Health Economic Analysis of China's Health Insurance System

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Abstract

This thesis consists of 3 chapters plus an introductory chapter and a concluding chapter. They are on three different topics, but they are all related to China's health insurance system from 2000 to 2011.

Chapter 1 is the introduction to the thesis, providing background to the Chinese insurance system, the theoretical underpinning of the three chapters, a description of the datasets used in the thesis, and an overview of the thesis.

Chapter 2 investigates whether there is adverse or advantageous selection in China's private health insurance market before 2003. We found evidence in favour of adverse selection in a pure private insurance market. For the public insurance group where people already got covered by a public insurance but face the choice of buying a supplementary private insurance, we found advantageous selection.

Chapter 3 examines whether implementing nearly universal coverage in 2009 led to a decrease in individual preventive behaviour prior to illness, termed ex-ante moral hazard. We exploit the longitudinal dimension of data from 2006 and 2009 and use Coarsened Exact Matching methods. The results do not provide strong evidence for ex-ante moral hazard.

Chapter 4 aims at evaluating whether there is ex-post moral hazard after the introduction of universal coverage. We measured ex-post moral hazard as the impact of co-payment rate on treatment cost, to assess the variation of total medical expenditure to patients due to the decrease of price. We conclude that there is ex-post moral hazard in outpatient services after the reform of universal coverage in China.

Chapter 5 is the concluding chapter, including a summary of the findings, policy implications, strength and limitations of the thesis, and challenges for future research.

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Declaration

I, Chen Chen, declare that this thesis titled, 'Health Economic Analysis of China's Health Insurance System', is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References. I confirm that:

- Chapters 2, 3 and 4 were presented at the University of York's Health, Econometrics and Data Group Seminar Series between 2013 and 2015.
- Chapter 2 was presented in July 2014 at Trinity College, Dublin, as part of the International Health Economics Association's 10th World Congress, Health Economics in the Age of Longevity.
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Chapter 1: Introduction to the Thesis

1.1Introduction

The health insurance market in China has experienced large reforms over the past few decades. From the 1940s to the 1990s, China's health system witnessed a transformation from a pure government delivery model to a model that was radically driven by profit incentives. Since the 1990s, the Government accelerated the marketization of hospitals. The Government cut subsidies to hospitals and pushed them to operate in a competitive market, although hospitals are still owned by the Government. However, a health insurance system was not well-structured in China. Not all people (19%) were covered by public insurance and commercial health insurance markets were very small. Only 9% of the population were covered by private insurance by 2000 (China Health Statistical Yearbook 2001). As a consequence, accessing a doctor has been difficult and expensive for an individual. This has been a major social concern for Chinese people which has led to social instability in recent years. After a nationwide extensive debate on the clashes between a "government approach" and "market approach", the Government of China initiated a comprehensive health-care reform in 2003, committing over RMB 850 billion (about 85 billion GBP) to the project in response to the increasingly severe problem in the health care system.

The reform signals a new chapter of China's health care system. Total health expenditure has increased from 3.65% of GDP in 1994 to 5.01% of GDP in 2010. This growth was primarily from out-of-pocket spending, but government spending contribution gradually became a major source after the health care reform. Private spending, i.e. payment directly from the patients, reached a peak of 59.97% of the total

health spending in 2001 and gradually declined to 35.52% by 2010 as a consequence of health care reform (2012 National Health Account). The reform was primarily focused on the following five areas: public insurance, service delivery, essential medicines, public health and public hospital reform. Among them, one of the most remarkable achievements is that the reform increased the population coverage of public insurance from 20% in 2000 to 99.6% in 2014 by providing two new public insurance schemes, namely the New Cooperative Medical Scheme (NCMS) and the Urban Residents Basic Medical Insurance (URBMI).

In recent years, there have been various studies examining the effectiveness of China's healthcare reform. Some studies look at the effect on access to health services (Wagstaff and Lindelow, 2008; Wagstaff et al. 2009; Meng et al. 2012). The results consistently show that the reform has significantly increased the utilization of healthcare facilities. Another strand of literature looks at the effect of healthcare reform on health outcomes (Liang et al., 2012; Cheng et al., 2015). The results are mixed. Some of the studies suggest that population health has improved after the reform, while others claim that there is no significant statistical result supporting this idea. Another strand of literature looks at the effect of China's healthcare reform on out-of-pocket expenditure (Wagstaff and Lindelow, 2008; Wagstaff et al. 2009; Yip and Hsiao, 2009; Long et al, 2013). Results indicates that the current reform appears to have no effect on reducing out-of-pocket expenditure.

No studies have looked at unintended consequences of China's healthcare reform. While the health reforms have allowed many more individuals to access health care services, there remain important research questions about the efficiency of the system. In particular, an important question is whether near universal coverage comes with certain concerns that are often associated with health insurance markets, such as

adverse selection and moral hazard. The rapid change in China's private and public health insurance market has provided a valuable scenario to evaluate such effects and to complement existing empirical evidence on adverse selection and moral hazard.

1.2Background of Chinese insurance system

1.2.1 Before the era of Universal Coverage: 1950s-2002

There has been a long history of Chinese insurance policies being designed separately for rural and urban populations. Figure 1 presents the insurance coverage situation during this period. Between the 1950s and 1970s, when China was under a central planning economy, China's health system was "a government delivery model and featured by government hospitals personnel funded by government or pooled community funds" (Ho, 2011). This means that all hospitals were operated by the government, with funding from either government or pooled community funds. Government subsidies were mainly given to providers rather than consumers. During the 1950s to 1970s, 80% of the population were rural and most of them were covered by Cooperative Medical Schemes (CMS). Run by agricultural communes in different areas, these schemes only covered primary health care services like basic medicines and immunization services. Although village doctors could only provide minimal care because of a lack of training, life expectancy at birth was improved from 40 years in 1949 to 65.5 years in 1980, a substantial improvement in population heath (Miller et al., 2011). Most of the urban population had access to health services through the employment based Labour Insurance System or the Government Insurance System. Chinese citizens in rural and urban locales had equal access to primary health care services at that time (Miller et al., 2011). There was no commercial insurance market during this 20-year period due to a massive nationalization movement in the 1950s.

Figure 1: Public health insurance in China from the 1950s to the 1970s

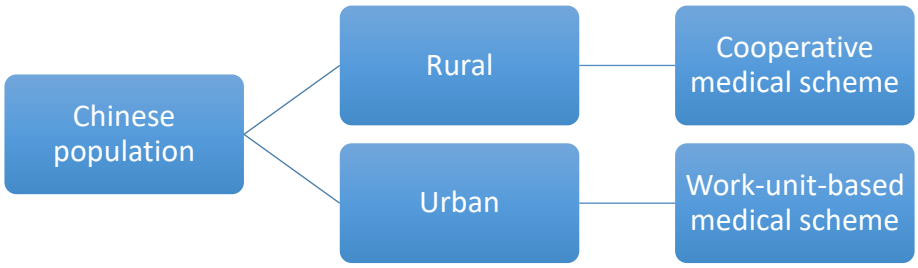
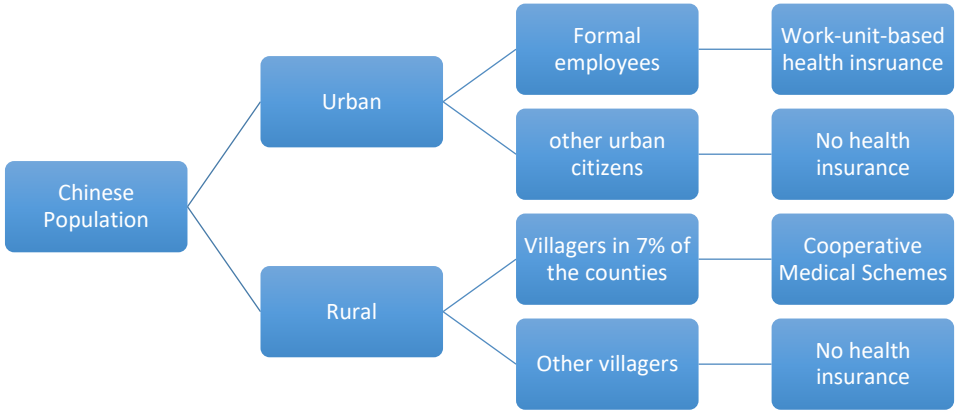


Figure 2 shows the health insurance system from the 1980s to the early 2000s. It was characterized by decentralization with the economy transforming from central planning to a market-based economy. Government revenue dropped sharply because it liberalized its economy and it began to decentralize financial management to local governments. By the early 1980s, the Cooperative Medical Scheme almost collapsed with the radical Cultural Revolution. Insurance coverage of counties in rural areas dropped from more than 90% to 7% of the counties by 1999, with village doctors becoming fee-for-service providers (Eggleston, 2012). In urban areas, public funding also declined dramatically, and local government tended to see care providers like other economic entities and encourage them to self-finance (Yip and Hsiao, 2015). Subsidies to the supply side only covered up to 10% of the expenses, leaving 90% of provider income from out-of-pocket payment from uninsured patients. The Government controlled the price for basic medicines to ensure financial accessibility to basic health care. However, hospitals and other care providers had profit-driven incentives to invest in high-end technologies that were without price control, leading to an over-utilization of higher-priced drugs and tests (Eggleston, 2012). The insurance coverage was declining over time. The majority of the Chinese population did not have public insurance between 1980 and 2002. Commercial health insurance

served as a role of supplementary to public insurance, but the market was relatively small. The share of the out-of-pocket spending out of total health expenditure increased from 20.43% in 1978 to 59.97% in 2001. This figure was underestimated because it was without "under the table" money from patients to doctors, called "red packet", paid in order to get better services (Eggleston, 2012).

By the late 1990s, problems and concerns had emerged in the health sector resulting from the rapid transformation of the Chinese economy. First, unnecessary high-priced drugs and high-tech tests led to a lack of efficiency of health care. Second, inflation in health care expenditure increased rapidly. China's total health spending increased from 3.65% of GDP in 1994 to 5.01% of GDP in 2010, with rapid growth primarily from out-of-pocket spending. Financial barriers on the demand side became one of the most severe problems (Eggleston, 2012). Third, there were disparities between rural and urban areas in terms of population health. For instance, mortality rates for under five-year-olds was much higher in rural areas than in urban areas (33 in 1000 in rural versus 13 in urban area in 2003) (Yip and Hsiao, 2015).

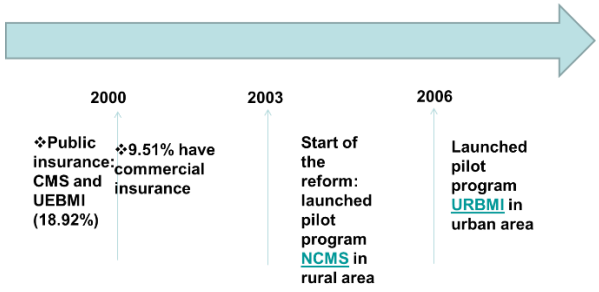
Figure 2: Public health insurance in China from the 1980s to 2002



1.2.2 The path towards Universal Coverage: 2003-2008

In the early 2000s, seeing a doctor was difficult and expensive became a major social concern for Chinese people and caused social instability. In response to huge criticism, the Chinese government started to pilot reforms in China's health care system. Generally speaking, the period between 2003 and 2009 saw the transformation of Government's subsidies from the supply side to the demand side mainly through subsidies to premiums for public health insurance. As shown in Figure 3, there were three public insurance programs being designed to expand insurance coverage to the whole population of China: 1) New Cooperative Scheme (NCMS) for rural residents, 2) Urban Employee's Basic Medical Insurance (UEBMI) for urban employees, 3) Urban Resident Basic Medical Insurance (URBMI) for other urban residents.

Figure 3: Timeline to Chinese health insurance reform



Public health insurance in rural area

In rural areas where 50.3% of the population live, the Government announced direct budgetary support for the NCMS in 2002. It was piloted in selected villages in 2003 and quickly expanded to nationwide. Three guidelines were given by central government to counties. First, it is a voluntary programme, but it requires full household participation to reduce adverse selection. That is to say, a family either has to have all members enrolled into the program or none. Second, the scheme is administrated (designed and implemented) at county level and the risk pooling is also at county level. Therefore, the programmes vary across counties in terms of premiums,

deductibles, and co-payments. Third, central government, local government and households all contribute to the funding. The primary objective is to deal with catastrophic expenditure and then gradually improve the benefit package of health insurance.

Beneficial packages of NCMS differ in three main aspects across counties: 1) the reimbursement rate of inpatient services; 2) the reimbursement rate of outpatient services; 3) whether the reimbursement is from a medical savings account. Medical savings accounts act like a bank account but can only be used for health care facilities. It can be used by any member from a household. Usually, funds in this account combine the premium paid by every family member with the subsidies from Government sources. Since each household differs in their numbers and composition and every local government differs in the amount of subsidy, the value across family medical accounts is not necessarily the same for each household. Only household members are entitled to use the funds in their own account.

Table 1: Models of different benefit packages for NCMS

Models	**Outpatient service**	**Inpatient service**	
Model 1	Paid by family saving accounts（Deductibles and caps apply）	Reimbursed according to a formula (Deductibles and caps apply)	65%
Model 2	Reimbursed through collective funds (No deductibles and caps)	Reimbursed according to a formula (No deductibles and caps)	7%
Model 3	Only reimburse expenditures for critical disease (Deductibles and caps apply)	Only reimburse expenditures for critical disease (Deductibles and caps apply)	11%
Model 4	Not covered by NCMS	Reimbursed according to a formula (Deductibles and caps apply)	17%

There are four main models of benefit packages for NCMS as shown in Table 1. A similarity shared by all four models is that benefit packages for critical illnesses like

cancer, uremia, etc. are more generous than other diseases. 65% of the counties implement the first model, in which inpatient services are reimbursed according to a formula while outpatient services are mainly paid by family medical saving accounts. Deductibles and reimbursement caps apply to the medical saving account. For instance, patients need to pay RMB 10 (approximately £1) out-of-pocket before they can use medical saving account to pay the remainder. They also have a reimbursement cap per outpatient visit and per year respectively. Reimbursement cap is the maximum amount that individuals can get reimbursed from the insurance policy. The amount that is above the cap is paid out-of-pocket by the patients. Deductibles, reimbursement rates and caps vary across different geographical regions and insurance schemes. The reimbursement rate of inpatient services was usually up to 50% during the piloting years. The second model, which is used in 7% of the counties, adopts the same way of reimbursement of inpatient services as the first one. The difference lies in outpatient services since outpatient reimbursement is through collective funds run by counties according to a specified formula. Families do not have a medical savings account in this model, and all the reimbursement for outpatient services are through collective funds, which is financed by insurance premiums, local and central government subsidies. There is no deductible or reimbursement cap under this model. The third model only reimburses expenditure for critical diseases, including both inpatient and outpatient services with different deductibles and reimbursement caps respectively. 11% of the counties use this model. The fourth model, implemented in 17% of the counties, only reimburses inpatient services but not outpatient services. Overall, benefits from NCMS are less generous than the other two schemes.

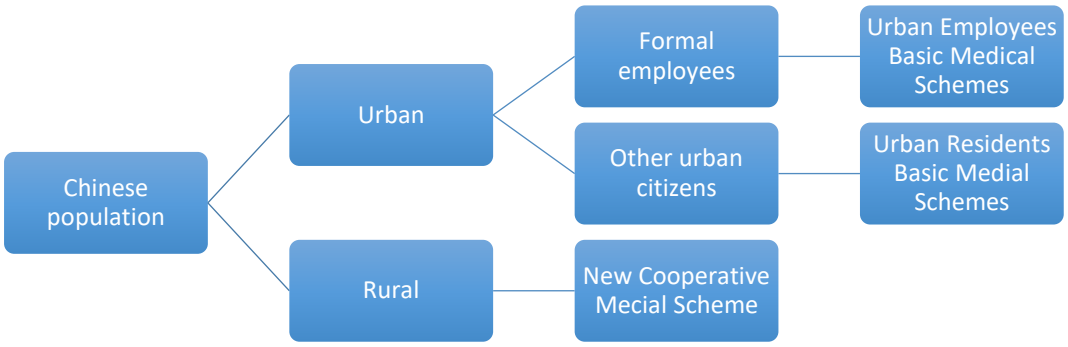
Public insurance in urban area

Among the urban population, employment-based coverage has been replaced by UEBMI from 1998 (Liu et al., 2012). UEBMI covers employees who are formally employed in the urban labour market. UEBMI covers 64% of the urban employed population which only accounts for 31% of the total urban population (Wan et al. 2011). Full-time employees are required to buy UEBMI. The premium is around 2% of their income. Their employers, acting as sponsors, pay 6% to 10% of individuals' income as subsidies. Employers' payments vary according to the ages of the employees. Payments from individuals go to an individual medical savings account. It is very similar to the family medical savings accounts in NCMS but can only be used by the employee rather than the entire family. Individuals can only use money from this account for medical expenditure. Payments from the sponsors go to "health care funds" run by the government used for redistribution. Co-payment rates vary from 0% to 50% for this insurance plan depending on insurance policies designed by local governments. The benefit is the most generous among the three social insurance schemes.

Later in 2006, central government piloted a similar program as NCMS to cover urban citizens who were not eligible for UEBMI, including the unemployed, students, retirees, and other dependents. It is called the Urban Residence Basic Medical Insurance Scheme (URBMI), which is a voluntary scheme, with government subsidizing premiums. Similar to the NCMS, the enrolment is at household level and the administration is at city government level. Generally speaking, the premium is lower than UEBMI but a little higher than NCMS. The premium is partly paid by the insured person and partly subsidized by central and local government. The benefit package puts emphasis on inpatient services and catastrophic diseases. Different

deductibles and reimbursement caps are applied according to levels of hospitals and different kind of diseases. The reimbursement rate varies from 50% to 65%. It reimburses very little or no outpatient expenditure.

Figure 4: Public health insurance from 2003 to 2008



Commercial insurance market

With regard to commercial insurance, individuals still have an incentive to purchase this even though they are covered by public insurance. First of all, public insurance plans do not provide full insurance. In other words, individuals still have to pay for some medical services out-of-pocket, such as dental services and hearing aid services. Secondly, medical costs have been climbing in recent years, especially for expensive devices and patented drugs. As a result, out-of-pocket payments from individuals could be significant even for services which there is partial subsidy. Thirdly, although the benefit package varies among different plans and different areas, public insurance schemes, especially URBMI and NCMS, often have low caps for reimbursement. Consequently, individuals who have serious acute illnesses or chronic illnesses will still have a huge financial burden even though they are partially covered by public insurance. Therefore, there is an opportunity for private insurance plans to fill the coverage gaps for public insurance.

Private health insurance in China serves around 7% of its population by 2012. It is mainly used by the public as a supplement to public health insurance. Private health insurance in China is mostly purchased by individuals rather than households. Although the size of the commercial insurance market is relatively small compared with public health insurance, it has undergone rapid growth in recent years. According to a report from McKinsey consultancy (2012), the number of private health insurance companies has grown at an annual rate of over 25% from 2001 to 2011. In addition, the per capita spending on private health insurance is almost ten times what it was ten years ago.

The number of private health insurance plans is also increasing. In 2008, there were a total of 300 insurance plans. The figure increased to about 1000 in 2012. Nevertheless, those plans are usually undifferentiated and concentrate on partial payments for hospitalization or contract on a particular severe disease. Currently, most of the top Chinese insurance companies offer private health insurance to groups and individuals, even though unlike many other mature insurance markets, there are no tax incentives for firms to buy group commercial insurance for their employees. To enhance their competitiveness and improve the service, most of insurance companies have launched a so-called instant claim initiative, which cover thousands of hospitals across the country. It is an operation model initiated by local government to build collaboration between hospitals and private health insurers. The most common initiative is the direct settlement of patient bills between hospitals and insurers (Chen and Wang, 2012). Through cooperation between insurance companies and hospitals, the public can not only receive better service from hospitals but also competitive offers from insurance companies.

Chapter 2 investigates the private insurance market from 2003 to 2009 in order to evaluate whether there is evidence of advantageous or adverse selection. During this period, a group of people had access to public insurance schemes and faced the choice to buy a supplementary private health insurance. Meanwhile other people who were not in a piloting area and were not eligible for public insurance had to choose between having no insurance coverage and buying private cover.

1.2.3 The path towards Universal Coverage: 2009—

After approximately 6 years of piloting insurance programs, the Chinese government officially announced a comprehensive health reform in 2009, with an investment of RMB 850 billion (around GBP85 billion) over three years (Ho, 2011). The first of five priorities of the reform was to further expand public insurance coverage and achieve universal coverage. In reality, more government investments were spent to subsidize the premiums of NCMS and URBMI to enroll as many residents as possible. By 2013, significant progress was made in terms of coverage rate, and the improvement of the benefit package. More than 95% of the population was covered by one kind of social insurance according to China Health Statistical Yearbook 2013. Meanwhile, reimbursement for NCMS became more generous, with the inpatient reimbursement rate gradually increased up to 75% and the outpatient rate increased up to 50% of expenditure (Yip and Hsiao, 2015).

Because the benefit packages and fund level are different across urban and rural health schemes, this fragmentation of rural and urban public health schemes is considered as a factor that cause disparities between rural and urban residents (Zheng, 2014). Since the middle of 2014, some areas in seven provinces piloted the consolidation of NCMS and URBMI schemes in order to coordinate the rural and

urban social development (Meng et al., 2015). However, data after 2013 are not available for our analyses, this consolidation element is not included in the thesis.

Expanding insurance coverage may usually be associated with the problem of moral hazard (Arrow, 1963). Although co-payment and household enrollment policies are introduced to deal with the problem, total cost of health care has increased tremendously after the implementation of near universal coverage. The rapid growth could partly due to satisfying previous unmet needs, and partly attributed by moral hazard (Tang et al., 2012). The aim of Chapter 3 and Chapter 4 is to test whether there is ex-ante or ex-post moral hazard comparing the data before and after the reform.

In the next section, I will present the theoretical background for main economic concepts discussed in the thesis, including adverse selection, advantageous selection, ex-ante moral hazard and ex-post moral hazard.

1.3 Theoretical background of the chapters

1.3.1 Theoretical model for adverse selection

Adverse selection exists in a market with asymmetric information. As discussed by Arrow (1963), insurance companies can only charge an average price under asymmetric information because they do not know the risk type of their consumers. In this case, generous plans will attract sicker people, while moderate plans will attract healthier ones. Later on, Rothschild and Stiglitz (1976) further developed this model and declared that competitive equilibrium cannot exist in a market with asymmetric information. The health insurance market is exactly such a market because consumers have greater information about their own risk type than health plans (Frank et al., 2000). The classical model predicts that consumers with higher risk of suffering financial loss due to sickness intend to have higher levels of health insurance coverage.

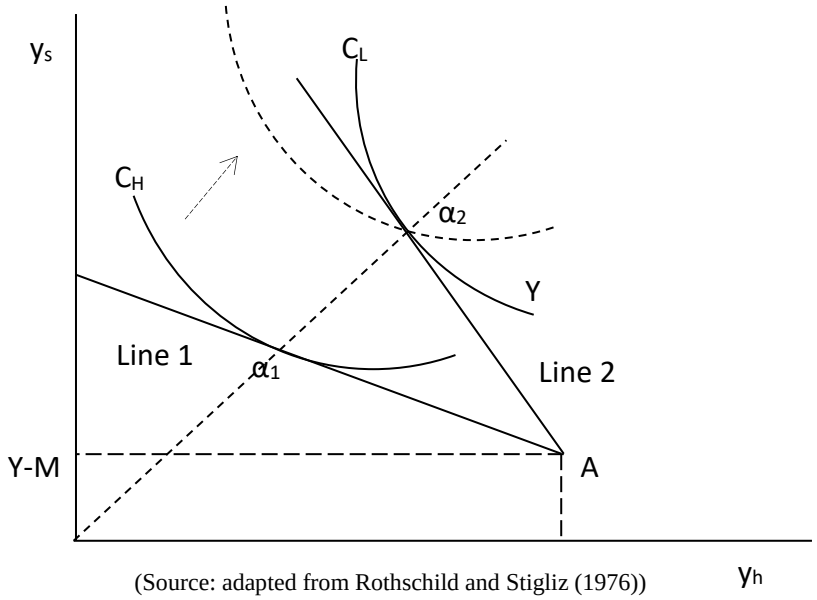
The basic model is established in a competitive market, characterized by free entry and perfect competition. Competitive insurance market equilibrium is defined as a status that "when customers choose contracts to maximize expected utility, (i) no contract in the equilibrium set makes negative expected profits; and (ii) there is no contract outside the equilibrium set that, if offered, will make a nonnegative profit." (Rothschild and Stiglitz, 1976).

Here we present a very simple version of Rothschild and Stiglitz model. Assume there is no insurance, individual's income is $y_h = Y$. If sick, his/her disposable income becomes $y_s = Y - M$, where M represents the cost of medical care. With insurance, the individual has disposal income $y_h = Y$-P, where P denotes the insurance premium if s/he is healthy. If the consumer suffers from sickness, disposal income becomes to $y_s = Y - M - P + I$, that is income minus medical care cost minus premium P, plus reimbursement I. Consumers choose the insurance contract to maximize their expected utility $= \pi u(y_s) + (1 - \pi)u(y_h)$, where π denotes the probability of getting sick. In this model, all consumers are assumed to be risk-averse ($U'' < 0$), which means that their utility function is concave. There are two types of consumers in the market, namely, L-type with low probability of getting sick (π_L) and H-type with high probability of getting sick (π_H), with $\pi_H > \pi_L$. They are identical in all aspects except for risk type.

The other kind of participants in the market are the competing insurers who sell insurance contracts. Companies are assumed to be risk-neutral and only concerned about expected profits. Two types of health plan are available for consumers – a generous plan (α_1) and a moderate plan (α_2). Generous plans are designed for H-type

consumers with higher premium and moderate plans are designed for L-type consumers with lower premium.

Figure 5: No equilibrium under symmetric information



(Source: adapted from Rothschild and Stigliz (1976))

If information about an individual's risk type is symmetric between consumers and insurance company, competitive equilibrium does not exist. As shown by Figure 5, C_H and C_L are indifference curves for H-type and L-type consumers respectively. Each point on the indifference curve gives the individual the same utility. X-axis and Y-axis refer to income when individual is healthy and sick. Points on diagonal line are full insurance because it gives no income difference with being sick or not. Point A is the initial endowment of all the consumers. Point A must be below the diagonal line (45% line) because $y_h > y_s$ when individual does not have insurance. Suppose contracts α_1 and α_2 satisfy separating equilibrium which allow both types of consumers to be fully insured which maximize their expected utility, α_1 and α_2 locate on the 45 degree line. Because consumers are risk-averse, both contracts will leave them the same disposable income regardless of their health status. Under perfect competition and free entry,

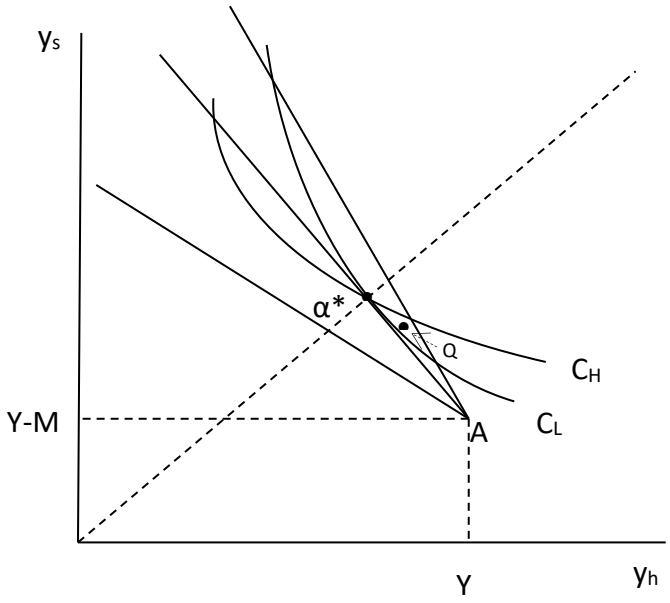
insurance companies make 0 profits. Line 1 and Line 2 are fair-odds lines which represents zero profit.

At this stage, H-type consumers have the incentive to buy a contract with lower premium α_2 which gives them higher disposable income when they are sick. Therefore, the equilibrium is not sustainable because H-type consumers have an incentive to deviate from α_1.

However, symmetric information is not the case in reality where the information about risk type is only one-dimensional to consumers. Rothschild-Stiglitz model shows that pooling contract equilibrium in which both types of consumers buy the same contract does not exist either. The proof is given in Figure 6.

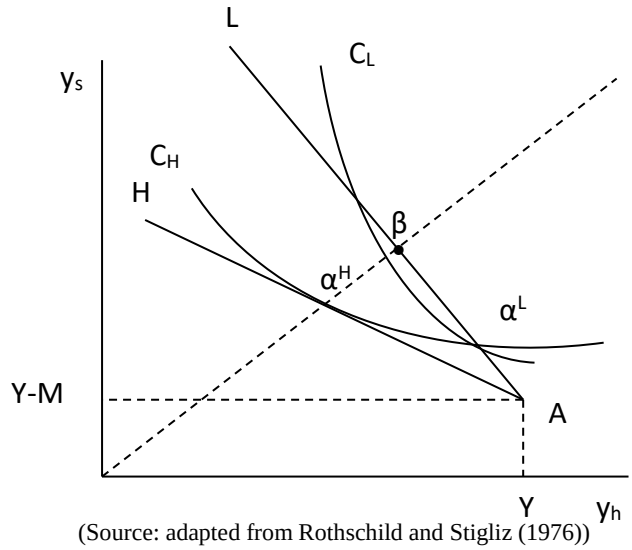
Suppose the contract α^* in Figure 6 signals a pooling equilibrium. Profit in equilibrium should be zero under perfect competition. A contract Q which is slightly above α^* will attract L-type consumers to deviate from α^* because it delivers higher utility. If there is a contract Q available in the market, this contract will attract the whole market because the market is perfectly competitive. Thus, it violates equilibrium condition (ii) stated above: "there is no contract outside the equilibrium set that will make a nonnegative profit" (Rothschild and Stiglitz, 1976).

Figure 6: No pooling equilibrium under asymmetric information



(Source: adapted from Rothschild and Stigliz (1976))

Figure 7: Separating equilibrium under asymmetric information



(Source: adapted from Rothschild and Stigliz (1976))

An alternative equilibrium—separating equilibrium—may exist if the proportion of low risk type is itself low. In a separating equilibrium, two types of individuals buy different insurance contracts. As indicated in Figure 7, contract α^L for L-type

consumers lies on line AL with a slope of $(1-\pi_L)/\pi_L$ and contract α^H for H-type consumers lies on line AH with a slope of $(1-\pi_H)/\pi_H$. H-type consumers would prefer contract α^H since they are fully insured. With regard to L-type consumers, they would prefer a contract on line AL. Similarly, contract β which gives them complete insurance would be more attractive than α^L. However, if the insurance company sells both contract α^H and β, H-type consumers would prefer β than α^H. In the case of asymmetric information, all consumers would buy β, which would make the insurance company not profitable. Therefore, contract α^H and β would not constitute equilibrium. Only when the insurance company offers contract α^H and α^L will there be equilibrium, because contract α^L lies on the intersection of H-type and L-type's indifference curves so that H-type prefer α^H than α^L while L-type prefer α^L than α^H. As a consequent, low-risk type consumers are only partly insured. Therefore, equity problem comes out here because high-risk individuals may "either receives poor care and poor service or pays a very high premium for good care and good service", which decrease their access to health care services (Ellis, 2000).

In conclusion, Rothschild-Stiglitz (1976) predicted a positive relationship between risk and insurance coverage. Individuals with high risk of suffering a loss will have high reimbursement and higher consumption.

1.3.2 Theoretical model for advantageous selection

De Meza and Webb (2001) explained contradictory empirical findings (Buchmueller et al., 2013) of adverse selection from a theoretical perspective. They introduced two additional factors –risk preference heterogeneity and transaction costs— that the classical model did not take into account to start their discussion.

The first innovation of this model that is different from Rothschild and Stiglitz (1976) is the inclusion of risk preference heterogeneity. The classical model simply assumes that all individuals have the same risk preference and that they only vary across their expected costs. De Meza and Webb (2001) relax this assumption and assert that risk averse individuals are not only more cautious to prevent bad events but also are more likely to buy insurance than risk-tolerant individuals.

Advantageous selection may emerge because of risk preference heterogeneity. Apart from individuals' differences in their expected risk of financial loss, individuals who are more risk averse may invest more in preventive health care, so they usually have lower risk. Moreover, willingness-to-pay for insurance increases with the degree of risk aversion. If individuals that are most risk averse are also associated with lowest expected cost through lower risk, and if their proportion is sufficiently large, advantageous selection would occur (Einav and Finkelstein, 2011).

Transaction or administrative costs related to marketing health insurance plans, selling plans and processing claims may also play a role. Newhouse (2004) provides evidence that the transaction fee in the health insurance sector is a factor that cannot be neglected. He points out that there is a competition over loading charges in the American health insurance market in recent years. De Meza and Webb (2001) point out that an implication of transaction costs is that it is not socially efficient to insure everyone if the transaction cost is greater than the risk premium for some individuals.

In their theoretical model, De Meza and Webb (2001) demonstrated the existence of pooling, and separating equilibria under advantageous selection. The basic model is built in a competitive market. They assume there are two insurance companies in the market and two types of individuals, *T* and *B*. Type *T* individuals are risk averse

and type *B* individuals are risk neutral. Both types of individuals are equally wealthy but differ in risk preference. They further assume that each insurance company has a transaction cost, C, per claim. Therefore, their utility functions could be expressed as:

$$EU_i(F_i, P_i, \lambda_i, W) = \pi(F_i)U_i(W - P) + \big(1 - \pi(F_i)\big)U_i(W - M + \lambda P) - F_i, \ i = T, B \tag{1.1}$$

Where F_i is a binary variable indicating individuals' preventive effort. P_i is the premium of the insurance, W represents wealth and λP ($\lambda > 0$) is the net premium pay-out in the event of sickness. M is the total medical expenditure in the event of sickness. F_i is a binary variable that "affects the probability of financial loss in the same way for all individuals.", which could be seen as their effort of taking precautions to prevent financial loss in future. Thus $\pi(F_i)$ can be seen as the probability of being sick. The authors assume that if $F_i = 0$, the probability of being healthy is π_0. Then the expected utility is:

$$EU_i(F_i, P_i, \lambda_i, W) = \pi_0 U_i(W - P) + (1 - \pi_0)U_i(W - M + \lambda P), \quad i = T, B \tag{1.2}$$

But if $F_i = \bar{F}$, the probability rises to π_F. The expected utility is:

$$EU_i(F_i, P_i, \lambda_i, W) = \pi_F U_i(W - P) + (1 - \pi_F)U_i(W - M + \lambda P) - \bar{F}, \quad i = T, B \tag{1.3}$$

Then, if we use equation (1.3) minus equation (1.2), we get equation (1.4). This indicates the gain in terms of expected utility from taking precautions to prevent the event of financial loss:

$$\Delta_i = (\pi_F - \pi_0)[U_i(W - P) - U_i(W - M + \lambda P)] - \bar{F}, \text{ with } \Delta_T > \Delta_B \tag{1.4}$$

Their model shows that partial pooling equilibrium and separating equilibrium are possible. The proof is shown in Figure 8. Suppose there are two types of individuals, *T*s and *B*s, in the market. Their respective utility functions are $U_i = U(\gamma_i + W) - F_i$, where *i* denotes the type of individual with respect to their risk preference, γ_i is the parameter indicating preference of specific individuals, *W* represents wealth. For *T*s, they have a lower α_i and they are risk averse with a strictly concave utility function U_T. Meanwhile, *B*s have higher α_i and they are assumed to be risk neutral with a linear utility function U_B.

In Figure 8, Point A is the wealth endowment with (W, $W - M$). Setting equation (1.4) equal to zero, we get the line PP′. It shows the state of (W, $W - M$) that delivers $\Delta_T = 0$. If $\Delta_T \leq 0$, *T*s have no incentive to take prevention effort because it does not yield higher utility. As shown in Figure 8, individuals (*Ts*) located in the lower region of PP′ take preventive effort, while *Ts* located in the upper region do not take preventive efforts. With regard to *B*s, they are assumed to be the ones that never take precautions.

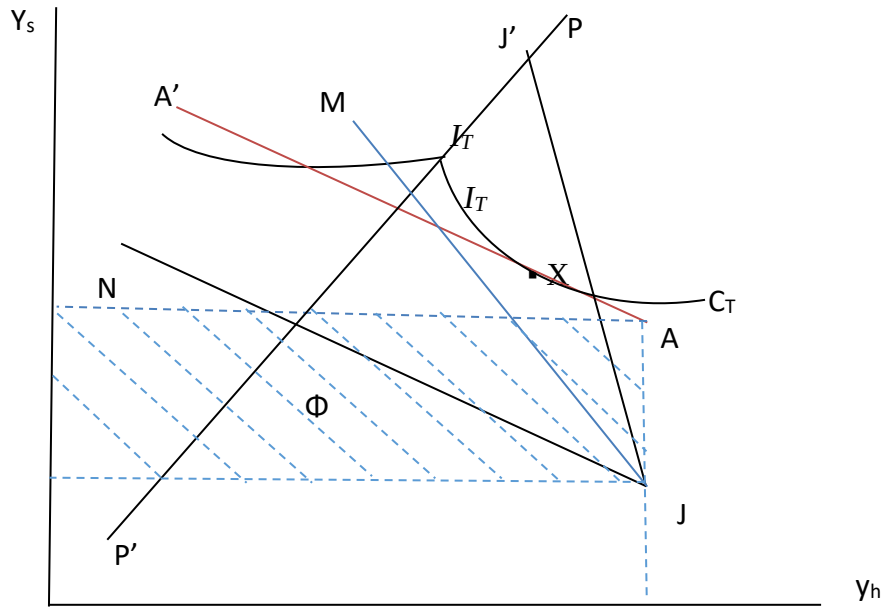
The indifference curves C_T are drawn in income space assuming optimal level of precautions is chosen. They are kinked where they cross PP′. This is because above PP′, the probability of loss is raised, and so the indifference curve is flattened. AA′ is the indifference curve of a *B*. It is linear because *B*s are risk neutral and they never take preventive efforts.

Under perfect competition, insurance companies make zero profit. The location of zero profit curve depends on the level of transaction cost Φ. When all insurance applicants take preventive efforts, the zero-profit curve is JJ′ where Φ is the lowest. J is below A because there is administrative cost for insurance companies. The size of

transaction cost Φ is shown in Figure 8 as the shaded area. This area captures the difference between the endowment point A and point J (the starting point of zero-profit curve of insurance companies). Curve JM shows the zero-profit curve when *T*s take preventive efforts and *B*s do not. JN is the zero-profit curve when nobody takes preventive efforts. When transaction cost is sufficiently high, no insurance company will offer insurance contract and all agents remain at their endowment point.

There is a partial pooling equilibrium when this contract X locates at the tangency between indifference curve of Ts and *B*s, which are I_T and AA′respectively in Figure 8. It maximizes the utility of *T*s (risk averse individuals) and leaving some *B*s (risk neutral individuals) uninsured. With regard to welfare, De Meza and Webb (2001) suggest that introducing a small but fixed tax on each insurance plan could yield a strict Pareto improvement if they further return the tax as a lump-sum subsidy to the whole population.

Figure 8: Partial pooling equilibrium when individuals' have different risk preferences



(Source: adapted from De Meza and Webb (2001))

Separate equilibrium may exist if the contracts (Z_T and Z_B) with *T*s and *B*s satisfied with the incentive compatibility:

$$\mathrm{E}U_T(Z_T) \geq \mathrm{E}U_T(Z_B)$$

$$\mathrm{E}U_B(Z_B) \geq \mathrm{E}U_B(Z_T)$$

It indicates that expected utility for *T*s from purchasing contract Z_T should be no less than the expected utility from purchasing contract Z_B. Meanwhile, the expected utility for *B*s from purchasing contract Z_B should be no less than the expected utility from purchasing contract Z_T.

Another condition that is needed to satisfy is the precautions incentive compatibility:

$$F_i = \begin{cases} \bar{F} \ \ if\ \Delta_i \geq\ 0 \\ 0\ if\ \Delta_i <\ 0 \end{cases}$$

Under separate equilibrium, all *T*s get contract Z_T but *B*s are uninsured. They also further show that a fixed tax on every insurance plan which later being returned as lump-sum subsidies to the whole population would be a strict Pareto improvement conditioning on the slope of *Ts*'s indifference curve.

In summary, the above mentioned two theoretical frameworks start with different assumptions and end up with different conclusions. At the beginning, empirical studies were conducted to test the classical predictions from Rothschild and Stigliz (1976). However, not all of them confirm the classical prediction. This literature was mainly trying to test the relationship between individual's risk type and their insurance coverage.

1.3.3 Theoretical framework for ex-ante moral hazard

Ex-ante moral hazard refers to actions taken before the individual develops a condition. Returning again to the model we presented in section 1.3.1, the probability of illness is now a function of preventive effort $\pi(V)$ with $\pi'(V) < 0$. The probability of illness is decreasing when individual makes more preventive effort. In order to look at the effect of insurance on prevention effort, we need to compare individual's incentive with and without insurance.

Here we present a simplified model adapted from Zweifel and Manning (2000). Suppose the individual has no health insurance, and s/he chooses the optimal prevention that maximizes their expected utility, which is

$$EU = \pi(V)u^s(Y - M - wV) + (1 - \pi(V))u^h(Y - wV) \quad (1.5)$$

Where Y is income, M is total medical cost, w is wage and wV indicates the monetary lost when taking preventive efforts.

The optimal level of preventive effort can be obtained from the first order condition:

$$\pi'(V)[u^s(Y - M - wV) - u^h(Y - wV)] = w\left[\pi(V)u'^s + \left(1 - \pi(V)\right)u'^h\right] \quad (1.6)$$

The right hand side of equation (1.6) in square bracket is equal to $EU'(y)$. Thus we get equation (1.7) below:

$$\pi'(V)[u^s(Y - M - wV) - u^h(Y - wV)] = wEU'(y) \quad (1.7)$$

The optimality condition indicates that the marginal benefit from reducing the risk of illness is equal to the marginal cost of preventive effort.

Now, suppose the individual has full insurance, he does not need to pay any medical expenditure now, but has a premium P to pay for the insurance. His/her expected utility is:

$$EU = \pi(V)u^s(Y - P - wV) + (1 - \pi(V))u^h(Y - P - wV) \quad (1.8)$$

The individual chooses the optimal prevention effort to maximize his expected utility, which gives the optimality condition:

$$\pi'(V)[u^s(Y - P - wV) - u^h(Y - P - wV)] = wEU'(y) \quad (1.9)$$

If we use the left-hand side of equation (1.9) to subtract the left hand side of equation (1.7), we get equation (1.10). It tells the difference of marginal benefit from prevention between the individuals with and without full insurance.

$$\pi'(V)[u^s(M - P) + u^h(P)] \quad (1.10)$$

We assume that $\pi'^{(V)} < 0$. $u^s(M - p)$ and $u^h(P)$ are both greater than zero. Thus the sign of equation (1.10) is negative. Compared to the case without insurance, the marginal benefit from prevention is reduced. This indicates that insurance reduces incentives towards prevention (Zweifel and Manning, 2000).

1.3.4 Theoretical framework for ex-post moral hazard

Since medical insurance lowers the marginal cost of health care to individuals, it may increase use (Pauly, 1974). This is termed as "ex-post moral hazard" in the insurance literature. There are two implicit assumptions under ex-post moral hazard. Firstly, the amount of health care is not contractible in insurance policy. Secondly, doctors would not implement optimal health care (Cutler and Zeckhauser, 2000).

Suppose individual's elastic demand of health care is a function of the price: q^D=*g(p)*. The price elasticity of the demand is $e_p = \frac{dQ/Q}{dP/P}$

Figure 9 presents three situations under different price levels of health care. Suppose the price of health care is set at M. With no insurance, the optimal consumption for individual is Q_1. It is the intersection of supply and the price level. With full insurance when the price of health care drops to zero, the individual consumes Q_2. With a co-payment, the price of insurance M' would be less than M but greater than zero. A positive P' reduces overconsumption.

Figure 9: Ex-post moral hazard with elastic demand

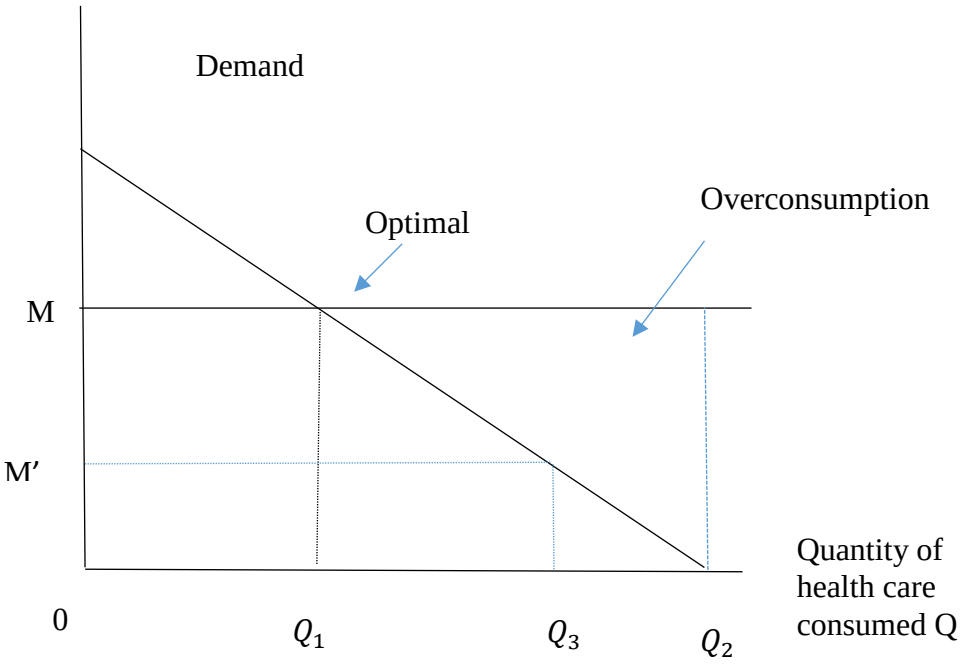


Figure 10 illustrates that overconsumption reduces when demand is less elastic, there will be no ex-post moral hazard when the demand is inelastic when the demand curve is vertical.

Figure 10: Ex-post moral hazard under different demand elasticities

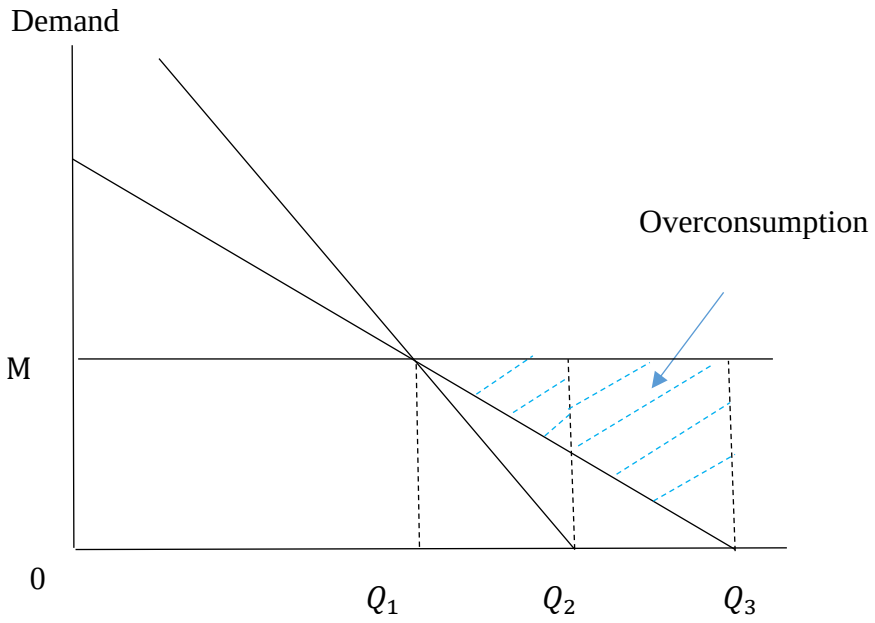
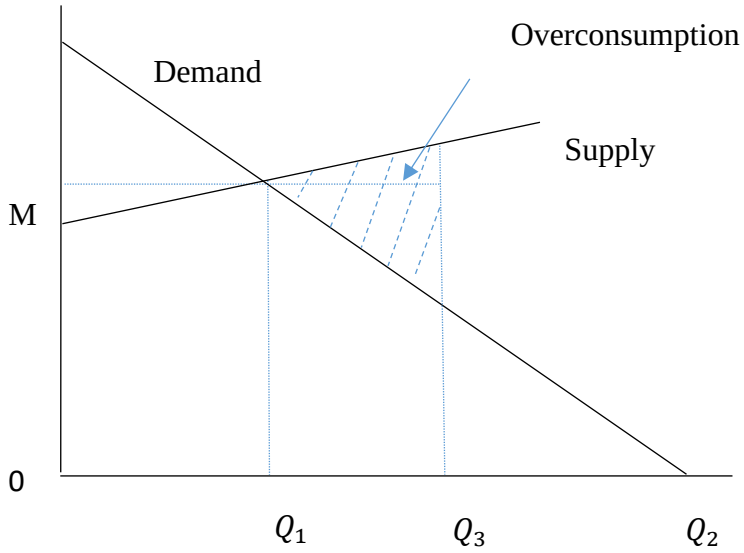


Figure 11 suggests that if we take a price elastic supply curve into consideration, then overconsumption is even larger. In the health care market, physicians and patients jointly determine what treatments will be performed. However, physicians will have a better idea than patients about the likely consequences of treatment (Folland et al., 2007). This theory suggests that physicians can influence the demand of health care services. If doctors allocate quantity Q_1 to patients, there will be no moral hazard.

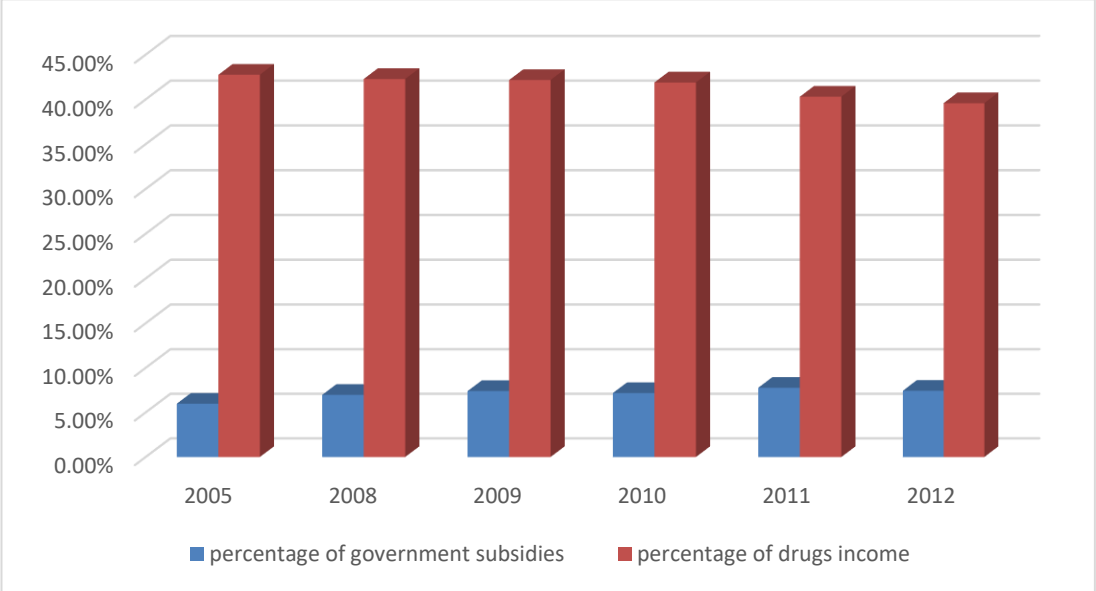
As shown in in Figure 11, when doctors have incentive to increase the quantity of supply as price goes up, the supply curve is upward sloping. Deadweight loss from overconsumption for a lower price of health care is even higher. Doctors' behaviour and their incentives depend on factors like degree of motivation, financial incentives, government allocation of resources, etc. (Cutler and Zeckhauser, 2000). Therefore, the degree of over-supply and the deadweight loss depend on these factors.

Figure 11: Ex-post moral hazard with upward sloping supply curve



In China, the main source of provider payments is fee-for-service payments (Yip and Hiao, 2009). Under fee-for-service payments, healthcare providers are reimbursed retrospectively. Thus, fee-for-service encourages providers to provide a higher quantity of services than under alternative payment arrangements because they do not bear the full financial-risk of over-provision. For example, drug mark-ups were allowed by the Chinese government before 2016, meaning that Chinese hospitals could sell drugs at higher prices than their costs, with the mark-ups normally amounting to 15 to 20 percent (Hesketh and Zhu, 1997). According to the China Health Statistical Yearbook 2013, income from selling drugs accounts for approximately 40 percent of their total income from 2005 to 2013. Income from drugs is illustrated across a number of years in Figure 12. While the proportion of income from this source has been decreasing slowly over time, there remains a strong incentive for doctors to over-provide expensive drugs, which may lead to ex-post moral hazard.

Figure 12: Composition of hospital income



Data Source: China Health Statistical Yearbook 2013

1.4 Data used in the thesis

We explore questions about adverse or advantageous selection and ex-ante moral hazard empirically by exploiting data from the China Health and Nutrition Survey (CHNS). To research the question around ex-post moral hazard, we use an alternative dataset The China Health and Retirement Longitudinal Study (CHARLS).

1.4.1 The China Health and Nutrition Survey

For Chapter 2 and Chapter 3, the CHNS is used. This is an ongoing cohort that was designed to examine the effects of the health, nutrition, and family planning policies and programs. This international collaborative project is conducted under the cooperation between the Carolina Population Centre at the University of North

Carolina at Chapel Hill and the National Institute for Nutrition and Health at the Chinese Centre for Disease Control and Prevention. It is a longitudinal survey starting in 1989 with eight additional panels collected in 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011. The survey covers nine provinces that vary substantially in geography, economic development, public resources, and health indicators. It uses a multistage, random cluster process to draw samples from each province. The sample size is documented to cover 4,400 households, covering 19,000 individuals with high follow-up rates. An advantage of this dataset is that it provides various information that we need for our analysis. Each round contains four categories of survey, including the household survey, individual survey, nutrition and physical examination and community survey. It contains respondents' health (e.g. self-reported health, disabled status, utilization of health facilities, medical expenditure, health insurance status, etc.), demographic information (age, gender, marital status, etc.), and socioeconomic status (household income, employment status, etc.).

Besides the advantages of the survey, there are also challenges with using this dataset. Firstly, there are many observations with missing values for some variables, especially for the health insurance premium, medical expenditure, marital status, education, self-reported health and household income. Even for age and gender, there are observations with missing values. In the process of cleaning the data, we found that almost all observations with missing age or gender have missing values for all variables. We have to assume that data is missing completely at random. Secondly, the information is not recorded in a consistent fashion across waves. In both chapters, lag values of some variables are key for the analyses. For example, lag values are used to predict expected medical expenditure for observations in Chapter 2. However, more than 1,000 observations do not have information on self-reported health or household

income in both waves. Therefore, although it is documented that there are around 19,000 observations in each wave, less than half of these are available for the analyses undertaken in this thesis.

To deal with missing data, we use three methods depending on different situations. Firstly, the observations with missing data for most of the variables (5.67% of the total sample) are simply dropped from the analysis. Secondly, we used imputation methods when there is missing data for a key variable. Take Chapter 2 for illustration, the premium for private insurance is a crucial to the analysis. However, there are a lot of respondents who bought insurance but did not report the premium. We employed linear prediction methods for those observations with missing data to impute the premium. Prediction error is a potential limitation for Chapter 2 and Chapter 3.

1.4.2 The China Health and Retirement Longitudinal Study

The China Health and Retirement Longitudinal Study is employed in Chapter 4. It is a dataset focusing on Chinese residents ages 45 and older to serve the needs of scientific research on the middle aged and elderly. The research team is based at Peking University with the support from the National Natural Science Foundation of China, the Behavioural and Social Research Division of the National Institute on Aging and the World Bank. The first round survey was undertaken in 2011, and included about 10,000 households and 17,500 individuals in 150 counties/districts and 450 villages/resident committees. It is conducted every two years. Wave 2011 and wave 2013 are currently available to the public. The study population of the survey draws from 28 provinces with various socioeconomic factors and other related health, nutritional and demographic measures. CHARLS adopts a multistage stratified Probability Proportional to Size (PPS) sampling, and an innovative software package

(CHALRS-GIS) to make village sampling frames. All samples are drawn in four stages, including county-level sampling, neighbourhood-level sampling, household-level sampling and respondent-level sampling. The goal of the sampling strategy is to collect a sample representative of the whole country.

I use this dataset for Chapter 4 for three reasons. Firstly, it contains sufficient information that I require for the analysis from the household questionnaire, including demographics, family structure, health status and function, biomarkers, health care and insurance, work, retirement and pension, income and consumption. Secondly, I would like to investigate the causal relationship between insurance status and medical expenditure. Since it is a survey with residents over 45 years old, the rate of getting sickness in this dataset is higher than in CHNS so CHARLS offers a larger sample size in analysis with increasing statistical power. Thirdly, the follow up rate is higher and there is less of a problem of missing data in CHARLS. It means that there is less concern about missing data bias, imputation bias or low statistical power in explaining the results.

1.5 Overview of the thesis

The second chapter investigates whether there is adverse or advantageous selection in China's private health insurance market. Traditionally economists argued that there is adverse selection, suggesting that high risk individuals purchase insurance (Arrow, 1963 and Rothschild and Stigliz, 1976). However, recent empirical evidence challenged the traditional approach and found that mainly low risk people buy insurance, which is referred to as advantageous selection (Buchmueller et al., 2013). Existing literature delivers inconsistent conclusion on the relationship between risk type and level of insurance coverage. Most of the existing literature examined adverse or advantageous effect in the context of a supplementary insurance market due to the

universal coverage for public insurance in high-income countries. The Chinese private insurance market before 2003 is a bit different from the markets in high-income countries, because only a small proportion of the population (i.e. formal employees) got covered by public insurance leaving the rest facing the choice between having no insurance or to purchase private insurance. This feature makes it an interesting case to investigate.

The sample data is divided into two subgroups according to people's public insurance status, because public insurance is not available for everybody in China. The first subgroup contains people without any public insurance. This enables us to identify the selection effect in a pure private market. The second subgroup includes those people who have public insurance. Since public insurance does not cover all medical expenditure, they have to decide whether to purchase supplementary private insurance. This subsample helps us to capture the effect in a supplementary insurance market. Logistic regression is adopted to identify the correlation between individual's risk and insurance coverage. Since at the time of the decision on purchasing supplementary insurance, the exact medical expenditure in the next period is unknown to individuals, we measure their risk by estimating whether their predicted medical expenditure is greater than the premium for private insurance. For the non-public insurance subgroup, we find evidence in favour of adverse selection. If people's expected medical expenditure is greater than the premium of private insurance, their probability of buying private insurance is 0.9% higher. This probability is relatively small but robust, but bear in mind that there were only 2% of the sample who bought private insurance. For the public insurance subgroup, we found advantageous selection. If individuals' expected medical expenditure is greater that the premium, their probability of buying supplementary private insurance is 2.5% lower. Inpatient

reimbursement rate, time for exercise and living in urban area are also significant indicators of purchasing private insurance.

The third chapter examines whether there has been an increase in ex-ante moral hazard following the introduction of public health insurance in China, and whether implementing nearly universal coverage led to a decrease in individual preventive behaviour prior to illness. Ex-ante moral hazard is predicted by classical economic theory suggesting that health insurance will reduce an individual's incentive towards taking preventive efforts to remain healthy (Arrow, 1963). Hopefully, this chapter could provide some policy implications if the Government wants to improve the efficiency of the program.

We exploit the longitudinal dimension of the data and use Coarsened Exact Matching methods. This makes it possible to deal with the self-selection into both voluntary programmes by matching individual's characteristics across a control and a treatment group prior to the reform. Proxies for preventive effort include smoking, vegetable and fruit consumption, overweight, obesity, preventive care, number of cigarette per day and time for exercise per day. The results do not provide strong evidence for ex-ante moral hazard. Insured and uninsured individuals are not significantly different in smoking, number of cigarettes per day, vegetable and fruit consumption, obesity, overweight, and preventive care visits post reform. Nevertheless, we find significant differences between treatment and control groups in terms of time spent exercising. People with insurance spend less time doing exercise than people without insurance, which provides supporting evidence of ex-ante moral hazard.

The fourth chapter aims at evaluating whether there is ex-post moral hazard after the reform and whether current deductibles and co-payments are effective enough to

reduce moral hazard. It investigates whether and to what extent total hospital medical expenditure increases as the price of health care services decreases. The health reform has increased the insured population coverage from 20% in 2000 to 99.6% in 2014. The reform increased people's access towards health care by reducing the price they face which potentially satisfied previously unmet need. Nevertheless, classical economic theory predicted that having insurance will increase the use of health care because the price is lower than it would be.

In order to disentangle adverse selection from ex-post moral hazard, we measured ex-post moral hazard as the impact of co-payment rate variation on treatment cost, which is the price elasiticy of the medical care. The sources of variation come from different places of residence and different insurance policies. We separate the sample by outpaitent and inpatient users. The key explanatory variable co-payment rate is found to be negatively associated with medical costs for the outpatient sample. This indicates that individuals who face higher co-payment rate are more likely to have lower medical costs. As the co-payment rate increases by 1%, medical costs decrease by 0.44% in 2011, and the magnitude increases to 1.64% from wave 2011 to wave 2013. No significant effect has been found for the sample of inpatient sample due to the small sample size.

Chapter 2: Adverse Selection or Advantageous Selection—Evidence from Chinese Health Insurance Market

2.1 Introduction

Who is going to buy health insurance? Traditionally economists argued that high risk people do so, a form of adverse selection (Arrow, 1963 and Rothschild and Stigliz, 1976). It has therefore been argued that a free market for health insurance has adverse consequences especially in light of the almost universally accepted health policy aim of equal access to health care according to need (Cutler, 2002).

The traditional approach has been challenged as it has also been argued that mainly low risk people buy insurance, implying advantageous selection (Buchmueller et al., 2013). Although it seems fair to argue that the health policy implications of advantageous selection seem less straightforward than those of adverse selection, the first question to be addressed is if the empirical evidence in health care mainly supports adverse or advantageous selection in health care.

A substantial number of empirical studies have been conducted to test the prediction from the classical asymmetric information model. Those empirical studies which will be reviewed in Section 2.2 demonstrate inconsistent results. Findings from Ellis (1989), Cutler and Rebber (1988), Frank et al. (2000) etc. provide evidence for adverse selection. They adopted different measures of consumers' risk type (e.g. ex-ante health expenses, ex-post health expense, age, health status and etc.) to confirm that those consumers with higher risk are more likely to have higher insurance coverage.

However, not all empirical studies find a positive correlation. On the contrary, Buchmueller and Feldstein (1997) and Fang et al. (2008) discovered that people with a lower risk of suffering financial loss buy more insurance, this being indicative of advantageous selection. De Meza and Webb (2011) explained advantageous selection from a theoretical perspective. They dropped the assumption from the classic model that everybody has identical risk preference, and declared that individuals know better about both their risk type and risk aversion than insurance companies. Advantageous selection is driven by risk aversion in which people who are risk averse could buy more insurance coverage even though they have lower risk of suffering financial loss due to sickness.

The presence of asymmetric information has diverse effects on health insurance market. Conditioning on different settings, empirical studies have yielded contradictory conclusions about the relationship between risk type and level of insurance coverage. Most studies have tried to identify adverse or advantageous selections in the context of people's choice between different plans or the choice of buying a supplementary health insurance plan. Thus they are different from this paper from the perspective of background.

Most of the existing literature examined adverse or advantageous effect in the context of supplementary insurance market due to the universal coverage for public insurance in high-income countries, which will be shown in literature review in the next section. As an emerging economy, China has been experiencing a change of the healthcare system in a short period of time, namely 10 years. It makes it an interesting case for investigation. Before 2003, only a small proportion of the population (e.g. formal employees) were covered by public insurance, leaving the rest facing the choice of either no health insurance or buying private insurance. Since 2003, the government

launched a reform in some experimental areas with a goal to achieve universal coverage of public insurance. However, newly launched public insurance plans which are subsidized by the government are voluntary insurance plans and only cover around 50% medical costs. Therefore, people covered under the public system still have an incentive to buy private insurance. There are two types of insurance markets in China: 1) A pure private insurance market where people do not have public insurance and face the choice of buying private insurance; 2) A supplementary insurance market where people have public insurance and face the choice of buying a supplementary private insurance. We are able to study the consequence of asymmetric information in the above-mentioned contexts: the Chinese health insurance market between 2004 and 2009.

2.2 Literature Review

In this section, empirical evidence for adverse selection and advantageous selection will be presented. It is not a systematic review in the strict sense, but relevant literature was identified by using key words searches on "adverse selection; advantageous selection; health insurance market" and using the library search engine from University of York, and E-resources including EconLit, Health Management Information Consortium, and Google Scholar. In addition, I also searched literature by reading reference lists from topic-related literature (citation pearl growing). Empirical studies are presented below where they are closely related to the topic and have more than 20 citations.

2.2.1 Empirical evidence for adverse selection

Empirical evidence for adverse selection is inconclusive. Some studies have shown findings consistent with the classic hypothesis of a positive correlation between risk and insurance coverage (Cutler and Reber, 1998; Cutler and Zeckhauser, 1997; Marquis, 1992; Ellis, 1989; Ellis, 1985). Other studies find evidence of advantageous selection whereby consumers with lower expected medical costs tend to have higher insurance coverage (Johar and Savage, 2012; Fang et al. 2008; De Meza and Webb, 2001; Waterhouse,1996).

A table of the literature organized by their empirical methodology is provided hereafter in Table 2. Empirical strategies to identify adverse or advantageous selection could be categorized into three groups: 1) comparison of risk measurement between different groups; 2) binary outcome regressions; 3) other methods.

2.2.1.1 Comparison of the means

Some early studies adopted comparisons of risk measurement between different risk groups (Ellis, 1989; Cutler and Zeckhause, 1997; Altman et al., 1998; Cutler and Rebber, 1988; Frank et al., 2000). Instead of using the term “adverse selection”, Ellis (1989) put forward “biased selection” to refer to the situation where a health plan “attracts a group of enrollees that differs significantly from the population average”. The data adopted by this study is a two-wave panel data from a large financial services firm with over 20,000 employees. Those employees had three different options for health insurance with different premiums, deductibles, co-payments and stop-losses. Firstly, employees were divided into nine groups according to their out-of-pocket health expenditure in the first wave. And then, researchers predicted their expected out-of-pocket health costs in the second wave. Second step, non-parametric loss function was used to calculate the “best” plan choice by minimizing the expected value

of out-of-pocket health costs. The result uncovered biased selection across the three plans. The results showed that employees with higher previous out-of-pocket expenses in 1982 and 1983 are more likely to choose the most generous plan.

Cutler and Zeckhauser (1997) did a case study using claims and enrolment data from Harvard University and Massachusetts Group Insurance Commission (GIC). They compared enrollees' different characteristics and expenses for different health plans and found that employees in a more generous plan (GIC's FFS plan) spend more and have higher risk than HMO members, indicating adverse selection.

Cutler and Rebber (1998) examined adverse selection using data from health choices by employees at Harvard University. Harvard University had a reform on health insurance pricing following the US government's proposal of changing health insurance from non-market goods into privately running plans in competitive market in 1986. They used age and predicted medical spending as the indicators for consumers' risk type. By analysing the characteristics of plan enrollment changes, they found employees who moved from a more generous plan (PPO) to the less generous plan (HMO) were 4-years younger on average than those who remained in PPO. Moreover, the average age-weighted medical spending for HMO enrollees was predicted to be 5 percent less than HMO enrollees. Their results indicated that significant adverse selection was induced by this reform. It caused welfare loss equivalent to 2 to 4 percent baseline spending.

Table 2: List of literature about adverse or advantageous selection

Literature	Data	Methodology	Control Variables	Results
Comparison of the means of variables indicating individuals' risk type				
Ellis (1989)	Panel data from two large financial services firms	Comparison of previous out-of-pocket expenses among different plans		Adverse selection: employees with higher previous out-of-pocket health expenses are more likely to choose the most generous plan
Cutler and Rebber (1988)	Health choices by employees at Harvard University	Comparison the means of age, medical spending by different groups of risk type		Adverse selection: employees who moved from Preferred Provider Organization (PPO) to Health Maintenance Organization (HMO) are 4-year-younger in average than those who remained in PPO
Frank, Glazer and McGuire (2000)	Panel data from health claims and enrolment files from Michigan Medicaid program from 1991 to 1993	Comparison between the predicted out-of-pocket medical expenditure and actual medical expenditure		Adverse selection: age and sex can explain around 21 percent of the variation between actual and predicted spending

Table 2: (Continued)

Literature	Data	Methodology	Control Variables	Results
Cutler and Zeckhause (1997)	Claims and enrolment data from Harvard University and Massachusetts Groups Insurance Commission	Comparison of the enrolees' different characteristics and expenses for different health plans		Adverse selection: employees in the more generous plan spend more, have higher risk
Altman, Cutler and Zeckhause (1998)	Claims and enrolment data from Massachusetts Group Insurance Commission	Comparison of the enrolees' different characteristics and expenses for different health plans		Adverse selection: People moving into more generous plan spent 47% more service in the next year
Logistic or Probit regression				
Scitovsky, McCall and Benham (1978)	Enrolment data from Stanford University employees	Logistic regression	Income, distance to the hospital, years of employment, age, gender, number of covered in the family, marital status	Adverse selection: people subscribed to the generous plan were more likely to be older and less healthy
Wang et al. (2006)	Panel data from the voluntary China's Rural Mutual Care Health Insurance Scheme	Logistic regression	Minor health, severe health, age, gender, household size, marital status, education, income, living area	Adverse selection: individuals with worse health status are more likely to buy the insurance than those with better health
Savage and Wright (2003)	1989-1990 National Health Survey	Probit regression	Age, country of birth, health status, marital status	Adverse selection: private hospital insurance are selected by people who requires hospital services that have long waiting time in public hospitals

Table 2: (Continued)

Literature	Data	Methodology	Control Variables	Results
Wolfe and Goddeeris (1991)	Panel data from the Retirement History Survey between 1969-1979	Probit regression	Health status, years of education, gender, ethnicity	Adverse selection: Individuals who have high lagged value of medical expenses are more likely to buy supplemental insurance
Gao and Wang (2009)	Enrolment data from a large Chinese insurance company: cross sectional data	Probit Regression	Occupation, age, gender, marital status, living area, premium, ex-post claim occurrence	Coexistence of adverse selection and advantageous selection: buyers who made more insurance claims intend to purchase less limits of basic insurance but more additional insurance
Other methods				
Marquis (1992)	RAND experiment data	Simulation Method		Adverse selection: the number of consumers in high risk quartile who bought the most generous plan were 73% more than those in low risk quartile
Van de Ven and van Vliet (1995)	Postal survey among privately insured individuals in the Netherlands	Risk adjustment model		Adverse selection: age and sex adjusted model can explain 40% expenditure variance between low- and high- cost plans

Table 2: (Continued)

Literature	Data	Methodology	Control Variables	Results
Cardon and Hendel (2001)	Single population from the 1987 National Medical Expenditure Survey	Estimation of a two-stage model		Adverse selection: healthier people are willing to pay less for insurance, while less healthy people are willing to pay more for insurance
Buchmueller et al. (2013)	NHS data from 2004-2005	Tests of the prediction from the classic model		Advantageous selection: individuals who bought private insurance have less ex-ante risk of hospitalization
Fang, Keane and Silverman (2008)	Medicare Current Beneficiary Survey and Health and Retirement Study	Least square regression		Advantageous selection: Medigap consumers are healthier than those without

Another study from Altman et al. (1998) suggested that adverse selection is a quantitatively important reason for the different premiums across health plans. They analyzed the data from Massachusetts Group Insurance Commission (GIC) by comparing individuals' characteristics with different health plans and found that people moving into more generous plan spent 47 percent more in the next year. In addition, a 2 percent effect of adverse selection was calculated. It accounts for the different premiums between two plans after adjusting for age and sex.

Frank et al. (2000) adopted data from health claims and enrolment files from Michigan Medicaid program from 1991 to 1993, including adults "who were eligible for Medicaid in 1991 and who were continuously enrolled in Medicaid programs till the end of 1993". They firstly claimed that the better the individual knows their future medical expenditure, "the bigger the distortion created by the plan in order to attract the profitable individuals" in a theoretical framework. They demonstrated the theory in an empirical study to compare the difference between predicted and real expenditure. Nine classes of services, such as birth-related disease, cancer care, gastrointestinal, etc., were identified according to ICD-9 codes and were analyzed respectively. A two-part model following Duan et al. (1983) and Manning et al. (1987) was used for each class of services. Age, sex, and prior spending were assumed to be known by individuals to predict their future spending. They found that age and sex can explain around 21 percent of the variation between actual and predicted spending. The proportion was even bigger when prior spending was included in prediction model.

2.2.1.2 Discrete choice models

A second common method to investigate the relationship between risk type and insurance coverage are binary outcome regressions like logistic or probit

regressions (Scitovsky et al., 1978; Wolfe and Goddeeris, 1991; Wang et al., 2006; Savage and Wright, 2003; Gao and Wang, 2009).

Although Scitovsky et al. (1978) did not bring up "adverse selection" directly, their study found a weak positive relationship between risk type and insurance coverage. They examined factors affecting Stanford University employees' enrolment choice between two health plans (Kaiser Plan and Fee-for-service Plan). They regressed consumer's choice (a dummy variable) on their family income, distance from home to the clinic, years employed, age, sex, health status, numbers of covered members in family, and marital status. Among those independent variables, age and health status can capture the risk type of the consumer. The least-squares regression results indicated that people subscribed to fee-for-service plan—a slightly more generous plan—were more likely to be older, less healthy, single and without children, indicating a positive relationship between risk and insurance coverage. However, they also admitted that there is a long-term effect of the existence of fee-for-service plan (since fee-for-service plan was the original plan that everybody had before the introduction of Kaiser Plan), so the effect of age of choosing between two plans still needs further investigation.

Research from Wolfe and Goddeeris (1991), on the difference of medical expenditure between Medicare beneficiaries with and without Medigap (a private supplementary insurance plan), also indicated the existence of adverse selection. A longitudinal dataset, Retirement History Survey, was employed in the Probit estimation of supplementary insurance. Coefficients of previous hospital and physician expenditures were significantly positive, which indicated the positive relationship between risk type and insurance coverage, but they also claimed that

the magnitude of adverse effect was not serious enough to cause efficiency problem.

Savage and Wright (2003) examined adverse selection by adopting probit regression using data for choices and private hospital use in Australia from 1989 to 1990. Five subsamples, young singles, young couples, couples with dependents, old couples and old singles, were analyzed separately. They measured individuals' risk type by their chronic medical conditions. Except for the old singles subsample, results from the other four groups suggested that private hospital insurance was selected by people who require hospital services that face long waiting times in public hospitals.

Wang et al. (2006) conducted research in the context of a voluntary Rural Mutual Health Care health (RMHC) insurance scheme in China. Longitudinal data employed in their logistic regression contains two waves of survey, 2002 and 2004, before and after the establishment of RMHC. As well as the whole sample, two subsamples were also analysed in logistic regressions. Because the subsidized scheme only covers individuals rather than covering all the family members, it allows the researchers to further examine the effect within households. The first subsample included those individuals in either fully enrolled or absolutely non-enrolled households, while the second subsample includes individuals in partially enrolled households. Risk type was measured by dummy variables indicating whether the respondent suffered from minor/serious health problems. Their findings suggested that individuals with worse health status are 1.6 times more likely to buy RMHC than those with better health status. Adverse selection was more obvious in partially-insured families because non-enrollees in partially

insured families have the best health status while enrollees in those families have the worse health status.

2.2.1.3 Other models

The third category includes literature using other methods like risk-adjustment models, simulation method, and least square regression (Marquis, 1992; Van de Ven and van Vliet, 1995; Cardon and Hendel, 2001; Buchmueller et al., 2013; Fang et al., 2008).

Marquis (1992) adopted a simulation method using the RAND experiment data to estimate the effects of adverse selection. RAND experiment, conducted from 1974 to 1982 in the United States, is a famous randomized trial in the health insurance market. This dataset provided information about households' anticipation of their health care spending, which was adopted as a measure of risk in the model. Individuals risk was allowing division into different groups. Controlling for age and gender, the number of consumers in high risk quartile who bought the most generous health plan were 73 percent higher than the number in low risk quartile.

van de Ven and van Vliet (1995) conducted research based on a postal survey among consumers who were insured by the largest private health insurance company in the Netherlands. Their risk-adjustment model showed that risk factors like age and gender explain 40 percent expenditure variance between low- and high-cost plans. If all risk factors were included, such as prior health and prior costs, 80% variance could be explained.

Cardon and Hendel (2001) estimated a two-stage structural model using data of single population from the 1987 National Medical Expenditure Survey in the US. In the first stage of the model, individuals chose the health insurance that gives

them the highest expected utility under uncertain health status in the next stage. In the second stage, consumers chose the health care consumption after realization of health status. Adverse selection was captured by examining the difference of private information/signals for the health status in next stage. Their findings that healthier people are willing to pay less for insurance while less healthy people are willing to pay more for insurance also demonstrated the existence of adverse selection.

2.2.2 Empirical evidence for advantageous selection

Empirical studies do not always find a positive relationship between risk type and insurance coverage. Buchmueller et al.(2013) tried to test the prediction of theoretical models in Australian private health insurance market. A test for selection into private health insurance by regressing realized losses on insurance coverage was conducted to examine the relationship between risk type and level of insurance coverage using NHS data collected by Australian Bureau of Statics in 2004 and 2005. The regression showed no significant difference in costs between those with private insurance and those without. By comparing the predicted probability of being hospitalized across two groups, the authors found a negative rather than a positive relationship. Individuals who bought private insurance have lower probability of hospitalization than those without insurance. Furthermore, they provided the underlining reasons for the advantageous selection. Income and risk aversion were claimed to be the causes because both are positively related to insurance coverage and negatively related to individual's risk type. On the one hand, the richer the individual, the more insurance coverage is s/he would like to buy. On the other hand, the richer the individual, the healthier s/he is likely to be, because s/he can buy healthier food etc. Therefore, risk type and insurance

coverage can be negatively related under this situation. The same is the case with risk aversion.

Fang et al. (2008) put forward strong evidence of advantageous selection in the US Medigap insurance market and also concluded sources from empirical strategies. Two datasets, Medicare Current Beneficiary Survey (MCBS) and Health and Retirement Study (HRS), were employed in this study. Results from regression of total medical expenditure on Medigap status (equals to 1 if the consumer bought Medigap otherwise 0) revealed that Medigap consumers are healthier than those without because important healthy factors (e.g. Body Mass Index and smoking) were positive and had significant partial relationship with Medigap coverage. Sources of advantageous selection were investigated in detail, including income, education, longevity expectations, financial planning horizons and cognitive ability. However, this study showed no support for risk preference, mentioned in Buchmueller and Feldstein (1997), for being a source of advantageous selection.

2.2.3 Empirical evidence in the context of Chinese insurance market

Two papers dealing with adverse or advantageous selection in the context of China are discovered after a search into the literature. In addition to Wang et al. (2006) mentioned above, Gao and Wang (2009) used enrollment data from a large Chinese private insurance company. They performed a multilinear regression initially to estimate the relationship between the basic insurance purchased and whether the consumer claimed medical expenses afterwards. Estimates from this regression exhibited a negative relationship between the level of basic insurance and the consumer's claim, implying advantageous selection. Furthermore, a probit model was adopted to identify the indicator of people's additional insurance status.

Claims were identified to be significantly and positively correlated to the consumer's additional insurance status. After adjusting for endogeneity problems due to the potential relationship between claim and insurance status, their findings were consistant with the prelimilary results that claims were positively correlated to the consumer's addiitonal insurance status.

2.2.4 Reflection on the empirical literature

The presence of asymmetric information has diverse effects on health insurance market. Conditioning on different settings, empirical studies have derived contradictory conclusions about the relationship between risk type and level of insurance coverage.

Most studies are conducted in high-income countries where most or all the population are covered by at least one type of health insurance. These studies attempted to identify adverse or advantageous selections in the context of people's choice between different plans or the choice of buying a supplementary health insurance plan. Thus, they are different from this paper from the perspective of motivation and context. In the context of this study, around 80% of the sample do not have health insurance.

Studies also use different proxies to measure people's risk of suffering financial loss in the event of illness: 1. Realized utilization (inpatient and outpatient visits); 2. Self-reported health; 3. Age; 4. Illness; 5. Realized medical expenditure; 6. Predicted medical expenditure. In this research, we add some of those variables as control variables but use another way to measure risk which we consider is more appropriate, this being whether expected medical cost is greater than the premium that individual would face.

In general, there is no unique conclusion that could be generated from the existing literature on whether there is adverse or advantageous selection in competitive health insurance market. In the next section, the data and methodology employed in this study will be explained.

2.3 Methodology

2.3.1 Data

The publicly available panel data from China Health and Nutrition Survey (CHNS) is used in this study. CHNS contains information about health, demographic, socioeconomic and nutrition policy studies. It covers nine provinces across north to south of China with different geography, economic development, public resources and health indicators. A multistage and random cluster process is used to draw samples. In each province, counties are stratified by low, middle and high income groups. Four counties are randomly chosen from a weighted sampling strategy. Provincial cities and a lower income city are chosen in seven provinces, while large cities were selected in other two provinces.

All together, they have conducted 8 waves since 1989 on four different levels, including household survey, individual survey, community survey, and nutrition and physical examination. Different questions are designed for different levels of survey. For each wave, they take three consecutive days to collect data for all four surveys. The household questionnaire asks about demographic information, economic activities (e.g. income and expenditure), and health services. Detailed data on health care utilization, health insurance coverage and medical providers are included in this health service section. An individual survey has been conducted since 2004, extracting all questions about individual activities, lifestyle

and health status etc. from household survey. Community questionnaires are answered by a knowledgeable respondent about the community infrastructure. The survey covers 4,400 households and 19,000 individuals for all 9 waves. The official website claims that the follow up rate is said to be high in the description, but they also include new respondents into the survey each year.

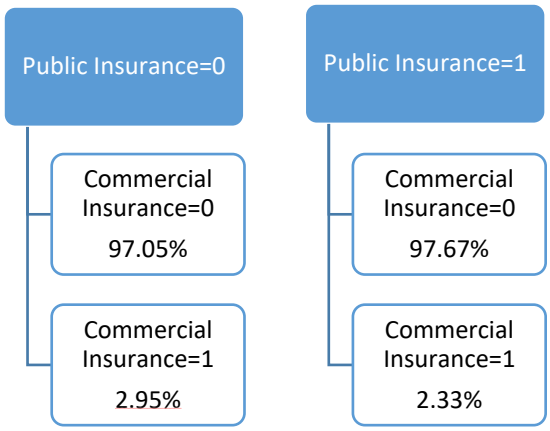
Observations in wave 2004, wave 2006, and wave 2009 are included in this study. Before wave 2000, the dataset does not contain information about whether respondents bought commercial insurance. From 2003, Chinese government started to launch the experimental public health insurance program in some areas in order to achieve universal coverage. However, this target has not been achieved yet. Therefore, there are still people without public insurance who face the choice of buying private insurance. Furthermore, public insurance schemes do not cover all medical expenditure, which means people with public insurance still have the risk of financial loss. Thus they also face the choice of purchasing supplementary health insurance privately. Consequently, there are two types of insurance markets in China since 2003: 1) A pure private insurance market where people without public insurance choose whether or not to buy private health insurance. Private insurance market is increasingly thriving in recent years, but their insurance plans do not vary much. Most of those plans cover a proportion of the inpatient cost for consumers. 2) A supplementary insurance market where people who have public insurance face the choice of buying supplementary private health insurance.

In order to test the choice effect in different markets, observations are split into two subsamples according to their public insurance status. Data cleaning processes include dropping observations with unknown and missing data for specific variables in regressions, correcting miscoded data for the variable “treatment costs”

and recoding missing as zeroes from "treatment costs" for certain observations. Observations missing information for age, household income, self-reported health, education are dropped from this study. In addition, 43 observations, who are supposed to be coded as missing, are miscoded for variable "treatment costs" in wave 2000 as "99999", this also indicating missing information.

After dropping such cases, there are 17,513 observations available for the analysis. Among them, 7,751 individuals do not have public insurance and 229 of them (2.95%) have private insurance (as shown in Figure 13). Meanwhile, there are 9,762 individuals with public insurance and 227 (2.33%) with supplementary private insurance.

Figure 13: Observations for subgroups



2.3.2 Survey questions

Table 3 lists the variables that are available for the analysis. Private health insurance status is a dummy variable generated from the question

> "Which of the following types of medical insurance do you have?"
>
> 1) Commercial insurance;
>
> 2) Free medical insurance;
>
> 3) Urban employee medical insurance: passway model;
>
> 4) Urban employee medical insurance: block model;
>
> 5) urban employee medical insurance: catastrophic disease insurance;
>
> 6) Cooperative insurance;
>
> 7) Health insurance for women and children;
>
> 8) EPI (expanded program of immunization) insurance for children;
>
> 9) Other.

This dummy is 1 when respondent crossed the option "commercial insurance" and 0 otherwise.

The premium for private insurance is recorded from the "what is your monthly contribution to this insurance?"

Information for medical expenditure is contained in the section starting with the question "During the past 4 weeks, have you been sick or injured? Have you suffered from a chronic or acute disease?" We calculate individual's medical expenditure in the past 4 weeks by aggregating answers from those follow-up questions:

1) “How much money did you spend on the illness or injury (spending outside the formal health sector)? (yuan)”

2) “How much did this treatment cost or has this treatment cost so far (including all registration fees, medicines, treatment fees, bed fees, etc.)?”

3) “How much money was spent or has been spent on treating your illness or injury in addition to the costs mentioned above? (yuan)”

Medical expenditure here is defined as the amount that the individual spent on treating the illness. These three questions are located in different sections of the questionnaire and they do not overlap. Question 1 is asking the situation before the individual went to the formal health sector. Question 2 is asking the situation when the individual went to the formal health sector. Question 3 is asking whether there is any expenditure the individual has not included in the answers to question 1 and 2. In China, people pay for medical services out-of-pocket at first and then apply for reimbursement from the health insurance (Yip et al., 2012).

Moreover, respondents who reported they were not sick in the last 4 weeks with missing values in “treatment costs” were treated as having 0 medical expenses in the analysis.

The outpatient (inpatient) reimbursement rate is from the question “What percentage of the fees for outpatient (inpatient) care does your (public) insurance pay (not including registration fee)?” respectively.

Health status is recoded into four dummy variables, namely, excellent, good, fair and poor, according to their answers to “Right now, how would you describe your health compared to that of other people your age?”

Variables available for controlling risk preference include smoking status, time spent doing exercise and whether the respondent drinks every day.

In addition, we have information on demographic characteristics like age, gender, years of education, working status, current marital status, disabled status and household income. Among them, "years of education" is not directly collected from the survey, but calculated from the question "How many years of formal education have you completed in a regular school?"

2.3.3 Estimation of premium

CHNS records the premium for private insurance if respondents bought private insurance. However, for those who did not have private insurance, we do not know the price they would face. Therefore, for these people, the premium is predicted for individuals who did not buy private insurance because everybody faces a potential cost of buying health insurance. The premium is predicted for two types of respondents: 1) respondents who bought insurance but did not report the premium; 2) respondents who did not buy insurance. For the second type of prediction, we are predicting what the price of insurance would have been, if they searched the private insurance market. The prediction method is identical for both types and is based on linear regression, specified as:

$$P_i = \boldsymbol{x'_i}\lambda + u_i \qquad (2.1)$$

Where P denotes premium; $\boldsymbol{x'_i}$ is a vector of predictors containing age, age squared, gender, smoking status, and medical expenditure in the past wave. In order to rule out inflation across waves, we predict premium for each wave separately. Therefore, the predicted premium can be calculated as:

$$\widehat{P_i} = \boldsymbol{x'}_i\hat{\lambda} \qquad (2.2)$$

Table 3: List of variables

Variable name	Explanation	Continuous or dummy
Private insurance	Whether the respondent bought private insurance?	Dummy
Public insurance	Whether the respondent bought public insurance?	Dummy
Premium	What is the monthly contribution for this insurance?	Continuous
Medical expenditure (in RMB)	What is the medical expenditure in the past 4 weeks? (calculated from dataset)	Continuous
Outpatient reimbursement rate	% fees outpatient covered in public insurance plans	Continuous
Inpatient reimbursement rate	% fees outpatient covered in public insurance plans	Continuous
Number of facilities	Number of facilities in the community	Continuous
Health Excellent	Right now, how would you describe your health compared to that of other people your age? Excellent	Dummy
Health Good	Right now, how would you describe your health compared to that of other people your age? good	Dummy
Health Fair	Right now, how would you describe your health compared to that of other people your age? Fair	Dummy
Health Poor	Right now, how would you describe your health compared to that of other people your age? Poor	Dummy
Smoking	Whether the respondent is smoking.	Dummy
Drinking every day	Whether the respondent drinks every day	Dummy

Time for Exercise	Time spent in doing exercise in minutes per week	Continuous
Working status	Are you presently working?	Dummy
Household income per capita per year	Calculated household annual income of the observations (inflated to 2011)	Continuous
Ln household income per capita (in RMB)	Ln (household income+1) (inflated to 2011) (per year)	Continuous
Education	How many years of formal education have you completed in a regular school?	Continuous 0,1,2,…18
Urban	Whether the respondent lives in urban area	Dummy
Age	Age of the respondents	Continuous
Disabled	Whether the respondent is disabled?	Dummy
Married	Whether the person is married?	Dummy
Male	Gender of the respondent	Dummy

2.3.4 Distinguishing adverse selection and moral hazard in empirical studies

A challenge for empirical studies to identify adverse selection is to distinguish between adverse selection and moral hazard because both of them could generate a positive relationship between individuals' medical cost and insurance coverage (Pauly, 1974; Abbring et al., 2003; De Donder and Hindriks, 2009; Einav and Finklstein, 2011). With adverse selection, the positive correlation comes from people have better knowledge of their higher expected medical cost being more likely to buy higher insurance coverage. With moral hazard, people may have incentive to take less effort to keep being healthy or less incentive to control utilization after joining the insurance plans. This would also generate positive

correlation between medical expenditure and insurance coverage. Although they have same consequence, the two situations suggest very different policy implications. Therefore, it is of great importance to distinguish between the two phenomena for empirical studies.

2.3.5 Risk measurement

To measure the risk type for respondents, we use a dummy indicating whether the individual's expected medical expenditure is greater than the private insurance premium. The reason for using expected medical expenditure is because that, at the time of the decision, exact medial expenditure in the next wave is unknown to individuals. In addition, individuals have more incentive to purchase the private insurance if their expected medical expenditure is greater than the premium. Otherwise, it is not financially beneficial for them to purchase insurance.

2.3.5.1 Prediction of expected medical expenditure—fixed effects

To generate this risk measurement dummy, the first step is to forecast expected medical expenditure for each individual. If we use pooled OLS, the estimation would be biased because of the heteroskedasticity across panel units and serial correlation within panel units. Thus, we use fixed effects model to allow for heteroskedasticity across panel units (Cameron and Trivedi, 2009). The fixed effects model is specified as:

$$m_{it} = \varphi_i + \boldsymbol{x'_{it-1}}\beta_1 + \varepsilon_{it} \qquad (2.3)$$

Where *i* and *t* denote the individual and wave respectively. m_{it} is the medical expenditure observed in the current wave. $\boldsymbol{x'_{it-1}}$ are regressors in wave t-1 including age, age squared, self-reported health dummies, log of household income, years of education and marital status. φ_i are individual-specific effects.

The fixed effects model allows φ_i to be correlated with the regressors $\boldsymbol{x'_{it-1}}$. However, fixed effects models do not permit time invariant variables like gender. Therefore, we divide the sample into two subsamples and forecast medical expenditure for males and females separately in order to explore gender effects.

In model (2.3), the medical expenditure we observe from the survey could potentially contain the moral hazard effect from having insurance. If we did not use it as an explanatory variable, the insurance effect would be captured in the error term. The coefficients estimated in model (2.3) would be biased if the insurance effect is correlated with variables in vector $\boldsymbol{x_{it-1}}$. For example, self-reported health in the past wave is likely to be correlated with insurance status in the current wave. Therefore, we further add $\beta_2 I_{it}$ into the fixed-effect prediction function as in model (2.4), where I_i represents the private insurance status in wave t. We then treat every individual as if they did not have private insurance in the current wave to wash out moral hazard effects.

$$m_i = \varphi_i + \boldsymbol{x'_{it-1}}\beta_1 + \beta_2 I_{it} + \varepsilon_{it} \quad (2.4)$$

Thus, the predicted medical expenditure $\widehat{m_i}$ can be calculated as:

$$\widehat{m_i} = \hat{\varphi}_i + \boldsymbol{x'_{it-1}}\hat{\beta}_1 \quad (2.5)$$

2.3.5.2 Risk measurement

In the final step, a dummy variable $R_i$indicating whether their expected medical expenditure is greater than the potential premium is generated. R_i, as shown in equation (2.6), is equal to 1 if individual's expected medical expenditure is greater than premium and equal to 0 if otherwise.

$$R_i = \begin{cases} 0 \; if \; \widehat{m_i} - P < 0 \\ 1 \; if \; \widehat{m_i} - P > 0 \end{cases} \quad (2.6)$$

2.3.6 Empirical strategy to identify adverse or advantageous selection

Logistic regression is adopted to identify the correlation between individual's risk type and their insurance coverage.

$$I_i = \delta_0 + \delta_1 R_i + \boldsymbol{x'}_i \delta_2 + \nu_i \quad (2.7)$$

Where I_i indicates individual's private health insurance status. R_i is a dummy variable (measure of risk) indicating whether individual's predicted medical expenditure is greater than premium. $\boldsymbol{x'}_i$ is a vector of variables containing individual characteristics (e.g. age, gender, self-reported health, risk preference, wealth Level, supply side factor, etc). ν_i is the error term. δ_1, and δ_2 are correspondent parameters. In practice, we use vce option in Stata to bootstrap standard errors of the estimates. Various studies have suggested that there are several variables influencing the decision of buying health insurance, like "risk preference, health status in the past, and the expected expenditures (related to premium)" (Van de Ven, **1**987; Cutler, and Zeckhauser, 1997; Einav, and Finkelstein, 2011). Such variables are included in the regression as control variables. For the public insurance subsample, we add another three control variables—outpatient reimbursement and inpatient reimbursement rate for public insurance and current working status—into the regression.

For measuring risk preference, we use smoking status, drinking status and time spent exercising as proxies. In health economics, individuals' risk preference can possibly affect the decision of purchasing health insurance and the amount of preventive effort both of which could influence the risk of mortality (Anderson and Mellor, 2008). There is debate about how to measure individuals' risk preference. Some literature in health economics uses smoking status, drinking status, seat beat use etc. (Vescusi and Hersch 2001; Hakes and Viscusi, 2007),

while other studies employ surveys asking hypothetical questions (Barsky et al., 1997; Dave and Saffer, 2007). One concern on using measures of health behavious as proxies for risk preference is that they may also reflect individuals' time preference (Anderson and Mellor, 2008). A criticism of surveys asking hypothetical questions is that these may not reflect individuals' real behaviour when they are at financial risk (Glaeser, 2000). For our study, the choice of proxies of risk preference is limited by the data. We can only use smoking and drinking status, time spent exercising as crude measures of risk preference. This is a potential weakness of the study.

2.3.7 Data descriptive statistics

Table 4 presents whole sample characteristics. The average age for the whole sample is 48.3 years old. 48.4% of them are male, 82.1% are currently married, and 26.9% are living in urban area. Average annual premium for private insurance is RMB 1171.6 (£97.63 per month), while annual household income is RMB 26,029.6 (£2196.08 per month). If the individual is sick, the mean of medical cost in 4 weeks is RMB787.9.

Table *5* shows descriptives for non-public insurance subsample. For this sample, average age of the respondents is 47.1 years old, approximately 47 percent of them are male and 80.7 percent of them are currently married. This table also provides comparisons across two clusters of people, those who bought commercial insurance and those who did not. P value from the test for significance of the difference between two clusters are also reported in the table.[1] Altogether, there

[1] T test is used to test the difference of means for continuous variables and pr test (test for proportions) is used to test the differences of means for dummy variables.

are 8,135 people (96.7%) that do not have any health insurance and 271 people (3.2%) that only have commercial insurance. Comparisons of the means between two clusters show that there are a larger proportion of people (63% vs 34%) with greater medical expenditure in the "buying private insurance" cluster, indicating adverse selection. It also suggests that people with private insurance are younger, have higher household income, spend more time for exercise and have more years of education. In addition, the proportion of people with good and fair self-reported health status in "having insurance cluster" is smaller, implying they are less healthy even though they are younger.

Table 4: Data descriptive statistic for the whole sample

Variable	Mean	Standard dev.
Age	48.351	15.942
Male	0.484	0.500
Years of education	7.218	4.159
Married	0.821	0.383
Disabled	0.006	0.078
Urban	0.269	0.443
Premium	1171.552	885.605
Expected medical expenditure	83.344	93.613
Household income (in RMB)	26029.580	33661.69
Medical expenditure (in RMB)	106.620	1403.291
Medical expenditure (expenditure>0) (in RMB)	787.910	3744.357
Smoking status	0.278	0.448
Drink every day	0.105	0.306
Time spend for exercise (in minutes)	13.194	58.386
Presently working	0.606	0.491
Number of facilities in the community	1.306	0.769
Outpatient reimbursement rate (%)	11.794	26.798
Inpatient reimbursement rate (%)	13.236	25.567
Self-reported health: excellent	0.131	0.338
Self-reported health: good	0.513	0.500
Self-reported health: fair	0.308	0.462
Self-reported health: poor	0.048	0.213
Number of observations	17,513	

Table 5: Data descriptive statistic for non-public-insurance subsample

	Full sample	Insurance=0	Insurance=1		
Variable	**Mean**	**Mean**	**Mean**	**Difference**	**P**
	(Std. Dev.)	**(Std. Dev.)**	**(Std. Dev.)**		**(ttest/prtest)**
Greater medical expenditure	0.347	0.338	0.631	-0.293	0.0000
(than premium)	(0.476)	(0.005)	(0.029)		
Annual premium (in RMB)	958.0847	956.392	1008.915	-52.523	0.1524
	(828.827)	(9.258)	(37.365)		
Expected medical	84.516	83.879	103.657	-19.778	0.0003
expenditure (in RMB)	(92.336)	(1.008)	(127.134)		
Household income per year	17082.720	16754.190	26944.690	-10190.500	0.0000
(in RMB)	(26216.980)	(287.312)	(1982.466)		
Medical expenditure in past	72.836	74.038	36.742	37.297	0.2526
4 weeks (in RMB)	(906.360)	(10.198)	(17.803)		
Medical expenditure in past	606.197	615.222	321.194	294.028	0.2641
4 weeks (expenditure>0)	(2553.309)	(82.743)	(147.953)		
Lag medical expenditure in	51.769	52.910	17.535	35.375	0.2357
past 4 weeks (in RMB)	(795.262)	(8.956)	(10.198)		
Lag medical expenditure in	654.396	664.230	279.529	384.701	0.2854
past 4 weeks(>0）(in RMB)	(2758.729)	(109.692)	(152.961)		
Smoking status	0.283	0.286	0.199	0.087	0.0009
	(0.450)	(0.005)	(0.024)		
Drink every day	0.100	0.101	0.070	0.030	1.6465
	(0.299)	(0.003)	(0.016)		
Time spend for exercise per	11.635	11.012	30.332	-19.320	0.0000
week (in minutes)	(61.172)	(0.661)	(5.766)		
Lag smoking status	0.290	0.294	0.177	0.117	0.0000
	(0.454)	(0.005)	(0.023)		
Lag drink every day	0.100	0.101	0.066	0.035	0.0296
	(0.300)	(0.003)	(0.015)		
Lag time spend for exercise	6.305	6.132	11.483	-5.351	0.0347
per week (in minutes)	(47.733)	(0.520)	(4.176)		
Number of facilities in	1.322	1.316	1.520	-0.203	0.0001
community	(0.814)	(0.009)	(0.067)		
Self-reported health:	0.119	0.119	0.107	0.012	0.2742
excellent	(0.323)	(0.004)	(0.019)		
Self-reported health: good	0.522	0.516	0.499	0.017	0.0001
	(0.496)	(0.006)	(0.029)		
Self-reported health: fair	0.308	0.313	0.379	-0.066	0.4034
	(0.462)	(0.005)	(0.022)		
Self-reported health: poor	0.051	0.052	0.015	0.037	0.0029
	(0.220)	(0.002)	(0.007)		
Lag self-reported health:	0.136	0.135	0.177	-0.042	0.0226
excellent	(0.343)	(0.004)	(0.023)		
Lag self-reported health:	0.516	0.513	0.520	-0.007	0.3099
good	(0.500)	(0.006)	(0.030)		

Table 5: (Continued)

Variable	Full sample Mean (Std. Dev.)	Insurance=0 Mean (Std. Dev.)	Insurance=1 Mean (Std. Dev.)	Difference	P (ttest/prtest)
Lag self-reported health: fair	0.304	0.307	0.288	0.119	0.0000
	(0.460)	(0.005)	(0.024)		
Lag self-reported health:	0.044	0.045	0.015	0.030	0.0087
poor	(0.205)	(0.002)	(0.007)		
Age	47.112	47.539	34.319	13.219	0.0000
	(15.939)	(0.174)	(1.022)		
Male	0.472	0.472	0.480	-0.008	0.3971
	(0.499)	(0.006)	(0.030)		
Years of education	6.930	6.859	9.041	-2.181	0.0000
	(3.999)	(0.044)	(0.202)		
Presently working	0.582	0.587	0.415	0.172	0.0000
	(0.493)	(0.006)	(0.033)		
Married	0.807	0.814	0.601	0.212	0.0000
	(0.395)	(0.004)	(0.030)		
Urban	0.259	0.251	0.498	-0.247	0.0000
	(0.438)	(0.005)	(0.030)		
Number of observations	7,751	7,570	181		

Descriptive statistics for public insurance subgroup are shown in Table 6. It shows different characteristics from the public-insurance subsample in terms of risk measurement. Among people who bought supplementary private insurance, there are only 64% of them with medical expenditure being greater than premium, compared with 91% in the other cluster. We also observe that people with supplementary private insurance are younger, have more years of education, earn higher income, have higher outpatient reimbursement rate, and spend more time exercising.

Table 6: Data descriptive statistic for public-insurance subsample

	Full sample	insurance=0	insurance=1		
Variable	**Mean**	**Mean**	**Mean**	**Difference**	**P (ttest)**
	(Std. Dev.)	**(Std. Dev.)**	**(Std. Dev.)**		
Greater medical	0.907	0.913	0.646	0.266	0.0000
expenditure	(0.291)	(0.003)	(0.030)		
Annual Premium (in	1335.784	1336.132	1320.666	15.466	0.394
RMB)	(892.872)	(8.676)	(45.524)		
Expected medical	82.44269	82.353	86.341	-3.989	0.256
expenditure (in RMB)	(94.578)	(0.910)	(7.480)		
% outpatient fee covered	20.970	20.923	23.033	-2.110	0.1628
by public insurance	(33.280)	(0.321)	(2.375)		
% inpatient fee covered	23.129	23.152	22.159	0.993	0.3070
by public insurance	(30.526)	(0.295)	(1.962)		
Household income per	22361.350	22059.010	35487.070	-13428.050	0.0000
year (in RMB)	(32972.290)	(305.987)	(4378.744)		
Medical expenditure in	132.612	133.965	73.850	60.115	0.2904
past 4 weeks (in RMB)	(1688.445)	(16.509)	(31.494)		
Medical expenditure in	902.188	915.385	422.488	492.897	0.2306
past 4 weeks (in RMB)	(4325.571)	(110.790)	(172.027)		
Lag medical expenditure	77.026	77.669	49.094	28.576	0.3720
in past 4 weeks (in	(1357.197)	(13.266)	(29.640)		
Lag medical expenditure	641.451	647.546	389.581	257.966	0.3570
in past 4 weeks(>0) (in	(3871.375)	(109.326)	(229.159)		
RMB)					
Smoking status	0.274	0.275	0.244	0.031	0.1392
	(0.446)	(0.004)	(0.027)		
Drink every day	0.109	0.108	0.130	-0.022	0.1405
	(0.312)	(0.003)	(0.021)		
Time spend for exercise	14.394	13.952	33.589	-19.637	0.0000
per week (in minutes)	(56.122)	(0.536)	(5.078)		
Lag smoking status	0.279	0.279	0.244	0.036	0.1092
	(0.448)	(0.004)	(0.027)		
Lag drink every day	0.111	0.111	0.114	-0.003	0.4382
	(0.314)	(0.003)	(0.020)		
Lag time spend for	11.262	11.007	22.366	-11.359	0.0004
exercise per week (in	(52.600)	(0.504)	(4.515)		
minutes)					
Self-reported health:	0.256	0.256	0.353	-0.097	0.4064
excellent	(0.230)	(0.002)	(0.014)		
Self-reported health:	0.583	0.583	0.504	0.079	0.2163
good	(0.402)	(0.004)	(0.025)		
Self-reported health: fair	0.136	0.136	0.134	0.002	0.4707
	(0.343)	(0.003)	(0.022)		
Self-reported health:	0.025	0.025	0.008	0.017	0.0439
poor	(0.156)	(0.002)	(0.006)		
Lag self-reported health:	0.138	0.137	0.175	-0.037	0.0463
excellent	(0.345)	(0.003)	(0.024)		

Table 6: (Continued)

	Full sample	insurance=0	insurance=1		
Variable	**Mean**	**Mean**	**Mean**	**Difference**	**P (ttest)**
	(Std. Dev.)	**(Std. Dev.)**	**(Std. Dev.)**		
Lag self-reported health:	0.509	0.508	0.602	-0.094	0.4802
good	(0.499)	(0.005)	(0.032)		
Lag self-reported health:	0.305	0.307	0.199	0.108	0.0001
fair	(0.460)	(0.004)	(0.025)		
Lag self-reported health:	0.048	0.048	0.024	0.024	0.0410
poor	(0.213)	(0.002)	(0.010)		
Age	49.304	49.503	40.670	8.833	0.0000
	(15.879)	(0.153)	(1.088)		
Male	0.493	0.492	0.549	-0.057	0.0382
	(0.500)	(0.005)	(0.032)		
Years of education	7.439	7.393	9.472	-2.079	0.0000
	(4.265)	(0.041)	(0.252)		
Number of facilities in	1.293	1.289	1.467	-1.778	0.0001
community	(0.731)	(0.007)	(0.053)		
Presently working	0.606	0.608	0.560	0.048	0.0714
	(0.489)	(0.005)	(0.033)		
Married	0.832	0.834	0.756	0.078	0.0007
	(0.374)	(0.004)	(0.027)		
Urban	0.274	0.056	0.053	0.004	0.4064
	(0.446)	(0.002)	(0.014)		
Number of observations	9,762	9,475	287		

2.4 Results for testing adverse or advantageous selection

2.4.1 Results for non-public-insurance group

Table 7 displays the results from logistic regressions for non-public-insurance subsample, including both coefficients and average marginal effects. The dependent variable is individual's commercial insurance status, while the variable of interest is the dummy "greater medical expenditure. All other control variables are listed in the results table. Without any control variables (column i), the coefficient of risk measurement is positive and significant, suggesting that buying private insurance is positively correlated with the probability of having greater medical expenditure than insurance premium.

When we include all control variables in column (ii), main results still holds. The coefficient is still positive and significant and the marginal effect does not change much. It implies that, even if we control for other variables, this result is still in line with data descriptive statistics and reveals that there is adverse selection in this market. This suggests that a 1% increase in household income will increase the probability of buying insurance by 0.9%. Even though only 2.39% of the whole sample bought commercial insurance, this not a negligible marginal effect.

If individuals have more years of education, they are more likely to buy insurance. For this subsample, we also find a strong regional effect that living in urban area will increase the probability of choosing private health insurance.

Table 7: Results of logistic regressions for non-public-insurance subsample

	(i)		(ii)	
	Commercial insurance	**Marginal effect[2]**	**Commercial Insurance**	**Marginal effect**
Greater medical expenditure than premium	0.314	0.009	0.333	0.009
	(2.33)**		(2.17)**	
Age			-0.077	-0.002
			(2.91)**	
Age square			0.000	
			(1.45)	
Number of facilities			0.056	
			(0.81)	
Presently working			-0.429	-0.012
			(2.70) **	
Lag self-reported health: good			-0.172	
			(0.97)	
Lag self-reported health: fair			-0.321	
			(1.45)	
Lag self-reported health: poor[3]			-0.513	
			(0.95)	
Lag smoking status			-0.163	
			(0.74)	
Lag drink everyday			0.471	
			(1.59)	
Ln household income			0.379	0.010
			(5.22)**	
Male			-0.217	
			(1.21)	
Lag time for exercise			0.000	
			(0.21)	
Education			0.057	0.002
			(2.35)*	
Married			-0.056	
			(0.27)	
Urban			0.669	
			(4.25)**	0.024
_cons	-3.651		-5.218	
	(6.76)**		(6.17)**	
N	7,751		7,751	

(* p<0.10 ** p<0.05 *** p<0.01)

[2] Marginal effect here refers to average marginal effect.

[3] Reference group is perfect health.

2.4.2 Results for public-insurance group

Table 8 demonstrates regression results for people who have public insurance and face the choice of buying a supplementary coverage. A negative correlation is found between an individual's risk type and insurance coverage, which conflicts with the classical prediction from Rothschild and Stigliz (1976). It is noticeable that when we control for other variables, the marginal effect is even stronger. A 1% increase in the probability of having greater medical expenditure than premium will result in a 2.5% decline in the probability of buying supplementary insurance. It entails that there is advantageous selection in the supplementary health insurance market.

However, the negative correlation between risk measurement and private insurance status could be due to the fact that employers bought private insurance for their employees. If this is the case, we cannot call it advantageous selection because it is not individual's own choice. Nevertheless, the coefficient of individual's working status is negative, indicating that people who currently have a job are less likely to buy private insurance. This could rule out this suspicion.

Furthermore, compared with people who report excellent health in the past wave, people who report good health status are less likely to buy supplementary insurance. We also found significant effects of outpatient and inpatient reimbursement rate, but their impacts are too small to be of concern. 1% increase in outpatient and inpatient reimbursement rate increase will result in a 0.019% increase in the probability of purchasing supplementary insurance. Other indicators of buying supplementary insurance include outpatient fee covered, household income, and education.

In addition, although we know the percentage of outpatient and inpatient fee covered by public insurance, we do not know respondents' expenditure for each service. Therefore, we could not subtract the expenditure paid by public insurance from total medical expenditure for this group. We report both regression with and without those two variables in column (ii) and (iii), and the results do not change dramatically, especially when we compare the marginal effect. Finally, although we found advantageous selection, we did not find significant effects related to the risk preference variables.

The results find adverse selection in a pure private insurance market where people choose whether or not to buy health insurance. Meanwhile, this study also identifies advantageous selection in the supplementary insurance market.

Table 8: Results of logistic regressions for public-insurance subsample

	(i)	(ii)		(iii)	
	Commercial insurance	**Commercial Insurance**	**Marginal effect**	**Commercial Insurance**	**Marginal effect**
Greater medical expenditure than premium	-1.200 (8.88) **	-1.138 (8.05)**	-0.025	-1.122 (8.00)**	-0.025
(Marginal effects)	-0.027				
Number of facilities		0.156 (1.99) *	0.003	0.167 (2.16)**	
Outpatient fee covered		0.009 (2.74)**	0.00019		
Inpatient fee covered		-0.009 (2.31)*	0.00019		
Age		-0.042 (1.51)		-0.043 (1.55)	
Age square		0.000 (0.69)		0.000 (0.73)	
Presently working		-0.374 (2.12)*	-0.008	-0.385 (2.18)*	-.009
Lag self-reported health: good		-0.407 (2.29)*	-0.009	-0.409 (2.31)*	
Lag self-reported health: fair		-0.629 (2.85)**	-0.014	-0.634 (2.87)**	
Lag self-reported health: poor[4]		-0.715 (1.59)		-0.720 (1.60)	
Lag smoking status		-0.229 (1.20)		-0.232 (1.21)	
Lag drink everyday		0.072 (0.30)		0.088 (0.37)	
Ln household income		0.250 (3.55)**	0.005	0.253 (3.59)**	.005
Male		0.186 (1.11)		0.184 (1.10)	
Lag time for exercise		0.002 (1.96)*		0.002 (1.90)	
Education		0.086 (3.87)**	0.002	0.088 (3.94)**	.001
Married		0.248 (0.90)		0.249 (0.90)	
Urban		0.196 (1.16)		0.170 (1.01)	
_cons	-2.999 (32.06)**	-4.745 (5.94)**		-4.779 (5.97)**	
N	9,762	9,762		9,762	

(* p<0.10 ** p<0.05 *** p<0.01)

[4] Reference group is perfect health.

2.5 Sensitivity analysis: prediction of medical expenditure—GLMs

Expenditure data always have a skewed distribution, because there is substantial proportion of zero expenditure. The situation is the same in this dataset. Literature on proposing alternative methods to model expenditure could be categorized into two categories (Fleishman et al., 2006). The first suggestion is to take log of expenditures to reduce the skewness. However, it needs retransformation of the estimates from the logged form to unlogged form, which would lead to biases if there is heteroskedasticity on the log scale (Manning, 1998). The second suggestion is using generalized linear models (GLMs). We choose GLMs to predict medical expenditure because it does not need retransformation of the dependent variable and it models both mean and variance functions on the original scale of the dependent variable (Buntin and Zaslavsky, 2004).

A simple model with outcome medical expenditure and predictors is implemented in Stata software. We allow for Poisson-like variance by assuming that the variance is proportional to the mean, and use a logarithmic link function to model expenditures. Predictors include age in t-1, age square in t-1, self-reported health in t-1, log of household income and year dummies. Since GLMs do not exploit panel data structure, we include year dummies to control for the heterogeneity being correlated with the time-varying covariates.

Table 9 demonstrates the results for logistic regressions using this type of predicted medical expenditure. This alternative way to predict medical expenditure does not change the main result. Even controlling for other variables the sign of the coefficient still holds the same. This suggests that our result is relatively robust with regard to the different methods of predicting medical expenditure.

Table 9: Final results using GLMs predicted medical expenditure

	(i)		(ii)	
	Non-public insurance group		**Public insurance group**	
	Commercial insurance	**Marginal effect**	**Commercial Insurance**	**Marginal effect**
Greater medical expenditure than premium	0.333	0.009	-1.138	-0.025
	(2.17)*		(8.05)**	
Number of facilities in community	0.056		0.156	0.003
	(0.81)		(1.99)*	
Outpatient fee covered			0.009	0.0002
			(2.74)**	
Inpatient fee covered			-0.009	-0.0009
			(2.31)*	
Age	-0.077	-0.076	-0.042	
	(2.91)**		(1.51)	
Age square	0.000		0.000	
	(1.45)		(0.69)	
Present working status	-0.429	-0.012	-0.374	-0.008
	(2.70)**		(2.12)*	
Lag self-reported health: good	-0.172		-0.407	-0.009
	(0.97)		(2.29)*	
Lag self-reported health: fair	-0.321		-0.629	-0.014
	(1.45)		(2.85)**	
Lag self-reported health: poor	-0.513		-0.715	
	(0.95)		(1.59)	
Lag smoking status	-0.163		-0.229	
	(0.74)		(1.20)	
Lag drink everyday	0.471		0.072	
	(1.59)		(0.30)	
Ln household income	0.379	0.010	0.250	0.006
	(5.22)**		(3.55)**	
Male	-0.217		0.186	
	(1.21)		(1.11)	
Lag time for exercise	0.000		0.002	
	(0.27)		(1.96)*	
Education	0.057	0.002	0.086	0.002
	(2.35)*		(3.87)**	
Married	-0.074		0.248	
	(0.33)		(0.90)	
Urban	0.669	0.018	0.196	
	(4.25)**		(1.16)	
_cons	-5.218		-4.745	
	(6.17)**		(5.94)**	
N	7,751		9,762	

(* p<0.10 ** p<0.05 *** p<0.01)

2.6 Policy implications

There are five goals of the Chinese health care reform which is officially launched in 2009, including 1) To improve the health insurance system by guaranteeing universal coverage of the social insurance, raising the government subsidies and reimbursement ceiling, improving the management of "health care funds" run by the government. 2) To insure people with critical illness. 3) To establish a national essential medicines system to meet patients' needs by categorizing "essential medicines" and setting guidance prices for them. 4) To improve the primary health services delivery system. 5) To provide everybody with equal access to public health services. However, Chinese government did not set an explicit goal for the private insurance market. Policy implications we present below are based on the above mentioned aims of the reform, and we divide them into two sections according to the different findings derived from the two different contexts.

2.6.1 Policy implications for adverse selection

In this study, we found adverse selection in the pure private insurance market. Adverse selection is considered costly in general because it will lead to different types of inefficiencies in the market. Firstly, from the demand side, consumers contracting with wrong plans will suffer from not being fully insured (Cutler and Zackhause, 1997). Second, as Rothschild and Stiglitz (1976) suggested, the market can not merely achieve separating equilibrium because of asymmetric information. Therefore, inefficiency is raised here if low-risk type consumers would obtain less than optimal coverage (Belli, 2001). The third type of inefficiency comes from insurance companies who have incentives to distort their mix of customers by

changing their insurance policies. In this case, some consumers with under-provided service by insurance companies may suffer from less than efficient quality of care (Glazer and McGuire, 2006). Last but not the least, there would be an equity problem if insurance companies anticipate adverse selection and reject high-risk type individuals. In other words, those high-risk type individuals may have less access to insurance.

Solutions to deter adverse selections are discussed extensively in literature. An extreme method would be full insurance coverage scheme, in which the government provide full and compulsory insurance for all individuals independent of their risk type (Neudeck and Podczeck, 1996). It is a way to achieve the best possible outcome, but it is not Pareto efficient for the market outcome. This approach could lead to ex-ante and ex-post moral hazard by reducing consumer's incentive to regulate their health behaviour to prevent bad events or the incentive to control for utilization if bad events take place.

An alternative proposed by Cutler and Zeckhause (1999) is reinsurance, which means the insurance for insurers. It works via removing all extreme spending from plan premiums. For example, one insurance plan could cover a proportion of the spending that is over a certain amount by buying another insurance from another company in a free market. If the problem of adverse selection comes from those high-spending users of more generous plans, reinsurance could reduce it. The risk of reinsurance is that if the expenditure of high-spending consumer is pooled, insurance companies may have less incentive to control consumer's utilization, again leading to moral hazard.

In recent years, increasing attention has been paid to risk adjustment and it is adopted in many high-income countries like Germany and the Netherlands. Van

den van and Ellis (2000) define it as “the use of information to calculate the expected health expenditures of individual consumers over a fixed internal of time and set subsidies to consumers or health plans to improve efficiency and equity”. The primary rationale for regulating a competitive health plan market is to provide financial access to health plan coverage for high-risk individuals. There are different risk adjustment models to predict the expected medical expenditure for individuals, including demographic models, prior year expenditures, diagnosis-based risk adjustment, and information derived from prescription drugs, self-reported information, mortality, and models using other information. Those models have various predicted power with a maximum of predicting more than 20 percent of actual variance (Van de Van and Ellis, 2000). Subsidizing premiums according to individual risk types is well acknowledged as an efficient way to decrease insurance companies’ incentive to denying high-risk consumers or distorting their policy. However, Cutler and Zackhause (1997) put forward that risk adjustment reduces employees’ or consumers’ incentives to choose the most cost-effective contracts. This is because if most of the premium is subsidized by employers or government, consumers would not notice much of an increase in the price of insurance.

With respect to low-income countries, McLeod et al. (2012) discussed the role of risk adjustment in South Africa. Its health system shares some similar features with China’s health system, and it is also in the progress of health care reform with one objective of universal coverage. Their article justifies the need for using at least age, gender and HIV prevalence in the risk adjustment model at provincial level. Besides, there are other middle-income or low-income countries

experimenting with risk-adjusted capitation fees including Thailand and Viet Nam (Ginneken, 2008).

However, one obstacle for China to apply risk adjustment is that its population is much larger than other countries. Giving each provincial government right to generate their risk adjustment models could be one potential solution to deal with large population.

China officially started the public health insurance reform by providing two voluntary schemes, NCMS and URBMI, to rural and urban population in 2009. To deal with adverse selection, the Government adopts a method which is very similar to the first means mentioned above, which is providing compulsory insurance to the public. They require full household enrollment to the scheme. It means that one household either has all members to join the scheme or none. Currently, the public health insurance coverage has reached over 96% in China, and only a few individuals are without any public insurance coverage. Non coverage is more likely to be related to geographical reasons rather than risk type (Qin and Lu, 2014). Therefore, full household enrolment is considered to be an effective way to reduce adverse selection.

2.6.2 Policy implications for advantageous selection

In the context China's partial public insurance system, where people have public insurance but have the choice of buying a supplementary insurance, we found advantageous selection where low-risk type individuals are more likely to purchase private insurance. Theoretically, advantageous selection would not lead to inefficiency if we do not consider transaction costs (Einav and Finklstein, 2011). However, for those with lower expected medical expenditure than their premium, they have too much insurance than is efficient. In contrast, those people who have

higher expected medical expenditure still face the risk of financial loss if they are not privately insured, especially when household income is a significant indicator of buying complementary insurance.

One of the goals of the government is to provide equal access to public health services. Results from our analysis suggest that high-risk individuals may still face financial barriers to health services and are under insured. Particularly when individuals have serious illness, they risk catastrophic health expenditure.

Policies could be set directly to address access problems for those with high expenditure. First of all, providing a more generous public insurance plan could reduce their financial loss directly, such as setting no deductibles or even offering full public insurance. Nevertheless, it might be too expensive to improve the benefit package for public insurance plans, bearing in mind that China is still at the stage of trying to roll-out universal coverage. Moreover, more generous public insurance plans might lead to moral hazard and cause welfare loss to the society. To prevent the risk of catastrophic health expenditure, Chinese government has been experimenting with Critical Illness Insurance since 2012.

Other solutions to drive out over-insured consumers could be via taxing insurance or "outlaw insurance coverage" (De Meza and Webb, 2001; Einav and Fenklstein, 2011). In other words, situation could be improved by using the money gained by insurance companies to subsidize those with higher expected medical expenditure than insurance premium. It could be fulfilled by applying the opposite strategies to deter adverse selection. For example, taxing applied to existing private insurance plans and redistributing the money raised to subsidize those high-risk type individuals could be one way to improve welfare.

2.7 Discussion

We investigated the choice of buying private insurance in Chinese insurance market, to test whether there is adverse or advantageous selection in buying private insurance. Since there are two types of costumers for private insurance market, we separate the sample into two subsamples. The first group is in a pure private insurance market, including people who do not have public insurance and face the choice of buying a private coverage. The second group is in a supplementary insurance market, containing people who have public insurance and face the choice of buying additional private insurance. By employing logit regressions using a survey data, we found adverse selection in the pure private insurance market and advantageous selection in the supplementary insurance market.

The results could imply that context matters when considering whether there is adverse or advantageous selection in competitive insurance markets. Recall those studies finding advantageous selection like Fang et al. (2008) and Buchmueller et al. (2013), they are also estimating supplementary insurance markets. For illustration, Fang et al. (2008) found that Medigap costumers are healthier than those without Medigap, in which Medigap is a supplementary health insurance plan to Medicare in the United States. Although the generalizability still need to be further established, it is worthwhile to conduct further study to test our hypothesis.

It was shown in the literature review that most of the previous empirical studies used data from insurance companies, but we adopted survey data in this study. The advantage of insurance company data is that information for variables of key interest is more complete and accurate. However, they only have the sample who are enrolled in the plan but do not have the sample who did not buy the insurance.

CHNS data enables us to investigate a larger population to get a more complete picture of the Chinese insurance market. Disadvantages of CHNS include that it is not conducted every year, so there are two or three years' gap between waves. Predictions based on wave t-1 might be inefficient because of the gap. In addition, variables collected in waves before 2000 are not quite consistent with variables post wave 2000. Thus, we can only include one wave of data to predict expected spending 2 to 3 years later, which may lead to prediction bias. Firstly, there is a 2-to-3-year gap between two periods, but 0 gap would be more valid for prediction. Besides, it would be better to include more than one year of previous data to predict expected spending in the subsequent period, but we can use only one wave due to the availability of the dataset. Second, we do not have information on whether individuals have multi contracts with private companies. In other words, the survey does not collect information for whether respondents bought private insurance from the same company or not and whether insurance company refused to sell them insurance.

2.8 Conclusion

In this study, we tested the theoretical hypothesis that individuals with higher risk of suffering financial loss will have higher insurance coverage in China's private insurance market. We found co-existence of adverse selection and advantageous selection, but this arises under different markets conditions. Adverse selection is identified in a pure private insurance market where people choose whether or not to buy health insurance and advantageous selection is found in a supplementary insurance market. It implies that it might not be a simple "yes or no" answer to the theoretical hypothesis but depends on the context that we are considering. Further studies are called to test this hypothesis.

Results from this research indicate that in the era of reform in China's health insurance market, there are still problems that call for attention. We proposed several solutions including risk adjustment in pure private insurance market, taxing insurance contracts and redistributing subsidies for high risk individuals in the partial public insurance market.

Chapter 3: Universal Coverage and Ex-ante Moral Hazard in China

3.1 Introduction

Classical economic theory predicts that health insurance will reduce an individual's incentives towards taking preventive efforts to remain healthy (Arrow, 1963). For example, compared with the case of no insurance, the insured may smoke more or exercise less, which ultimately may increase demand for health care utilization. Since this change in behaviour in response to insurance occurs before the event of sickness, it is termed ex-ante moral hazard.

Empirical evidence of ex-ante moral hazard has been seen in other markets. For example, Zavadil et al. (2007) found evidence of ex-ante moral hazard in the Dutch car insurance market. They define ex-ante moral hazard as agents having less incentive to reduce the probability of an accident. Although there is a theoretical possibility of ex-ante moral hazard in health care, some literature (Zweifel and Manning, 2000; Kenkel, 2000) suggested that it might have little consequence for health insurance markets, since risk aversion may also interact with the effect of insurance coverage on preventive activities. For example, even though the monetary component of health care access is covered by insurance, risk-averse individuals may still suffer from utility losses from ill-health, so this may dampen any incentive to reduce preventive effort for those who have insurance.

The theoretical debate on the extent to which ex-ante moral hazard impacts on health care expenditures in the presence of insurance helps formulate hypotheses to be subjected to empirical scrutiny. For example, one could test whether health insurance affects people's behaviour to the extent that they undertake less

preventive activities to maintain health. There is a large empirical literature that has attempted to answer this question. However, this literature provides inconsistent conclusions. Some papers (Kenkel, 2000; Courbage and Coulon, 2004; etc.) are in line with the view that insurance induces little ex-ante moral hazard, but others (Cherkin et al., 1990; Dave and Kaestner, 2009; Yilma et al., 2012) provide evidence of the existence of substantial ex-ante moral hazard. Section 3.2 will review and debate these findings.

The work presented here examines whether there is evidence of ex-ante moral hazard following the introduction of a public health insurance system in China, and whether implementing nearly universal coverage led to a decrease in individual preventive behaviour prior to illness. Since a reduction in preventive efforts will increase the probability of ill-health or disease, the existence of ex-ante moral hazard will increase health care expenditures. As a consequence, there will be an external cost on society. As an upper-middle income country (World Bank, 2015[5]), China has not reached the same level of health care spending as high-income countries. Health expenditure in 2013 was 5.6% of GDP, well below the OECD average of 9.3%. Moreover, since the reform has been officially in place since 2009, this chapter could provide some policy implications if the government wants to improve the efficiency of the programme. In addition, the government has equity justifications for providing effective insurance. Thus, it is of great importance to analyse whether health care spending is used effectively.

The paper is divided into six sections. Section 3.2 is a review of the existing empirical literature. Section 3.3 introduces the data employed in this study. Section

[5] Source from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

3.4 presents the empirical strategy. Following the methodology, results are presented in section 3.5. Discussion and conclusions are given in the sixth, and final section.

3.2 Literature review of empirical studies

This section presents a review of empirical studies on ex-ante moral hazard in health insurance markets as listed in Table 10. We searched for relevant literature using the key words "ex-ante moral hazard; health insurance" in the library search engine from University of York, E-resource like EconLit, Health Management Information Consortium, and Google Scholar. In addition, I also read empirical studies from the reference lists of related literature. Studies are summarised below if :1) these are closely related to the topic 2) they can inform the methodology of this study; 3) they have more than 20 citations. Testing whether there is ex-ante moral hazard requires a test of the pure effect of insurance coverage on individuals' preventive behaviours. An ideal scenario would be to ensure nothing else could affect changes in preventive behaviours except insurance. In this case, a test of ex-ante moral hazard would consist of simply comparing preventive efforts in a population before and after taking up insurance.

However, in reality this requirement is seldom satisfied. One significant empirical challenge is individual unobservable heterogeneity. For instance, an individual's risk preferences are unobserved and these could be positively correlated with both preventive efforts and insurance coverage. Risk-averse individuals may exert more preventive efforts and at the same time be more likely to buy insurance when it becomes available. In this case, the incentive for changing preventive efforts may be more related to risk preferences rather than a change in

the status of insurance coverage. Thus, a failure to control for risk preference could lead to biased estimates of the effect of ex-ante moral hazard. To overcome the problem of individual unobserved heterogeneity, strategies such as randomized controlled trials (Manning et al., 1987), natural experiments, instrumental variable (IV) techniques (Courbage and Coulon ,2004; Kelly and Markowitz, 2009), propensity score matching methods (Yilma et al. 2012), structural models (Yilma et al., 2012; Courbage and Coulon, 2004; Kelly and Markowitz, 2009) and difference in difference methods (Dave and Kaestner, 2009; Preux, 2011; Ghislandi et al., 2014) have been employed. Table 10 presents a summary of the key literature in this area.

Keeler and Rolph (1988) adopted data from a randomized controlled trial, the RAND health insurance experiment, to investigate whether there is ex-ante moral hazard. They used well care visits as the proxy for preventive behaviour and compared the number of "well care" visits between different coinsurance groups. Well care visits refer to the preventive visits that individuals do physical exam in health care facilities. Their results showed that people with free medical insurance make fewer well care visits than people with co-payments, which provided evidence of ex-ante moral hazard.

Roddy et al. (1986) explored ex-ante moral hazard in the US insurance market taking advantage of a natural experiment. In July 1977, the United Mine Workers of America (UMVA) health plan changed via the introduction of a 40% co-payment requirement which affected the insurance coverage of beneficiaries. Before the reform, UMVA members and their families had been provided with full coverage health insurance without a deductible. In December 1997, there was a strike that led this coinsurance being suspended. Starting in March 1978, the health

plan changed to a $5 co-payment for outpatient visits and prescription drugs. They considered three periods in their study: 1) A baseline period of full coverage from January 1977 to July 1977; 2) The first year of 5% co-payment from April 1978 to March 1979; 3) The second year of 5% co-payment from April 1979 to March 1980. They used the number of visits for preventive care as a proxy of preventive activities and compared the demand for preventive care among three periods. They identified a 25% fall in preventive visits in the first $5 co-payment per visit period compared to 40% coinsurance period and a 28% fall in the second $5 co-payment period. The authors considered that these reductions are indicative of ex-ante moral hazard. However, using co-payment as a proxy for insurance coverage status makes it difficult to separate ex-ante moral hazard from ex-post moral hazard. This strategy has rarely been used in recent literature.

Although natural experiments provide an opportunity to study the effect of insurance on preventive behaviours, the disadvantages are considerable. First, they fail to control the time trend and other factors that could also affect preventive efforts. For example, the number of hospitals and health centres might have changed during the experimental period. These would influence the utilization of health care services if not appropriately controlled for. Thus, a causal effect of insurance will not be identified in this case. Moreover, the use of the co-payment as an indicator of the change in price of health services in the early literature might be more related to ex-post moral hazard rather than ex-ante moral hazard, because the requirement for co-payment happens after using health care facilities which is supposed to be ex-post. More recent literature seldom adopts this proxy to measure ex-ante moral hazard (Courbage and Coulon, 2004; Stanciole, 2008; Kelly and Markowitz 2009).

Recent studies have started to use other approaches to examine ex-ante moral hazard in health insurance markets, such as instrumental variable (IV), system equations methods, difference in difference, and matching methods. In particular, they have started to estimate ex-ante moral hazard by testing several behaviours of preventive effort under insurance coverage. Such behaviours include smoking behaviour, alcohol consumption, effort in exercising and obesity (Courbage and Coulon 2004; Bhattacharya and Packalen, 2008; Stanciole, 2008). Courbage and Coulon (2004) tested for ex-ante moral hazard using the year 2000 wave of the British Household Panel Survey in the context of UK private insurance system. Two proxies for the indication of preventive care used were the frequency of exercise and being a smoker. Initial results from a simple probit model could not reject the null hypothesis of no evidence for ex-ante moral hazard. However, this result could be subject to bias due to endogeneity because insurance status could correlate with both health behaviours and the error term that includes the effect of risk preference. Nevertheless, their results were validated by further implementing an IV strategy. They instrumented private medical insurance choice by choice of political party support. Results from IV estimates confirmed that there was no clear evidence of ex-ante moral hazard.

Using data from the 1993-2002 Behavioural Risk Factor Surveillance system in the US, Kelly and Markowitz (2009) used IV techniques to investigate whether insurance affects the probability of being obese. They regressed body mass on insurance status and other control variables and instrument insurance status with the percentage of each state's workforce employed in firms of different sizes to address endogeneity bias. Their findings showed that having insurance is associated with a higher body mass and that there exists a positive correlation

between having insurance and being overweight, but they found no evidence showing that insurance affects the probability of being obese.

Another approach is to use system equations methods, which usually involves a structural equation for health insurance coverage and reduced form equations for lifestyle behaviours. Stanciole (2008) inspected ex-ante moral hazard in the context of the US market by adopting the U.S Panel Study on Income Dynamics from 1999-2003. He estimated a system of multivariate probit equations and found that among lifestyle choices such as heavy smoking, heavy drinking, lack of exercise and obesity, ex-ante moral hazard was only identified from the effect of insurance coverage on an increase in the probability of being obese. Using the same methodology, Khan and Kaestner (2008) found evidence of ex-ante moral hazard in people in public programmes from the US but limited evidence for employer sponsored and Health Maintenance Organization (HMO) coverage.

The difference in difference (DID) method is used to compare a change over time in a control group to the same change in a treatment group. The treatment effect on the outcome of interest is based on the difference between the changes in the control and treatment groups. Using DID, Dave and Kaestner (2009) presented evidence of ex-ante moral hazard in the context of Medicare in the United States. Their results revealed that Medicare beneficiaries were associated with an increase in unhealthy behaviours (e.g. smoking, physical activities, alcohol participation etc.). They further adopted difference-in-difference-in-difference (DDD) approach as a robustness check. This approach introduces another difference between interactions of uninsured status and age dummies for any differential trends between individuals who are insured versus uninsured. Results from DDD are very similar to the simpler DD method in this study.

Preux (2011) adopted data from the US Health and Retirement Study in a DID study and found anticipatory ex-ante moral hazard. Individuals were found to reduce investments in healthy lifestyle (e.g. physical activity, smoking and drinking) before being insured if they expected to be insured in the future.

Propensity score matching is another method used in the literature to overcome a lack of randomization in observational studies to ensure treated and control groups have similar characteristics. It allows for a comparison of control and treatment groups that have a similar ex-ante probability of participating in the treatment. Yilma et al. (2012) employed this method to test for the presence of ex-ante moral hazard with reference to malaria prevention in Ghana. They used a panel data in the Brong Ahafo regions and found that ex-ante moral hazard is present, especially when the level of effort and cost required for prevention is high.

In summary, in order to estimate whether there is ex-ante moral hazard in health insurance markets, an empirical difficulty is to deal with the endogeneity problem of insurance status because insurance status is both correlated with unobserved risk preference and health preventive behaviours. Existing empirical studies provide various strategies to overcome this problem, providing several options for identifying a causal effect. Interestingly, a large literature is within the context of high-income countries with compulsory health insurance programs, and very few papers investigate ex-ante moral hazard in the context of voluntary health insurance systems. This paper further contributes to the existing literature by estimating whether ex-ante moral hazard existing in the Chinese health insurance system in which enrolment is voluntary

Table 10: Table of empirical literature on health insurance and ex-ante moral hazard

Literature	Data	Methodology	Preventive behaviours being tested	Control Variables	Results
Roddy et al. (1986)	The United Mine Workers of America Health and Retirement Funds' Computerized claims system	Natural experiment: Compare preventive care utilization between difference co-payment groups	Preventive care	None	Ex-ante moral hazard
Keeler and Rolph (1988)	RAND Health Insurance Experiment	Randomised controlled trial: Compare well care visits between different coinsurance groups	Well care visits	None	Ex-ante moral hazard
Cherkin et al. (1990)	Data from Washington State enrolees in a health maintenance organization	Natural experiment: Compare utilization data between enrolees with co-payment and without co-payment	Preventive care	None	Ex-ante moral hazard
Yilma et al. (2012)	Panel data of 400 households in Brong Ahafo region	Propensity-adjusted household fixed effects model	No. of members who slept under net	Age, gender, wealth, wage, employment status, religion	Ex-ante moral hazard
Courbage and Coulon (2004)	2000 British Household Panel Survey	Instrumental variable, Probit model	The frequency of exercising, and being a smoker	Age, gender, education, subjective well-being, income	There was no evidence of ex-ante moral hazard.
Kelly and Markowitz (2009)	Behavioural Risk Factor Surveillance System	Regress body weight on health insurance status and other control variables with instrumental variable techniques to address endogeneity of health insurance	Obesity	Age, gender, education, ethnicity, race, number of children, income marital status, food price	Ex-ante moral hazard

Table 10: (Continued)

Literature	Data	Methodology	Preventive behaviours being tested	Control Variables	Results
Stanciole (2008)	U.S. Panel Study of Income dynamics (1999-2003)	Multivariate probit model of individual choice of insurance coverage and lifestyle choices	Heavy smoking, heavy drinking, lack of exercise and obesity	Age, gender, income, marital status, kids, chronic disease, education, race, employment status, living area	Health insurance has significant incentive effects on lifestyle choices, increasing the propensity to heavy smoking, lack of exercise and obesity and decreasing the propensity to heavy drinking.
Khan and Kaestner (2008)	Medicare current Beneficiary Survey (2000-2005)	Multivariable regression models	Exercise, weight, diet, alcohol consumption, and smoking		They find limited evidence of ex-ante moral hazard with employer sponsored and HMO coverage.
Spenkuch (2012)	Data from Seguro Popular Experiment in Mexico	Least squares estimates	Preventive care (flu shot, pelvic, pap smear, mammogram, eye exam)	Age, gender, wealth, employment status, location type, number of doctors, Self-rated health, BMI, chronic disease	They find evidence of ex-ante moral hazard
Tavares (2014)	4th Portuguese National Health Survey (2005)	Multivariate Probit regressions	physical activity, eating healthy snacks, dirking alcohol between meals	Age, gender, income, education, family size, married, employment status, chronic disease	There is evidence of ex-ante moral hazard in deciding to do sports and eating healthy snacks.

Table 10: (Continued)

Literature	Data	Methodology	Preventive behaviours being tested	Control Variables	Results
Dave and Kaestner (2009)	First eight waves of the Health and Retirement Study (HRS)	Difference-in- deference estimates; and difference-in-difference-in-difference estimates	Exercise, smoking and alcohol use	Age, marital status, employment, household size, number of living parents, assets, total years worked and year dummy variables	Obtaining health insurance reduces prevention and increase unhealthy behaviours among elderly men.
Preux (2011)	Nine waves of the US Health and Retirement Study	Difference-in- deference estimates; and difference-in-difference-in-difference estimates	Physical activity, smoking, and drinking	Mobility, gender, race, marital status, education, employment status, years of working, wealth, self-assessed health	If uninsured individuals expect to be covered in the future, they will reduce their investment in healthy lifestyle already before being insured.
Ghislandi et al. (2014)	Thai Health and Welfare Survey	Difference-in- deference estimates	Smoking, drinking, drinking and driving, annual check-up	Age, gender, education, out-of-pocket expenditure	They find no evidence of ex-ante moral hazard.

3.3 Data

The China Health and Nutrition Survey (CHNS) is used to investigate the extent of ex-ante moral hazard in China. It is an on-going survey, which aims at examining the impact of social and economic transformation on individuals' health behaviours, health status and nutrition. It is a longitudinal survey conducted every 2 to 3 years. The sample size—selected by a multistage, random cluster process—is representative, containing approximately 4,400 households with 26,000 individuals across 9 provinces, each with a different geography, level of economic development, available public resources, and status on key health indicators. It takes 3 consecutive days for each interview to collect information for the four component surveys: household; nutrition; community and adult. Survey questions include information on household and individual economic, demographic, and social factors.

We use waves 2006 and 2009 in the analysis. Wave 2006 is before the officially launched reform and wave 2009, immediately following the reform.

We investigate all individuals who are eligible for the three types of public insurance schemes. There are 4,997 observations in each wave in the original dataset. First, we dropped observations on survey respondents who are under 18 because they are too young to make economic decisions. We further deleted observations that are covered by commercial insurance plans and observations who had public insurance before wave 2006 because their insurance status does not change from pre to post reform. Furthermore, observations with missing values for age, marital status, education, household income, height, and weight are dropped from the study. Finally, we only keep individuals observed in both 2006 and 2009 to ensure the comparability of preventive behaviours between the

two waves. This leaves 2,918 observations in each wave on which to undertake analysis. None of these 2,918 individuals were insured in wave 2006. 2766 changed their insurance status from uninsured to insured in wave 2009, while 152 of them remained uninsured in wave 2009. A possible reason for explaining them not joining the schemes could be due to the low enforcement level of local government (Qin and Lu, 2014). Or they simply chose not to join.

Table 11: Comparable data descriptive statistics

	Control		Treatment	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Wave2006:				
Smoking	0.276	0.449	0.276	0.448
Veg fruit (in grams)	169.735	366.476	227.625	619.763
Overweight	0.199	0.399	0.237	0.527
Obesity	0.106	0.308	0.086	0.281
Preventive care	0.022	0.146	0.013	0.114
Number of cigarettes per day	4.216	8.427	4.724	9.465
Time for exercise per day (in minutes)	7.466	42.813	5.579	26.864
Age	49.820	14.149	49.448	15.357
Male	0.440	0.496	0.461	0.500
Education (in yrs)	6.255	4.114	7.579	4.300
Household income per capita per year (in RMB)	17947.380	27314.140	25012.600	42856.84
Married	0.865	0.342	0.855	0.353
Presently working	0.657	0.475	0.678	0.469
Chronic disease	0.092	0.289	0.118	0.324
Urban	0.198	0.399	0.204	0.404
Number of Observations	2,766		152	

Table 11 illustrates comparable descriptive statistics for the sample used for estimation in wave 2006. “Veg fruit” represents individuals’ vegetable and fruit consumption within 3 days in grams. Overweight and obesity are dummy variables generated from BMI which is a measure based on individuals’ weight in relation to their height to see whether they have healthy weight. It is calculated

as the weight divided by square of the height. An individual is defined to be overweight if his/her BMI is between 25 and 30, while s/he is defined to be obese if his/her BMI is bigger than 30. Preventive care is also a dummy variable indicating if an individual visited for preventive care in the past 4 weeks. The comparative descriptives tells that people who remained uninsured (treatment group) ate more vegetables and fruit, were more likely to be overweight, less likely to be obese, took less preventive care visits, smoke more cigarettes per day, took less time for exercise. In addition, the average year of education for control group (people who changed from being uninsured to insured) is 6.3 years, while the number for treatment group is 7.6 years. Individuals in treatment group earned more household income per capita, and were more likely to have chronic disease thus less healthy.

3.4 Empirical strategy to test ex-ante moral hazard

To estimate the effects of insurance status on an individual's health behaviours, we choose all available proxies for preventive behaviours in our dataset that have been used in previous literature, including smoking status, number of cigarettes per day, vegetable and fruit consumption, overweight, obesity, preventive care visits, time spent exercising.

Lifestyle decisions like smoking, veg fruit consumption and exercise, are widely used because the literature has suggested that they may affect future health. They can be seen as investments, or a disinvestment in the case of smoking, in health production. A study from McGinnis (1993) found that "tobacco smoking, poor diet and physical inactivity, and misuse of alcohol have been estimated to be responsible for 900,000 deaths annually — nearly 40% of total yearly mortality

in the United States". Preventive care visits in our dataset include general physical tests and receiving different types of vaccine injections. A concern of using preventive care visits as a proxy of preventive behaviour is that preventive care visit is also related to ex-post moral hazard. This may be less of a concern in China because most preventive care services are not included in health insurance plans and, thus, it might be reasonable to consider such visits as a preventive behaviour that an individual makes to avoid future disease.

Overweight and obesity are outcomes of having an unhealthy lifestyle. Since body weight can be lowered with proper diet and exercise, overweight, obesity and their associated health conditions are preventable and not directly related to the utilization of health care. Even though obesity is the output of an unhealthy lifestyle, it can be used as a proxy for many lifestyle choices. Kelly and Markowitz (2009) argue that body weight and obesity are desirable outcomes in their study of ex-ante moral hazard.

Since we only observe survey data before and after the reform, random assignment of observations to a control and treatment group is not available for the study. Instead, assignment to treatment cannot be assumed random as individuals are likely to self-select into insurance status. The difference-in-difference approach may also suffer from a self-selection problem because the Urban Basic Medical Insurance (UBMI) and New Cooperative Medical Scheme (NCMS) are voluntary programmes, and it is not possible to control for people who chose to join the program. That is, we cannot assume that the take-up of insurance is exogenous to individual's behaviour. Thus, difference-in-difference methods do not allow us to examine the pure causal effect of universal coverage on health behaviours due to this endogeneity problem. Some literature deals with

this problem by using a system of equations regressions. However, it is not plausible here due to the small sample size we have at our disposal.

Instead we exploit the longitudinal dimension of the data and use matching methods. This makes it possible to deal with the self-selection into voluntary programmes by matching individual's characteristics across a control and treatment group prior to the reform at t-1 (2006). The basic identifying assumption is that, conditional on t-1 characteristics, the outcomes we observe are independent of the selection mechanism into treatment.

3.4.1 Propensity Score Matching

Propensity score matching (PSM) has been used in previous studies to control for observed differences in characteristics between treated and control individuals by ensuring common support and balance across pre-treatment covariates. It is a means for dealing with selection bias in observational studies to identify causal effects. Proposed by Rosenbaum and Rubin (1983), the propensity score is a matching method used to match individuals within a control group to treated individuals. Matching is undertaken on the basis of the closeness of the relative propensity of receiving treatment for individuals in the control and treated groups. After matching all background information across individuals in the treatment and control group, assumed to be correlated with both the outcome and treatment assignment, the difference in outcomes between the two groups identifies the treatment effect (in this case public insurance status). The approach is useful under the assumption that selection into insurance is based on observable characteristics.

There are different matching algorithms that can be used, such as nearest neighbour matching, calliper, and kernel density matching (Caliendo and

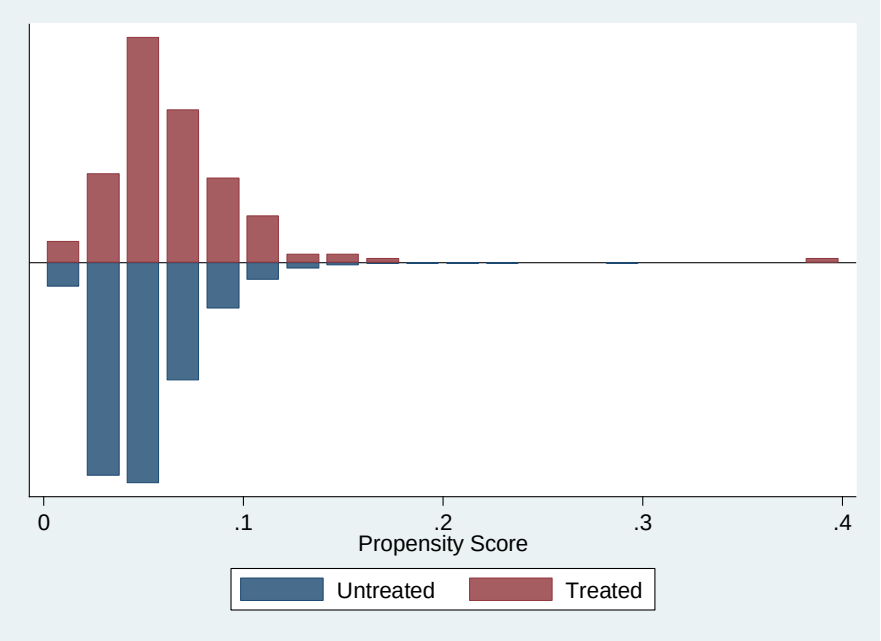
Kopeinig, 2008). Nearest neighbour (NN) matching is the most straightforward matching estimator. It matches the individual from the control group to a given individual in the treatment group with the closest propensity score. The propensity score is the estimated probability of an individual being treated obtained from a probit or logit regression of treatment status against covariates for both control and treated individuals. Calliper matching is useful when the closet remaining neighbour to a treated individual is far away. In such circumstances matching may lead to bias since treated and control individuals may not be sufficiently similar across characteristics and hence have divergent propensity scores. In this case, caliper matching imposes a tolerance level, or a caliper, on the maximum propensity score distance. This improves matching and reduces bias but is potentially at the cost of removing individuals from the treated group for whom close matches within the defined calliper for the control group cannot be found. Kernel density matching is a non-parametric matching estimator that uses weighted averages of all individuals in the control group to construct the counterfactual outcome for treated individuals, with weights depending on the distance between the treated individuals and the controls. Individuals from the control group who are far away from the treated on the basis of a propensity score receive a lower weight than those close to the treated individual.

Since matching locates observations in a control group and pairs them with observations in a treated group, this implies that it is better to have more observations in the control group relative to the treated group. This allows for a closer match to treated individuals. However, there are fewer observations (n=152) in the control group in our sample. In order to ensure we can find matched observations from a “control” group for our “treated” group, we reverse the two

groups. In other words, the control group in our analysis is now defined as observations who change insurance status from being uninsured to being insured. Accordingly, the treated group includes individuals who remain uninsured in both waves. An implication is the interpretation of our results should be read in reverse, but it does not affect the intuition from our results for testing for ex-ante moral hazard. By reversing the usual treatment and control groups, we are testing whether individuals who remain uninsured (new treatment group), have different (more positive) health behaviours to individuals who take-up insurance (new control group).

There are two key assumptions using PSM. First, the assignment to treatment (in this case not taking up public insurance) is independent of outcomes given the propensity score. This is known as the conditional independence assumption. It is often written as $\mathrm{p}(\mathrm{T} \perp \mathrm{y}|p(x))$ where $p(x)$ is the propensity score, based on characteristics *x*, T is treatment assignment and y is the outcome. In addition to being used as proxies for preventive behaviours, health behaviours such as smoking, time for exercise and etc. are often used as proxies for risk preference in empirical studies. We match on these proxies for risk preference using pre-reform data (2006) together with socio-economic variables. This satisfies the above conditional independence assumption because individuals in the control and treated groups have identical/similar propensity to join the insurance programs after matching on both general socio-economic characteristics and risk preferences. Second, there is common support over estimated propensities. Our empirical strategy satisfies this assumption as shown in Figure 14. Those Extreme observations are off support and are needed to be thrown out of the analysis because we cannot find suitable controls for them.

Figure 14: Graph showing common support before PSM



To implement PSM, we first calculate the propensity score using information from 2006 (wave t-1). The propensity score is the probability of assignment to treatment conditional on all covariates observed prior to treatment (note that post-treatment variables are not included as they might be contaminated by the treatment).

$$P(X)=Pr\{Not\ entering\ into\ public\ insurance^{6}=1|\ Xi_{t-1}\}$$

In the second step, we use multiple matches to each treated individual, using nearest neighbour matching. The matching is undertaken with replacement, which means each observation in the control group could be used multiple times to match to observations in the treatment group. Moreover, we define a calliper of 0.0001 which means the maximum propensity score difference is 0.0001. The

[6] Note that the control and treatment groups are reversed

covariates we used for matching including age, education, gender, marital status, working status, living area, chronic diseases, log household income and risk preference proxies. Proxies for risk preferences include: smoking status, vegetable and fruit consumption, being obese and time spent for exercise per day and preventive visits. All are measured prior to the reform at t-1 (2006). After matching, each individual in the treatment and control group have very similar propensity to enter into one of the three public insurance schemes. It is important to match risk preference in wave 2006 to control for the endogeneity problem of the update of insurance status, to ensure that following matching the distributions of risk preference in the control and treatment group are balanced. This ensures that observed differences in the behavioural outcomes can more reliably be ascribed to changes in behaviour due to changes in insurance statues rather than underlying risk preferences. Following matching, there are 2,899 observations available from which outcomes in wave 2009 can be analysed, 19 observations were out of common support (3 in the treated group and 16 in the control group). Table 12 shows the results from testing pre-treatment balance following PSM. The null hypothesis of the t test is that variables for matching have the same mean within control and treatment groups. The higher the p value, the better the balance between control and treatment groups. We are able to achieve good balance for some variables like age, education, urban, but not for variable like smoking, veg and fruit consumption, or presently working.

Table 12: Pre-treatment imbalance testing results after PSM for wave 2006

	Mean		t-test p>|t|
Variable	**Control**	**Treated**	
Smoking	0.26	0.35	0.088
Veg fruit	152.76	188.47	0.389
Overweight	0.20	0.23	0.405
Obesity	0.09	0.06	0.497
Preventive care	0.01	0.02	0.512
Time for exercise per day in minutes	5.35	8.04	0.490
Age	49.65	49.80	0.928
Male	0.43	0.46	0.627
Education (in yrs)	7.31	7.46	0.768
Ln Household income per capita per year (in RMB)	8.50	8.40	0.477
Married	0.88	0.90	0.569
Presently working	0.66	0.72	0.295
Chronic disease	0.09	0.12	0.411
Urban	0.21	0.20	0.765
No. of obs.	2763	136	

In the third step, we estimate the average treatment effects on treated (ATET) given the propensity score. The ATET is the causal effect of universal coverage on the outcome of an individuals' health related behaviours. Results are reported in the section 3.5.

3.4.2 Coarsened Exact Matching

As an alternative to PSM we also apply coarsened exact matching (CEM). Coarsened Exact Matching (CEM) is a monotonic imbalance-reducing matching method that is designed to improve the estimation of causal effects (Iacus et al., 2011). As can be seen from Table 12, PSM improves balance across pre-treatment covariates for some variables, but not others, notably smoking status, working status and veg and fruit consumption. CEM is an exact matching algorithm which

is likely to lead to better balance across covariates. Therefore, we apply CEM as the main matching method and report most of the results based on this method. CEM and PSM have similar aims to other matching methods, which is to find at least one non-treated (control) observation with similar observable characteristics for every treated case. However, CEM is considered to be a faster and easier matching method which requires fewer assumptions and possesses more attractive statistical properties for many applications than other matching methods (Blackwell et al., 2009). The method performs exact matching for discrete variables, and coarsens continuous variables into intervals or groups prior to performing exact matching on the coarsened variables. Since exact matching is performed across discrete and coarsened variables, an advantage is that it creates balance across variables.

CEM benefits from two features: 1) the balance between treated and control group is chosen ex-ante by the user because the user chooses the interval level of balance (that is the width of the groups for continuous variables in which matching takes place). Except for health behaviours, we wish to match as many observable characteristics as possible, so that the difference of the outcome (health related behaviours) between control and treated group is due to insurance status. 2) Since the approach coarsens variables like age and educational years into groups and perform exact matching, adjusting the imbalance on one variable has no effect on other variables (Blackwell et al., 2009). On the other hand, PSM often requires users to trade off among different matching logarithms and to check the resulting balance, which may improve for some variables but get worse for others.

In practice, for dummy variables like gender the approach performs exact matching. Generally, CEM is considered a better matching method than other traditional matching strategies, since it will reduce the imbalance of the dataset with smaller variance and bias (Ho et al., 2007). However, because criteria for coarsened exact matching are stricter and hence more difficult to locate, CEM will end up with a smaller sample size than the propensity score method. For example, finding exact matches is more difficult than finding approximate matches using PSM.

The implementation of CEM includes two steps. In the first step, the control and treatment groups are defined. Here we are interested in the effect of the reform in insurance market launched in 2008. However, since we reverse the treatment and control group, the treatment group comprises those people who remain uninsured. We start with exactly the same sample size and also the same set of covariates used for matching as in PSM. By matching observations according to a wide set of potential confounders in wave t-1, we wish to control for other variables that are both correlated with health insurance and health behaviour. We perform CEM on age (coarsened into 5 groups,16-36, 36-55, 55-75,75-95, and 95 above), years of education (coarsened into 4 groups, 0-6, 6-12, 12-18, and 18 above), gender, marital status, working status, living area, chronic diseases, log household income, smoking, being obese, vegetable and fruit consumption (coarsened into 2 groups, 0-600, and 600 above), and time for exercise per day (coarsened into 5 groups, 0-18, 18-36, 36-54, 54-72, and 72 above). After processing, there are 1623 observations in wave 2009 available for analysis.

Table 13 shows the results for pre-treatment imbalance after CEM. Although we lost more data than from PSM, the imbalance is systematically reduced with

CEM as evidenced for the following variables, like obesity, smoking status, preventive care. The null hypothesis of the t test is that variables for matching have the same mean within control and treatment groups. The P values in CEM are generally bigger than the ones in PSM, which indicates that the balance has been improved after performing CEM.

Table 13: Pre-treatment imbalance testing results after CEM for wave 2006

	Mean		**t-test p>|t|**
Variable	**Control**	**Treated**	
Smoking	0.24	0.24	1.000
Veg fruit	168.66	200.76	0.382
Obesity	0.05	0.05	1.000
Time for exercise per day in minutes	4.93	4.96	0.989
Age	48.71	49.48	0.546
Male	0.44	0.44	1.000
Education (in yrs)	7.14	7.34	0.592
Ln Household income per capita per year	8.46	8.54	0.384
Married	0.89	0.89	1.000
Presently working	0.71	0.71	1.000
Chronic disease	0.10	0.10	1.000
Urban	0.21	0.21	1.000
No. of obs.	1492	131	

In the second step we implement normal Logit or OLS regression by using the matching weight from the CEM. Weights need to be incorporated into the analysis because we match with replacement and hence many control individuals can be matched to a given treated individual. We estimate:

$$H_i = \delta_0 + \delta_1 I_i + \boldsymbol{x'_i}\delta_2 + \nu_i \quad (3.1)$$

Where H_i indicates individual's health preventive behaviours. If H_i is a binary variable, we implement normal logit regression. However, if H_i is a continuous

variable, we implement OLS regression. I_i is a dummy variable indicating whether an individual I is enrolled in one the public insurance schemes. $\boldsymbol{x'_i}$ is a vector of variables containing individual characteristics (e.g. age, gender, whether having chronic diseases, income, etc.), ν_i is the error term. δ_1 , and δ_2 are corresponding parameters to be estimated.

Table 14 illustrates the situation of data loss from both PSM and CEM. It suggests that data lost is mostly from the control group (98.38%). This will have little impact on the average treatment effect on the treated (ATET) since the ATET is defined on treated individuals for whom matches are formed. The vast majority of treated individuals have matches. Although CEM improves the balance of the data across treated and control groups, it also suffers from losing more observations than Propensity Score Matching (PSM). Based on this vulnerability, we also report the results from PSM for sensitivity analysis for the main results. In total, CEM produces 131 treated individual matched with 1492 controls, whilst PSM produces 136 treated individuals matched with 2763 controls.

Table 14: Sample size after performing PSM and CEM

	Whole sample size		Number of observations in control group		Number of observations in treated group	
		Data loss		Data loss		Data loss
Original	2,918		2,766		152	
PSM	2,899	19	2,763	3	136	16
CEM	1,623	1295	1,492	1,274	131	21

3.5 Results

Table 15 illustrates the overall average treatment effect (ATET) for the outcomes we are interested in. We have reported results from both the PSM method and CEM method. The two methods do not give very different results. As we can see from Table 15, ATETs are statistically insignificant in most outcomes except for "time for exercise per day". Generally, individuals not entering into public health insurance spend slightly more time exercising. In other words, participation in the public health insurance scheme will lead on average to 14.35 minutes less exercise per day, which indicates evidence of ex-ante moral hazard. The result from PSM is very similar for this health preventive proxy but we find a slightly larger effect. However, we find no significant effect on an individual's smoking behaviour, number of cigarettes per day, being overweight, being obese, and preventive care visits. Together this indicates public health insurance participation has a very limited effect on reshaping individual's health behaviours. An explanation for this result is that some of the health behaviours such as smoking are quite addictive, for which it takes more time to change behaviour. Exercise takes less time to take up and this shows in our short run analysis.

Table 15: Results for ex-ante moral hazard from pooled sample

	Coarsening Exact Matching			Propensity Score Matching	
Variable	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**	**ATET (Std. Err.)**	**P value**
Smoking	0.30 (0.20)	0.06 (0.04)	0.135	0.29 (0.06)	0.263
Smoking(male)	0.44 (0.28)	0.11 (0.07)	0.117	0.64 (0.10)	0.536
Veg and fruit consumption	-45.71 (37.52)	-45.71 (37.52)	0.223	-13.8947 (37.96)	0.674
Overweight	0.01 (0.20)	0.001 (0.04)	0.962	0.27 (0.05)	0.469
Obesity	0.01 (0.36)	0.001 (0.02)	0.977	0.10 (0.03)	0.836
Preventive care	0.28 (0.44)	0.01 (0.02)	0.521	0.04 (0.02)	0.436
No. of cigarette per day	0.71 (0.83)	0.71 (0.83)	0.393	5.05 (1.31)	0.346
Time for exercise per day (in minutes)	14.35** (4.68)	14.35** (4.68)	0.003	14.78** (4.81)	0.004

(* p<0.10 ** p<0.05 *** p<0.01)

Health behaviours may vary for different income groups. For example, low-income individuals may do less exercise because they do more labour intensive work in general. Similarly, it has been shown empirically that people with low income generally smoke more (Sobal and stunkard, 1989). Therefore, it is sensible to divide the sample according to income level in order to investigate heterogeneity in effects across income groups. Accordingly, ATETs are calculated separately for two income groups (a relatively low income group and a relatively high income group) employing CEM alone.

The cut-off point we use is the median of per capita household income (RMB 9617.167) in our sample. Results are reported in Table 16. The results are similar to Table 15. Participation in public health insurance has no effect on an individual's smoking behaviour for both income groups. One interesting result is the average probability to be overweight for high-income individuals is reduced by 1.1%. In contrast, there is no significant adjustment for low-income individuals. Reductions in the time for exercise per day are observed for both high income and

low-income groups. On average, high-income individuals spend 12.64 minutes less after participating in the program.

Table 16: ATETs by income groups

	Low Income Obs=811			High income Obs=812		
Variable	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**
Smoking	0.31 (0.26)	0.06 (0.05)	0.236	0.47 (0.31)	0.08 (0.05)	0.131
Veg and fruit consumption	1.13 (44.08)	1.13 (44.08)	0.979	-5.80 (40.80)	-5.80 (40.80)	0.887
Overweight	-0.0043 (0.2997)	-0.0008 (0.0575)	0.989	0.63** (0.31)	0.11** (0.52)	0.037
Obesity	-0.25 (0.76)	-0.01 (0.04)	0.745	-0.18 (0.63)	-0.01 (0.04)	0.777
Preventive care	0.29 (1.10)	0.005 (0.02)	0.791	0.30 (0.65)	0.01 (0.03)	0.644
No. of cigarette per day	0.04 (1.31)	0.04 (1.31)	0.977	1.94* (1.12)	1.94* (1.12)	0.085
Time for exercise per day in minutes	14.29** (6.23)	14.29** (6.23)	0.003	12.64** (6.31)	12.64** (6.31)	0.045

(* p<0.10 ** p<0.05 *** p<0.01)

Individuals with higher education might have more health knowledge (Grossman, 1997), thus Table 17 reports the ATETs by education levels. We have divided the sample into two sub-samples. One group of individuals have education less than or equal to 9 years, and the others with years of education of more than 9 years. We use this cut-off point because China has a 9-year compulsory education policy, which highly encourages everybody to have at least 9-years of education. Participation in the public health insurance has no effect on all outcomes of interests for the less educated group. In contrast, well-educated individuals in average spend 14 minutes less on exercise if they have insurance.

Table 17: ATETs by education

Variable	Low education (<=9 yrs) Obs=1414			High education (>9yrs) Obs=209		
	Coef. (Std. Err.)	**ATET (Std. Err.)**	**P value**	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**
Smoking	0.16 (0.30)	0.03 (0.05)	0.597	0.48 (0.42)	0.10 (0.10)	0.249
Veg and fruit consumption	8.48 (37.71)	8.48 (37.71)	0.822	-16.90 (37.22)	-16.90 (37.22)	0.650
Overweight	0.34 (0.28)	0.06 (0.05)	0.214	0.67 (0.46)	0.11 (0.07)	0.139
Obesity	-0.98 (0.74)	-0.06 (0.05)	0.190	1.83* (0.88)	0.06* (0.03)	0.89
Preventive care	0.78 (0.58)	0.02 (0.02)	0.191	(outcome not vary)---	---	---
No. of cigarette per day	0.37 (0.99)	0.37 (0.99)	0.710	2.67 (1.66)	2.67 (1.66)	0.419
Time for exercise per day in minutes	13.85 (4.22)	13.85 (4.22)	0.361	14.10** (8.91)	14.10** (8.91)	0.043

(* p<0.10 ** p<0.05 *** p<0.01)

Table 18 displays the estimates of ATETs by gender. Generally, there is no big difference between males and females. We find significant effects for male in terms of smoking and number of cigarettes per day. They indicate that individuals who remain uninsured smoke more than insured males, which is the opposite of what ex-ante moral hazard would suggest. A significant difference between men and women is in the effects of public insurance participation on time spent exercising. On average men spend nearly 7 minutes less per day; this being significant at 1% level while the reduction amounts to 11 minutes for woman, but this is only significant at 10% level. Again this suggests ex-ante moral hazard effect with regard to time spent exercising.

Table 19 reports the estimates of ATETs by age groups, since there is a huge gap between young and elder people in terms of health behaviours. For example, older people may exercise less because of their mobility status, so it is reasonable to investigate the outcome difference within each age group. We have fixed the age threshold to 50 years. Again, the results show no large difference for most outcomes except for Time for Exercise per Day. Participation in public health

insurance has no significant effect on older individual's time spent on exercise. In contrast, younger individuals are significantly affected with about 13 minutes less for exercise after participating in the programme.

Table 18: ATETs by gender

	Male Obs=667			Female Obs=956		
Variable	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**
Smoking	0.65* (0.36)	0.16* (0.86)	0.062	-0.31 (1.06)	-0.007 (0.02)	0.769
Veg and fruit consumption	9.14 (47.78)	9.14 (47.78)	0.848	-11.11 (38.38)	-11.11 (38.38)	0.772
Overweight	0.36 (0.36)	0.07 (0.07)	0.303	0.46 (0.32)	0.07 (0.05)	0.145
Obesity	0.88 (0.60)	0.04 (0.03)	0.161	-1.51 (1.03)	-0.09 (0.06)	0.148
Preventive care	1.27 (0.88)	0.02 (0.02)	0.204	-0.17 (0.76)	0.006 (0.03)	0.829
No. of cigarette per day	3.24* (1.67)	3.24* (1.67)	0.054	-0.33 (0.38)	-0.33 (0.38)	0.392
Time for exercise per day in minutes	7.89*** (8.43)	7.89*** (8.43)	0.009	11.12* (4.75)	11.12* (4.75)	0.053

(* p<0.10 ** p<0.05 *** p<0.01)

Table 19: ATETs by age

	Age<50 Obs=896			Age>=50 Obs=727		
Variable	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**	**Coef. (Std. Err.)**	**ATET (Std. Err.)**	**P value**
Smoking	0.34 (0.33)	0.06 (0.06)	0.297	0.29 (0.34)	0.05 (0.07)	0.405
Veg and fruit consumption	-22.53 (40.25)	-22.53 (40.25)	0.576	19.24 (44.67)	19.24 (44.67)	0.667
Overweight	0.40 (0.33)	0.07 (0.05)	0.233	0.44 (0.34)	0.08 (0.06)	0.190
Obesity	-0.27 (0.63)	-0.02 (0.04)	0.673	-0.14 (0.77)	-0.006 (0.04)	0.860
Preventive care	0.13 (1.10)	0.002 (0.02)	0.908	0.44 (0.66)	0.02 (0.03)	0.505
No. of cigarette per day	0.78 (1.16)	0.78 (1.16)	0.502	1.55 (1.26)	1.55 (1.26)	0.220
Time for exercise per day in minutes	12.95* (6.88)	12.95* (6.88)	0.060	7.05 (5.42)	7.05 (5.42)	0.194

(* p<0.10 ** p<0.05 *** p<0.01)

In conclusion, we do not find evidence of ex-ante moral hazard for most of the health related behaviors except time spent exercising. Generally, people who are

not in the public insurance system spend more time doing exercise per day than people who participated in the universal coverage system. However, public insurance does not affect other health related behaviours or indicators.

3.6 Discussions and conclusion

In this study, we aimed to examine whether universal coverage has affected health related behaviours of insured individuals by employing data from CHNS from waves 2006 and 2009. In order to identify a causal effect, we used propensity score matching and coarsened exact matching methods. By using matching methods, we attempt to control for observed heterogeneity between control and treatment individuals. Moreover, by performing matching on panel data, we avoid the problem often associated with voluntary insurance schemes because we match on the probability of entering the insurance scheme. Thirdly, we deal with the endogeneity of the insurance status by matching on individuals' pre-treatment risk preference.

The results from CEM and PSM are quite consistent. They do not provide strong evidence for ex-ante moral hazard. For example, insured and uninsured individuals are not significantly different in smoking, number of cigarettes per day, vegetable and fruit consumption, obesity, overweight, and preventive care visits. Nevertheless, we find significant differences between treatment and control groups in terms of time spent exercising. People with insurance spend less time doing exercise than people without insurance, which provides evidence of ex-ante moral hazard. This may be because time spent exercising is not that addictive. It requires less time to change behaviour, so the effect is shown in our short run analysis.

We further divide the sample into different subsamples by income, education, gender and age to examine differences from the pooled sample. For example, unlike the results from the pooled sample, we do not find any significant differences according to insurance status for people with low education, but find evidence of ex-ante moral hazard in the higher education subsample in terms of time spent exercising. This might be because of a substitution effect since people with low education generally do more exercise at work. Furthermore, in the sample of people older than 50 years old, there is no difference in any health preventive behaviours, whereas we find significant results for time spent exercising within the subsample of individuals younger than 50 years old. This, to some extent, confirms that our results are reasonable because older people naturally spend less time exercising so any differences in this group would be harder to detect.

Although there is a theoretical possibility that insurance would affect individuals' health behaviours, we did not find strong evidence in the context of Chinese universal coverage system, except for time for exercise. There are two possible explanations for this result.

First, near universal coverage does not provide full insurance and individuals still have to pay for some medical services out-of-pocket since individuals still have to pay up to 50 percent of co-payment with out of pocket expenditure for inpatient visits. The co-payment rate is even higher for outpatient visits. As a consequence, out-of-pocket payments from individuals could be significant, thereby diluting incentives for ex-ante moral hazard. Thus, being covered by insurance may not necessarily change preventive efforts because there is still a financial burden.

Second, we only look at the behaviour in the period immediately after the reform, which is quite a short run analysis. Young and educated people seem to be the only group that are affected by the preventive variable in our analysis. They are more likely to understand the policy change and take actions in short run. However, many life style behaviours do not alter immediately after entering to the insurance program, such as overweight and obesity. Few studies using short run data find evidence of ex-ante moral hazard for these two proxies for preventive behaviours (Courbage and Coulon, 2004; Stanciole, 2008; Khan and Kaestner, 2008). Further studies could focus on long run effects on those life style activities.

Chapter 4: Ex-post Moral Hazard after the Universal Coverage Reform in China

4.1 Introduction

Near universal coverage is one of the most important achievements of China's 2008 health care reform. According to official statistics, the reform has increased coverage from 20% in 2000 to 99.6% in 2014 by providing two new medical insurance schemes to rural and urban residents (China Health Statistical Yearbook, 2014). On the one hand, these insurance reforms have increased people's access to health care by reducing the prices they face at the point of use. Where this is in response to health care need, it potentially satisfies previously unmet need. On the other hand, medical insurance may increase health care usage beyond that needed because of the lower cost of health care to the individual, which is termed "moral hazard" (Pauly, 1968). Total medical expenditure in China has greatly increased by 82.4 percent from 2006 to 2011 (China Health Statistical Yearbook 2013). Moral hazard, and not just previously unmet need, could be one of the reasons contributing to the drastically increased expenditure.

There are two types of moral hazard, ex-ante and ex-post. Ex-ante moral hazard refers to the effect of health insurance on an individual's behaviour before the event of sickness. For example, people may not invest in preventative behaviours, such as smoke more or take less time exercising, after receipt of health insurance. Ex-post moral hazard refers to the situation when health care services are required. Having insurance will increase the use of health care because the price is lower than it would be if an individual does not have insurance. Because it happens after

the event of sickness, it is termed ex-post moral hazard. This increase could be due to demand-side as well as supply-side activities. Demand-side moral hazard describes the situation where being insured lowers the financial cost of health care, so it encourages a higher rate of usage (Donaldson and Gerard, 1989). Supply-side, or supplier induced moral hazard implicitly assumes that there is asymmetric information between physicians and patients. The asymmetric information is due to physicians having more knowledge about health care services than patients, leading them to "choose a quantity or a quality of treatment different from the one that patients would choose themselves with the same information" (Bardey and Lesur, 2006). It is most likely to occur in a system that mainly uses fee-for-service and where doctors have financial incentives to provide excess services than would otherwise be efficient in resolving the health problem (Bardey and Lesur, 2006).

This paper focuses on ex-post moral hazard and insurance coverage. It aims at examining whether and to what extent medical expenditure increases as the price of health care services decreases. The policy implications of ex-post moral hazard have been under great discussion since Pauly (1968). As an emerging economy, China's universal coverage is reported to be unsustainable because the expenditure is higher than the health care budget in some provinces (Fang, 2015). Ex-post moral hazard might be a significant contributor to this problem.

Economists and policy makers propose various methods to reduce moral hazard, among which deductibles and co-payments are the most common. China's universal coverage also introduced these two methods to deal with moral hazard and to complement the limited medical funding from the government (which is tax-financed). The deductible is set such that individuals must pay out of pocket before the insurer pays any expenses. Meanwhile, the co-payment rate is set to

allow the individual to share a proportion of health care expenditure each time a medical service is accessed. However, doctors in China are not monitored or paid if they control the total medical expenditure. If doctors act more in the financial interest of the hospital (because hospital are driven by profit incentives), they may have incentive to prescribe medicines with higher price or let the patients take high-tech tests when it is not necessary. These issues motivate the idea of conducting this empirical study. It is of great policy importance to investigate whether higher medical expenditure is due to health insurance, and whether current deductibles and co-payments are effective enough to reduce moral hazard.

The remainder of the paper can be divided into the following parts. Section 4.2 presents a review of empirical studies for ex-post moral hazard. Section 4.3 presents the background of insurance policies of the public insurance schemes. Section 4.4 introduces the data –Chinese Health and Retirement Longitudinal Study (CHARLS) – employed in this study. The empirical strategy and results are provided in Section 4.5. Concluding remarks are included in the last section.

4.2 Empirical studies for ex-post moral hazard

Many empirical studies have been conducted to test the existence of ex-post moral hazard because it has important policy implications. Using the key words "ex-post moral hazard; health insurance; universal coverage", I searched literature in library catalogue of University of York and Google Scholar. Empirical studies are selected to review here if they can inform the methodology to answer the research question and have more than 20 citations (in Table 20). Empirical studies investigating the impact of health insurance on utilization can be divided into two categories, namely, supply side induced ex-post moral hazard and demand side induced ex-post moral hazard.

Studies investigating supply side induced moral hazard mainly focus on hospital responses to a change in the price of health care services. For example, Ellis and McGuire (1996) looked at hospital responses to the change in reimbursement policy by examining a natural experiment in New Hampshire in the United States. In January 1989, New Hampshire Medicaid introduced a discharge-based payment system to replace the former costs based system. They defined the moral hazard effect as the change in the length of stay per discharge "due to the change in treatment policy, holding patient severity constant". By conducting several OLS regressions using five years of data from Medicaid psychiatric discharges, they argued that a 1.8 days reduction in length of stay per discharge in private hospitals could be seen as a pure moral hazard effect. That is, prior to the introduction of the discharge-based payment system moral hazard existed – hospitals had an incentive to keep patients in longer than necessary as this would increase their income.

Similarly, Lundin (2000) examined physician incentives to changes in drug prescriptions in response to patients' insurance coverage in Sweden. The author selected seven patent drugs that faced generic competition and tried to answer the question: do physicians take price into account when they decide which drug to prescribe. Prescription microdata at patient level was used in both simple probit models and random-effects probit models. A moral hazard effect was suggested because empirical evidence showed that patients who have to "pay large sums out-of-pocket" were less likely to have trade-name versions prescribed than patients getting most of their costs reimbursed.

There is a methodological difference between the two categories of supply side and demand side studies of moral hazard. When looking at empirical evidence

from the supply side, researchers do not need to consider the problem of distinguishing adverse selection from moral hazard (Ellis and McGuire, 1996; Butler et al., 1997; Lundin, 2000). This is because moral hazard from the supply side is not correlated with consumer's incentive to join an insurance scheme. Therefore, the issue of selection is not relevant. This class of literature is less relevant to our study because we do not have information of physicians' behaviour.

In contrast, issue of selection is a challenge for studies that examine demand side moral hazard. A positive correlation between health insurance and health care spending arises because of both moral hazard and adverse selection. With ex-post moral hazard, people covered by insurance may have an incentive to use more health care because the price is cheaper, which would generate a positive correlation between medical expenditure and insurance coverage. But at the same time, the positive correlation can also come from people who have better knowledge of their higher expected medical cost being more likely to take out health insurance. This happens before the event of buying insurance, and is referred to as adverse selection into the insurance scheme. In this case, health insurance is endogeous because of an individual's unobserved expectations of higher medical cost. Although ex-post moral hazard and adverse selection have the same consequences, the two situations suggest very different policy implications. Adverse selection is considered costly in general because it will lead to different types of inefficiencies in the market. For instance, some consumers with under-provided services by insurance companies may suffer from less than efficient quantity of care if insurance companies have incentive to distort their mix of customers by changing their insurance policies (Glazer and McGuire, 2006). Possible solutions to adverse selection include full insurance at the

population level, but this will potentially cause ex-ante and ex-post moral hazard (Savage and Wright, 2003). Solutions to ex-post moral hazard, on the other hand, might include introducing a deductible and a co-payment rate to the insurance policy.

Therefore, it is of great importance to distinguish between adverse selection and ex-post moral hazard in empirical studies in order to not overstate the effect.

The literature has used different methods to estimate demand side ex-post moral hazard. Manning et al. (1987) employed data from RAND Health Insurance Experiment, where individuals were randomly assigned into different insurance plans with different co-payments. One of the main goals of the RAND experiment was to study the effect of cost sharing of health insurance on utilization of health services. Since the individual could not choose the health plan or the form of co-payment, health insurance and co-payment were exogenous in their study. In other words, because of randomization insurance status was not endogenous and so adverse selection was not a problem. Results from the RAND experiment suggest that cost sharing reduces health care consumption. This increase could be both due to supply side moral hazard and the consumer's response. Furthermore, they estimate the medical price elasticity to examine the responsiveness of consumer's demand response to a price change. They found a price elasticity of -0.2, which means that a 1% increase in price will lead to a 0.2% decrease in medical expenditure. This is robust if accounting for health status and income (Newhouse et al., 1993).

Chiappori et al. (1998) presented an empirical study on moral hazard effects in health care demand in France. In 1993, a reform called "The loi Veil" changed the cost sharing rate of some social insurance schemes. Since the reform gave

individuals no chance to choose insurance policies, adverse selection was ruled out from this study. Their paper mainly investigated two groups of people. The treatment group consisted of people who had a co-payment rate of 10%, while the control group contained people who faced no charge for physician visits. Results from panel probit regressions demonstrated that there was a significant structural change following the reform for the treatment group for home visits but not for office physician visits. They concluded that there is moral hazard for some office physician visits. When non-monetary costs were important, for instance for those with severe illness, the co-payment did not change health care demand.

However, randomized experimental data or natural experimental data are not always available. Accordingly, other studies using non-experimental data have been proposed, but this usually means having to disentangle adverse selection and ex-post moral hazard.

Coulson et al. (1995) employed a two stage model to evaluate the moral hazard effect in a supplementary medical insurance market for the elderly in the United States. The data they employed was the Mail Survey of Health Insurance and Medicine Use, completed by elderly Pennsylvanian Medicare beneficiaries in 1994. They measured health care utilization as prescription drug usage. In the first stage, they adopted a multinomial logit model to calculate insurance choice. In the second stage, they corrected the endogeneity bias of insurance status by using the estimates from first stage in a nonlinear least-squares second stage model. After ruling out the adverse selection effect, they found evidence of moral hazard in the context of supplementary medical insurance market. Their results showed that double insurance coverage produced a larger demand effect.

Vera-Hernandez (1999) examined private insurance choice in Catalonia. They employed similar methods to Coulson et al. (1995). In order to distinguish ex-post moral hazard from adverse selection, the author's instrument health insurance as social class, occupation and etc, arguing that, after conditioning on these variables, health insurance status is no longer endogenous. They found no significant increase in hospital visits under duplicate coverage (if the individual has compulsory medical public insurance and private insurance) in the subsample of heads of household, but a significant positive effect for non-heads of household. However, they did not conclude this was evidence of moral hazard because the results show that variables related to health status, such as chronic illness, acute illness, have an important impact on number of doctor visits.

Koc (2005) also tries to avoid the unobservable endogeneity problem using instrumental variables. The study used US data from 2000 Medical Expenditure Survey. The econometric results demonstrated the presence of ex-post moral hazard and further suggested that moral hazard for physician visits is higher for people with better health. Their findings suggest that the additional health care used by the insured may be the intended result of purchasing insurance, implying the existence of demand side ex-post moral hazard.

Similarly, Savage and Wright (2003) employed instrumental variable techniques to deal with the selection problem. They investigated moral hazard in Australian private hospitals using 1989-1990 National Health Survey. The predicted probability of being insured was treated as an instrument for insurance choice to avoid the endogenous problem of insurance choice. They found a substantial moral hazard effect from the significant increase in the length of stay for those people who are more likely to be insured.

Wolfe and Goddeeris (1991) also attempted to distinguish moral hazard and adverse selection in the context of Medicare supplementary insurance (Medigap) in the US. Retirement History Survey in a model of health care demand. They assumed that health is persistent and decays between periods. Thus there is an autocorrelation problem in the health care demand function. By correcting the autocorrelation problem, the authors separate the adverse selection effect from moral hazard effect. After separating the adverse selection effect, they found no significant evidence of moral hazard. The 49% increase in hospital expenditures are all due to "unexplained" reasons rather than from ex-post moral hazard.

Bajari et al. (2014) conducted a two-step semi-parametric estimation to disentangle moral hazard and adverse selection using the US Health and Retirement Study. They calculated the elasticity of total medical expenditure with respect to a change in the rate of co-payment of medical expenditures and compared elasticity estimates among different insurance categories. They found a 1% increase in the rate of co-payment led to a 0.21% drop total medical expenditures, suggesting the existence of moral hazard.

Barros et al. (2008) took a different approach by using a matching technique to estimate the impact of additional coverage on the demand for health care, in the context of the Portugal health insurance system. The treatment group included individuals covered by a common health insurance plan in Portugal (called ADSE). Since this group of people have access to Portuguese NHS like other citizens, they have double coverage. A matching estimator was used to estimate the average increase in the demand for health services among the treatment group that has double coverage. In general, they found a positive and large effect of ADSE on demand for health care. The largest effects are from the group of young

Table 20: Summary of the empirical literature on ex-post moral hazard

Literature	Data	Context	Methodology	Results and size of the effect
Ellis and McGuire (1996)	Five years of data from Medicaid psychiatric discharges	United States	Natural Experiment	Ex-post moral hazard: 1.8 days' reduction in length of stay per discharge when changed to a discharge-based payment system.
Lundin (2000)	Prescription microdata at individual level	Sweden	Simple probit models and random-effects probit models	Ex-post moral hazard: patients who have to "pay large sums out-of-pocket" were less likely to have trade-name versions prescribed than patients getting most of their costs reimbursed.
Manning et al. (1987)	RAND experiment data	United States	Randomised Controlled Trial	Ex-post moral hazard: the size of price elasticity is -0.2. A 1% increase in price will lead to a 0.2% decrease in medical expenditure.
Wright (2003)	1989-1990 National Health Survey	Australia	Instrumental Variable	No significant evidence of moral hazard.

Table 20: (Continued)

Literature	Data	Context	Methodology	Results and size of the effect
Chiappori et al. (1998)	A longitudinal dataset at individual level	France	Natural experiment	Mixed results: For GP home visits, change in relative price had a moderating influence. When non-monetary costs were important, the co-payment did not change health care demand.
Coulson et al. (1995)	Data from the Mail Survey of Health Insurance and Medicine Use	United States	Two-stage model	Ex-post moral hazard: people enrolled in a more generous plan fill 0.56 more prescription than those in a less generous plan.
Koc (2005)	2000 Medical Expenditure Survey	United States	Instrumental Variable	Ex-post moral hazard: additional health care used by the insured may be the intended results of purchasing insurance.
Bajari et al. (2014)	US Health and Retirement Study	United States	Two-step semi-parametric estimation	Ex-post moral hazard: a 1% increase in the co-payment rate led to a 0.21% drop in total medical expenditures.
Barros et al. (2008)	Data from a survey in Portugal at individual level	Portugal	Matching technique	Ex-post moral hazard: young people aged from 18-30 under ADSE coverage had 30% more blood and urine test than those with no ADSE.

people aged from 18 to 30 under ADSE coverage. They had 30% more blood and urine tests than those who were not covered by ADSE, but moral hazard effects could not be identified for dentist visits.

The price elasticity refers to the percentage change in health care expenditure due to the percentage change in price of health care. If there is a negative correlation, it is defined as ex-post moral hazard (Pauly, 1968). The price elasticity of health services varies from study to study, ranging from -0.04 to -0.67 (Zweifel and Manning, 2000).

Different effect sizes could arise for several reasons. Firstly, the methods chosen by researchers might contribute to the different size of effect. For example, studies using instrumental variables employ different instruments for health insurance status. The power of the instruments in predicting health insurance status are different, thus the size of effect would be different. Secondly, the contexts of each study are distinct. Most of the empirical studies are within one country or area. They often have different demographic characteristics and health care systems. For example, if there is under-supply of health care facilities in one country, the price elasticity would not be as high as in those countries with more generous supply of health care facilities.

Most of the empirical literature has shown evidence of ex-post moral hazard, though the effects don't appear particularly large. If the randomized experimental data or natural experimental data are available, there is no need to consider the selection problem because changing the price of medical services is exogenous. However, if there is no exogenous shock to the price of medical insurance, researchers have to use other techniques to deal with the selection problem. The

literature has tended to use instrumental variables and matching methods in such circumstances.

4.3 Background of insurance policies

There are three types of public insurance schemes in China that covered approximately 98% of the population in 2015, namely the Rural New Cooperative Medical Scheme (NCMS), Urban Resident Medical Insurance Scheme (URBMI) and Urban Employee Basic Medical Scheme (UEBMI). According to their employment status and place of residence, there is only one type of scheme available for each individual. NCMS is designed to provide coverage for rural people, UEBMI for Urban formal employees, and URBMI for other urban residents. The only choice residents have is to enroll or not to enroll in their eligible scheme. This means that the scheme in which people are enrolled is exogenous to their knowledge and preferences, so adverse selection does not arise.

The main funding source of UEBMI is payroll taxes, while government subsidies are the main funding sources for NCMS and URBMI. These three schemes are administered and operated by national and local authorities. At the national level, NCMS is administered by the Chinese National Health and Family Planning Commission, while NRBMI and UEBMI are administered by the Chinese Ministry of Human Resources and Social Security. The Government decentralizes the operation of the schemes to each local government by providing guidelines. After that, each provincial government gives an implementation plan to their local governments, which allows the municipal and county level governments (lower level governments than provincial governments) to design and operate their own insurance policies. NCMS funds are pooled at the county level, and URBMI and UEBMI are pooled at municipal level. There are roughly

2,583 NCMS schemes, 333 UEBMI schemes and 333 UEBMI schemes (Meng et al., 2015), corresponding to 2,583 counties and 333 cities in China. In general, benefit packages of UEBMI are more generous than the other two schemes. After 2012, the Chinese Government started piloting a reform that consolidated the URBMI and NCMS social health insurance schemes into one scheme called Urban and Rural Resident Medical Insurance (URRBMI) to achieve a more equitable and efficient health system within 20 years.

Although there are many different policies under each scheme, the main elements of the schemes are very similar to each other. Basically, inpatient services and outpatient services are the two main categories. Under each category, deductibles, co-payment rates and caps are designed specifically by local municipal and county level governments. The co-payment rate l_{ijhk} for individual *i* living in *k*, having disease type *j*, receiving treatment in hospital of level *l*, can be shown as:

$$l_{ijhk} = \max(A_{ijk} + H_{ijk}(\alpha_{ih}, m_i), m_i - C_{ijk}) \quad \text{j=0, 1; h=1, 2, 3; k=1, 2,…, 333} \tag{4.1}$$

Caps C_{ijk} are specified in different local government documentations. The amount that is higher than the cap is paid out-of-pocket. Subscript *j* is binary for catastrophic illness. The deductibles and co-payment rates are much lower for catastrophic diseases so that catastrophic spending is less of a financial threat for those patients. Subscript *k* represents different areas of residence. Therefore, the cap C_{ijk} varies across different types of illness *j* and different areas of residence *k*. m_i represents the total medical expenditure per illness for individual i. If m_i is less than C_{ijk}, the co-payment rate l_{ijhk} equals to $A_{ijk} + H_{ijk}(\alpha_{ih}, m_i)$. The deductible A_{ijk} represents the amount that the insured person has to pay out-of-

pocket, which varies across different areas of residence k. $H_{jik}(\alpha_{ih}, m_i)$ is a step function showing the co-payment rates that the insured persons face. It depends on two elements, α_{ih} and m_i. α_{ih} represents different co-payment rates due to the level of hospitals h. Basically, patients are encouraged to seek health services from low-level hospitals. Therefore, the co-payment rates are lower for services from low-level hospitals. One of the reasons is to deal with ex-post moral hazard, because low-level hospitals are often associated with lower prices for health services. $H_{ijk}(\ m_i)$ is a step function that represents the co-payment rates that differ according to the total amount paid for the services. These differences are set out in Table 21. Lower co-payment rates are often associated with higher medical costs. If m is larger than C_{ijk}, the co-payment $l_{ijhk}$is $\ m - C_{ijk}$, which is the amount over the insurance cap.

Table 21: An illustration of the insurance policy design for one county

<table>
<tr><th colspan="2">Outpatient Services</th><th colspan="3">Inpatient Services</th></tr>
<tr><td colspan="2">• Deductibles (in RMB)
• Paid out-of-pocket
• Varies among different classes of hospitals</td><td colspan="3">• Deductibles (in RMB)
• Paid out-of-pocket
• Varies among different classes of hospitals</td></tr>
<tr><td colspan="2" rowspan="2">• Co-payment rate l_{ijhk}</td><td colspan="3">• Co-payment rate l_{ijhk} (for illustration)</td></tr>
<tr><td>Village-based clinics</td><td>No deductible but with cap</td><td>30%</td></tr>
<tr><td rowspan="3">Class 1 hospitals
$h = 1$</td><td rowspan="3">30 %
The most generous</td><td rowspan="3">Class 1 hospitals (The most generous)
$h = 1$</td><td>Deductible-3000 (in RMB)</td><td>45%</td></tr>
<tr><td>3000—10000 (in RMB)</td><td>40%</td></tr>
<tr><td>10000-Cap (in RMB)</td><td>35%</td></tr>
<tr><td rowspan="3">Class 2 hospitals
$h = 2$</td><td rowspan="3">40 %</td><td rowspan="3">Class 2 hospitals
$h = 2$</td><td>Deductible-5000 (in RMB)</td><td>50%</td></tr>
<tr><td>5000—20000 (in RMB)</td><td>45%</td></tr>
<tr><td>20000-Cap (in RMB)</td><td>40%</td></tr>
</table>

<table>
<tr><td rowspan="3">Class 3 hospitals
$h = 3$</td><td rowspan="3">50 %
The least generous</td><td rowspan="3">Class 3 hospitals
(The least generous)
$h = 3$</td><td>Deductible-5000 (in RMB)</td><td>65%</td></tr>
<tr><td>5000—20000 (in RMB)</td><td>60%</td></tr>
<tr><td>20000-Cap (in RMB)</td><td>50%</td></tr>
<tr><td>Catastrophic diseases ($j = 0,1$)</td><td>In %</td><td>Catastrophic diseases ($j = 0,1$)</td><td></td><td>In %</td></tr>
<tr><td colspan="2">• Caps C_{ijk} (in RMB)
The amount higher than the cap is paid out-of-pocket</td><td colspan="3">• Cap C_{ijk} (in RMB)
The amount higher than the cap is paid out-of-pocket</td></tr>
</table>

4.4 Data

4.4.1 The China Health and Retirement Longitudinal Study

The China Health and Retirement Longitudinal Study (CHARLS) aims to collect representative and high quality micro data from a sample of residents over 45 years old in China, but it still includes very few observations who are younger. The baseline survey took place in 2011. The sample included 10,000 households and 17,000 individuals in 150 counties and 450 villages. The survey is conducted every two years and we use data for 2011 and 2013. As mentioned in section 4.3, the consolidation of UEBMI and URBMI started in 2012. However, there are only 2% of the observations that have the new URRBMI insurance.

The study population of the survey draws from 28 provinces, which are diverse, with variations found in a wide-ranging set of socioeconomic factors and other related health, nutritional and demographic measures. CHARLS adopts a multistage stratified Probability Proportional to Size (PPS) sampling, and an innovative software package (CHALRS-GIS) to make village sampling frames. All samples are drawn in four stages, including county-level sampling, neighbourhood-level sampling, household-level sampling and respondent-level

sampling. The goal of the sampling strategy is to collect a sample representative of the whole country.

The household questionnaire contains 8 categories of information, including demographics, family structure, health status and function, biomarkers, health care and insurance, work, retirement and pension, income and consumption and interviewer observation. Interviewer observations include questions that the interviewer records.

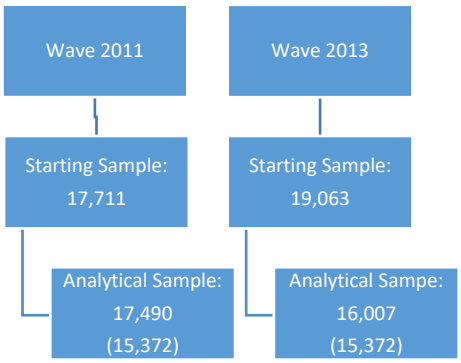
In the section of health status and functioning, information is collected on self-reported health status, general health status (according to the diagnosis) and disease history, lifestyle and health behaviours, functional limitations, cognition and depression.

Another section covers health insurance and the use of health care. It asks respondents about their health insurance status, the type of health insurance, health care costs and utilization. Interviewees are asked about the total cost of their last visit to health care facilities and the amount of out-of-pocket medical expenditure. From the answers to these questions, we are able to calculate the co-payment rate for each individual reporting that they have used health care services.

There are two waves of data available for the analysis, wave 2011 and wave 2013. Both of them are after the officially launched health care reform in 2008. Figure 15 presents the progress of data cleaning. The starting sample is 17,711 individuals in wave 2011 and 19,063 in wave 2013. The data cleaning process includes dropping observations with missing data for some variables that are included in the regressions, such as age, marital status, education, and household income. Since people who are younger than 18 are more likely to be monitored by their parents, the decision to use medical facilities is unlikely to be made by

the respondent so these individuals are dropped from the analysis. The number of observations who are younger than 18 years old is relatively small (172 in both waves). In total, we have 33,497 observations available for the analysis, with 17,490 in wave 2011 and 16,007 in wave 2013 respectively. There are 15,372 individuals appearing in both waves (as shown in bracket in Figure 15).

Figure 15: Data cleaning process for ex-post moral hazard



4.4.2 The calculation of the co-payment rate

The co-payment rate used in the analysis is the l_{ik} in equation (4.1). The co-payment rate l_{ik} consists of three elements, including the deductible A_k, the co-payment rate $\alpha_k H(x_k)$, and the cap C_k. However, the survey does not provide information for these three elements, just the total payment.

The survey asks two sets of questions about outpatient and inpatient medical cost respectively. For outpatient services, the first question is the total outpatient cost. Individuals are likely to remember the total cost because most of the insurance policies require patients to pay the total cost at the time of use and apply for reimbursement afterwards. Nevertheless, interviewers are asked to check the receipts of the cost if possible. The next question is the amount that is self-paid. The same set of questions are again asked with regard to the last inpatient services used. Therefore, the co-payment rate is calculated as the reported self-payment

divided by the reported total medical costs. This information is available only when the individual has used health services, so we do not have the information of the co-payment rates that would be faced by non-users.

Other things that influence the co-payment are the level of facilities and the seriousness of the sickness. Even though the questionnaire does not ask about the level of the facilities individuals used, it provides information on the types of medical facilities the individual used. There are 8 types of facilities namely 1) general hospital, 2) specialized hospital, 3) Chinese medicine hospital, 4) community healthcare centre, 5) township hospital, 6) health care post, 7) village clinic/private clinic and 8) other. Three dummy variables are generated from this question indicating the level of hospital. Level one hospitals include 6) and 7), level two hospitals include 3), 4) and 5), while level three hospitals include 1) and 2). Generally, the price for similar treatment is highest in level 3 hospitals and lowest in level 1 hospitals.

The questionnaire also includes a question asking about the kind of treatment the individuals received. There are 8 categories of treatment: 1) injection, 2) laboratory test, 3) surgery, 4) X-ray, CT, B ultrasonic, MRI, 5) Medications 6) IV (drip infusion), 7) traditional treatment (e.g. massage, acupuncture), and 8) other.

4.4.3 Data descriptive statistics

Table 22 shows the data descriptive statistics for the whole sample. The average age of the whole sample is 59.75, among which 47% are male, 86% are married and 20% are based in urban areas. 91% of the sample is covered by one of the public insurance schemes. This has increased by 1% between wave 2011 to wave 2013. 11% are covered by UEBMI, 5% are covered by URBMI, 73% are covered by NCMS, and 2% are covered by URRBMI. The medical cost increased from

148.23 to 232.14 (in RMB) from 2011 to 2013 with the average utilization increasing from 18% to 21%.

Table 22: Data descriptive statistics for ex-post moral hazard (Whole sample)

	Whole Sample		Wave 2011		Wave 2013	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Co-payment rate	0.91	0.27	0.94	0.21	0.87	0.31
Medical cost (in RMB)	188.33	1725.30	148.23	1262.40	232.14	2117.62
UEBMI	0.11	0.31	0.11	0.31	0.11	0.32
URBMI	0.05	0.21	0.04	0.21	0.05	0.22
NCMS	0.73	0.44	0.73	0.44	0.73	0.44
URRBMI	0.02	0.13	0.01	0.11	0.02	0.14
Government medical insurance	0.02	0.14	0.02	0.14	0.02	0.13
Public insurance	0.91	0.28	0.91	0.29	0.92	0.27
Utilization	0.20	0.40	0.18	0.39	0.21	0.41
Sickness	0.10	0.29	0.08	0.28	0.11	0.31
Age	59.75	10.64	59.00	10.14	60.56	11.10
Male	0.47	0.50	0.48	0.50	0.46	0.50
Urban	0.20	0.40	0.22	0.41	0.19	0.39
Disabled	0.22	0.41	0.18	0.38	0.27	0.44
Smoking	0.33	0.47	0.31	0.46	0.36	0.48
Married	0.86	0.35	0.87	0.33	0.84	0.37
Separated	0.00	0.06	0.00	0.07	0.00	0.06
Divorced	0.01	0.09	0.01	0.09	0.01	0.08
Household income (in RMB)	40446	491560	36377	678112	47990	27244
Srh-excellent	0.23	0.18	0.23	0.17	0.24	0.20
Srh-good	0.37	0.26	0.38	0.27	0.37	0.25
Srh-fair	0.24	0.43	0.23	0.42	0.24	0.43
Srh-poor	0.13	0.33	0.13	0.33	0.12	0.32
Srh-very poor	0.03	0.17	0.03	0.16	0.03	0.17
Illiterate	0.14	0.43	0.14	0.50	0.14	0.12
Primary education	0.12	0.32	0.12	0.41	0.12	0.08
Secondary education	0.29	0.36	0.29	0.45	0.29	0.09
Vocational education	0.02	0.11	0.02	0.15	0.02	0.03
Tertiary education	0.28	0.36	0.28	0.45	0.28	0.09
No. of observations	33,497		17,490		16,007	

Table 23 presents descriptive statistics for the sample who utilized health care services. It shows that, although public insurance coverage went up 1%, the co-payment rate went down from 68% to 40% from wave 2011 to 2013 and the

medical cost went up from 812 to 1,096. Without controlling for other variables, the data descriptive statistics suggest the opposite of ex-post moral hazard, because it suggests that as the co-payment rate decreases, medical cost increased.

Table 23: Data descriptive statistics for ex-post moral hazard (Utilization=1)

	Whole Sample		**Wave 2011**		**Wave 2013**	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Outpatient Co-payment rate	0.54	0.43	0.68	0.41	0.40	0.41
Inpatient Co-payment rate	0.51	0.32	0.59	0.32	0.50	0.32
Medical cost (in RMB)	958	3803	812	2864	1096	4510
UEBMI	0.11	0.31	0.10	0.30	0.12	0.32
URBMI	0.04	0.21	0.04	0.20	0.05	0.21
NCMS	0.77	0.42	0.77	0.42	0.77	0.42
URRBMI	0.02	0.13	0.01	0.11	0.02	0.14
Government medical insurance	0.02	0.14	0.02	0.14	0.02	0.13
Public insurance	0.95	0.22	0.94	0.24	0.96	0.20
Utilization	1.00	0.00	1.00	0.00	1.00	0.00
Sickness	0.07	0.26	0.07	0.25	0.08	0.26
Level 1 hospital	0.42	0.49	0.44	0.49	0.40	0.49
Level 2 hospital	0.32	0.36	0.30	0.46	0.33	0.47
Level 3 hospital	0.36	0.48	0.33	0.47	0.40	0.49
Age	60.35	10.59	59.85	10.12	60.82	10.99
Male	0.42	0.49	0.42	0.49	0.42	0.49
Urban	0.19	0.39	0.19	0.39	0.19	0.39
Disabled	0.27	0.44	0.21	0.41	0.31	0.46
Smoking	0.28	0.45	0.24	0.43	0.30	0.46
Married	0.85	0.36	0.86	0.34	0.84	0.37
Separated	0.00	0.07	0.01	0.08	0.00	0.06
Divorced	0.01	0.08	0.01	0.08	0.01	0.09
Household income (in RMB)	56479	35732	53146	50249	55264	342445
Srh-excellent	0.21	0.11	0.21	0.10	0.21	0.12
Srh-good	0.24	0.19	0.24	0.20	0.24	0.19
Srh-fair	0.30	0.41	0.29	0.40	0.31	0.42
Srh-poor	0.20	0.40	0.21	0.41	0.19	0.39
Srh-very poor	0.05	0.22	0.05	0.22	0.05	0.22
Illiterate	0.20	0.43	0.20	0.50	0.20	0.12
Primary education	0.22	0.31	0.22	0.41	0.22	0.09
Secondary education	0.24	0.32	0.24	0.43	0.24	0.09
Vocational education	0.03	0.12	0.03	0.16	0.03	0.04
Tertiary education	0.31	0.36	0.31	0.46	0.31	0.10
No. of observations	6,541		3,175		3,366	

4.5 Empirical strategy to test ex-post moral hazard

We measured ex-post moral hazard as the impact of variation in the co-payment rate on treatment cost, allowing us to calculate the price elasiticy of the medical care. It is important to justify that co-payment rate is exogenous in our analysis. The first requirement is that individuals do not choose insurance schemes with lower co-payment rates. As described in the last section, the co-payment rate in China is not chosen by an individual. It is voluntary for them to take out the insurance but the co-payment rate is exogenously decided by local health insurance policies. The second requirement is that individuals do not migrate to places (provinces) with a lower co-payment rate. It is reasonable to assume that individuals do not migrate to places with a lower co-payment rate because the primary driver of immigration in China is the choice of occupation rather than to get a cheaper medical services (Nahm and Tani, 2012). Thirdly, it is worth noticing that the co-payment rate is different between inpatient and outpatient services within each insurance scheme. Insurance schemes are often more generous to inpatient services and offer lower co-payment rate for inpatient services. However, there is gate keeping for inpatient services in China. Every individual needs to receive a referal from a doctor at an outpatient department before accessing inpatient services. And then, it is the doctor's decision to give them inpatient or outpatient services, so individuals have no choice here as well.

Since the co-payment rate is exogenous, the context is very similar to the literature that employes a form of natural experiment. The researcher does not need to consider the selection problem because the co-payment rate is set exogenously by the insurance policy makers. Therefore, we can use a simple fixed effect model to estimate the price elasticity of medical services. The fixed effect

model captures the individual-specific effect. The specification of the model is as follows:

$$Ln(Medicalcost_{it}) = \beta_1 + \beta_2 copaymentrate_{it} + \boldsymbol{x'_{it}}\gamma + \delta_i + \varepsilon_{it} \quad (4.2)$$

Where log medical cost in the last 4 weeks is the dependent variable. Variation in co-payment rate comes from different residences and different levels of health facilities. $\boldsymbol{x'_{it}}$ is a vector including control variables. We control for individual's health status using self-reported health. It includes 5 categories, starting from excellent, good, fair, poor to very poor. Other control variables are age, gender, education, urban, household size, household income, marital status, self-reported health, and level of hospitals visited. δ_i is individual specific fixed effect, and ε_{it} is individual-specific error. β_2, and γ are the coefficients to be estimated.

If there is ex-post moral hazard, we would expect β_2 to be negative. It suggests that people with lower co-payment rate (cheaper cost of medical services to the individual) are more likely to have higher medical expenditures, this being suggestive of ex-post moral hazard.

4.6 Results for testing ex-post moral hazard

There are three groups of people in the sample, non-users of medical services, outpatient users and inpatient users. For the key explanatory variable co-payment rate, we only know the co-payment rate for outpatient users and inpatient users. Therefore, I only include outpatient and inpatient users in the analysis, and omit the non-users.

4.6.1 Testing ex-post moral hazard for using outpatient services

Table 24 shows the regression results for testing ex-post moral hazard associated with outpatient services. The dependent variable for each regression is

ln medical cost. Regressions (i) and (ii) include the samples of outpatient users in wave 2011 and wave 2013 respectively. Regressions (iii) (iv) (v) and (vi) are fixed-effects regressions including samples from both waves 2011 and 2013.

The key explanatory variable co-payment rate is found to be negatively correlated to medical costs for the first five regressions. It indicates that individuals who face higher co-payment rate are more likely to have lower medical costs. For example, for wave 2011, as the co-payment rate increases by 1%, the medical cost decreases by 0.44%. The magnitude increases from 0.44 to 1.64 from wave 2011 to wave 2013. For the regressions (iv), (v) and (vi), I separate the sample according to the type of insurance schemes under which individuals are reimbursed. The effects are still negative and significant for NCMS and NEBMI The price elasticity of UEBMI is the highest. Since UEBMI has the most generous benefit package among the three schemes, it implies that the problem of ex-post moral hazard for UEBMI is more serious than its counterpart for NCMS. For the last regression, the number of observations is too small to yield meaningful results.

With regard to other control variables, the regressions suggest that older individuals are more likely to be associated with higher medical costs. However, gender or living in urban areas do not play significant role in affecting medical costs. I also control the levels of hospital visited for each regression. The direction of the coefficients for these variables are to be expected because services at level 3 hospitals are the most expensive. Putting level 2 hospitals as the comparison group, individuals who visited level 3 hospitals are more likely to have higher medical costs, while individuals who visited level 1 hospitals are more likely to have lower costs. This is in line with the expectations, because level 3 hospitals

are the most advanced hospitals so they are often associated with higher expenditure. Variables to control health status are self-reported health. The comparison group comprises those in good health, which is the second category below excellent health. The results suggest that individuals that reported the poorest health tend to have higher medical costs than those who reported good health, while other groups tend to have lower medical costs. When the sample is divided according to the reimbursement insurance scheme, this set of variables are no longer significant.

4.6.2 Testing ex-post moral hazard for using inpatient services

As mentioned in section 4.3, co-payment rates for inpatient services $H_{ijk}(m_i)$ vary across different levels of inpatient costs. The higher the medical costs, the lower the co-payment rate. Thus, I separate them into different ranges of medical costs. However, since the sample size is too small, we cannot conclude from the regressions. The result is shown in Table 25.

4.7 Discussion and conclusion

This study aims to test whether there is ex-post moral hazard after the health insurance reform in China. We define ex-post moral hazard as the increase in total health care consumption due to a lower price from higher insurance coverage (Zweifel and Manning, 2000). In the empirical analyses, the co-payment rate is the key explanatory variable. A higher co-payment rate means a higher price of health care faced by a consumer. The regression results for outpatient users indicate a negative causal correlation between co-payment rate and total health care expenditure. This means that consumers who face a higher price are more likely to have lower total health care expenditure, which indicates there is ex-post

moral hazard for outpatient services. If the co-payment rate increases by 1%, the total medical expenditure decreases by 1.1%. The price elasticity—the percentage change in expenditure as a result of the percentage change in price-—is bigger in UEBMI than in NCMS.

This increased medical expenditure could be partly due to unnecessary utilization of health care services, partly because newly available health insurance satisfies previously unmet needs. We tried to control individuals' need by including measures of disability and self-reported health into the regression, but it does not suggest that the price effect we found are all unnecessary. Measuring individuals' need is more complicated than that. It "must balance clinical, ethical, and economic considerations" (Wright et al., 1998). In addition, it is not possible for us to disentangle whether this induced demand is from the perspective of consumers or providers, because providers' information is not available for the analysis.

Nevertheless, the existing Chinese public insurance policies have put much emphasis on countering inefficient demand for care by consumers. First of all, co-payment rates and deductibles are adopted to put some financial burden on patients so as to discourage "unnecessary" utilization. Indeed, the co-payment rates of Chinese public insurance (with an average around 50 percent) are generally higher than most of the high-income countries. The high co-payment rate imposes relatively higher financial barriers to the poor and unhealthy (Eggleston and Hsieh, 2004). Secondly, insurance policies provide financial incentives for consumers to demand care from those providers offering treatment at lower cost. As explained in Section 4.3, the co-payment rates are lower if the individual seek health care in a lower level hospital. This policy is based on the

fact that there is no gatekeeping process in Chinese health care system. Consumers can seek health care at any level of hospital (subject to their ability to meet out-of-pocket expenses). Our results suggest that introducing consumer-side regulations is not effective enough to counter ex-post moral hazard.

Physician-patient agents' theory asserts that physicians play an important role in choosing the amount of health care consumption of their patients because they act as experts with greater knowledge than their patients. The proposition from this theory is that it is ineffective to introduce co-payment rates because it keeps risk averse individuals from being covered by complete insurance (Ma and McGuire, 1997). Ideally, we would have these types of data and could study whether more drugs where prescribed, or whether patients had longer stays than necessary. However, in this study we have no information on whether the physicians write unnecessary prescriptions, whether patients had excessively long stays in hospital or patients' types of stay. As introduced in Chapter 1, profits from selling drugs account for large proportion of hospitals' total income (around 40%), which gives physicians strong incentives to prescribe unnecessary drugs. This is consistent with the findings of our empirical results. Methods to counter provider ex-post moral hazard were not widely used in China's public health insurance policies at the start of the reform, but a provider payment reform has been underway in recent years.

The literature provides several ways to counter supply-side moral hazard. Firstly, direct government regulation is considered as a means of controlling providers. For instance, general practitioners in UK are limited by the list of pharmaceutical prescribing. Findings from Irwin et al. (1986) indicate that "more regulation to encourage generic prescribing and local formularies is likely to lead

to cost effective changes in prescribing habits" (Donaldson and Gerard, 1989). A more recent example would be the national Electronic Medical Record System introduced by Bureau of National Health Insurance in Taiwan's health care sector. The system traces and advises both physicians' and individuals' behaviors. On the one hand, this system prevents consumers with excessive visits by guiding them to seek health services more properly. On the other hand, it also regulates physicians' actives by monitoring their quantity and quality of treatments (Li et al., 2015). However, this system would have high administrative cost.

Supply-side cost sharing of costs borne by the providers is the most common way to regulate provider's behaviour (Donaldson and Gerard, 1989). For example, capitation will provide financial incentive for providers to lower cost if the Government rewards a fixed payment per enrolled consumer per period for strictly limiting services provided. Supply-side cost sharing will not add financial risk to patients (Eggleston and Hsieh, 2004). Existing empirical evidence from Taiwan and Korea indicates that supply-side cost sharing can improve efficiency without undermining equity (Lang et al., 2004; Kwon, 2003). Their findings prove that the introduction of capitation methods leads to a decrease in spending per case. Accordingly, Eggleston and Hsieh (2004) suggest that provider incentives would be the focus for future health care reform to counter inefficient health care demand. The Chinese government has been piloting a supply side cost-sharing payment method. Some of the areas have moved from fee-for-service payment to prospective payment. Prospective payments make providers bear the financial risks of over-provision and, thus, provide incentives for them to reduce inefficient use of services (Yip and Hiao, 2009).

Table 24: Regression results for ex-post moral hazard (outpatient users)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	Wave 2011	**Wave 2013**	**FE**	**FE NCMS**	**FE UEBMI**	**FE URBMI**
Co-payment rate	-0.442	-1.642	-1.101	-1.089	-2.792	6.302
	(6.90)**	(21.61)**	(9.34)**	(2.83)**	(2.75)*	
Age	0.009	0.007	0.171	0.144	0.774	2.109
	(3.06)**	(2.16)*	(2.17)*	(0.53)	(0.99)	
Male	0.010	-0.071	0.094			
	(0.16)	(0.86)	(0.13)			
Urban	0.097	-0.130	0.641			
	(1.31)	(1.57)	(0.32)			
Smoking	-0.134	-0.006	0.010	-0.590	1.996	
	(1.96)*	(0.07)	(0.05)	(0.94)	(1.46)	
Married	0.055	0.247	-0.361	0.170	2.446	
	(0.66)	(2.61)**	(0.94)	(0.22)	(0.98)	
Separated	0.307	0.759	-0.629	-2.504		
	(0.97)	(1.39)	(0.60)	(1.47)		
Divorced	0.062	-0.066	-0.275	4.148		
	(0.20)	(0.18)	(0.33)	(2.28)*		
Ln household income	0.009	0.015	0.040	0.079	0.053	-0.057
	(1.28)	(1.75)	(2.95)**	(1.82)	(0.57)	
Disabled	0.046	0.028	-0.029	0.610	0.202	
	(0.73)	(0.40)	(0.16)	(1.21)	(0.13)	
Level1hospital	-0.713	-0.597	-0.588	-0.105	-4.439	
	(8.29)**	(6.51)**	(3.94)**	(0.22)	(2.01)	
Level3hoshospital	1.189	1.120	0.864	1.264	-0.614	
	(14.15)**	(12.45)**	(6.25)**	(2.94)**	(0.63)	

Table 24: (Continued)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	Wave 2011	**Wave 2013**	**FE**	**FE NCMS**	**FE UEBMI**	**FE URBMI**
Self-reported health excellent	-0.624 (2.52)*	0.047 (0.18)	-0.781 (1.46)	-1.281 (0.78)	2.169 (1.00)	
Self-reported health fair	-0.281 (4.32)**	-0.287 (3.72)**	-0.346 (2.78)**	-0.388 (0.97)	-0.484 (0.59)	
Self-reported health poor	0.251 (3.95)**	0.212 (2.58)*	0.149 (1.32)	0.218 (0.71)	-1.470 (1.26)	
Distance to the facility	0.002 (0.0003)***	0.0007 (0.0005)**	-0.001 (0.001)	0.002 (0.0004)	0.0005 (0.002)	
Primary education	0.088 (1.15)	-0.048 (0.13)	0.013 (0.06)	0.837 (1.36)	3.638 (1.81)	
Secondary education	0.117 (1.50)	-0.521 (1.44)	0.012 (0.06)	0.517 (0.82)	1.897 (1.04)	
Vocational education	0.096 (0.58)	-0.815 (1.10)	-0.386 (0.95)		2.958 (1.51)	
Tertiary education	0.126 (1.72)	-0.346 (1.08)	0.299 (1.69)	0.119 (0.21)	-1.752 (0.75)	
_Cons	4.705 (19.60)**	5.889 (22.13)**	16.335 (3.33)**	14.511 (0.86)	-44.600 (0.88)	-122.021
R^2	0.30	0.26	0.21	0.45	0.43	1.00
NT	3,175	3,366	6,541	1,542	342	71

(* p<0.10 ** p<0.05 *** p<0.01)

Table 25: Regression results for ex-post moral hazard (inpatient users)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)
Insurance scheme	**NCMS**	**NCMS**	**NCMS**	**URBMI**	**URBMI**	**URBMI**	**UEBMI**	**UEBMI**	**UEBMI**
Medical cost	(0,3000)	(3000,5000)	>5000	(0,3000)	(3000,5000)	>5000	(0,3000)	(3000,5000)	>5000
Co-Payment rate	0.909	-0.118	-0.636	102.438	0.479	-0.636	-0.719	0.060	-0.013
	(1.66)	(2.17)*	(0.56)			(0.56)			(0.03)
Age	-0.019	-0.003	-0.018	0.629	-0.019	-0.018	0.007	0.008	-0.004
	(0.93)	(1.68)	(0.77)			(0.77)			(0.54)
Male	-0.031	-0.003	0.339	35.791	-0.315	0.339	0.589	-0.037	0.077
	(0.07)	(0.10)	(0.80)			(0.80)			(0.43)
Smoking	0.969	0.019	0.355	38.269		0.355	-0.125		-0.098
	(1.99)*	(0.50)	(0.57)			(0.57)			(0.51)
Married	-0.073	-0.059	0.072	40.379	0.018	0.072	0.044	0.228	0.230
	(0.14)	(1.40)	(0.12)			(0.12)			(0.70)
Ln household income	-0.018	-0.001	0.001	-7.786		0.001	0.791	0.002	-0.019
	(0.33)	(0.13)	(0.01)			(0.01)			(1.01)
Level3 hospital	-0.001	0.047	0.918	-5.281		0.918		-0.102	0.327
	(0.00)	(1.62)	(1.56)			(1.56)			(1.49)
Disabled	-0.286	0.052	0.029	-21.001		0.029			0.195
	(0.74)	(1.70)	(0.06)			(0.06)			(1.12)

Table 25: (Continued)

	(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(j)**
Insurance scheme	**NCMS**	**NCMS**	**NCMS**	**URBMI**	**URBMI**	**URBMI**	**UEBMI**	**UEBMI**	**UEBMI**
Medical cost	(0,3000)	(3000,5000)	>5000	(0,3000)	(3000,5000)	>5000	(0,3000)	(3000,5000)	>5000
Srh-fair	0.030	0.042	-1.778			-1.778			-0.301
	(0.06)	(0.80)	(1.12)			(1.12)			(1.31)
Srh-poor	0.528	-0.031	0.588			0.588			-0.039
	(1.18)	(0.97)	(1.44)			(1.44)			(0.19)
Primary	-0.006	0.083	0.110			0.110			0.198
	(0.01)	(0.89)	(0.13)			(0.13)			(0.52)
Secondary	-0.057	-0.122	1.073			1.073			0.050
	(0.06)	(1.27)	(1.48)			(1.48)			(0.13)
Tertiary	-0.321	-0.082							0.252
	(0.45)	(1.68)							(0.51)
2013.Wave	-1.560	-0.107	-0.162			-0.162			0.290
	(2.55)*	(2.38)*	(0.35)			(0.35)			(0.89)
Separated		0.128							
		(0.95)							
Divorced									0.568
									(0.61)
_cons	8.105	8.719	10.293	-168.625	9.496	10.293	-0.397	7.754	9.525
	(4.92)**	(58.40)**	(5.30)**			(5.30)**			(11.43)**
R^2	0.16	0.22	0.59	1.00	1.00	0.59	1.00	1.00	0.10
NT	171	83	27	9	5	27	7	7	121

(* p<0.10 ** p<0.05 *** p<0.01)

Chapter 5: Conclusion to the Thesis

This thesis considers the unintended consequences of the major reforms to the Chinese health insurance market. The reforms aimed to provide universal coverage for the Chinese population, reduce financial barriers to health care, and ensure equal access to public health services. Health insurance schemes are typically associated with unintended consequences such as adverse selection, ex-ante moral hazard or ex-post moral hazard. I explore these three topics with respect to China's health insurance system in the thesis. In this concluding section, I will provide a summary of each of the thesis chapters, their policy implications, together with strengths and limitations. Finally, I will propose some future research.

5.1 Summary of the findings

The first substantive chapter sets out the context of China's private insurance markets prior and after to the official large health insurance reform from 2004 to 2009. It examines whether there is adverse or advantageous selection in China's private insurance market. We look at two separate markets: the first is a pure private insurance market where people face the choice of purchasing private insurance or otherwise going without any health insurance. Secondly, we look at a supplementary insurance market where people are partially covered by public insurance but have a choice to buy a supplementary private insurance. In the pure private insurance market, the results provide evidence of adverse selection, with individuals at higher health risk more likely to buy private insurance. Solutions for the Government to deter adverse selection include full and compulsory

insurance, reinsurance for health insurance companies and risk adjustment methods (Neudeck and Podczeck, 1996; Cutler and Zeckhause, 1999; Van den van and Ellis, 2000). In a supplementary insurance market, we find evidence supporting advantageous selection. People at lower risk are more likely to buy supplementary insurance. This conflicts with classical theory of adverse selection, and the unexpected finding may be due to the difference in risk preference of the individuals. The theory of advantageous selection explains the individuals' behaviour by adding the difference in risk preference.

The second and the third substantive chapters consider the problem of moral hazard during the period of establishing nearly universal public insurance in China from 2006 to 2013. These two chapters take into account the setting in China where there has been a huge increase in total medical expenditure from 2006 to 2013. Besides previously unmet need, ex-ante and ex-post moral hazard could be the reasons contributing to the drastically increased expenditure. By employing matching methods and using panel data, we are able to identify a causal relationship between health insurance coverage and individuals' preventive behavior. However, we do not find strong evidence of ex-ante moral hazard. The only significant effect is on individuals' time spent exercising, those with public insurance spending less time doing exercise than those who do not have insurance. Having public insurance, however, does not have a significant effect on preventive behaviors such as smoking, number of cigarettes per day, vegetable and fruit consumption, obesity, being overweight, or preventive care visits.

The final substantive chapter is on the topic of ex-post moral hazard. It investigates whether and to what extent an individual's hospital medical

expenditure increases as the price of accessing health care services decreases and whether current deductibles and co-payments are effective at overcoming ex-post moral hazard. The empirical results show that as the co-payment rate increases, medical costs decrease, providing evidence of ex-post moral hazard. The findings from this study suggest that current policies on demand-side regulations, such as co-payments and deductibles, are not effective enough to discourage "unnecessary" utilization. High co-payments and deductibles may even impose relatively higher financial barriers to the poor and unhealthy. A possible explanation is the physician-patients' theory (Bardey and lesur, 2005). This theory emphasizes physicians' expert knowledge about medical services, with physicians playing a more important role than patients in deciding the quantity and quality of health treatment. If this theory holds, regulatory solutions might be directed at changing physician incentives rather than patient behavior.

5.2 Policy implications

Policy implications can be framed by the goals laid out by the Chinese Government. Five goals of the Chinese health care reform are explicitly expressed by the Government: 1) To improve the health insurance system by achieving universal coverage of public insurance schemes, raising government subsidies and reimbursement ceiling, and improving the management of "health care funds"; 2) To insure people that have critical illness; 3) To establish a national essential medicines system to meet patients' needs; 4) To improve the primary health service delivery system; 5) To ensure equal access to public services (Yip et al., 2012).

Findings from the first study (Chapter 2) suggest that whether there is adverse or advantageous selection is likely to depend on the context of the health

insurance market. For a pure insurance market, we find evidence supporting adverse selection. Currently, the Government does not really focus on private insurance. This study looks at the situation before the large reform starting in 2003. Since the start of the reform, the Government has taken actions in order to reduce adverse selection. In the public insurance market, both NCMS and URBMI are voluntary schemes in a pure health insurance market. The premium is subsidized by the government, so the price of public health insurance is much cheaper for the user than private insurance. It is reasonable for individuals to enter public health insurance prior to private health insurance. This is the same situation as the setting in a pure insurance market where individuals have the choice of entering into the public insurance schemes or otherwise going without any health insurance. Thus adverse selection potentially exists according to our findings from Chapter 2. To reduce adverse selection in NCMS and URBMI, the Chinese government requires full household enrollment into the schemes. This implies that a family either has all members enrolled into the program or none. Currently, the public health insurance coverage has reached over 96% in China, and only a few people are without any public insurance coverage. Non coverage is more likely to be related to geographical reasons rather than risk type (Qin and Lu, 2014). Therefore, full household enrolment is considered to be an effective way to reduce adverse selection.

With regard to the pure private insurance market, although we find evidence of adverse selection, this market is quite small nowadays because of the development of near universal coverage. The private insurance market serves mainly as a provider of supplementary insurance. In this market, we find evidence supporting advantageous selection. People with lower risks are more likely to buy

private insurance. A problem associated with advantageous selection is that people who have higher expected medical expenditure still face the risk of financial loss if they are not privately insured because they face high co-payments. Accordingly, they may still have a financial barrier to health services. Policies could be designed directly to address such access problems. Providing more generous public insurance plans to such people is a potential solution. The Chinese Government has been experimenting with Critical Illness Insurance since 2012 to reduce the financial risk for people that suffer from chronic disease or face catastrophic costs. In addition, such people will have higher reimbursement rates and lower deductibles.

Solutions to correct for adverse selection or advantageous selection, such as full and compulsory public insurance, may lead to moral hazard problems. The classical theoretical framework of Arrow (1963) predicts that providing higher insurance coverage may reduce individuals' and providers' incentives to control medical utilization. On the one hand, higher coverage may reduce individuals' incentive to invest in preventive behaviours. This will increase the chance of falling ill, which is ex-ante moral hazard. On the other hand, higher insurance coverage may also reduce individuals' or provides' incentive to control medical utilization when health care is required. This is due to the price of treatment being lower than it would be if an individual does not have insurance.

Near universal coverage has provided insured individuals with higher insurance coverage and lower prices for health care. However, we do not find strong evidence suggesting that universal coverage has affected health related behaviours in China. There are two possible explanations for the findings. First, near universal coverage does not actually provide full insurance. Out-of-pocket

payments from individuals remain high (Eggleston, 2012), thus diluting incentives for ex-ante moral hazard. Second, we only look at the preventive behaviour in our short run analysis of just 3 years. Some lifestyle behaviours do not alter immediately after entering the insurance programme and effects may take longer to materialise.

Unlike the findings for ex-ante moral hazard, we have identified a causal relationship between the co-payment rate and health care expenditure for out-patient services. This suggests that the Chinese public insurance system faces either potential inappropriate demand for care by consumers or inefficient supply of care by providers. Since the start of the reform in 2003, deductibles and relatively high co-payment rates have been adopted to deter inappropriate demand for care. The results from this chapter suggest that consumer-side regulations are not sufficient to counter completely ex-post moral hazard. Moreover, the high co-payment rate imposes relatively higher financial barriers to the poor and unhealthy (Eggleston and Hsieh, 2004). This consequence is not in line with the goal of equity stated by the Government. Recent literature suggests that countering supply-side ex-post moral hazard is more effective in many Asian countries and regions with universal coverage (Eggleston and Hsieh, 2004). Physician-patient agents' theory supports this idea and asserts that physicians play a more important role in choosing the amount of health care consumption of their patients. Therefore, future effort could be put into supply-side regulations so as to deter ex-post moral hazard. Direct government regulation and supply-side cost sharing of costs borne by the providers are two methods promoted by literature.

5.3 Strengths and limitations of the thesis

In Chapter 2 we are able to use survey data to test whether there is adverse or advantageous selection. Most of the previous literature adopted data from insurance companies. Data from insurance companies has the advantage of being more accurate and complete, but it only covers the population who are enrolled in the insurance plan. CHNS enables us to study a larger population, including those individuals who decided not to purchase insurance. Moreover, the scenario before universal coverage reform in China provides a different context from previous literature because most of the population were not eligible for any public health insurance. It makes the study of a pure private insurance market possible.

In this chapter, risk type is a key variable in the analysis. We argue that if individuals' expected their medical expenditure to be greater than the premium then it would be rational for them to buy private insurance. Expected medical expenditure and the premium the individual would face are both important for generating the risk type variable. However, by definition, the premium paid is not available for individuals who do not purchase private insurance. Thus we have to predict the premium that they might have faced, but decided not to pay. Consequently, prediction error is a potential limitation for this chapter. Another limitation comes from the gap between the waves. CHNS has two or three years' gap between waves. Predictions of the expected medical expenditure which is based on previous waves might be inaccurate, and more so the longer the gap between waves. Lastly, due to the limitation of the dataset, we can only use smoking and drinking status, time spent exercising as crude measures of risk preference. This is a potential weakness of the study.

Chapter 3 contributes to the literature in that it investigates ex-ante moral hazard in the context of a voluntary health insurance system, while most of literature on the subject is conducted within the context of high-income countries with compulsory health insurance programmes. Matching methods, such as CEM and PSM, make it possible to deal with self-selection on observable characteristics into voluntary programmes. By matching individual's characteristics across a control and treatment group prior to the reform, we match their probability of entering the insurance scheme. Compared with PSM, CEM achieves better balance across covariates, but both matching methods give consistent results, suggesting that the results are robust to the choice of matching techniques. The relatively small sample size due to missing information in the dataset is a potential limitation of this chapter. Secondly, we only look at preventive behaviours in the period immediately after the reform. Some of the preventive behaviours do not change over such a short period of time. This could be one reason that we do not find strong evidence of ex-ante moral hazard.

In Chapter 4, the exogeneity of the co-payment rate enables us to measure ex-post moral hazard in a natural experimental setting. The co-payment rates are set exogenously by insurance policy makers. Therefore, we do not need to distinguish adverse selection from ex-post moral hazard. For this chapter, we employ another dataset, CHARLS. Since it focuses on people who are over 45 years old, there are more health care users than in the general population, especially for outpatient services. This means that we have a larger sample size on which to run the analysis. The results show a negative and significant correlation between the price of medical care faced by individuals and their medical expenditure. We provide evidence supporting the existence of ex-post moral hazard. However, this dataset

does not provide supply-side information. Thus it is not possible to disentangle whether this induced demand is from the perspective of consumers or providers.

5.4 Challenges for future research

Findings from Chapter 2 imply that setting (whether it is a pure or supplementary insurance market) matters when testing whether there is adverse or advantageous selection. This is an interesting angle for future research. However, this empirical study is still subject to some limitations due to the quality of our dataset. There is also a requirement for more empirical studies to support or otherwise the findings in this thesis. Chapters 3 and 4, on the topic of moral hazard and universal coverage, are both based on a relatively short run analysis. It is of policy importance to see whether the insurance reform is associated with "unnecessary" utilization in the long term. Further research could put emphasis on both demand-side and supply-side behaviours, so that policies could be designed more effectively to deal with inappropriate utilization.

China has experienced radical changes in its health insurance system in a relatively short period of time. It has been in a process of experimenting and improving, which provides opportunities for researchers to find out what is working and how to best expand insurance coverage, improve health and protect against financial risk. For example, the Chinese government is experimenting with a consolidation of URBMI and NCMS. More research could be based on this consolidation process to see whether it is efficient and improves equity in access to health care between rural and urban populations.

This thesis tries to take the opportunities created by the reform to contribute to the health economics literature, focusing on the unintended problems associated with providing universal coverage. Future research could be on the topics of

improving coverage, equity and package design of the public insurance schemes. These studies deserve continuous attention in terms of methodological research. For instance, most of the limitations of this thesis are related to the availability of dataset. In future studies, qualitative research methods can supplement research methods to help understand issues like preventive behaviour, individuals' risk preference, and necessary or non-necessary care.

List of Abbreviations

y_h	Disposable income when individual is healthy
Y	Income
y_s	Disposable income when individual is sick
M/m	Medical expenditure
P	Premium of health insurance
EU	Expected utility
u^s	Utility when individual is sick
u^h	Utility when individual is healthy
π	Probability of getting sickness
π_L	Probability of getting sickness for low-type consumers
π_H	Probability of getting sickness for high-type consumers
λP	The net premium pay-out in the event of sickness
α_1	Generous health plan
α_2	Moderate health plan
T	A risk averse individual
B	A risk neutral individual
γ_i	The parameter indicating preference of specific individuals
W	Wealth
w	Wage
F_i	A binary variable that affects the probability of financial loss
Φ	Transaction cost
Q	Quantity of health care consumed
x'_i	A vector of predictors
λ	Coefficient

φ_i	Individual-specific effects
I	Insurance status
R_i	Risk measurement for individuals
P(X)	Probability of not entering in the public insurance
H_i	Individual's health preventive behaviours
l_{ijhk}	Co-payment rate that individual *i* living in *k* faces
A_{ijk}	Deductible of an insurance scheme
α_{ih}	Different co-payment rates due to the level of hospitals *h*
C_{ijk}	Cap of an insurance scheme

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