue and the proportion of antibiotics income in the medicine income (The annual accounting statements of Hubei Zhongshan Hospital, 2009–2011)](image-url)
In figure 4.5 the red line shows trend of the antibiotics income proportion relation to total medicine income. After implementation of direct supply mode, the proportion of antibiotics income experienced a significant decline. The proportion decreased from 49.7% prior to the adoption of direct supply to about 19%, a decline of 30%. The decline in the proportion of antibiotic use is also indicated the use of antibiotics developed in a more rational and scientific way.

### 4.2.3 Horizontal comparison of the relevant indicators

According to the statistics published by the Information Center of Hubei Provincial Health Department, the average proportion of medicine expense in the total out-patient medical cost is 53.75% in 2011, higher than the national average of 50.30% over the same period. (Information Center of Hubei Provincial Health Department, 2012) After the implementation of the medicine direct supply, the proportion of out-patient medicine expenses in Zhongshan hospital dropped from 49.82% to 46.15%, which is significantly below the national average level.

![Horizontal comparison of the proportion of medicine expenses in the total medical costs in out-patient and in-patient in 2011](image)

Figure 4.6: Horizontal comparison of the proportion of medicine expenses in the total medical costs in out-patient and in-patient in 2011 (Information Center of Hubei Provincial Health Department, 2012)

In 2011, in-patient medical expenses in medical institutions in Hubei Province accounted for 38.97%. The national medical expenses account for 41.03% of the total in-patient medical cost, slightly higher than the Hubei Province level. After the implementation of the medicines direct supply mode, the proportion of in-patient medication costs in Zhongshan hospital decreased from the previous 38.87% to 25.52%. It can be seen from Figure 4.6, that the proportion of its medication costs is not only far below the national average but also substantially lower than the average proportion of Hubei Province.
According to the investigation of the World Health Organization, China is one of the countries with higher proportion of antibiotic use. In China, the use of antibiotics accounted for more than 35% of the total medicines, even in some cities, the proportion of antibiotics use in in-patient up to 80% (Ma, 2011). Among them, the use of broad-spectrum antibiotics and joint use of two or more antibiotics accounted for 58 percent, higher than the international level of 30%. Based on the research of antimicrobial drug use in four cities (Beijing, Shanghai, Guangzhou and Chengdu) in China, the average proportion of antibiotics use in selected 16 state-operated hospitals is 72.1% (Ma, 2011). But in developed countries, the amount of use of antibiotics accounted for the total amount of drugs is generally not more than 9% (Wenzel, MD, MSc, 2010). These data reflect the serious problem of overuse of antibiotics in Chinese medical institutions. However, after the implementation of medicines direct supply, the use of antibiotics is controlled at the level of around 20%, which is very outstanding in China.

4.3 Interview with Zhongshan

In order to investigate the effects of the direct supply mode from the perspective of doctors and patients, I conducted a semi-structured interview with the director of Surgery Department Jinbo Luo and two patients Yuyuan Liu and Huajun Xiao. Under this interview approach, the initiative in the interview process is controlled by interviewees; therefore, the efficiency of this approach is relatively low. However, compare with the structured interview, the semi-structured interview is more flexible and new problems can be found during the interview (Lindlof and Taylor, 2002) and very suitable for gathering the information I want to explore. So as to get a deeper understanding of the new system, I want to choose more representative interviewees. The doctor is chose from the largest department in the hospital—surgery department and to make the comparison, patients are chosen deliberately, one represents the patients with chronic diseases, another represents the general patients.

4.3.1 Interview with doctor Luo

Luo think the most important change in the implementation of the direct supply mode is that commercial bribery in the hospital is reduced. Before the introduction of direct supply mode, the drugs were supplied by several pharmaceutical wholesalers. In order to gain market share, most of the pharmaceutical wholesalers would send the medical representatives to do public relations. However, the medical representatives usually use some unfair competition behaviors to encourage doctors to prescribe their medicines, such as bribe for the doctors. The doctor's prescribing permissions is restricted after implementation of the direct supply mode. Medical representatives cannot market their medicines through using public relations, therefore commercial bribery in hospital has been curbed. Luo mentioned that the direct supply mode also eased the phenomenon of big prescription and abuse of antibiotics to a certain extent.

Luo also believed that the direct supply mode provided a reference for formulating essential medicine list and improving compensation mechanism in the future health
care reform. Zhongshan Hospital streamlined their medication directory. The number of medicines has been streamlined from 1443 to 704. The medicine supply companies have changed from the previous 39 western medicine companies and 18 Chinese medicine companies into only one supplier--Jiuzhoutong. The facts proved that the direct supply catalog of medicines basically meet the hospital's medication demands and the quality of medicines has also been guaranteed by the Jiuzhoutong. However, Luo felt that the streamlined drugs are really just "basically" meet the medication needs of patients, especially in the Department of Surgery. Because the demands for antibiotics after surgery are usually huge, the medicines in the new catalog sometimes cannot provide a best regimen of treatment. He believed that this directory of medicines is still need to be modified in the future.

In the interview, Luo mentioned that the Zhongshan hospital adjusted the revenue structure of the doctors after the implementation of the direct supply mode. They add a risk allowance into the original revenue structure "salary + bonus", accordance with the workload of doctors to compensate them. It improved the work enthusiasm of doctors. But Luo still hold the opinion that the income of doctors has greatly reduced after implementation of medicines direct supply mode, the doctors still have the motivation to prescribe expensive medicines, the phenomenon of big prescription and abuse of antibiotics is still exists in the hospital.

In addition, Luo felt that the direct supply mode enhanced the social image of hospital and doctors. The implementation of the direct supply mode in Zhongshan received extensive attention from the media, patients and some academics. The trust and support from the patients has been greatly improved and the relationship between doctors and patients has also become better and better.

4.3.2 Interview with patients

To make the comparison, I have deliberately chosen two representatives of the patients. Liu represents the patients with chronic diseases, Xiao represents the general patients.

In the interview, Liu mentioned that in the Chinese Social health insurance system, if the patients want to reimburse their medical expenses, they are required to take medicines from the specified hospital’s pharmacy. But it is easier for patients to find that the same medicine has the different prices in hospital’s pharmacies and in general pharmacies. In general, the drug prices in the hospital’s pharmacies are much higher than the prices in the general pharmacies. So for the patients, they would like to choose the hospital with lower medicine price to treatment, especially for those patients with chronic diseases, because they are also the largest long-term consumers of the medicines. Liu think the medicine price in the hospital is an important factor that he would consider when he chose the hospital. In contrast, Xiao does not think so. Xiao think the medicine price in the hospital is a factor that she will consider, but not so important.
However, they both know the Zhongshan hospital introduce direct supply mode to limit their drug price, and they both felt that the medicine prices in Zhongshan have been significantly decreased after the implementation of medicines direct supply mode. Moreover, Xiao mentioned that because the drug prices in Zhongshan are lower, her employer signed a cooperation contract on employees' medical insurance with Zhongshan hospital. That is their employees can reimburse their medical expenses if they seek treatment at the Zhongshan Hospital. Xiao and Liu both believed that after the implementation of the direct supply model, the reputation of Zhongshan Hospital has dramatically improved. They more and more trust in the doctor's prescriptions and are willing to purchase the medicines.

However, it can be learn from the interviews that patients are not satisfied with the expensive inspection fees. Almost all the patients have to do a complete set of check at the time of admission and this is regarded as unnecessary. In addition, Liu felt that the phenomenon of big prescriptions still exists in the hospital.

4.4 The problems in Direct Supply Mode

As we have mentioned above, the implementation of direct supply mode in Zhongshan hospital has made a positive attempt to reduce medicine prices, regulate doctors' prescriptions, and promote health care reform and also made remarkable achievements. However, in the concrete practice of the process, there are still some problems exist in this mode.

4.4.1 Only one supplier cannot meet the demand for hospital medicine and easy to form a monopoly

Since adopting the direct supply mode, Zhongshan hospital selected Jiuzhoutong as their sole medicine supplier. It not only avoided some public relations behaviors of suppliers but also simplify the program of purchasing medicines. However, because the scale and development level of Chinese current pharmaceutical wholesale enterprises is limited, even Jiuzhoutong which included into the "top 500 Chinese enterprises." for six consecutive years still cannot fully meet the needs of Zhongshan Hospital, resulting in some prescription drugs cannot be guaranteed. In addition, the large pharmaceutical wholesaler was selected by a one shot game but signed a long-term cooperation contract with the hospital. This arrangement is not is unreasonable. One shot game tendering system is conducive to reduce asymmetric information between the hospital and the bidders therefore reduce the purchasing price in the future, but once the winner get the supply contract, it is easier to form a monopoly. Hence, in order to get the long-term cooperation contract, the bidders will not only provide a “good-looking” offer but also offer some commercial bribery secretly. Moreover, without competition, it is easier for a successful wholesaler to form a monopoly. Indeed, the empirical evidence also shows that it seems to be true. We can find that the medical expenses per capita in Zhongshan hospital experienced a
sharp decline and rebounded in the second year. The suppliers would lack the impetus to improve their supply service. Therefore, it is not conducive to sustained reductions in medicine prices.

4.4.2 The medicines catalog lacked flexibility

After Zhongshan Hospital streamlined the medicines catalog of direct supply, the number of medicines is dropped from 1473 to 713, more than half of the types of drugs have been subtracted. The new catalog of drugs can regulate the conduct of the doctors, but at the same time, it also implies that some drugs cannot be purchased by patients. Some less frequently used and lack alternative medicines are not in the list of direct supply medicines. Hence, sometimes the patients are unable to obtain the drugs they need in a timely manner through the direct supply. To some extent, the direct supply mode would affect the effectiveness of therapy.

4.4.3 The price mechanisms of direct supply medicines are inadequate

In order to ensure the medicine prices are significantly reduced after adopting the direct supply mode, drug prices of direct supply company must be lower than the current bid price and the gross margin of drugs was controlled within 3%. Imports and original research drug prices must be lower than that in the same level of hospitals. Generic drugs prices shall not exceed that in cheap pharmacies and the prices of medicines should be made timely adjustments with government's command. However, the empirical evidence shows that in the beginning of implementing direct supply mode, the medicines prices of supplier Jiuzhoutong have decreased significantly. But due to the fluctuations of price in the pharmaceutical market and the asymmetric information between government departments, hospitals and pharmaceutical wholesaler companies, Jiuzhoutong is constantly adjusted their medicine prices, leading their medicine supply price is neither stable nor transparent.

In fact, the determination of drug prices is a crucial part in the whole process of health reform. In the medicine price control measures of Zhongshan hospital, only limit drug prices must lower than the current bid price give the supplier a large flexible space to add price. And the requirement of gross margin less than 3% is very difficult to effectively monitor in the actual operation. These pricing measures cannot guarantee that the price of drugs reduced to a reasonable level. How to control drug prices in the direct supply at a reasonable level is still a difficult problem in a reform.
4.4.4 The increase in treatment cost to a certain extent offset the decline in drug prices

![Figure 4.7](image-url)

Figure 4.7: The structure of the income (in millions) in Zhongshan hospital before and after introducing the direct supply mode (The annual accounting statements of Hubei Zhongshan Hospital, 2009~2011)

It can be seen from Figure 4.7, after the implementation of the direct supply mode in Zhongshan, the medicine income was significantly reduced while the medical income has continued to rise, which went up 19.86 million and 49.48 million yuan in the first year and second years, respectively. Thus, the existing direct supply mode still cannot form an effective control on the rising cost of treatment, and this no doubt caused a new burden to the patient. The reduced medicine expenses were offset by rising medical costs to some extent.

4.5 Some suggestions

4.5.1 Suggestions for Supplier choosing and tendering mechanism

Original mode selected one wholesaler company as sole supplier. The problems such as medicines cannot be timely supplied and substantially large price fluctuations indicate that the competition mechanism needs to be introduced and the selection process needs to be improved. I proposed that in the new mode, the relevant departments can encourage the hospital to select a wholesale company as the main supplier, and also pick some other companies as sub-suppliers. On the other hand, one shot game tendering mechanism should to be modified. Because the medicine supply is a long-term cooperation contract, the hospital should gather a large number of bidders and form repetitive tendering. As a result, it not only avoids the monopoly but also to be better to compress the purchasing price in the future. Of course repeated game tendering will also bring more tendering costs, so the hospital should consider a balance between these factors when decide the number of times of repetitive tendering.
4.5.2 Formulate the medicines catalog scientifically

When implementing the direct supply of medicines, Zhongshan Hospital developed a very streamlined medicines catalog. But sometimes the patients cannot buy the drugs they need in a timely manner which affected the effectiveness of therapy. Therefore, the hospital can give doctors a certain threshold of autonomy, for example, the doctors’ prescription can include 5% to 10% of other drugs which are not listed on the catalog of direct supply medicines. In addition, due to the changing disease spectrum and the continuous development of medical science, the catalog of direct supply medicines must be constantly adjusted and improved.

4.5.3 Guide the orderly change from “revenues from prescription medication” to “revenues from medical services”

By analyzing changes in treatment cost in these three years, we found that the medicine income was significantly reduced while the medical income has continued to rise and this caused a new burden to the patient. From the results of interviews, the hospital likes to ask the patients to do a number of expensive examinations before their admission. The result is that too many medical resources are concentrated on the introducing a variety of advanced medical equipment. However, most hospitals lack effective incentives to improve the medical staff technical level and quality of service. Under the direct supply mode, the hospital needs to pay attention to the rapid increase in treatment costs and establish a complete policy system to guide the orderly change from “revenues from prescription medication” to “revenues from medical services”.

4.5.4 Some good systems we can learn from abroad

In the literature review section, I described the medicine distribution systems in five countries. There are some good systems which are worth to be learned. In the United States, the large wholesaler’s intermediary services have some similarities with the direct supply mode in Zhongshan hospital. The difference is that in the U.S., this kind of intermediary wholesaler has been very widespread and with a certain strength. Their intermediary services can fully meet the demands of different hospitals. But in China, the direct supply mode is only a pilot project and Zhongshan hospital is the unique pilot hospital. In addition, due to that there is no formation of scale, many pharmaceutical manufacturers thought the wholesaler Jiuzhoutong breaking pricing rules and began to stop supplying medicines to it, resulting more than 30 kinds of commonly used drugs out of stock in hospital. Hence, I think in order to promote the adoption of direct supply mode in a widespread region, the government should encourage the development of those large pharmaceutical wholesalers and make their development to drive the changes in the pattern of purchasing and selling medicines.

About controlling the drugs prices, we can partially learn from Japan, which has a system of mainly government pricing and then the market regulation. The hospital should on the basis of the current bidding price, the lowest purchase price of retail
pharmacies and other factors, to set the highest drug price in the hospital. At the same time, the hospital can do some pharmaceutical cost and market price surveys, and control the prices of medicines from the ex-factory price. In addition, negotiating the circulation rate is necessary, but it may reduce the profit of supplier. Of course, if the hospital gives some compensation from the big amount of purchases to the supplier, this problem can be solved.

I think the key of the medical reform is the separation of dispensing from prescription. It is also the sticking point in reducing the price of medicine. In the Sweden, its thorough separation of dispensing from prescription is worth learning. All the pharmacies in hospital are owned by pharmacy companies. People can buy common medicines in pharmacies, but the special medicine must hold a doctor's prescription. Specifically, how to implement in practice and achieve the goals of separating dispensing from prescription is still needs to be studied and thought about.
Chapter 5 Conclusion and Discussion

5.1 Comparison of two purchasing and selling modes of medicines

5.1.1 The commons of two modes

The core of the uniform bidding mode and the direct supply mode is reducing the prices of medicines. They both reduce the medicine expenses of patients by squeezing the high profit margins in the medicine circulation, and preventing commercial corruption. Meanwhile, the implementation of these two programs needed to get the permission and support from the government. In addition, the income through business with pharmaceutical companies is easy to associate with commercial bribery and unfair competition. The phenomenon of "different prices of medicines in one city" will have a certain impact on other non-pilot medical institutions.

5.1.2 The advantages of the two modes

Under the uniform bidding mode, the more bidders participate in the bidding, the less money that hospital needs to pay and the uniform bidding mode provides a good platform to attract more bidders. The supplier with a lower cost will win the bid and get the medicine supply contract. The complex interest chain of medicines which from the pharmaceutical manufacturer to the hospitals and then to patients is compressed. But at the same time, the benefits of hospital and pharmaceutical supplier are all maximized.

Under the direct supply mode, the medicines are sent directly from the manufacturers to medical institutions. It minimized the intermediate links in the circulation of pharmaceuticals. Choosing a large pharmaceutical wholesale enterprise as a transit hub between pharmaceutical manufacturers and hospital implies that medical institutions do not need to face the pharmaceutical companies directly and they would not spend more money on searching costs and negotiation costs.

5.1.3 The disadvantages of the two modes

Uniform bidding mode selects suppliers for every specific medicine through a number of tenders. It will bring a large amount of preliminary investigation work on judging the quality of medicines. And in a short term, it will break the existing pattern of the medicine distribution market. In addition, the corporate exit mechanism has a certain mandatory, and medical institutions have to face a very large short-term repayment pressure on repaying to the exit businesses.

Direct supply mode through a tender to select a wholesaler to supply many specific medicines so that reduced pre-judge work on the qualities of medicines. But only one wholesaler cannot meet the demand for hospital medicine and it will cause the
monopoly of the exclusive supplier. Moreover, after implement the direct supply mode, the medical expenses has continued to rise thus caused a new burden to the patient. In order to compensate for lower drug prices, the doctors will increase amount of medicine use thus cause the unreasonable overmedication.

5.2 Some suggestions for how to build the purchasing and selling modes of medicines in China

In China, from pharmaceutical factories to consumers, medicine prices increase several times during the circulation. In order to raise the ex-factory prices of medicines, the manufacturers apply for the approval of new medicines by changing the specifications, packaging of their medicines. The multi-layer drug wholesalers use price adding to compensate for the public relations fees, rebates and other costs. In addition, hospitals' price-adding space is 15% of the purchase price even under the uniform bidding mode. Doctors tend to prescribe large amount of expensive medicines to get more rebates. As a result, there is a stable coalition of interests between manufacturers, wholesalers and pharmaceutical representatives, medical institutions and some government staffs. Hence, the medicines prices are finally resulting at a high level.

In the long run, in order to cut off the phenomenon of “revenues from prescription medication”, the key of reforming the purchasing and selling mode in the pharmaceutical industry is the separation of medical services and pharmaceutical sales. We can use a variety of ways such as reforming the payment mode of medical expenses and procurement outsourcing. The reform of the purchasing and selling drugs is a complex program. It needs several pilots to explore the policy institutions and effective safeguards which are in line with Chinese national conditions, to gradually lower drug prices.

If we consider this problem from a short-term perspective, direct supply mode can be adopted to solve the core issue of excessive price-adding in medicine circulations. In actual implementation, first of all, medical institutions determine the medicine catalog according to the situation of medicine use. And then, medical institutions select their main supplier and sub-suppliers through public biddings. At the same time, pharmaceutical wholesalers have also been assigned to medical institutions. Later, medical institutions can improve their price mechanism of medicines to ensure their patients really enjoy lower medicine prices, for example, the way of setting the price ceiling can be considered. However, for the decline in revenue, the hospital could compensate through a "Fixed Benefit" from their medicine supplier.

5.3 Some suggestions for future academic research

First of all, my study on uniform bidding mode was limited by sources and spaces. Due to that the use of the uniform bidding mode is widespread in China, the database is huge and it is difficult to collect the first hand data from those hospitals which
implement the uniform bidding mode. Future research on uniform bidding mode could attempt to collect more reliable data to verify the empirical effects in the actual implementation.

Secondly, I narrowed my target on two mode analyzing, case related to uniform bidding mode and case related to direct supply mode in Zhongshan hospital. The conclusion I have made is based only from the cases on uniform bidding mode and direct supply mode in Zhongshan hospital. However, think these conclusions are useful for other modes and other hospitals as well. I would like to suggest future research on a broader background in different patterns of purchasing and selling medicines and in different hospitals.

Thirdly, the data collected from Zhongshan hospital have the mutual bias that affected by some inevitable factors, such as the different treatments have the different medical expenses and number of patients with “expensive deceases” would be vary in each year. It is difficult to eliminate these biases during the comparison although I carefully checked and adjusted all the data I used in the thesis. In the future study, deep research on direct supply mode is necessary. It could discuss how to balance the interests of hospitals and wholesalers in the implementation and how to promote this mode nationwide.

Fourthly, this thesis mainly studied the vertical relations in the pharmaceutical industry chain. Future empirical research could involve the horizontal relationships between the pharmaceutical industry and other related industries.
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Appendix A

The bidder i’s payoff function as follow:

\[
\pi_i = \pi_i(P_1, P_2, c_1, c_2) = \begin{cases} 
  P_i - c_i, & \text{when } P_i < P_j; \\
  (P_i - c_i) / n, & \text{when } P_i = P_j; \\
  0, & \text{when } P_i > P_j. 
\end{cases}
\]  

(1)

Note: In the formula (3.1), i, j = 1, 2, ..., n; i ≠ j.

To find Bayesian Nash equilibrium of this game, we should first find the bidding strategies space of both sides. Gibbons (1999) proposed that in a static Bayesian game \( G = \{S_1, ..., S_n; T_1, ..., T_n; u_1, ..., u_n\} \), the strategy \( S = (S_1^*, ..., S_n^*) \) is a Bayesian Nash equilibrium. For each player i and for each of i’s type \( t_i \) in \( T_i \), \( S_i^* (t_i) \) solves:

\[
\max \sum_{t_i \in T_i} u_i(S_i^* (t_1), ..., S_i^* (t_{i-1}), S_{i+1}^* (t_{i+1}), ..., S_n^* (t_n)) p_i(t_i | P_i)
\]  

(2)

In my sealed bid auction model, bidder i’s strategy function is \( P_i(c_i) \), the collection of all such functions \( P_i(c_i) \) constitute its strategic space. To each \( c_i \) in the \([0,1]\), the \( P_i(c_i) \) solves:

\[
\max \left[ (P_i - c_i) p(P_i | P_j(c_j)) + \frac{1}{n} (P_i - c_i) p(P_i = P_j(c_j)) \right]
\]  

(3)

Due to \( c_i \) obey a continuous distribution, and \( P_i(c_i) = a_i + b_i c_i, \) \( P_j(c_j) = a_j + b_j c_j \), then, the probability of \( P_i = P_j \) will equal to 0. The above equation (3) becomes:

\[
\max \left[ (P_i - c_i) p(P_i | P_j(c_j)) \right]
\]  

(4)

Setting \( \Phi (P_j) \) is the Inverse Function of \( P(c_i) \), that means when the selected bidding price is \( P_j \), the corresponding cost of bidder \( j \) is \( \Phi (P_j) \), i.e. if \( P_i = P_j(c_i) \), then \( \Phi (P_j) = c_j \) (Michael, 1994). Due to the \( c_i \) obey the uniform distribution on \([0,1]\) and each participant costs are independent of each other, it has:

\[
p[P_i | P(c_j)] = p[\Phi(P_i) | c_j] = [1 - \Phi(P_i)]^{-1}
\]  

(5)

Thus, substituted the formula (5) into formula (4), get:

\[
\max \left[ (P_i - c_i) p(P_i | P_j(c_j)) \right] = \max \left[ (P_i - c_i) \times [1 - \Phi(P_i)]^{-1} \right]
\]  

(6)

Then, the first-order conditions of the optimal strategy of player i is:

\[
1 - \Phi(P_i) + (P_i - c_i) \times (n-1) \times \frac{d}{dP_i} \Phi(P_i) = 0
\]  

(7)

In order to make the \( P (\cdot) \) to be a symmetric Bayesian Nash equilibrium, the solution of above the first-order condition should be equal to \( P (c_i) \). Therefore, the above
equation (3.12) becomes:

\[ 1 - \Phi(P(c_i)) + (P(c_i) - c_i) \times (n - 1) \times \frac{d}{dP_i} \Phi(P(c_i)) = 0 \]  
(8)

From above assumption, we known \( \Phi(P_i) = c_i \). For simplicity, the following formulas omitted i. Hence, the above equation (8) becomes:

\[ 1 - c + (p - c) \times (n - 1) \times \frac{dc}{dP} = 0 \]

\[ \Rightarrow (1 - c)dP - (P - c)(1 - n)dc = 0 \]  
(9)

In order to solve the equation (9), we must first figure out whether it is a full-differential equation (Zill, 1993), here set \( M(P, c) = 1 - c \), \( N(P, c) = (P - c)(1 - n) \). Then, it has \( \frac{\partial M}{\partial c} = -1, \frac{\partial N}{\partial P} = -(n - 1) \), they are not equal, so the equation (3.14) is not a full-differential equation. However, owing to \( -\frac{\partial M}{\partial c} \times \frac{\partial N}{\partial P} = \frac{n - 2}{c - 1} \) does not have any relationship with \( P \), the equation (9) has the Integrating factor \( \mu(c) \) which excluded from the \( P \) and a solvable equation:

\[ \frac{\partial M}{\partial c} \times \frac{\partial N}{\partial P} = \frac{n - 2}{c - 1} \]  
(10)

Hence, the above equation (9) becomes:

\[ (c - 1)^{n - 2} [(1 - c)dP + (P - c)(1 - n)dc] = 0 \]  
(11)

And this equation (11) is a full-differential equation. Because \( \mu(c) = (c - 1)^{n - 2} \neq 0 \), this equation (11) has the same solutions with the equation (3.14). According to the method of solving the full differential equation, we can obtain:

\[ \int (c - 1)^{n - 1} dP + \int (c - 1)^n(1 - n)dc = 0 \]

\[ \Rightarrow (c - 1)^{n - 1}(P - 1) \times \frac{n - 1}{n}(c - 1)^n = 0 \]

\[ \Rightarrow P^*(c) = \frac{n - 1}{n}c + \frac{1}{n} \]

It is not difficult to find that \( P^*(c) \) increased with the increase of \( n \), in particular, when \( n \rightarrow \infty \), \( P^* \rightarrow c \).
Appendix B

Interview with Zhongshan

Interview Questions from interview with Jinbo Luo at the Department of Surgery of Zhongshan Hospital in Wuhan, 2012.05.07, 13:00. Interviewed and translated from Chinese to English by Liu Xu.

1 What do you think is the most important change brings by the implementation of the direct supply mode in the hospital?
2 Do you think the direct supply mode is really reduced the prices of medicines for the patients?
3 How did the direct supply mode curb the commercial bribery in the hospital?
4 What are the contributions of implementation of the direct supply mode do you think for the future health care reform?
5 How many medicines have been streamlined after introduce the direct supply mode?
6 Before introduce the direct supply mode, how many pharmaceutical suppliers for the entire hospital?
7 Do you think Jiuzhoutong can meet the hospital's medication demands and guaranteed the quality of medicines?
8 Can you give some comments for the new catalog of medicines?
9 Do you think the income of doctor is really decreased after introduce the direct supply mode?
10 How did the hospital improve their compensation mechanism for the decrease in income of doctors?
11 Do you think the doctors still have the motivation to prescribe expensive medicines?
12 Do you think what kind of external effects have also brought by the direct supply mode?
Interview Questions from interview with Yuyuan Liu and Huajun Xiao
outpatient department of Zhongshan Hospital in Wuhan, 2012.05.08, 16:00.
Interviewed and translated from Chinese to English by Liu Xu.

1 What factors would you consider when you choose the hospital?
2 Do you feel that the medicine prices in hospitals’ pharmacy are higher than that in
general pharmacy?
3 Do you think the medicine price is an important factor that you would consider
when you choose the hospital?
4 Why did you choose the Zhongshan hospital for treatment?
5 Do you know the direct supply mode launched by Zhongshan hospital?
6 Did you feel the decrease in medicine price after introduce the direct supply mode
in Zhongshan?
7 Do you trust the doctors’ prescriptions and willing to purchase the medicine from
pharmacy of Zhongshan hospital after the new reform?
8 What kind of changes do you not satisfied with after the implementation of the
direct supply mode in Zhongshan?
9 Do you think the phenomenon of big prescription is still exists in the hospital?