Australia's Capital University

Modelling Medical Insurance Reform in China – Distributional Effects for Urban Employees and Residents

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Doctor of Philosophy Degree

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Abstract

In the last decade or so, China has begun to reform its health care system nationwide, due to pressures like an ageing population and increasing demand on health services. In the late 1990s, the Chinese government established the medical insurance scheme for urban employees and retirees. Then, in 2003, a new rural co-operative medical insurance scheme was established for rural areas in China. Most recently, in late 2007, a medical insurance program was introduced in 79 pilot cities, aiming to cover all urban residents who are not in the labour market and with all urban residents becoming beneficiaries by 2010.

Given China's considerable size and diversity, both geographically and demographically, the reform of the medical care system faces many challenges. It is important to analyse and evaluate the impact of the reform on individuals' health care benefits and on their financial burden due to medical expenses.

This research investigates the sustainability of the urban medical insurance system, involving both urban employed individuals and non-working residents. The key aims focus on three aspects. First, it assesses the distributional impacts of medical insurance policies and predicts medical expenses for urban employees and retirees. Second, it estimates the potential urban resident population entering the medical insurance scheme and predicts the medical costs. Third, it estimates and evaluates the contribution of the differing levels of the Chinese government to the medical insurance scheme.

With co-operation from the Bureau of Labour and Social Security of Kunming (capital city of Yunnan Province, China), this thesis creates two static microsimulation models for predicting and evaluating the medical insurance policies in China's urban areas. The model for urban employees and retirees investigates the balances of the social pool fund and personal savings accounts, and the medical expenses shared by different kinds of payment modes. The model for non-working urban residents predicts the distributional impacts on families, estimates the medical expenses and evaluates the insurance capacity of the social pool fund.

Three kinds of data are used in the research. The first is the individual level data of medical care records of the urban employees and retirees in Kunming. This administrative data helps to create the microsimulation model for urban employees and retirees for the period of 2006-2010. The second type of data involves the 0.1 per cent sample of the National Population Census in 2000 and the results of the 2005 Population Survey. These data provide the demographic information on urban residents and updated population structures. The third data type provides information on health service use of urban residents, which mainly comes from the second and the third National Health Services Surveys of 1998 and 2003.

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CHAPTER 1 INTRODUCTION

1.1 Medical Insurance System in China

1.1.1 China's Social Security System

In the last decade or so, China has begun to reform its health care system nationwide, due to pressures such as an ageing population and increasing demand on health services. The Chinese government established the medical insurance scheme for urban employees and retirees in the late 1990s. Then, in 2003, a new rural co-operative medical insurance scheme was set up for rural areas in China. More recently in late 2007, a medical insurance program has been inaugurated in 79 pilot cities which aim to cover all the urban residents who are out of the labour market.

As an important part in the social security system, the health care system usually goes hand in hand with the other parts of China's social security system, like the aged pension and the unemployed, disability, and maternity care systems. When considering China's medical insurance system, it is essential and necessary to discuss China's social security systems.

China is the world's biggest developing country with a large population — yet the development between urban and rural regions is unbalanced. Establishing a sound social security system in China is an important guarantee of social stability. In light of China's actual situation, and adhering to the principle of "putting people first", the Chinese Government has attached great importance and devoted every effort to establishing and improving its social security system.

Primarily, the Chinese social security system was first introduced in 1951 with the promulgation of the Labour Insurance Regulations. For almost three decades until the late 1970s, the social security system was employment-based — an individual received employment and income protection, and obtained social security benefits for sickness, maternity, work injury, death and old age (Leung, 2003). Beginning with the economic reforms in 1978, China has experienced rapid economic, social, and cultural changes over the past three decades. Along with the transition from a planned economy to a market economy, China's social security system has also undergone dramatic changes since the early 1980s.

These changes, like the ageing population, significant economic growth, and large migration from rural to urban areas, has put significant pressure on China's social security system.

With the establishment and improvement of China's market economy system in the 1980s, a series of reforms have been introduced to change the traditional social security system. Since then a basic framework of a social security system has been set up in China corresponding to the market economy system. Generally, a stable social insurance fund comes from the government, employers and employees.

Basically, China's social security system includes social insurance, social welfare, special care and placement systems, social relief and housing services. As the core of the social security system, social insurance is composed of five parts: pension insurance, unemployment insurance, medical insurance, work-related injury insurance and maternity insurance. To guarantee the basic living standards of the elderly and safeguard their legitimate rights and interests, the Central Government has reformed the fund-raising model in an attempt to establish a multi-level old-age insurance system marked by sustainable development. Relative reforms have also been made for the other parts of the social insurance system, among which the medical insurance system is the most complicated and crucial scheme to be reformed.

1.1.2 Medical Insurance Reform

Medical insurance is one of the most important aspects in the social security system and plays an essential role in people's daily lives. In 1998, on the basis of several rounds of pilot programs and experimental implementation, the Chinese Government promulgated the "Decision on Establishing a Basic Medical Insurance System for Urban Employees" (State Council, 1998). The decision started a national reform of the basic medical insurance system for urban employees. To standardize medical services and reduce costs, the Chinese Government simultaneously promoted the reform of the basic medical insurance system, medical and healthcare system, and pharmaceuticals production and circulation system.

This basic medical insurance system conceptualized an innovative system with low benefit levels; cost sharing among employees, employers and the State; and wide coverage. Under this medical insurance system, a social pool fund and personal savings accounts have been established (State Council, 2004). The social pool fund is mainly responsible for serious illnesses, while personal savings accounts are responsible for minor illnesses. After more than

a decade of carrying out this medical insurance scheme, significant achievements have been made in providing basic medical services for urban employees and retirees.

For rural areas where the majority of the population are living, the rural cooperative medical care system was established by the Central Government in 2002. This medical care system is designed to guarantee coverage of medical expenses for villagers to be hospitalized or to have serious diseases treated (Ding and Yin, 2005). The Central and local governments and individuals jointly fund the scheme, in which participants pay 10 Yuan and governments supply another 40 Yuan per person to the fund. The Chinese Ministry of Health reported that, by the end of June 2006, the cooperative medical care system in rural areas registered 410 million people, which accounts for 47.2 per cent of the country's rural population (Ministry of Health, 2007).

After establishing a medical insurance system for the urban employed in 1998 and founding a new cooperative medical care system in rural regions in 2002 designed to cover all rural residents, urban residents outside the workforce became the only group without medical cover. China launched a pilot project of medical insurance in September 2007 to cover 240 million urban residents outside the workforce, and all urban residents will become beneficiaries by 2010 (MLSS and NBS, 2007). The pilot project has been carried out in 79 cities, including large cities as well as county-level cities (Zhao, 2007). Both the Central government and local governments fund the subsidies.

1.1.3 Problems and Arguments on the Medical Insurance Scheme

From 1999 onwards, the Chinese Government has been working hard to achieve the goal of wide coverage of the medical insurance system. However, quite a large population of non-public enterprises and self employed personnel have not been covered by the scheme. In addition, some public and collective enterprises cannot join the scheme because of their lower economic capacity. By the end of June 2007, the basic medical insurance scheme for urban employees only covered 43 per cent of the target population (Dong, 2007).

Hence the coverage of the medical insurance scheme and imbalance of health sources are still the major problems challenging the government. This, as a result, affects the equity and efficiency of the medical insurance scheme among different groups of people. The other problem is the impact on family incomes since the medical care reform. Using the national

China Household Income Project data, Gao (2006) provided empirical evidence on how social policy changes in urban China reflected on family benefits from 1988 to 2002. Empirical results show that even though the real value of social benefits increased over time, its increasing pace lagged behind that of market earnings, yielding a smaller share in final household income since the medical care reforms.

In recent years, arguments and controversies on the reform of the medical insurance system in China have become more common. In July 2005, the Development Research Centre of China's State Council and the World Health Organization jointly published a study titled "China's Reform of the Medical and Health System". The study came to the conclusion that the reform of the national medical system is "basically unsuccessful" (DRC State Council, 2005). The report pointed out that inequality in access to medical services and low efficiency in the use of funding were the two main symptoms of the malfunctioning medical system.

Nearly one year later, in May 2006, the research group of "the report of China's medical and health reform" issued a green book "Medical and Health 2006" (Dong, 2006). The Green Book believed that the ten-year medical insurance reform commenced in 1995 had indeed led to many problems, especially in low fairness in access to medical services and low efficiency in funding health.

The reform of the medical system in a country of 1.3 billion people, admittedly, is a very difficult task, especially considering the chronic inefficiency of the State medical system that emphasized equality at the expense of efficiency in the planned economy period. In addition, the ageing population in China imposes a heavy burden on medical insurance. The reform of China's medical insurance system faces many challenges. This reform has been advancing slowly, primarily due to an impractical financing policy. Given China's considerable size and diversity, both geographically and demographically, further extension of pilot programs and implementation to all citizens will still take a long time.

1.2 Aims and Objectives of the Thesis

The ongoing medical insurance reform in China for both urban and rural areas has had a profound impact on the financing, organization and provision of health services. It is

important to analyse and evaluate the impact of the reform on individuals' health care benefits — in particular, on their financial burden due to medical expenses. The control of the rapidly increasing health services expenses, as well as the provision of basic medical services to all populations, is a major indicator of the success of the reform. Powerful policy analysis tools are needed urgently to support the medical insurance policy makers. However, very few research studies have been found on the prediction and evaluation of the medical insurance policy. Significant gaps in knowledge still remain, which this current research aims to fill.

This research focuses on the urban medical insurance system reform, involving both urban employees and residents who are out of the labour market. The key aims of this research can be described in at least three aspects. First, it assesses the distributional impacts of medical insurance policies and predicts the medical expenses for urban employees and retirees. Second, it estimates the potential urban resident population entering the medical insurance scheme and predicts the medical costs. Third, it estimates and evaluates the responsibility or subsidies of the Chinese government to the medical insurance scheme. In this way, this research aims to advance the understanding and impact of health insurance reform in China, and to assist in future policy formulation and implementation.

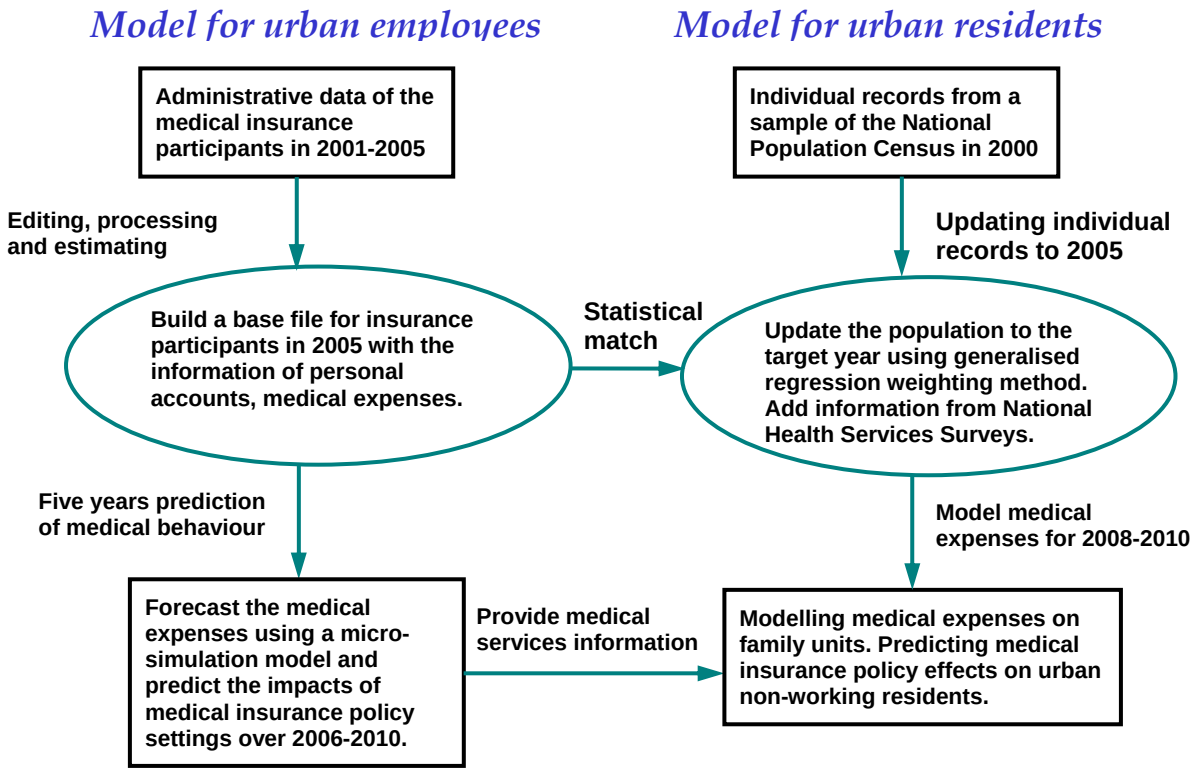
Selecting one of the southwest capital cities in China, Kunming, Yunnan Province, this project creates two static microsimulation models of the medical insurance system in China, with the goal of greatly improving the decision support tools available to Chinese medical insurance policy makers. Using microsimulation techniques, this project answers two major research questions:

- Is the current social medical insurance policy for urban employees sustainable in a short term period from 2006 to 2010?
- What is the cost of expanding the social medical insurance to all urban residents without employment over 2008-2010?

The projections stop at 2010, the point where there is close to 100 per cent coverage of medical insurance scheme for urban non-working residents. To answer these research questions, two static microsimulation models are created for urban employees and non-working residents. Figure 1.1 gives an overview of the research framework used in creating the two microsimulation models. In the model of simulating medical services of urban

employees (left hand side of Figure 1.1), administrative data over 2001-2005 are used. Based on these administrative data sources, a base file for insurance participants in 2005 is built. Then the model forecasts medical expenses and predicts the impacts of medical insurance policy settings. Regarding the model for non-working residents, another static microsimulation model (right hand side in Figure 1.1) is constructed by mainly using the individual records from a sample of the fifth National Population Census in 2000. Using a population re-weighting method, the Census records are updated to the target years. Then, along with the supplementary information on medical expenses, the model predicts medical insurance policy distributional effects on non-working residents.

Figure 1.1 Framework for creating two static microsimulation models



The two models are connected with each other by the methodology of statistical matching. Through this way, the model for urban employees provides the medical services information which is needed in constructing the model for urban residents. The construction of these two models is discussed in detail in Chapter 5 and Chapter 6 respectively.

In the context of this thesis, unless otherwise specified, ‘urban employees’ includes both employees and retirees (used to have jobs). Their monthly incomes come from their wages and pensions. ‘Urban residents’ indicates residents who are not in the labour force (NILF), involving children, students and non-working adults.

1.3 Kunming’s Medical Insurance Project

1.3.1 Brief Introduction to Kunming

In cooperation with the Bureau of Labour and Social Security of Kunming, this project is focused on the medical insurance system of the city of Kunming. Kunming, capital of Yunnan Province, located in the southwest of China, with more than 2400 years of history, is the centre of Yunnan’s politics, economics, culture, techniques and traffic. Simultaneously, Kunming is also China’s famous historical culture city and the outstanding tourist city. Covering an area of 21,111 square kilometres, a total population of 6.08 million at the end of 2005, Kunming governs five areas and eight counties, including 0.74 million nationals from 26 minority groups (Kunming Municipal Government, 2006).

Kunming is skirted on three sides by mountains, with one side opening onto a vast lake (called Dianchi). The city is nicknamed “City of Spring” due to the fact that it is covered all the year round with the rich verdure of trees and plants. Its land is pockmarked with historical artefacts, places of cultural interest, and gardens landscaped with a picturesque taste. Kunming is world-famous for its abundance of camellias, orchids, azaleas and Primula malacoides, which can be found in the Kunming Botanical Garden, where 4,000 varieties of tropical and subtropical plants grow profusely (China Today, 2008).

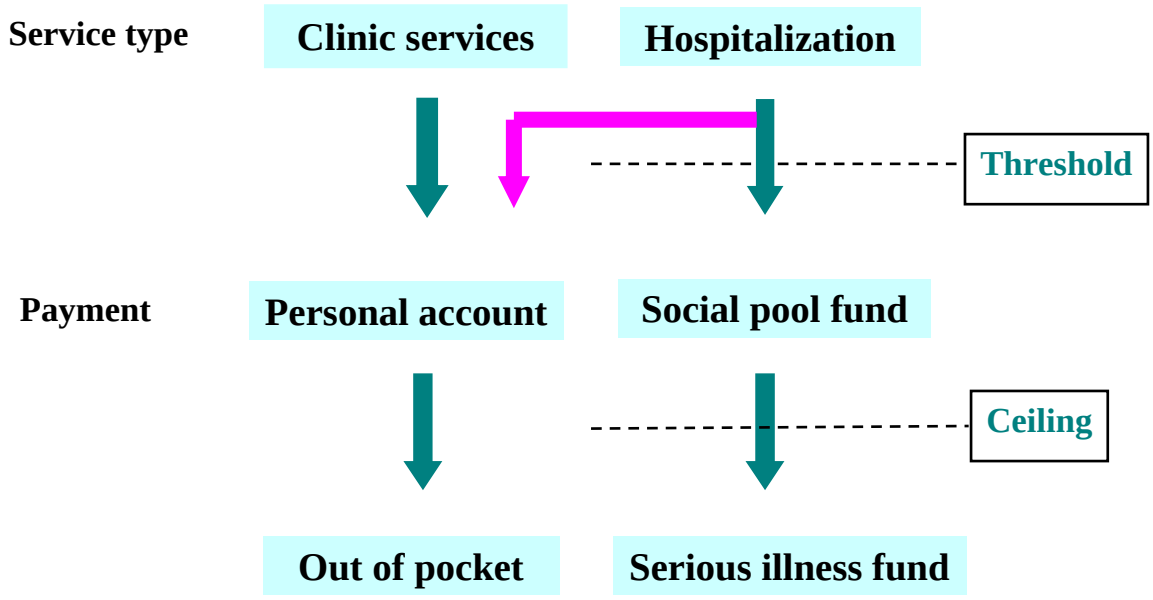
1.3.2 Medical Insurance Scheme for Urban Employees

Kunming commenced its medical insurance reform for urban employees and retirees in April 2001. There were about 1.08 million insured urban employees and retirees at the end of 2005. As a mandatory social security system organized by the Kunming government, all enterprises located in Kunming and their employees are required to be covered by the basic medical insurance system. Medical insurance policies in Kunming are similar to the other cities in China.

Like other urban areas in China, the basic medical insurance funds in Kunming, contributed jointly by employers and employees, include the basic medical insurance pool fund (social pool fund) and the basic medical insurance personal savings account (personal savings account). Basically, the social pool fund is mainly responsible for hospitalization expenses, while the personal savings accounts are responsible for outpatient treatment fees.

Medical services are classified into two types, as Figure 1.2 shows. One is clinic services involving clinic treatment (as occurs with seeing a General Practitioner in Australia) and medications in pharmacies; the other is hospitalization services involving hospital admission, special disease, emergency, chronic disease and special check-up. For clinic services, patients are responsible for all the incurred medical expenses, first from their personal savings accounts, and then as out of pocket expenses when the personal savings accounts are exceeded. For hospitalization services, a large part of medical expenses is covered by the social pool fund, while patients share a small part of the medical expenses (including a threshold payment).

Figure 1.2 General payment mode of medical expenses for employees



If the medical expenses exceed the maximum coverage (ceiling) provided by the social pool fund, patients can continuously get benefit from a serious illness fund which covers a quite large amount of medical expenses. Besides these two funds, another type of fund – the 'Government official fund' which is financed by the local governments – provides a supplement to government officials for their medical expenses.

1.3.3 Medical Insurance Scheme for Residents without Employment

As one of 79 pilot cities chosen by the Central Government, Kunming began its urban residents' medical insurance scheme in October 2007. The medical insurance policy in Kunming is similar to the other pilot cities on both premium collection and payment mode. Participation in the medical insurance plan is on a voluntary basis. The plan aims to provide basic medical insurance for children, students and adult residents who are out of the labour force. The premiums are paid by households or families, instead of individuals, and the governments give subsidies of at least 70 per cent of the insurance premiums annually to each participant, with more going to families with low-income earners and disabled individuals. A medical insurance pool fund has been set up for assisting hospitalization and clinic serious illness treatments.

By the end of February 2008, several months since the beginning of the scheme, 0.207 million urban residents had been covered by the medical insurance scheme. The goal has been set to cover 0.90 million urban residents who are out of the labour workforce under the medical insurance scheme in 2009, and to cover all 1.2 million of urban residents in 2010.

Compared with the medical insurance scheme for urban employees and retirees, the insurance capacity of the medical insurance plan is lower and inferior for urban residents. First, the basic medical insurance fund only covers medical costs incurred in hospitalization services, serious illness clinics and clinic emergencies, while the general clinic services are totally under patients' own charges. Hence, no 'personal savings accounts' were established for urban residents. Second, the proportion paid by the social pool fund for the employed is much higher than that for residents. For example, for patients admitted to a big hospital, the social pool fund pays 85 per cent of the total bill for an employed patient, while only covering 50 per cent for a resident patient. Third, the maximum ceiling under the social medical insurance for the employed (49,000 Yuan) is more than double that for residents (20,000 Yuan). Finally, after the payment ceiling under the social medical insurance scheme is depleted, a further insurance scheme called serious illness fund is available for employed individuals, but is not currently applicable for residents.

1.4 Data Sources in This Research

To build microsimulation models of the medical insurance system requires individual level medical data. Three kinds of data are used in the projects for different purposes. The first one is the individual data of medical care records of the urban employees and retirees in Kunming. This administrative data helps to create the microsimulation model for urban employees and retirees for the period of 2006-2010. The second data is about information on Kunming's population, involving a 0.1 per cent sample of the National Population Census which was conducted in 2000 and results of the 2005 Population Survey. These data provide the demographic information on urban residents and updated population structures. The third kind of data provide health services information of urban residents, which mainly comes from the second and the third National Household Health Surveys, conducted in 1998 and 2003 (Centre for Health Statistics and Information, 2004), respectively.

1) Administrative Medical Care Records

The main data used in creating the static microsimulation model for urban employees and retirees are administrative medical records under the basic medical insurance scheme in Kunming over the period of 2001-2005. The datasets originally consist of five kinds of medical insurance records for each insured individual:

- Basic individual datasets, which provide individuals' demographic information.
- Individual status alteration datasets, which provide individual status alteration information.
- Medical insurance premium datasets, which record the amount of premiums contributed by individuals and their employers to the medical insurance scheme.
- Medical expenses datasets of hospitalization, which provide medical expenditure records in both hospitalization and special disease services.
- Medical expenses records of ordinary clinic services, which provide the medical expenditure records in both general clinic services and medications in pharmacies.

These five kinds of datasets are linked up with each other through the unique personal identifiers and together formed the whole medical insurance data sources of the participants for the period of 2001-2005. This made up the detailed base data for modelling the medical behaviour of insured employees and retirees.

2) Data Sources of Population

There are two kinds of population information about Kunming in this research – a sample dataset from the National Population Census conducted in 2000 and a reported dataset compiled from the 1 per cent Population Survey conducted in 2005. These two kinds of datasets help to construct the base file of all urban residents in Kunming.

The sample from the 2000 Population Census conducted in late 2000 was created by the statistical method of selecting households randomly, with a sample rate of 0.095 per cent. As each record corresponds to a person, the Population Census provides demographic information of individuals and their households. The sample contains 5395 individual records of Kunming residents, representing a population of 5.78 million in 2000.

At the end of 2005, China conducted a 1 per cent nationwide population survey. According to the report of the survey by the National Population and Family Planning Commission of China (China population, 2006), Kunming had a population of 6.0857 million in 2005. The assembly of this population survey provides benchmarks for updating the population from 2000 to 2005.

3) Health Expenses Resources

The health expenses information for urban residents comes mainly from China's second and third National Health Services Surveys conducted in 1998 and 2003, respectively, and is supplemented by other sources of health expenses information.

Conducted at the household level, the Surveys covered the health situation of the people interviewed, their requirements for health services, the actual use of the health services and the factors affecting such use. The contents of the survey included demographic characteristics of selected individuals, household income, medical security status, disease problems in the two weeks previous to the survey, and hospitalisation admission in the previous year. As a big city (with a population of more than 1 million), Kunming had a county (or section) of Wuhua selected in the second and the third Health Services Surveys, which sampled 600 households.

As a supplement to the health services information, average hospitalization costs by sex by age group over 2005-2007 incurred in a general public hospital in Kunming are used.

Together with the information gathered from the Surveys, it is then possible to model medical expenses of all urban residents in Kunming. Furthermore, it is also possible to predict the health services expenses by treating the family as a micro unit.

1.5 Research Methods and Model Construction

1.5.1 Microsimulation Models

As mentioned above, the main method to be used in this research is microsimulation modelling techniques. Microsimulation models are special forms of simulation built on computer programs using individual level data. They use this data to determine what is happening currently at the individual level. The programs then allow for simulation, predicting what the population will do in the future based on certain assumptions. This can include looking at the behaviour of the individuals over time and extrapolating that into the future — or making assumptions about changes in behaviour that may occur over time. The results are then aggregated, so that the behaviour of the population as a whole, or sections of the population, can be seen.

An overview of what constitutes microsimulation, the various types of models, some of the technical characteristics and considerations, and examples of model applications can be found in Harding (1996), Li and Gao (1999), Gupta and Kapur (2000) and Harding and Gupta (2007). Basically, microsimulation models are by definition quantitative; typically complex and large; and more commonly static, deterministic, non-behavioural and non-spatial – although new microsimulation models are emerging that are increasingly dynamic, encompass behavioural elements, or are designed as spatial models (Brown and Harding, 2002).

The application of microsimulation to social and economic modelling was pioneered in the late 1950s by Guy Orcutt (1957). Microsimulation models have been traditionally divided into two broad categories – static and dynamic (Harding and Gupta, 2007; Li and Gao, 1999). Static models typically use static ageing techniques to update cross-sectional microdata up to the required point in time. These techniques usually involve re-weighting the micro-data and up-rating monetary values. Most static microsimulation models measure the immediate (or first-round) impacts of policy change, before individuals change their behaviour in response to the policy change.

Dynamic models often start from exactly the same cross-section sample surveys as static models. However, rather than using static ageing procedures like re-weighting, dynamic models simulate the major life events of individuals within the original microdata or base file. These life events involve birth, education, labour force participation, marriage, divorce, death, etc., in accord with the relative probabilities of such events happening to real people within that particular country (Harding and Gupta, 2007).

Advances in computing power in recent years have accelerated the use of microsimulation. Microsimulation has proven to be a particularly useful tool for policy analysis in many countries. Since the early 1990s, microsimulation has flourished and the range of its application has become quite broad. Apart from making a major contribution to the development of tax and transfer policies, microsimulation models in recent years have become more common in the research and policy areas of health and aged care. A few examples in the research areas of health services can be found in Gupta and Harding (2007).

Microsimulation modelling has traditionally been applied to income and tax policies and social security systems and only recently – over the last ten years – to the health field. As a result, there are still only a few health microsimulation models developed worldwide. This research contributes to this growing body of work, both in terms of the ongoing development of microsimulation methodologies and techniques as well as to its application in new countries and policy settings. By creating two static microsimulation models, this research aims to predict and evaluate medical services of individuals under the medical insurance system for Chinese urban employees and residents.

1.5.2 Modelling Medical Insurance Scheme for Employees

As described in Section 1.2, the first model to be created is to predict the medical insurance scheme for urban employees and retirees of Kunming. The model to be set up in this research takes each insured individual as a basic simulation unit, and selects those items from the insured participants' personal records datasets that have a direct or indirect relationship with medical expenses as predicting variables. The basic time unit that the model simulates is a year. With 2006 as the commencement year, the model forecasts the medical service expenses and medical insurance policy settings for five years until 2010.

The model constructed in this project firstly considers the payments for the medical insurance premium monthly, and simulates the insurance participants' usage of medical services for the forecasting year. The model then considers the change of the participants' age group, new entry, income adjustment, and increases of different types of medical expenses. The model proceeds into the next year until the end of the simulation period. Finally, the model aggregates the annual participants' medical expenses according to different categories of medical services, total medical expenditure and balances of different kinds of medical insurance funds for the whole simulation period.

The model consists of five main modules – Participant module, Clinic module, Chronic disease module, Special check-up module and Hospitalization module – corresponding to the estimations of number of population, personal annual income, and different kinds of medical expenses.

1.5.3 Modelling Medical Insurance Scheme for Residents

The second model to be built is to predict the medical behaviour and forecast medical expenses for urban residents in Kunming in using hospital services. The key aims of this research are to assess the distributional impacts of medical insurance policies and to predict the medical expenses for urban residents. From the perspective of collecting the premiums, establishing a social pool fund, and paying for the incurred medical costs, the amount of subsidies by the different level of governments will be estimated, as well as the medical costs of hospitalization for different levels of income families. The research creates a static microsimulation model to project the impact of the medical insurance scheme on families in an urban area of China, and to assist in setting future policy.

The datasets to be used in creating such a model mainly include two parts – sample dataset from the 2000 Population Census for all urban individuals in Kunming; and datasets under the social medical insurance scheme for urban employees and retirees in Kunming. The former dataset offers the complete household or family structure which is useful when estimating and evaluating the impact of the medical insurance plan on families. The population records in the latter datasets provide comprehensive medical services information and, as a whole, are a subset of the former dataset. The other data source comes from the second and the third National Health Services Surveys in 1998 and 2003.

Three steps will be involved in establishing the microsimulation model for urban residents. First, the records of the population in 2000 will be updated to the target year 2005-2010. Second, the updated population will then be statistically matched with the dataset of the urban employees and retirees. Finally, including the information from the National Health Services Surveys, the insurance coverage and medical services costs on hospitalization over the period of 2008-2010 will be projected.

1.6 Location of the Research

This research is completed at the National Centre for Social and Economic Modelling (NATSEM, website at http://www.canberra.edu.au/centres/natsem/), University of Canberra, Australia.

NATSEM is a specialist microsimulation modelling centre, established at the University of Canberra in 1993. NATSEM aims to be a key contributor to social and economic policy debate and analysis in Australia, by developing models of the highest quality, undertaking independent and impartial research, and supplying valued consultancy services. The NATSEM models and results are used now by a wide range of Federal and State Government departments to answer questions about the distributional and revenue impacts of possible policy changes. The models have played an important role in public policy debate in Australia.

Since its establishment in 1993, NATSEM has constructed models and undertaken research across a wide spectrum of social and economic policy, including tax, social security, health insurance, pharmaceutical benefits, education, child care, effective tax rates, low wage earners, income inequality, poverty, intergenerational transfers, rates of return, housing, utility concessions, assets, and macro–micro links, hospital usage and the child support scheme. NATSEM has an international reputation as a centre of excellence for analysing microdata and constructing microsimulation models.

As one of the leading countries in adopting microsimulation techniques in the health research area, Australia has created comprehensive models of health services and aged care. In the late 1990s, NATSEM began to apply microsimulation techniques to health policy issues. Over the

last decade, NATSEM has extended the benefits of its traditional microsimulation modelling to the health and aged care arenas, including the Australian Pharmaceutical Benefits Scheme, hospital and medical (including doctor) services usage and costs, chronic disease prevention, and the need for aged care services and private health insurance.

1.7 Summary

This chapter presented briefly the research background of China's social security systems and particularly China's medical care system and medical insurance reform. The introduction presented the aims and objectives in this research. This thesis creates two static microsimulation models for predicting and evaluating the medical insurance policies in China's urban areas, one for urban employees and retirees, and one for urban residents who are not in the labour market like children and elderly persons. This chapter also overviewed the data sources to be used in the research and gave a simple introduction to microsimulation techniques.

This PhD thesis consists of nine chapters. As mentioned here, Chapter 1 gives an introduction and a comprehensive overview for the whole research. The remaining chapters are grouped into three parts. Part I provides a background to this research and includes Chapter 2, Chapter 3 and Chapter 4. Part II details the construction of the two static microsimulation models and includes Chapter 5 and Chapter 6. Part III gives the simulation results of the models and includes Chapter 7 and Chapter 8. Chapter 9 presents conclusions of the whole thesis research, and presents possible problems and questions for future research.

Part I

Chapter 2 gives a literature review focusing on the social security programs and reforms, first internationally by selected countries to provide an international context, and then the reforms of China's social security system. Due to the issues of demographic change and ageing population worldwide, the review will be mainly around two important aspects of social security systems – namely age pensions and health services. For China's case, it will focus on the general tendency and reform process of the Chinese social security system, including

pension insurance, unemployment insurance, medical insurance, insurance for work-related injuries, and maternity insurance.
Chapter 3 continues the literature review in Chapter 2 and details the background of China's medical security system. Medical insurance reform in urban areas will be introduced, involving different kinds of medical service patterns, and the implementation and development of medical insurance reform nationwide in China. The rural health care system and development will also be canvassed. With the description of current arguments and controversies on the medical insurance reform, the rationale underlying the main research objectives of this thesis will become clear.

Chapter 4 reveals the main methodology to be used in this thesis research – microsimulation modelling and the categories in its application and construction. It then focuses on the establishment of microsimulation models in different countries regarding health systems and aged care. By introducing the application of microsimulation techniques, the basic idea of a model constructed to analyse China's urban medical insurance scheme will be derived.

Part II

Chapter 5 details the construction of the static microsimulation model to predict the impacts of the medical insurance scheme for urban employees and retirees of Kunming.

Chapter 6 establishes the second static microsimulation model for predicting the medical services and forecast medical expenses on hospitalization services for urban residents who are out of the labour force in Kunming.

Part III

Chapter 7 summarizes the results of modelling medical insurance scheme for urban employees and retirees, considering aspects such as medical expenses distribution, payment distribution and balances of different kinds of pool funds and personal savings accounts. For two medical insurance policy scenarios, the model estimates the distributional impacts of the medical insurance system on participants and explores the benefit or burden under the medical insurance scheme.

Chapter 8 gives the results of modelling medical services and expenses for urban residents who are out of the labour force. The model considers hospital services as well as clinic services for serious illnesses. Distributions of different types of population, contributions to the medical insurance premium, and distributions of incomes of individuals and families are covered. For three medical insurance scenarios, the model predicts the hospitalization services costs and payments, as well as the balance of the social pool fund and the medical burden on families.

PART I BACKGROUND

CHAPTER 2 SOCIAL SECURITY SYSTEMS AND REFORM

2.1 Introduction

This thesis focuses on the policy of health care system reform in China. In the last decade or so, China has begun to reform its health care system nationwide, due to pressures such as an ageing population and increasing demand for health services. When reviewing the Chinese health care system reform, it has been found that this issue usually goes hand in hand with other parts of China's social security system, like the aged pension and the unemployed, disability, and maternity care systems. In China, five parts of the social insurance umbrella – retirement insurance, unemployment insurance, work related injury insurance, medical insurance and maternity insurance — are well organized and under the management of the Ministry of Labour and Social Security of China. Similar organization has happened in the counterpart levels of the Provincial and Municipal governments. So it is important in this literature review to look beyond just the health care system to examine more broadly the social security system, both internationally and domestically.

Internationally, social security is one of the most important socio-economic systems for a country in modern times, under government funding or support. Under a social insurance program, society as a whole insures its members against various risks they all face, and members pay for that insurance through contributions to the system. Such risks include individually based risks, such as how long they will be able to work, how long they will live, how much they will spend on their medical services and aged care, how much they will earn and save over their lifetimes, and how much they will earn through retirement savings.

In many countries, social security is financed largely on a 'pay as you go' basis. In a 'pay as you go' system, the contributions made by active employees today are used to pay the benefits of current beneficiaries (Government Accountability Office, 2005). In recent years, many countries are facing demographic change and the effects of population ageing on their social security systems. The number of employees for each retiree is falling in most developed countries as well as many developing countries, straining the finances of national age pension programs — particularly where contributions from current employees fund payments to current beneficiaries (Bovbjerg, 2005; Marston and McDonald, 2007).

In most countries of the world, life expectancy has increased continually over the past decades, and further improvements are expected. As a result of this, along with declines in fertility, the aged population is growing dramatically. However, at the same time, the growth of the labour force is expected to slow dramatically (Bovbjerg, 2005). Internationally demands for social security particularly focusing on the issues surrounding ageing, like age pension and health services, are growing significantly. Reforming the social security system is high on the reform agenda for many countries in the world (Cotis, 2003).

This chapter will first review the social security programs and reforms by selected countries, particularly Australia, New Zealand, Sweden, Germany, the United Kingdom and the United States, to provide an international context. It then introduces the reform of China's social security system. Although social security concerns varying factors in different countries, social security in most countries generally provides some safety net for citizens in terms of age pensions, unemployment benefits, disability benefits, etc. and also subsidizes costs of health services and aged care. Due to the issue of an ageing population worldwide, the review in this chapter will be mainly around two important aspects of social security systems – namely age pensions and health services. The other related issues may be discussed around these two aspects. For China's case, it will focus on the general tendency and the reform process of the Chinese social security system, including pension insurance, unemployment insurance, medical insurance, insurance for work-related injuries, and maternity insurance. Following the description of the urban social security system, the social security provisions in China's rural areas will be introduced briefly.

2.2 Reform of Social Security Internationally

2.2.1 Social Security of Australia and New Zealand

This section first describes the social security or social welfare systems in Australia and New Zealand. These two countries are considered together for a couple of reasons. The main reason is the similarity of their social security systems, while both countries also have high immigrant populations. The other reason is the closeness between Australia and New Zealand in geographical location and mutual relationships. In both Australia and New Zealand, the term 'superannuation system' is generally used rather than 'pension system'. To most

Australians and New Zealanders, the term ‘pension’ refers to the government provided safety net aged pension provided on a means tested basis to those who have been unable to save for their own retirement (non-self funded retirees).

Australia’s Social Security

Social Security, in Australia, refers to a system of social welfare payments or cash transfers provided by the Commonwealth Government of Australia. These payments are administered by a Government body named Centrelink. In Australia, most benefits are subject to a means test on income and/or assets. Many of the factors that have driven change in Australia are common throughout other world economies.

In comparing Australia’s welfare system with those of other Western countries, Whiteford (2005) stated that Australia has the most progressive welfare system in the Western world. No other country targets its spending so heavily to the real poor. In Australia, among those of working age, the poorest 20 per cent receive 14 times as much as the richest 20 per cent. Whiteford made a central conclusion that Australia operates the most targeted social security system in the OECD (Organisation for Economic Co-operation and Development) countries and, probably, in the world. Apart from New Zealand, no one else has a welfare system approaching Australia’s.

The Australian social security system offers a range of cash transfer payments and concessions to individuals and families. In terms of coverage and scope, the system has developed incrementally over the past 100 years and has largely fulfilled a residual role in alleviating poverty and hardship. Unlike most European countries, Australia did not opt for a social insurance model of social protection. Instead social security payments at the national level were funded through general revenue (Marston and McDonald, 2007).

From the beginning of the last century into the 1980’s, Australia had a two tier system. The major part was the federal government’s safety net age pension which was introduced in 1909 and funded by government tax revenue. The other part of the system consisted of a mix of public sector and private sector arrangements. Federal and State governments offered retirement benefits to public servants (Jones, 2005). Life insurance companies also offered personal superannuation savings plans through a network of agents, providing pension

products direct to retirees or through the superannuation fund. Superannuation was encouraged by means of generous taxation concessions.

This started to change in the 1980s. By the late 1980s, occupational superannuation covered a substantial proportion of the workforce. Employers were obliged to pay minimum levels of contributions into superannuation funds on behalf of their employees. From 1 July 2005, employees have the right to choose the fund into which their employer pays the compulsory 9 per cent contribution. The government is also a provider of superannuation benefits in its own right as an employer of public servants.

Recent welfare-to-work reforms in Australia, introduced in July 2006, have extended the principle of 'work-first' to compel single parents and disabled people living on social security payments to undertake paid work and work related activities (Marston and McDonald, 2007). The Australian Government expects that these policy changes will encourage greater workforce participation, and higher levels of income — and consequently lead to improved outcomes for parents and disabled people.

Australia has a comprehensive universal health care system, in which almost 70 per cent of total health expenditure in Australia is funded by the government (AIHW, 2006). The Australian Government's major contributions include the two national subsidy schemes: Medicare and the Pharmaceutical Benefits Scheme. Medicare is Australia's universal health insurance scheme, which came into operation in 1984, and which subsidises payments for services provided by doctors and optometrists. The Pharmaceutical Benefits Scheme subsidises the cost of a wide range of prescription medications bought from pharmacies. In addition, public hospital services are also provided with assistance from Australian government funds (delivered through the States and Territories). More than 50 per cent of hospital recurrent and infrastructure funding are provided by the States or Territories. All of these arrangements help all Australians access adequate health care at an affordable or no cost. These schemes are further integrated with social welfare arrangements, with larger rebates provided for individuals or families who receive certain income support payments (such as for unemployment or disability).

To compensate for the health insurance schemes coverage and to meet a variety of additional health services demands, private health insurance funds have been offered to Australians since

1984. These funds provide cover for their members who choose to be treated as private patients in either public or private hospitals, and provide a range of other benefits to insured people. In response to a significant decline in health insurance membership in the late 1990s, the Australian Government introduced various incentives to encourage uptake and retention of private health insurance, the most notable being a 30 per cent rebate on membership fees and the introduction of lifetime cover. As of late 2005, around 43 per cent of the Australian population was covered by private health insurance for hospital treatment (AIHW, 2006).

Social Welfare in New Zealand

Similar to Australia, social welfare has long been an important part of New Zealand society and a significant political issue. It is concerned with the provision by the state of benefits and services. Together with fiscal welfare and occupational welfare, it goes to make up a key part of social policy of New Zealand.

A regular unemployment benefit was first introduced in 1938. Today, the benefit is payable to a person 18 years of age and over who has lived in New Zealand for at least two years and is unemployed, is capable of and willing to undertake suitable work, and has taken reasonable steps to secure employment (Wikipedia, 2007).

New Zealand has its own universal superannuation system which was first introduced, in 1938, a means-tested old age pension at age 60 years and universal superannuation at age 65 years. In the 1970s the third National government created a superannuation scheme that paid 80 per cent of the average wage to married people over 60 years old. Currently superannuation is paid to all aged 65 years and over and is taxable.

In New Zealand, there are Sickness Benefit and Invalid's Benefit. The Sickness Benefit is payable to those who are temporarily incapacited from working through sickness or accident. The Invalid's Benefit is paid to those permanently incapacited or totally blind. Applicants must be at least 16 years of age and residentially qualified. In 2007, the residence requirement was set at two years.

Apart from these schemes, another beneficial scheme, the Domestic Purposes Benefit (DPB), was first introduced in New Zealand in 1974 (Department of Labour, 2007). It provides State financial support primarily for single mothers, irrespective of whether the father was

contributing to maintenance payments. There are a small number of fathers on DPB. While there is a Widow's Benefit for women with children whose partner has died, this is not available to men.

Recent major changes to social welfare in New Zealand include announcement in October 2006 of the Working New Zealand reform to the service delivery of Work and Income. Amending legislation was passed by the New Zealand Parliament in June 2007 including introducing a 'Purpose and Principles' section. The government hopes the changes will introduce intensive employment support to every New Zealander who is receiving a benefit and is able to work.

From September 2007, there have been a number of changes to the delivery of welfare benefits, with the changes focusing mainly on youth with a goal of having all aged 15 to 19 year olds engaged in employment, training, or education (Wikipedia, 2007). People applying for the Unemployment Benefit will be required to undertake work or training-related activities in the period between their first contact with Work and Income and their benefit commencing. They will also be required to look for and accept any offer of suitable work during that time. Similar new measures will also apply to people on Sickness and Invalid Benefits, and the Domestic Purposes Benefit. Beneficiaries could have their benefits cut by up to 50 per cent if they fail to comply.

2.2.2 Social Security of Other Countries

Demographic changes – greater longevity and a lower birth rate – coupled with the continuing prevalence of early retirement, have set off alarm bells worldwide (Spencer, 2005). It is becoming increasingly clear that there is a need for social security reform, especially with respect to national age pension systems and medical benefit schemes. Research by Bovbjerg (2005) showed that based on preliminary work, all countries in the OECD have, to some extent, reformed their national pension systems, consistent with their different economic and political conditions. Nearly all of the OECD countries reduced benefits, and most have also increased contributions, often by increasing statutory retirement ages. Many countries reformed their national health care systems to tackle problems like an ageing population and continued growth in health care spending.

Sweden

The Swedish social security reform was introduced because projections showed that the existing generous 'pay as you go' defined benefit system was not economically viable in the long term. It was found that the contribution rate probably would have to be increased from 18.86 per cent in 1994 to as much as 24 per cent by 2015 (Spencer, 2005). Launched in 1999, the new system applies fully to those who were younger than age 45 years at that time. Transition measures provide for a mixed pension – with part of the pension from the old system and part from the new – for those who were age 45 to 62 years. Older individuals remain entirely in the old 'pay as you go' system.

Under the reform, the system of calculating benefits was substantially changed; this is likely to mean lower pensions than under the old system (Kruse and Palmer, 2006). In the new system, there is a guaranteed minimum pension or 'safety net', financed by the Government, payable in the event that the total social security pension does not equal specified levels. The disability and survivors' pensions under the old 'pay as you go' system were moved into a separate program that was fully financed and operated by the Government.

In Sweden, quality health care for all is a cornerstone of the Swedish welfare state. The main strengths of the Swedish health care system include provision of health care services for all based on need, democratic control and local accountability, control over total expenditures and effective management of clinical activities. Like elsewhere in the OECD countries, Sweden is facing the population ageing problem. The ageing of Swedish society has important social and political implications, as fewer persons of productive age are available to provide financial support for the increasing demands being placed on the health care system.

Beginning with the Long-term care reform in 1992, the Swedish health care sector has undergone several important reforms (Glenngard et al., 2005). Generally, national reforms that have had an impact on the health care system have focused on three broad areas: the responsibilities of provision of health care services; priorities and patient's rights in health care; and cost containment. The main remaining challenges include integration of care and health inequalities.

Germany

In Germany, as the population ages the proportion of those in work in the population as a whole will continue to fall sharply; at the same time the proportion of old people, those aged over 65 years, will rise sharply. This will lead to a deterioration in the so-called dependency ratio of the over-65 year-olds to the 15-64 year-olds. It is estimated that the ratio will climb from around 24 per cent at early 21st century to around 50 per cent in 2050 (Finke et al., 2003). This will give rise to enormous budgetary problems for the national pension system and health care services. So, in 2001, a pension reform in Germany was conducted to handle these problems (Merkli, 2002).

The introduction of the pension reform in 2001 was merely a first step towards overhauling the pension system. The reform was soon followed by disenchantment in 2003 and 2004, as two other pension laws were passed (Busemeyer, 2006). These laws aimed at maintaining the long-term fiscal sustainability of the public pension system, linking benefit increases to developments in life expectancy and the employment rate, and gradually phasing in the taxation of pension benefits while exempting contributions.

Germany has one of the best health care systems in the world, with almost 90 per cent of the population (about 73 million people) covered by public health insurance companies, and the other 10 per cent – mostly high earners and the self-employed – covered by private insurance plans. But, in recent years, the system has faced a massive budget shortfall, largely due to rising costs, low birth rates and stubbornly high unemployment. Experts suggested that the health care system needs substantial reform (James, 2006).

The health care system in Germany was reformed first in 2004 (Tuffs, 2004) and then in 2006 (Moulson, 2006). While increasing slightly employer/employee premium contributions, more Federal Government funds were injected into the health system to slow a steady rise in insurance premiums paid by employers and employees. The core aims of the reforms are to intensify competition and to counter the fast rising price of caring for the country's aging population.

United Kingdom

The United Kingdom was quite late in establishing an earnings related Social Security program, which was not done until the 1970s. At that time, a well-established private pension

sector was already in place. Voluntary carve-outs were permitted in the United Kingdom not to reduce or privatize a pre-existing Social Security program, but to protect a pre-existing defined benefit private pension system. Later, for ideological reasons, employees were allowed to establish individual account plans to reduce their participation in Social Security (Blake and Turner, 2007).

In the United Kingdom, workers can "contract out" of Social Security, replacing part of their Social Security benefits with private pensions, either through a defined benefit plan or, since 1988, an individual account defined contribution plan (Department for Work and Pensions, 2007). Since 1993, an age-related payment to the individual account has been used in the United Kingdom. The payment to the individual account rises with age to provide a financial incentive not to contract back into the Social Security system at later ages.

In the United Kingdom, most of the health care has been provided by the National Health Service (NHS), which is funded by a system of National Insurance. About 15 per cent of all spending on health in the UK is privately funded but this includes the patient contributions towards NHS provided prescription drugs, so private sector health care in the UK is quite small (Wikipedia, 2007). In the last decade or so, health reforms in the UK focused on several issues, which involved retaining and expanding the elements of competition, focusing on the prevention of ill-health rather than curing disease, and reducing the patient's waiting time.

The Blair government allowed private health care providers to bid for NHS work. Some treatment and diagnostic centres are now run by private enterprise and funded under contract. However, the extent of this privatisation of NHS work is still very small. Since 2007, the government of Gordon Brown has announced several new reforms for care in England. One is to take the NHS back more towards health prevention by tackling issues that are known to cause long term ill health. The second reform is to make the NHS a more personal service, and encourage doctors to provide more services at times more convenient to the patient, such as in the evenings and at weekends. For the waiting time, the National Health Service will ensure from December 2008 that no person waits longer than 18 weeks from the date that a patient is referred to the hospital to the time of the operation or treatment (Wikipedia, 2007).

On the 7th January 2008, the UK's Prime Minister Gordon Brown outlined a programme of "deeper and wider" reform of the National Health Service to enhance its role in care,

prevention and personalised health services (Brown, 2008). In his speech, Mr. Brown stated that the NHS faces three new challenges in the 21st century - embracing technological change, meeting rising expectations of healthcare and adapting to a shift in priorities from tackling infectious disease to managing long-term conditions and "lifestyle diseases". The goal of the reform is "building on the values, principles and idealism of the NHS to create for the next decade an NHS that is: here for all of us but personal to each of us; focused on prevention as much as cure; and strong and confident enough to put real control into the hands of individuals and their clinicians".

United States

In the United States, Social Security is funded through a payroll tax paid equally by the employee and the employer. Covered workers are eligible for retirement benefits and for disability benefits. If a covered worker dies, his or her spouse and children may receive survivors' benefits. The program does not have individual accounts and tax receipts are not invested on behalf of the worker. Instead, current receipts are used to pay current benefits – a 'pay as you go' system (Wikipedia, 2007).

It is estimated that the costs of the social security benefit in the United States will soon start to grow rapidly. Social security is projected, in 2017, to pay out more cash in benefits than it receives in revenues. After that time, the gap between costs and income grows continuously, and, unless action is taken to close this gap, the trust funds will eventually be depleted in 2041 (Government Accountability Office, 2005). As a result of the ageing population and the slower labour force growth, fewer workers will be able to contribute to social security for each aged, disabled, dependent, or surviving beneficiary. The challenge posed by the growth in social security spending becomes even more significant in combination with the more rapid expected growth in Medicare and Medicaid spending. It is becoming increasingly clear that there is a need for social security reform.

Hence, a wide variety of options for reform have been proposed. One measure that is advocated by President George W. Bush calls for diverting part of the social security contribution to be used to purchase a funded personal retirement pension (Spencer, 2005). After several years' discussions and arguments, in April 2007, a Trustees Report (John, 2007) indicated the time for the debate on the social security program is over. The report shows that the program faces massive annual deficits starting in just 10 years and now is the time to

focus on solutions. In the report, several plans to establish personal retirement accounts have been shown to fix Social Security.

With regards to the health care system, the United States is the only wealthy, industrialized nation that does not provide universal health care. However, in comparison with other developed nations, the United States spends significantly more on health care (Goldman and McGlynn, 2005). Most Americans with private coverage receive it through employer-sponsored plans. Health care reform was a major concern of the Bill Clinton administration; however, the Clinton health care plan was not enacted into law. More recently, in 2003, President Bush signed into law the Medicare Prescription Drug Improvement, and Modernization Act which included a prescription drug plan for elderly and disabled Americans (Centers for Medicare and Medicaid Services, 2007). This legislation provides seniors and people with disabilities with the first comprehensive prescription drug benefit ever offered under the Medicare program, the most significant improvement to senior health care in nearly 40 years.

In the near future, the target of health care reform in the United States is to dramatically increase health insurance coverage, especially among the working poor, and to significantly reduce the rate of growth in health care spending. Reforming or restructuring the private health insurance market is often suggested as a means for achieving health care reform in the U.S. A report published by the Commonwealth Fund in December of 2007 (Schoen et al., 2007) examined 15 federal policy options that have the potential to lower health spending relative to projected trends. These options included increased use of health information technology, promotion of health and enhancement of disease prevention, research and incentives to improve medical decision making, reforming the payment of providers to encourage efficiency, and limiting the tax federal exemption for health insurance premiums. The report concluded that, taken together, they had the potential to reduce future increases in health care spending by $1.5 trillion over the next 10 years, while also improving value in terms of access, quality, and health care outcomes.

2.3 Social Security System in China

So far, this chapter has provided an international perspective on the review of social security systems and reform; this section will review China's social security system and changes. China is facing the same problems of demographic change and an ageing population as elsewhere in the world. But China is also encountering some additional challenges, including large rural migration to urban areas plus the rapid economic changes over the last three decades or so, both of which are impacting heavily on China's social security system.

To establish and improve a social security system, that corresponds with the level of economic development, is a necessary requirement for coordinated economic and social development. Beginning with the economic reforms in 1978, China has experienced rapid economic, social, and cultural changes. Along with the transition from a planned economy to a market economy, China's social security system has also undergone dramatic changes since the early 1980s, both in its nature and in its composition.

2.3.1 Background of China's Social Security System

Primarily, the Chinese social security system was first introduced in 1951 with the promulgation of the Labour Insurance Regulations. For almost three decades until the late 1970s, the social security system was employment-based — an individual received employment and income protection, and enjoyed heavily subsidized benefits and services such as housing, food and education. The individual could also obtain social security benefits for sickness, maternity, work injury, death and old age (Leung, 2003). Labour insurance for workers in the state sector and governmental staff covered pensions, medical care, occupational injury, etc.

During this period, the basic model of this system was a combination of social insurance and enterprise liability. Enterprises paid a certain amount of the total wage bill to a labour insurance fund that was managed by the All-China Federation of Trade Unions. Pensions and disability benefits were paid from the fund while other benefits were provided by the enterprises according to standards prescribed by the central government. Where an enterprise was unable to pay a benefit, subsidies were provided from the fund.

The market reform of the economic system since 1978 led to widespread and profound changes in the Chinese economy and society. As a result of the economic reforms, the role of the public sector in the national economy became weaker in both urban and rural areas, whilst the private sector, both the domestically financed and that dependent on foreign investment, became increasingly important.

These changes had significant impacts on social policy. They meant weaker government control over the financial resources and the behaviour of many enterprises in social welfare, which had been a key condition in the old security system. In other words, the government would no longer be responsible for any pension benefits. With the growing autonomy of state-owned enterprises, they had to shoulder more and more of the social security expenses themselves. The newly developing private sector was outside the traditional welfare circle. In most important welfare respects, such as pensions and medical insurance, the employees in these private sectors could not be included in the traditional welfare system. Since there was no mechanism for the sharing of risk between enterprises with an ageing workforce and those that employed a higher ratio of young people, the social security costs of some state-owned enterprises were extremely high. As a result, the traditional welfare system had to be changed to cover more people and more contingencies.

Social security reforms were introduced following the economic reforms in 1978, which aimed at converting the enterprise-financed labour insurance programmes into a unified social insurance scheme with the central and local governments sharing specific responsibilities. Enterprises and individuals had to share the expenses in the financing of the scheme. With the establishment and improvement of China’s market economy system in the 1980s, a series of reforms have been introduced to change the old social security system. Since then a basic framework of a social security system has been set up in China corresponding to the market economy system. Generally, a stable social insurance fund comes from the government, employers and employees.

The following subsections will focus on the reforms of the five parts of the social security system in China; they involve pension insurance, unemployment insurance, medical insurance, work related injury insurance and maternity insurance.

2.3.2 China's Pension Insurance

China is facing an increasing social security burden with the rapid growth of its ageing population. At the end of 2005, China had nearly 144 million people aged over 60, accounting for 11 per cent of its population; and the number is rising by 3 per cent every year. The ratio between active employees and the retired is expected to reach 2.5 to 1 by 2020 (China Daily, 2006a). To guarantee the basic living standards of the elderly and safeguard their legitimate rights and interests, the Central Government has reformed the fund-raising model in an attempt to establish a multi-level old-age insurance system marked by sustainable development.

After the initial experiments in several cities in the early 1980s, all cities in China were encouraged to set up pool funds for pensions in 1985, so that enterprises with different ratios of retirees could share their costs. The State Council (China's national cabinet) enacted the Decisions on the Reform of the Retirement Insurance System of Employees in Enterprises in 1991 (Gao, 2006). The Decisions called for the establishment of a multi-level pension system based on pool funds and individual savings. Under the new pension system, both enterprises and individuals were required to contribute to these pool funds.

In 1997, the Central Government unified the basic old-age insurance system for enterprise employees in urban areas across the country by implementing a social pool fund plus personal savings accounts scheme. Enterprise employees who have reached retirement age as determined by law (60 for male employees, 55 for female cadres and 50 for female workers) and who have paid their share of the premiums for 15 years or more shall be entitled to collect a basic old-age pension every month after retirement (State Council, 1997).

Under this scheme, the total contribution allocated to the individual accounts would be equal to 11 per cent of the employee's monthly wages, in which the individuals concerned contribute 4 per cent. Individual contributions would increase by 1 per cent of the individual's wage every two years, from 4 per cent up to a maximum of 8 per cent. Meanwhile, the contributions from employers to the individual accounts would decrease gradually to 3 per cent as the individual's contribution increased. The rate of the employer's contribution to the pool fund was up to the local governments, but the maximum rate was not allowed to exceed 20 per cent of the total wage bill (Zhu, 2002).

Initially, China's basic pension insurance scheme covered only State-owned enterprises and collectively-owned enterprises in urban areas and their employees. In 1999, this coverage was expanded to include enterprises with foreign investment, private enterprises and other types of enterprises in urban areas, as well as their employees. In 2002, China expanded its basic pension insurance coverage to all those who were employed in a flexible manner in urban areas.

From January 2006 onwards, personal savings accounts equivalent to 8 per cent of payroll have been established for each employee (State Council, 2005). It is composed of the total individual contribution and a supplement from the employer's contribution. The rest of the employer's contribution, an average of 16 per cent of payroll, goes into the local social pool fund.

2.3.3 Schemes for the Unemployed in China

Before the economic reforms which began in 1978, through the traditional social security system of public ownership, full and life-long employment, job creation through administrative procedures, job assignment and restricted labour mobility, the Chinese government was effective in keeping unemployment under control. As such, unemployment assistance was considered unnecessary. With the economic reforms of the state-owned enterprises and the gradual introduction of a labour market in the early 1980s, lay-offs and unemployment became a reality.

Initially an unemployment insurance scheme was set up in 1986. However, because of its narrow coverage, the scheme was under-utilised in the late 1980s. The scheme catered only to employees in state-owned enterprises declaring bankruptcy, or employees being dismissed by a state-owned enterprise. Initially, the unemployment benefits were also tied to the wage level. As unemployment rates rose in the early 1990s, the scheme became a more prominent means of providing assistance to the unemployed (Leung, 2003).

At the beginning, the scheme was financed solely by drawing 1 per cent of the total payroll of the participating enterprises. Also the initial regulations on unemployment insurance limited the scheme largely to employees of state-owned enterprises. Since 1999, as the regulations on unemployment insurance (State Council, 1999) have taken effect, the percentage has been 3 per cent, with 1 per cent coming from the employees' salary. The coverage has been extended

to all types of employees and economic sectors. By the end of 2006, a total of 111.87 million people participated in the unemployment insurance scheme (MLSS and NBS, 2007), accounting for 39.52 per cent of the total employed in that year.

The Chinese central and local governments sped up the development and improvement of the unemployment insurance system to guarantee the basic livelihood of the unemployed and ensure a basic standard of living. At the same time the governments also made great efforts to help individuals laid off from State-owned enterprises find new jobs. Various re-employment services centres were established in State-owned enterprises to help their unemployed find new jobs. Since 1998, the Chinese Government has put into operation a system that provides for three guarantees: basic livelihood guarantee for laid-off persons from State-owned enterprises, unemployment insurance guarantee and minimum living standard guarantee for urban residents. From 1998 to 2005, 2.4 million people laid-off from State-owned enterprises benefited from the minimum living standard guarantee and 1.9 million of them were re-employed (Tian, 2006).

2.3.4 China's Medical Insurance

When the People's Republic of China was first established in 1949, one of its most important goals was to improve its public health system. The establishment of a well-organized public health system made it possible for the government to provide free basic health services for the entire population.

As time passed, in the late 1980s, the shortcomings of such a free medical service became more and more obvious. The government or State-owned enterprises could not afford the mounting pressures brought by fast-rising medical expenses. Employees could not receive the large amounts of public subsidies they once enjoyed. Reform of the traditional health care system was essential.

In 1998, on the basis of previous trials, the Chinese Government promulgated the "Decision on Establishing a Basic Medical Insurance System for Urban Employees" (State Council, 1998), promoting a national reform of the basic medical insurance system for urban employees. To standardize medical services and reduce costs, the State simultaneously promoted the reform of the basic medical insurance system, medical and healthcare system, and pharmaceuticals production and circulation system.

Efforts have been made to ensure the insured enjoy necessary medical services, to curb unreasonable medical expenses, and to enhance the efficient utilization of the basic medical insurance fund. By the end of 2006, 157.32 million people around China had participated in the urban basic medical insurance scheme (MLSS and NBS, 2007), which accounted for 55.57 per cent of the total employed population (283.10 million) in urban areas.

Medical insurance is one of the most important aspects in the social security system and plays an essential role in people's daily lives. After establishing a medical insurance system for the urban employed in 1998 and founding a new cooperative medical care system in rural regions in 2002 to cover all rural residents (Ding and Yin, 2005), the Chinese government is now establishing a new medical insurance system for all urban residents, including those outside the workforce. At the end of September 2007, 79 cities had been selected to launch the pilot program for urban residents (Zhao, 2007).

This topic on the reform of China's medical insurance is also the main theme in this thesis. The description above provides a brief overview of medical insurance in China. A detailed literature review will be provided in the next chapter.

2.3.5 Work-related Injuries and Maternity Insurance

The central Government has made great efforts to establish an insurance system for work-related injuries that includes work-related injury prevention, compensation and recovery. Since January 2004, when the "Regulations on Insurance for Work-related Injuries" (State Council, 2003) went into effect, the coverage of such insurance has expanded rapidly. By the end of 2006, as many as 102.68 million employees had underwritten this insurance scheme (MLSS and NBS, 2007) — a 21.11 per cent increase compared with 2005.

The scheme is financed solely from employer contributions according to a differential rate (by sector, to be adjusted every five years) and a floating rate (by enterprise, to be adjusted each year according to the accident rate of the enterprise in the previous year). The rate throughout the country ranges from 0.3 to 2 per cent of the total payroll, with a national average of about 1 per cent (Zhu, 2002). The fund is used not only to pay for various benefits but also for accident prevention, occupational rehabilitation, safety bonus, promotion and research, as

well as administrative expenses of operational agencies and labour appraisal committees. Specific allocations for each item are at the discretion of local governments.

Under the regulations on insurance for work-related injuries, all enterprises and individual businesses engaged in industry and commerce with employees must participate in work-related injury insurance, and pay insurance premiums for all their employees, permanent as well as temporary. The individual employees do not pay such premiums.

The other important part of social insurance is maternity insurance. In 1988, China introduced a reform of the maternity insurance system. At the end of 2006, there were more than 64.59 million employees covered by maternity insurance (MLSS and NBS, 2007), a 19.43 per cent increase compared with 2005.

The maternity insurance system mainly covers urban enterprises and their employees, and in some places, women employees of government agencies, public institutions, mass organizations and enterprises. The premiums are paid by the employers participating in the maternity insurance scheme, and should not be more than one per cent of the total wage bill. Individual employees do not pay the premiums. Employers who have not participated from the scheme are still responsible for providing maternity insurance benefits. Employees giving birth to babies may enjoy a childbirth allowance for 90 days according to law. Women employees who have given birth to babies or had abortions shall maintain their original wages and positions, and get reimbursements for their medical expenses according to related regulations (Ministry of Labour and Social Security, 1994).

2.3.6 Social Security in Rural Areas

The majority of the Chinese population lives in rural areas, where the economic development level is comparatively low. In accordance with the characteristics of rural socio-economic development, the State's social security measures in rural areas are different from those practised in urban areas.

Old-age security in rural areas is centred mostly on families. In the 1990s, China began to try out an old-age insurance system in some of the rural areas in accordance with the actual level of local socio-economic development. By the end of 2003, the introduction of old-age social insurance had been carried out to various extents in the rural areas of 1,870 counties (cities,

districts). 54.28 million people had underwritten the old-age insurance programme, which had accumulated a fund running to 25.9 billion Yuan, with 1.98 million rural residents drawing the old-age pension (China Daily, 2004).

In 2004, the Chinese Government began to experiment with a system that supports and rewards households that practise family planning by having only one child or two girls in some of the rural areas. Each person of such couples may receive a minimum of 600 Yuan a year from the age of 60 years till the end of his or her life. This reward is provided jointly by the central and local governments (China Daily, 2004).

Before the reform, the health insurance system in rural areas was the rural cooperative medical schemes funded by members themselves. In order to guarantee that rural residents' basic medical needs are satisfied, to alleviate their medical burdens and to address the problem of poverty caused by illness or prevent them from re-entering poverty because of illness, in 2002, the central government began to set up a new rural co-operative medical service system based mainly on a financial pool against serious disease scheme (Ding and Yin, 2005).

Rural residents can participate freely in such a co-operative medical system, which is organized, led and supported by the government with funds coming from the central and local governments and rural villagers themselves. Currently, the cooperative medical care system is the main system in rural areas. Under this system, subscribers are funded at a level of 50 Yuan per person - 20 Yuan from the central government, 20 Yuan from the local government and 10 Yuan from the individual (Xinhua News, 2007a).

By the end of June 2006, 720 million rural residents, or 82.8 per cent of the country's rural population had been covered by the cooperative medical care scheme, which is primarily meant to guarantee medical expenses for villagers to be hospitalized or to have serious diseases treated (Xinhua News, 2007a). This system is popular with villagers.

China's Ministry of Health, on behalf of the Chinese government, promised that its basic medical and health care system will cover all rural residents by 2010. This promise was made at a two-day forum in November 2007 on China's rural health care services, organized jointly by the World Health Organization (WHO) and China's Ministry of Health. The government's

investment would account for the main part of the fund for the system and the government will also encourage other public bodies and individuals to raise funds for the system (Xinhua News, 2007b).

2.3.7 Recent Development of Social Security

China is the world's biggest developing country with a large population, yet the development between urban and rural regions is unbalanced. Establishing a sound social security system in China is an important guarantee of social stability. In light of China's actual situation and adhering to the principle of "putting people first", the Chinese Government has attached great importance and devoted every effort to establishing and improving its social security system.

In the political report, delivered at the 17th National Congress of the Communist Party of China on 15th October 2007 (Hu, 2007), Hu Jintao (Chinese President) stated that China will accelerate the establishment of a social security system covering both urban and rural residents and guarantee their basic living conditions. The report also said that China will step up the building of a sound social security system that is based on social insurance, assistance and welfare, with basic old-age pension, basic medical care and subsistence allowances as its backbone, and supplemented by charity and commercial insurance.

Basically, China's social security system includes social insurance, social welfare, special care and placement systems, social relief and housing services. As the core of the social security system, social insurance is composed of five parts: pension insurance, unemployment insurance, medical insurance, work-related injury insurance and maternity insurance. By the end of September 2007, 197 million Chinese had been insured for pension insurance, 115 million for unemployment insurance, 189 million for medical insurance, 115 million for work injury insurance and 73 million for maternity insurance, according to the Ministry of Labour and Social Security (Xinhua News, 2007c). This compares with a total Chinese population in 2007 of 1.32 billion.

However, these different kinds of insurances were regulated according to different regulations or polices. China lacked a comprehensive law to regulate its social security system and safeguard the management and operation of the social security system as a whole. As a result, currently, some employers have refused to insure their employees or deliberately defaulted paying insurance fees for their staff, due to lack of clear punishment. Meanwhile, an

incomplete social security system also hindered rational migration of labour (Xinhua News, 2007c).

To tackle the problem, a draft law on social security to safeguard operation of an extensive social security system was submitted, in December 2007, to the Standing Committee of the National People's Congress (NPC), or China's top legislature, for the first reading (Liu et al., 2007). The draft law outlined the legal framework for the social security system and specified principle, scope, prerequisites, management and supervision of the social security system. According to the law, the pension and unemployment insurance would cover all full-time employees, excluding public servants; the medical insurance would cover all employees; and work injury and maternity insurance would cover all employees, excluding public servants. Public servants are excluded because they already receive more generous provisions through their employers.

2.4 Summary

As one of the most important socio-economic systems for a country, social security plays an essential role in maintaining a stable society. Many countries around the world have undergone rapid demographic change and face an ageing population, putting significant pressure on social security financing, especially on age pension and health care services. Despite having well developed medical and social security systems, many developed countries like Australia and New Zealand still face manifold pressures forcing them towards social security reform. Developments in China in recent years are consistent with what is happening elsewhere in the world. Combined with its own significant economic growth and large migration from rural to urban areas, all of these issues place significant pressure on China's social security system.

This chapter first outlined the social security programs and reforms internationally for selected countries. Countries covered in this chapter comprise Australia, New Zealand, Sweden, Germany, the United Kingdom and the United States. Each of the countries considered in this chapter has managed to make significant changes to their social security systems.

In China's case, this chapter primarily focused on the review of five core parts of the social security system: pension insurance, unemployment insurance, medical insurance, insurance for work-related injuries, and maternity insurance. This was followed by the introduction of the social security system applied in China's rural areas.

Social security reforms were initially introduced in China following the economic reform of 1978. Since then, a series of reforms have been introduced to change the traditional social security system. In about three decades, a basic and reasonable framework of a social security system has been set up in China corresponding to the market economy system.

China is the world's biggest developing country with a large population. It is clearly a difficult task to establish a sound social security system for each individual. In light of China's actual situation and adhering to the principle of "putting people first", the Chinese Government has attached great importance and devoted every effort to establishing and improving its social security system.

In the next chapter, China's health care background and medical insurance system reform will be reviewed in detail.

CHAPTER 3 CHINA'S MEDICAL INSURANCE SYSTEM AND REFORM

3.1 Introduction

The ongoing medical insurance reform in China has had a profound impact on the funding, management and provision of health services. As introduced in the previous chapter, in 1995 a new medical care insurance system was inaugurated in urban China, through several rounds of pilot programs and experimental implementation. By inaugurating medical care insurance reform China took a significant step, in introducing a network of designated hospitals and patient choice in each item of medical services. From 1998 onwards, the medical insurance reform for urban employees and retirees has been extended to the whole country (Duan, 2006). Under this new medical insurance system, a social pool fund and personal savings accounts have been established. By the end of 2006, a total of 157.32 million employees and retirees had joined this basic medical insurance program. Of these 115.80 million were employees, representing 40.90 per cent of the total employed (283.10 million) (MLSS and NBS, 2007).

Whether the benefits of reform can be extended to rural areas where the majority of the population are living constitutes an important benchmark against which to judge the success of China's economic development and social progress. Hence the rural cooperative medical care system was established by the Central Government in 2002, which is primarily meant to guarantee coverage of medical expenses for villagers who need to be hospitalized or have treatment for serious diseases (Ding and Yin, 2005). Central and local governments and individuals jointly fund the scheme, in which participants pay 10 Yuan and governments supply another 40 Yuan per person to the fund. Statistics provided by the Ministry of Health showed that by the end of June 2006, the cooperative medical care system in rural areas covered 720 million rural residents, or 82.8 percent of the country's rural population (Ministry of Health, 2007). This system is popular with villagers.

After establishing a medical insurance system for the urban employed in 1998 and founding a new cooperative medical care system in rural regions in 2002 designed to cover all rural residents, urban residents who are outside the workforce became the only group without medical cover. In September 2007, China launched a pilot project of medical insurance to

cover 240 million urban residents outside the workforce, and all urban residents will become beneficiaries by 2010 (State Council, 2007). The pilot project has already been implemented in 79 cities, including large cities as well as county-level cities. The subsidies are funded by both the central government and local governments.

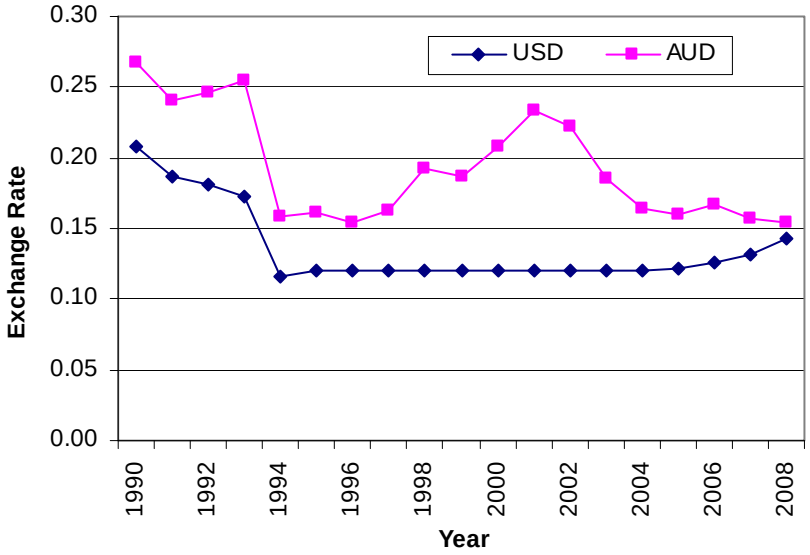
Until now, China has introduced and promoted medical insurance in urban areas, and has trialled cooperative medical care in the countryside. In this sense, all Chinese are expecting to be able to afford medical treatment.

This chapter will first describe the background of China's medical security system. It then introduces medical insurance reform in urban areas, involving different kinds of medical service patterns, followed by the implementation and development of medical insurance reform nationwide. The rural health care system and development will also be canvassed. With the description of current arguments and controversies on the medical insurance reform, the rationale underlying the main research objectives of this thesis will become clear.

There is one point that must be mentioned in advance. In this chapter and the rest of this thesis, when discussing costs, such as medical expenses or contributions to the medical insurance scheme, Chinese currency is used regularly. Figure 3.1 gives the average exchange rate over the period of 1990 – 2008 of the Chinese currency (which is measured in Yuan) compared with the US and Australian Dollars respectively.

Compared with the US Dollar, the Chinese Yuan had a downward trend during the period of 1990 to 1993, with a large fall between 1993 and 1994. After that, the Chinese Yuan remained basically stable against the US Dollar, with one Chinese Yuan around 0.12 to 0.13 US Dollars. However, in the last couple of years, the Chinese Yuan has showed a slightly upward trend. The Chinese Yuan has fluctuated much more with respect to the Australian Dollar and one Chinese Yuan is currently around 0.154 Australian dollars.

Figure 3.1 Exchange rate of 1 Chinese Yuan to US Dollars and Australian Dollars respectively during period of 1990 – 2008



Notes: Data source for 1990-1994 comes from: http://www.x-rates.com/cgi-bin/hlookup.cgi; for 1995-2008 comes from: http://www.oanda.com/convert/fxhistory. The latest date for 2008 was on 11th August.

3.2 Background of Medical Security System

China's medical security system was first established in the urban sector in the early 1950s, immediately following the founding of the People's Republic of China. This system became an integral part of the remuneration package for employees in the public sector, along with wages and salary, compensation for work-related injuries, retirement pensions, medical benefits, and "collective welfare" including housing (Liu, 2002). Government workers and employees enjoyed free medical services under this system. Spouses and children of public sector workers could have half of their medical expenses reimbursed.

Prior to the market economy reforms of the early 1980s, the medical security system in the urban areas consisted of two primary programmes: the Government Insurance Scheme for civil servants and employees of public institutions funded out of taxations, and the Labour Insurance Scheme operated and financed by urban and state-owned enterprises for employees, retirees and their dependents. Both the Government Insurance Scheme and the Labour Insurance Scheme were developed through central government policy guidelines although they were managed, funded and operated by local governments and enterprises for their own employees and retirees. The key feature of the system was that the providers were the

employers – that is the civil service or enterprise. Overall this employer-based system provided employees with a package of free or heavily subsidised services including health care. Medical expenditures were reimbursed (initially in full and later by a large percentage) by the employer under both schemes (Xu et al., 2007).

Thus, under these circumstances, most health service providers in the cities were State-run hospitals or clinics managed by the Central Government or local governments. They were funded mainly through public investment and enterprise and public employee insurance, with only a small proportion from out of pocket payments. Enterprises and other employers usually paid for the treatments of their employees according to 'service items' after treatment had been provided. Large enterprises and other workplaces often had their own hospitals and clinics (World Bank, 1997). This system had helped deliver a particularly high level of health care to those urban residents eligible for insurance.

However, coverage was far from even. Large Central State-owned enterprises were more likely to provide medical services with greater coverage for employees and their dependants than local government collectives could provide. After the economic reforms of 1978, the traditional health insurance system also proved unable to provide medical services for the growing numbers of urban residents working in the private sector. Furthermore, the system began to place a growing burden on some state enterprises and public finances. Government spending on public employee insurance rose 15 per cent per year between 1978 and 1993 (World Bank, 1997). Between 1986 and 1992, enterprise and public health insurance spending together grew at an annual average of 25 per cent, while fiscal income was growing at a mere annual average of 10 per cent (Duoji, 1995). Older state enterprises paying for the medical treatment of large numbers of retired workers bore a disproportionately large share of this increased spending.

The increased spending on enterprise and public employee health insurance was due partly to the rising patient demand for services, and partly to the growing numbers of people eligible for health insurance. Costs had also been rising due to the increased availability of expensive new medicines and technological innovations, coupled with the autonomy that some hospitals had in charging high prices for some diagnoses and treatments, over-prescribing of medicines and providing unnecessary diagnostic tests and treatment in order to increase their profits

(Hillier and Jie, 1996). Under such circumstances, significantly changing the traditional health insurance system was inevitable.

From the early 1980s, the Chinese Central Government has made a series of efforts to reform the urban health insurance system. The reform has been done in a gradual manner by using trials to test schemes in different localities and to develop policies. In 1995, the Central Government launched medical insurance reform pilot projects in the two medium-size cities of Zhenjiang and Jiujiang and for the Hainan special economic zone (later Hainan Province). By the end of 1998, the State Council (National Cabinet) issued a "Decision on Establishing a Basic Medical Insurance System for Urban Employees", which conceptualized an innovative system with low benefit levels; cost sharing among employees, employers and the State; wide coverage; and a combination of a social pool fund with personal savings accounts (State Council, 2004).

At the early period of the medical insurance reform, the Central Government picked several localities to trial different pilot projects that served different purposes. Representative patterns of medical insurance pilot projects included a: Three-stage pattern, Separate block pattern, Mixed pattern, and Pattern for serious illness. These pilot projects are briefly reviewed in the next section.

3.3 Early Pilot Reform Projects

Around 1995, the Central Government launched several pilot reform projects to achieve different objectives. A few medium-sized cities or areas were chosen as representatives to trial different types of pilot programs — that is, the so called 'Three-stage pattern', 'Separate block pattern' and 'Mixed pattern'. For each of these patterns, the social pool fund and personal savings accounts were set up. With respect to big cities like Beijing and Shanghai, the Central Government was very prudent in reforming the old medical insurance system. A social pool fund was set up initially in these big cities to handle those with severe illnesses, but no personal savings accounts were established. Table 3.1 summarises the early pilot programs with respect to aspects of trial place, time of commencement of the program,

covered population, whether personal savings accounts are available or not, and medical cost payment modes. These early pilot reform projects are detailed below.

Table 3.1 Early pilot programs in the medical insurance reform

Items	**Three-stage pattern**	**Separate block pattern**	**Mixed pattern**	**Serious illness pool pattern**
Representative cities or areas	Zhenjiang; Jiujiang	Hainan Province	Shenzhen	Beijing, Shanghai
Commencement of the program	Early 1995	July 1995	July 1996	April 1995
Covered population	All workers, employees and retirees	All employees in the city	Different schemes for different groups of people	First state-owned employees and then all employees
Covered costs	Clinic services and hospital treatment	Clinic services and hospital treatment	Clinic services and hospital treatment	Severe illnesses
Set up social pool fund	Yes	Yes	Yes	Yes
Set up personal savings accounts	Yes	Yes	Yes for permanent residents; No for temporary residents.	Not available
Medical expenses payment mode	Jointly through the personal savings account, out of pocket payment, and the social pool fund in both clinics and hospitals	Personal savings account and social pool fund managed independently. The former mainly for clinic services, the latter mainly for hospital treatment.	Permanent residents paid as for the 'Three stage pattern'; temporary residents had to meet the cost of outpatient services themselves.	Social pool fund covers costs incurred in hospitalization services and clinic services for serious illnesses

3.3.1 Three-stage Pattern

The three-stage pattern was trialled by the two medium-size cities of Zhenjiang (Jiangsu Province) and Jiujiang (Jiangxi Province). Both of these cities are located in the east of China (see Figure 3.2 for their locations). The medical insurance reform began in early 1995 and was broadly the same across both cities. The basic idea of this pattern is to pay the medical expenses occurred in both clinics and hospitals jointly through the personal savings account, out of pocket payment, and social pool fund.

Figure 3.2 Illustration of locations of the pilot programs in medical insurance reform

Source: http://www.fas.usda.gov/pecad/remote/china/chinamap.gif

All workers and employees (but not their family members) were to be insured through their employers. At municipal level, a medical insurance fund was formed to administer the social pool fund and personal savings accounts. The monthly employer's contribution was 10 per cent of the total wage bill for the previous year and the employee's contribution was 1 per cent of the monthly wage (since 2002, the contributions have been adjusted to 9 per cent for employer and 2 per cent for employee). The employee's total contributions plus about half of the employer's contribution was put into personal savings accounts according to employee's age (greater proportion for elderly individuals than for younger people), with the rest being put into the social pool fund (Xiong et al., 2003).

Within those services designated by the local health authorities, the participants have choices of hospitals and pharmacies. For insurance benefits, three funding channels with different levels of co-payment by the patient were constructed. In the first instance all medical

treatment costs for in- and out-patient services were paid out of the accumulated personal savings account. If there was nothing left in the account, the participant had to pay an amount of up to 5 per cent of his or her annual income (since 2002, this rate has been increased to 10 per cent). Costs of treatment over and above this were borne largely by the social pool fund, although the participant had a continuing obligation to share a small percentage of the costs. For retirees the sharing scales were half of the payments paid by employees, according to their pensions.

Under the social pool financial system, costs were settled with service providers using an empirically based schedule of costs for contractual in- and out-patient services. If the hospital's spending fell short of this schedule it was allowed to keep the surplus. Amounts overspent were split between provider and insurer. To avoid the previously common practice of hospitals selling drugs at inflated prices, the range of sources from which drugs could be obtained was widened and a system of separate accounting introduced. Constraints were also placed on methods of prescribing and quantities dispensed (Zhenjiang Government, 2002).

Compared with the traditional healthcare system, the three-stage pattern has brought improvements, in that the personal savings account and co-payment have made people more cost-conscious. The age-related increase in contributions paid into the personal savings account also makes sense, given the health risks of old age. With standardization of medical procedures and services, the three-stage pattern had a quite large representativeness in the beginning of the reform. The reform of prescribing methods and widening of the range of sources from which drugs could be obtained represent undoubted progress. The definition of treatment schedules for medical procedures and services and lists of reimbursable drugs could also be a starting point for the design of a system of universal basic healthcare provision for the whole population.

However, there were also problems with the medical insurance reform. Employers with a young and healthy workforce were afraid that their contributions would be used to cross-subsidize the burden of care carried by state-owned enterprises. As a result, they tried to avoid joining the urban medical insurance scheme. The other problem is an ethical dilemma. Under the three-stage pattern of payment, a patient can only access the social pool fund after the accumulations in his or her personal savings account have been used and a small amount of out of pocket money has been paid. This has meant that some patients use their personal

savings accounts for unnecessary medical services to gain quick access to the social pool fund. This behaviour weakened the accumulation function of the personal savings accounts. Presently, only a few areas (like cities of Zhenjiang and Xiamen) have implemented this payment pattern (Wang, 2005). However, they have made some adjustment and improvement for the payment pattern — for example, hospitalization treatment can benefit from the social pool fund directly rather than from the personal savings account first as originally designed.

3.3.2 Separate Block Pattern

The separate block pattern was trialled by Hainan Province (located in South China, see Figure 3.2) at the beginning of the reform. In this medical insurance pattern, the personal savings account and social pool fund were managed independently. Personal savings accounts were mainly responsible for clinic treatment, while the social pool fund was mainly responsible for hospital treatment.

Hainan Province enacted new rules on medical insurance in July 1995, that covered all employees in the city irrespective of the ownership of the enterprises, and all self-employed individuals. Contributions were 10 per cent of their monthly wages and 1 per cent for employers and employees respectively. Self-employed individuals paid 11 per cent. Pensioners and their employers were exempted from paying the premium. The amount of percentage of monthly wages or pensions paid into the personal savings account varied with the employee's age category (4 per cent for employees aged 40 years or under, 5 per cent for employees aged 41 to 50 years, 6 per cent for employees aged over 50 years, and 8 per cent for pensioners). The remainder of the contributions went to the social pool fund (Hainan Province, 1995).

Treatment costs were differentiated by serious and non-serious illness, the former being met out of the social pool fund and the latter out of the personal savings account or by the patients' out of pocket payment. The patients also shared the cost of medical services covered by the social pool fund, up to a maximum amount which was set in relation to average monthly earnings or pensions for the previous year. For employees this maximum was two months' average wage. Above this minimum requirement, contributions towards the costs were taken on a graduated scale (Table 3.2). Where the cost was exceeded by up to ten months' average wage, 15 per cent for employees was taken from the personal savings account and 85 per cent was paid from the social pool fund. Where the cost was exceeded by

ten to 20 months' average wage, the employee shared 9 per cent of the cost, and where it was exceeded by more than 20 months' average wage the rate fell to just 5 per cent, with the remainder being paid out of the social pool fund. For pensioners, the sharing scales were half of the payment paid by employees according to their average pensions. If there was no money left in the personal savings account, the participant had to pay the portion of the cost payable from their own personal savings account. In the context of this thesis, "personal savings account" means "personal medical savings account", which can be used exclusively to pay the expenses incurred in medical treatments.

Table 3.2 Percentage of payment shared by social pool fund and personal savings account for serious illness for employees

Paid by	Medical expenses compared to the monthly average wage of employees			
	Less than 2 months	**2 to 10 months**	**10 to 20 months**	**Above 20 months**
SPF	None	85%	91%	95%
PSA	100%	15%	9%	5%

Notes: SPF – Social pool fund; PSA – Personal savings account

Due to a relatively high and consistent level of participant co-payment, the separate block pattern is chiefly notable for the strict separation which it operates between personal savings accounts and the social pool fund. If the costs of treatment were greater than the assets in the personal savings account, no subsidies were given, but assets remaining in the account could be bequeathed to a participant's heir. While the participant co-payment was paid directly by personal savings account, payments from the social pool fund were cleared between the social security authority and the medical service provider.

Using the lessons from the early medical insurance reform trial, Hainan Province later revised the premium contributions and payment percentage by the social pool fund. Since 2001, contributions for employers have been decreased to 6 per cent, and for employees have been increased to 2 per cent of their monthly wage. For hospitalization or treatment of serious illnesses, the minimum requirement for employees is 9 per cent of the annual average wages of the previous year (and 7 per cent for pensioners). After this threshold, the social pool fund covers 80 per cent of the medical cost, reaching a threshold up to a maximum of four times the annual average wages. The patients shared the rest, contributing 20 per cent of expenses. The relative coverage by the social pool fund for pensioners is 90 per cent (Hainan Province, 2001).

The separation of the social pool fund and personal savings accounts coupled with differentiated participant co-payment that is dependant on the severity of the illness could be the way forward for future reforms. Currently the majority of urban areas are utilising this separate block pattern of payment (Wang, 2005). There is, however, a possible problem here in that diagnosis of the medical condition might be manipulated.

3.3.3 Mixed Pattern

The mixed pattern, represented by the city of Shenzhen (located in Guangdong province, a city of about 1 million people, a neighbour to Hong Kong and a special economic zone, see Figure 3.2 for its location), carried out different medical insurance schemes for different groups of people. In Shenzhen, general medical insurance covered all workers and employees of public and private enterprises, governments, social organizations and other employers. In July 1996, a decision was made to divide insurance provision into two main groups: the first is a combined medical insurance scheme covering both in- and out-patient treatment for employees and pensioners who are permanent residents in the city; and, the second is a medical insurance scheme that exclusively covered hospital inpatient treatment for unemployed workers and employees who are temporary residents. A special separate medical insurance scheme was established for retired military personnel and military personnel medically discharged (Medical Knowledge Net, 2007).

Under this medical insurance scheme, permanent resident employees contributed a rate of 9 per cent of their wages, of which 7 per cent came from the employer and 2 per cent from the employee. For unemployed labourers and temporary resident employees the total rate was 2 per cent, which came from the employer or the unemployment insurance administration. This group has to meet the cost of outpatient treatment themselves. However, 90 per cent of the cost of inpatient treatment is borne by the health insurer. For pensioners, 12 per cent of contributions were paid by government finance, the employer or the pension fund.

Personal savings accounts were set up only for participants of the combined medical insurance scheme. Into these, 50 per cent of monthly contributions were paid for persons aged up to 44 years, and 60 per cent for persons aged 45 years or over. In this group, the cost of outpatient treatment was paid basically in the same manner as for the 'Three-stage pattern' described above. That is, the patient funded the cost out of the personal savings account; if

there was no money left in the account, the patient must pay all further costs him- or herself, up to a threshold of 10 per cent of the annual average wage in the previous year, after which a large proportion was paid out of the social pool fund. Overall, 90 per cent of the cost of hospital stays and 80 per cent of the cost of chronic illness treatment and treatment for special check-up clinics were met by the social pool fund.

Several years later, in July 2003, Shenzhen municipal government adjusted the medical insurance policy settings in order to make them more reasonable and efficient. For example, the contributions for the combined medical insurance scheme were lowered from 9 per cent to 8 per cent, of which 6 per cent was paid by employers. In addition, the distributions to the personal savings accounts were allocated across more age groups, instead of just two age groups like the initial medical insurance scheme (Bureau of Shenzhen Social Insurance Fund Administration, 2003).

In comparison with the 'Three-stage pattern', the 'Mixed pattern' stood out by virtue of its broader coverage and the differentiation of participants according to age and residence status, applying a greater range of insurance schemes. While this differentiation made it harder to standardize conditions of care, it did facilitate better account of various costs and health risks. With the rapid progress of urbanization in China in recent years, more and more of the rural population are migrating to the cities. Solving the problem of social and health security for these migrants is a big challenge for local authorities. Shenzhen's differentiated pattern of medical insurance scheme might provide a good example of how local authorities can solve the challenge of providing social security for these migrants.

3.3.4 Serious Illness Pool Pattern

The expenses of serious illnesses were indeed a heavy burden for relatively small medium sized state-owned enterprises under the traditional health care system, since these enterprises were often unable to carry the risks of expensive treatment. In the beginning of the medical insurance reform in the 1990s, the serious illness pool scheme set up a social pool fund for severe illness, that did not use personal savings accounts. Costs of outpatient treatment were, in principle, to be met from the patient's own pocket. The pilot scheme includes Beijing's pool fund that covers a large amount of medical treatment cost and Shanghai's pool fund for serious illness that results in clinic and hospital treatment.

Beijing

In Beijing, a social pool to meet the costs of treating particularly severe illness was trialled in state-owned enterprises as early as 1987. The criteria applied were medical diagnosis plus a given level of treatment costs. By 1992, a large number of group insurance funds were established at district and municipal level, into which state and municipal collectives paid between 3 and 5 per cent of their total wage bill. The funds met the cost of illnesses categorized as particularly severe, but all other treatments had, as before, to be paid for by the individual's employer or by the patient themselves (Rosner, 2004).

In April 1995, a regulation was enacted in Beijing to set up a unified severe illness pool fund, in which employers and employees paid 6 and 1 per cent, respectively, of the average monthly wage in the previous year. Each city district was directly responsible for collecting and administering contributions and paying out benefits. The City's Central Administration took 10 per cent of the total contribution for the purposes of risk equalization and macro adjustment (Beijing Municipal Government, 1997).

For the reimbursement in Beijing, all costs of treatment for severe illnesses above 2,000 Yuan were insured. The reimbursement rate varied with the medical treatment costs as described in Table 3.3.

Table 3.3 Reimbursement rate for costs incurred in severe illnesses in Beijing

Costs range (Yuan)	Percentage of reimbursement
Between 2,000 and 5,000	90%
Between 5,000 and 10,000	85%
Between 10,000 and 30,000	80%
Between 30,000 and 50,000	85%
Above 50,000	90%

The remainder were shared by the employer and the employee, of which the employer's payment rate must be at least 70 per cent. As of 1997 this serious illness system was extended to private-sector employers, self-employed workers and laid-off workers. This scheme had played a great role in reducing the medical burden for both employer and employee. This serious illness pool scheme had been in effect in Beijing until 2007, that has been replaced with a new basic social medical insurance scheme (Beijing Municipal Government, 2007).

Shanghai

Medical insurance reform began in Shanghai in May 1996, in line with the principles of 'Total cost control' and 'Structural adjustment'. 'Total cost control' is for medical organisations (e.g. hospital) for controlling their total cost, 'structural adjustment' is for different departments in a medical organisation according to their medical service characteristics. As a result the rise in hospital costs was kept in check, while drug sales as a proportion of hospital incomes were reduced and the contribution of medical procedures and services to hospital incomes were increased. In May 1996, a trial general insurance scheme was introduced for all employees and pensioners in the city, in which family members were not included (Li et al., 2004). This insurance was designed to cover the cost of inpatient hospital treatment and serious illness that was treated in clinics through a social pool fund (above a given level of participant co-payment).

Under this serious illness insurance scheme, contributions were collected and managed by the city's Social Security Administration Centre. Employers initially funded this by deducting 4.5 per cent of their wage bill. The employee contributed 1 per cent of his or her wage bill. Within the co-payment threshold, the costs of hospital stays were shared between employees and employers, with the employer covering a large part of the costs. Of the costs in excess of the participant co-payment threshold, 85 per cent were paid by the medical insurance scheme and the remaining 15 per cent was shared by the employer and employee (China's Labour Information Net, 1996). This serious illness insurance scheme was replaced later in 2000 by a new basic medical insurance system which covered both outpatient and inpatient medical services (People Net, 2002).

3.4 Nationwide Implementation of the Medical Insurance Scheme

In December 1998, the State Council issued "the Decision on Establishing a Basic Medical Insurance System for Urban and Township Employees" that was designed to draw on the experiences of the pilot projects and sought to standardize the social security system (Xu, 2007). The new medical insurance system covers all employers and employees in urban areas working in government organizations, enterprises, social groups and non-profit-making bodies. The social insurance bureau at the local level is responsible for collecting

contributions, accrediting, contracting various healthcare providers including clinics, pharmacies and hospitals, and paying for services offered by the providers.

Under this system, two accounts have been established: the personal savings account (personal-savings system) and the social pool fund (social insurance system). Each of these caters to a different kind of medical care, that is ordinary illness and serious illness, respectively. The funds for basic medical insurance come mainly from premiums paid by both employers and employees. In principle, the employer contributes 6 per cent of the total wage bill, of which 30 per cent is credited to the employee's personal savings account and the balance paid into the social pool fund. An employee pays 2 per cent of his or her monthly wage, which is fully credited to his or her personal savings account. Retirees are exempted from paying the premiums (State Council, 2004). Assets held in personal savings accounts will bear interest and may be transferred, enjoyed and bequeathed to the holders' heirs. In practice, local governments have generally adjusted the contribution rates according to their circumstances. The government also contributes to the scheme by way of tax concessions and subsidies for administrative costs, as well as through complementary schemes for civil servants (Wang, 2005).

Medical expenses are shared by the medical insurance fund and the individuals themselves. Outpatient treatment fees (smaller amounts) are mainly paid from a personal savings account, while hospitalization expenses (larger amounts) are paid predominantly from the social pool fund. The minimum and maximum payments from the social pool fund are clearly set out. The minimum payment is, in principle, about 10 per cent of the average annual wage of local employees, and the maximum payment is about four times the average annual wage of local employees. Medical treatment in high-grade hospitals results in a low percentage of reimbursement from the social pool fund, and vice versa. Medical expenses greater than beyond four times the average wage are usually settled with commercial medical insurance schemes or public-run supplementary schemes.

Nowadays, all urban areas have implemented the new medical insurance scheme for employees and retirees. By the end of 2006, the scheme covered 157.32 million people, an increase of 12.4 per cent compared with the previous year 2005, and involving 115.80 million employees and 41.52 million retirees (MLSS and NBS, 2007).

3.5 Rural Cooperative Medical Care System

3.5.1 Background of Rural Medical Service

Since the 1950s, China has established a relatively comprehensive rural medical care system. Between the 1950s and 1970s, the Chinese rural population had some access to first-aid medical services, although what they received was low-level medical treatment due to the laggard economic and scientific situation in China. A community-based healthcare system (cooperative health insurance) used to cover about 90 per cent of the rural population in the mid-1970s and was once seen as an excellent example for developing countries. The system was partly financed by the collective, and partly by prepayment and co-payment (Hussain, 2000). The rural population received basic medical services from the local cooperative medical care clinics.

Unfortunately, this community-based healthcare system collapsed with the introduction of the household responsibility system and the market-oriented rural reform in the early 1980s. Gradually, inexpensive medical treatment became rarer and medical treatment expenses increased significantly. Given their low incomes, few rural residents had their own medical insurance. During that period, a large majority of the rural population were uninsured and paid out of pocket for healthcare.

According to the statistics from National Statistics Bureau, between 1990 and 1999, the net per capita annual income of rural residents increased from 686 Yuan to 2,210 Yuan — about a three-fold increase. However, during the same period, the per capita clinic and hospitalization costs of an individual increased from 10.9 Yuan and 473.3 Yuan to 79 Yuan and 2,891 Yuan, respectively (Jia, 2005) — roughly a seven fold increase. The average cost of one hospital admission exceeded the average annual income of the majority of rural households. It had become quite common for rural families to fall into poverty just because one member of the family had become seriously ill.

The challenge was not just limited to individuals. Government-subsidized township hospitals, originally established to treat basic diseases among rural residents and to support village doctors and small clinics, were being hit by a tidal wave of problems. People were unwilling to go to the township hospitals, which were poorly equipped. Other problems, such as high

medicine prices and unemployment, also threatened the existence of township hospitals (Jia, 2005).

Under that situation, it became essential for the Government to resume the cooperative medical system through a substantial subsidy for poor rural households.

3.5.2 Cooperative Medical Care System

One crucial issue facing China has been the big gap between urban and rural areas in terms of medical services. In 2003, the central government launched a trial of the new rural cooperative medical care system. The principle of the new system is to stop rural residents from falling into poverty as a result of disease (Ding and Yin, 2005).

Under the cooperative medical care policy, the central government, local governments, and individuals invest in the scheme together to establish a medical insurance account, to which an individual contributes 10 Yuan per year and governments' subsidise a further 40 Yuan per person annually. The money accumulated is then used to fund hospital treatment and serious illness. For those poverty-stricken people, local governments pay the insurance on their behalf (Li et al., 2006). Generally speaking, the contribution of 10 Yuan per person a year does not put any financial pressure on rural people. The financial aid they receive when they need to see a doctor for a serious disease or to be hospitalized is enough to prevent them from becoming bankrupt.

This medical care system is quite popular in rural areas. By the end of June 2006, the cooperative medical care system in rural areas covered 720 million rural residents, or 82.8 percent of the country's rural population. Recently, the Chinese government made a plan to have its basic medical and health care system cover all rural residents by 2010. The plan said the government's investment would account for the main part of the fund for the system. A three-level medical and health care system including the county, township and village will be built all over the country (Xinhua News, 2007b).

3.6 Current Developments and Problems

From 1999 onwards, the Government has been working hard to achieve the goal of better coverage of the medical insurance system. Every year, the central Government holds a working conference to urge local governments to expand medical insurance coverage. However, quite a large population of non-public enterprises and self employed personnel have not yet been covered by the scheme. In addition, some public and collective enterprises cannot join the scheme because of their lower economic capacity. By the end of June 2007, the basic medical insurance scheme in urban areas only covered 43 per cent of the target population (Dong, 2007). Enlarging the coverage of the basic medical insurance scheme remains a big task for governments. There is no doubt that further expanding the coverage of social medical insurance and reducing the proportion of self-pay patients continues to be the top priority on the government agenda.

Social medical insurance coverage is limited for several reasons. First, it is not attractive to those whose employment is relatively secure (such as employees in government or public organizations) or whose incomes are high (such as employees in foreign-invested enterprises or some domestic private enterprises). Second, enterprises in poor financial condition are not able to contribute the employers' part of the medical insurance contributions. Third, members of socially disadvantaged groups, especially the unemployed, and employees in the informal sectors (e.g., self-employed), enjoy no health security at all. Fourth, medical care for children and students is not currently covered, providing another challenge for the government.

The other important reason for limited coverage relates to the large drop in the government's investment in the health care system. Gao Qiang, former Chinese Health Minister, revealed in a report in 2005 that government contributions to hospital running costs had dropped from an average 30 percent in the 1970s and 1980s to 7.7 percent in 2000. This has forced many public health institutions to overcharge patients to break even. The medical fees paid by the patients were not only covering the cost of the services and medicines, but were also paying for the wages and subsidies of medical staff, new medical apparatus and hospital facilities (Agencies, 2005).

To tackle these problems, law enforcement has been intensified to compel more private enterprises to join social medical insurance. As early as 2005, in the proposal of the 11th

Five-Year Plan (2006-2010) for National Economy and Social Development, the central government set a goal of eliminating the free health care schemes remaining in the public sector and merging them into social medical insurance. The plan outlined that a harmonious socialist society should be promoted by starting with the most direct and practical issues that concern the interests of the masses (Xinhua News, 2005).

Later in September 2006, the National Development and Reform Commission (NDRC) released a document concerning the country's healthcare development programme. It had set 2010 as the target for providing all citizens in the country with basic healthcare, i.e., all residents in both urban and rural areas would have access to basic healthcare at that time (China Daily, 2006b).

The year 2006 was a major turning point in the development of China's health security system, as the Chinese Government pledged to take major responsibility for the health sector. The Government has promised to play a major role in establishing a basic health care system covering urban and rural residents, a national basic prescription medicines system, and a multi-layer medical insurance system (Li and Jiang, 2007). The Chinese government has realised that accelerating the building of a social security system that covers both urban and rural areas is important for achieving sustainable economic and social development.

Apart from strengthening and enlarging the coverage of the basic medical insurance scheme for urban employees and pensioners, and the cooperative medical care system for rural residents, the Central Chinese government has launched a medical insurance program in 79 selected cities to cover non-working urban residents, such as children, students and elderly people. The target has been set to establish a medical service system which covers all urban residents by 2010.

Under this urban residential medical insurance program, both central and local governments have subsidized the insurance project. Participation in the insurance plan is based on the free will of residents. The premiums are paid by households, instead of individuals, and the governments give subsidies of at least 40 Yuan annually to each participant of the insurance program in pilot cities, with more going to families with low-income earners and disabilities (State Council, 2007).

3.7 Research on the Medical Insurance System and Arguments

The implementation of China's health insurance reform program faces several major challenges, including risk transfer from work units to municipal governments, diverse need and demand for health insurance benefits, and incongruent roles of the central and regional governments (Liu et al., 2002). The transformation from a planned economy to a market-oriented economy in China has had a profound impact on access to health care for a vast majority of the Chinese population. Research by Lim et al. (2004) showed much unmet medical need (16 per cent), which is mainly attributed to the perceived high cost of care. Among those with unmet medical need, 71 per cent had no health insurance. Low coverage of medical insurance scheme and imbalance of health sources are still the major problems challenging the governments (Xu, 2007). This, as a result, affects the equity and efficiency of the medical insurance scheme among different groups of people.

The health care reform process has gradually shifted away from welfare provision through enterprises to greater emphasis on individual taxes and contributions. The Government has also taken a more active role in providing a safety net for the urban poor. Using the national China Household Income Project data, Gao provided empirical evidence on how social policy changes in urban China affected family benefits from 1988 to 2002 (Gao, 2006). Empirical results show that even though the real value of social benefits increased over time, its incremental pace lagged behind that of market earnings, yielding a smaller share in final household income since the medical care reforms. Using data from three household surveys, Wagstaff and Lindelow (2008) analysed the effect of insurance on the probability of an individual incurring 'high' annual health expenses. Their main results suggest that, in all three surveys, health insurance increases the risk of high and catastrophic spending.

In recent years, debates and controversies on the reform of the medical insurance system in China have become more common. In July 2005, the Development Research Centre of State Council and the World Health Organization jointly published a study entitled "China's Reform of the Medical and Health System". The study came to the conclusion that the reform of the national medical system is "basically unsuccessful." In the wake of this report, health care reform in China has been the subject of much discussion and public debate (DRC State Council, 2005).

The report further pointed out that inequality in access to medical services and low efficiency in the use of funding were the two main symptoms of the malfunctioning medical system. The research concluded that the reform of China's medical system and health system lagged behind the reform of its economic system. While these problems require urgent attention, broadly speaking, a market-based approach should ultimately serve China well, and over time should produce a better health care system (Go, 2006).

Nearly one year later, in May 2006, the research group of "the report of China's medical and health reform" issued a green book "Medical and Health 2006" (Dong, 2006). The Green Book believed that the ten-year medical insurance reform commenced in 1995 had indeed led to many problems, especially low fairness in access to medical services and low efficiency in funding of health. The reasons for these problems, the Report identified, were the lack of governments' investment, poor supervision and off-side functioning. The Green Book argued that what Government had done was to reduce financial support for hospitals gradually – to alleviate its fiscal burdens left over from the old free public medical system – and allowed hospitals to sell drugs to maintain their operations. An inevitable result was the impact on efficiency, and doctors' over-prescription, which was used to subsidize deficits in service provision.

The reform of the medical system in a country of 1.3 billion people, admittedly, is a herculean task, especially considering the chronic inefficiency of the State medical system that emphasized equality at the expense of efficiency in the planned economy period. The government needs to accelerate the establishment of a medical system to ensure the basic health care needs of the general public are met.

3.8 Summary and Aims of This Research

This chapter has provided an overview of the establishment process of the medical insurance system in China. The reform of the medical insurance system for urban employees and retirees, involving the background of the traditional social medical security system, pilot programs and developments were reviewed. The health care system in China's rural areas was introduced briefly, followed by the introduction of medical insurance program for urban

residents out of the workforce. After nearly two decades of trials and practices, the Chinese Government has set a goal to provide basic medical services for both urban and rural residents by 2010. The progress can be summarised as three major steps.

The first step is for urban employees and retirees. After several rounds of pilot programs, the basic medical insurance scheme has been established in China for urban employees and pensioners since 1998. Under this medical insurance scheme, two accounts have been set up – personal savings accounts and the social pool fund. The personal savings account is basically responsible for ordinary disease, while the social pool fund is for serious disease.

The second step concerns health care of rural residents. In 2003, the Chinese Central Government enacted a regulation to build a new cooperative medical care system for rural residents, in which Central government and local governments subsidise a large part of the contribution. The scheme initially covers expenses incurred in hospitalization and serious illnesses treatment.

After these two reforms of medical insurance system, is the third step – building the medical insurance scheme for urban residents without work, involving children, students and elderly people. This step just started in September 2007, with the Central Government choosing 79 pilot cities to launch a pilot program for urban residents. This system is expected to cover all urban residents in China by 2010.

With the Government taking the major responsibility for investing in the basic medical insurance system for all Chinese people, it is reasonable to believe that all Chinese people will be able to enjoy basic medical services by 2010.

However, the ongoing medical insurance reform in China for both urban and rural areas has had a profound impact on the financing, organization and provision of health services. It is important to analyse and evaluate the impact of the reform on individuals' health care benefits — in particular, on their financial burden due to medical expenses. The control of the rapidly increasing health services expenses, as well as the provision of basic medical services to all populations, is a major indicator of the success of the reform. Powerful policy analysis tools are needed urgently to support the medical insurance policy makers. However, very few

research studies have been found on the prediction and evaluation of the medical insurance policy. Significant gaps in knowledge still remain, which this current research aims to fill.

This research focuses on the urban medical insurance reform, involving both urban employees and urban residents out of the labour force. The key aims of this research, as discussed in Chapter 1, are to assess the distributional impacts of medical insurance policies and to predict the medical expenses for urban employees and residents using microsimulation technologies. In this way, this research aims to advance the understanding and impact of medical insurance reform in China, and to assist in future policy formulation and implementation. Selecting one of the southwest capital cities in China, Kunming, Yunnan Province (refer to Figure 3.2 for the location of Kunming), this project creates two static microsimulation models of the medical insurance system in China, with the goal of greatly improving the decision support tools available to Chinese medical insurance policy makers.

CHAPTER 4 MICROSIMULATION MODELLING

4.1 Introduction

The main method used in this research is microsimulation. By creating microsimulation models, this research predicts and evaluates medical services of individuals under the Chinese urban medical insurance system. This chapter gives an introduction to microsimulation modelling and the categories in its application and construction. The chapter then focuses on the establishment of microsimulation models in different countries regarding health care systems, which is the main topic in this research. By introducing the application of microsimulation, the basic idea of model construction for analysing China's urban medical insurance scheme is derived.

4.2 Microsimulation Models

A microsimulation model differs from other types of models in that it operates on individual units rather than on aggregate information. In the social and economic sciences, those units are individual economic units. The database used as input to a microsimulation model contains unit records describing persons, households, or firms. The simulation model applies a set of rules to each individual record. Harding and Gupta (2007) described the defining characteristic of microsimulation models as an analysis of the likely behaviour of and the impact of policy change upon persons (or families, or firms, or other micro-units). Microsimulation models are often constructed on top of microdata, with sample surveys or administrative data forming typical base datasets for such models. In both cases, the microdata usually contain thousands of individual or micro-unit records, with a host of variables describing the demographic, labour force, income and other characteristics of each individual or family.

In practice, microsimulation models are special forms of simulation built using computer programs and applying microdata – individual level data. They use this kind of data to determine what is happening currently at the individual unit. The programs then allow for

simulation, predicting what the population will do in the future based on certain assumptions. This can include looking at the behaviour of the individuals over time and extrapolating that into the future – or making assumptions about changes in behaviour that may occur over time. The results are then aggregated, so that the behaviour of the population as a whole, or sections of the population, can be seen. By using the individual level as the basis of the model, microsimulation allows analysis at a very detailed level or, through aggregation, more general analysis can be done. This micro-level focus distinguishes microsimulation models from other modelling approaches that operate with groups or cells, or aim to simulate a population as a whole (Harding, 1996). Further, unlike modelling based on a typical or median case, microsimulation models provide a much richer source for research by enabling the exploration of heterogeneity and diversity within the simulated population (Brown and Harding, 2002).

An overview of what constitutes microsimulation, the various types of models, some of the technical characteristics and considerations, and examples of model applications can be found in Harding and Gupta (2007), or in a Chinese version by Li and Gao (1999). The application of microsimulation to social and economic modelling was pioneered in the late 1950s by Guy Orcutt (1957). Advances in computing power in recent years have accelerated the use of microsimulation.

Microsimulation has proven to be a particularly useful tool for policy analysis in many areas of policy and has been widely used in many countries in the world. Microsimulation models are uniquely placed to answer the often asked ‘What if’ questions, because they are not limited to answering pre-defined scenarios. The microsimulation model allows a wide range of social and economic policy scenarios to be superimposed onto the individual level and the outcomes at this individual level to be observed. In addition, where a model provides projections, questions may be posed about the future impact on individuals. This is particularly important in capturing the complete distributional impact of policies based on changing demographics, whose full effects may take a considerable amount of time to filter through (Kelly, 2003).

4.3 Static and Dynamic Microsimulation Models

Microsimulation models are by definition quantitative, typically complex and large. Although there is a broad range of microsimulation models, they have been traditionally divided into two broad categories – static and dynamic (Harding and Gupta, 2007; Li and Gao, 1999). Static models typically use static ageing techniques to update cross-sectional microdata up to the required point in time. These techniques usually involve re-weighting the micro-data and up-rating monetary values. Most static microsimulation models measure the immediate (or first-round) impacts of policy change, before individuals change their behaviour in response to the policy change. That is, static models take a cross-section of the population at a particular point in time and apply different policy rules on individual units. These models generally do not attempt to incorporate behavioural change and are used principally to calculate the instantaneous (or morning-after) impact of changes in policies.

Static models can also be used to project the longer term by use of 'static ageing'. This method involves the re-weighting of the original population cross-section in such a way that the characteristics of the cross-section align with external reference data or projections. For example, a scenario may specify birth rates at a future point in time and the original microdata can then be re-weighted to align the model with this scenario. This technique effectively forces a sample into line with external estimates at a future point in time, ignoring the processes that generated the individual observations. AMP.NATSEM "Tomorrow's Consumers" Report (Harding et al., 2006) is another static ageing example.

An example of a static microsimulation model is STINMOD – Static Incomes Model (Lloyd, 2007) of NATSEM. The first version of STINMOD was released in 1994 (Lambert et al., 1994; Schofield, 1995) with new versions being released each year. This model is publicly available, runs on a personal computer and can be accessed via a user-friendly interface. STINMOD simulates the payment of personal income taxes and the receipt of social security cash transfers in Australia. It allows the user to input changes to a variety of government policies and to immediately see the impact on individuals and groups. It is now the standard model used by Australian federal governments for their analyses of possible budget policy options in this area.

Dynamic models often start from exactly the same cross-section sample surveys as static models. However, rather than using static ageing procedures like re-weighting, dynamic models simulate the major life events of individuals within the original microdata or base file. These life events involve birth, education, labour force participation, marriage, divorce, death, etc., in accord with the relative probabilities of such events happening to real people within that particular country (Harding and Gupta, 2007).

Conceived by Orcutt, dynamic microsimulation is a 'bottom-up' strategy for modelling the interacting behaviour of decision makers (such as individuals, families or firms) within a larger system. This modelling strategy utilizes data on representative samples of individual units, along with equations and algorithms representing behavioural processes, to simulate the evolution through time of each individual unit and hence of the entire population of individuals. Used mostly for applied purposes thus far, dynamic microsimulation has enormous untapped potential for path breaking basic research.

An example of a dynamic microsimulation model is DYNACAN – Longitudinal Dynamic Microsimulation Model (Morrison, 2007) – built within the Canadian Department of Human Resources and Social Development, and commencing construction in 1994. DYNACAN is a closed, stochastic, longitudinal, dynamic microsimulation policy model, simulating the longitudinal evolution of individuals and many of their characteristics within family contexts. After some limited policy application in the beginning of its development, DYNACAN became part of the formal process for assessing the impacts of prospective changes to the Canada Pension Plan. The most recent impact projections have involved a variety of assessments of possible changes to Canada Pension Plan contribution and benefit rules (e.g., for survivors' benefits and child-rearing dropouts).

Another example of a dynamic microsimulation model is APPSIM – Australian Population and Policy Simulation Model. A five-year project funded by the Australian Research Council and 13 Commonwealth agencies, which started in late 2005 (Harding, 2007). APPSIM aims to provide snapshot output of the characteristics of the population and government programs, with individuals being aged to about 2050. It is designed to answer the types of questions that other dynamic microsimulation models have tackled e.g., likely future distributional consequences of changes in social security and taxation programs and the likely future retirement incomes of the baby boomers.

Since the early 1990s, microsimulation has flourished and the range of its application has become quite broad. This is attributed, as indicated by Harding and Gupta (2007), to at least three factors – the increased availability of suitable microdata; the growing demand by policy makers for the types of analyses that only microsimulation models can provide; and the growing concern about the social and economic impacts of population ageing. Furthermore, the increasing complexity of policy requires complex models to estimate their impact. Edited by Harding and Gupta (2007), the book 'Modelling Our Future: Population Ageing, Social Security and Taxation' and its companion book 'Modelling Our Future: Population Ageing, Health and Aged Care' (Gupta and Harding, 2007) report on a variety of microsimulation models and their vast applications in different research areas. In August 2007, the first General Conference of the International Microsimulation Association – 'Celebrating 50 years of Microsimulation' was held in Vienna, Austria. The conference papers using different categories of microsimulation can be viewed and downloaded at the Conference Web: http://www.euro.centre.org/IMA2007.

Apart from making a major contribution to the development of tax and transfer policies, microsimulation models in recent years have become more common in the research and policy areas of health and aged care (Gupta and Harding, 2007). The models involve pharmaceutical subsidies, human resource issues in health, medical insurance schemes, and aged care, etc. Another fast growing research area is spatial microsimulation, that focuses on predicting the local effects of policy change and service needs of small area populations (Brown and Harding, 2005; Chin and Harding, 2006; Ballas et al., 2006; Holm et al., 2007; Tanton, 2007; Chin et al., 2005).

The above description gives a brief overview and introduction to microsimulation and its application. The following sections will focus on the review of microsimulation models regarding health care systems, which is the main topic of this research.

4.4 Microsimulation in Health Research in Australia

In the late 1990s, NATSEM began to apply microsimulation techniques to health policy issues (Schofield, 1998a). Over the last decade, NATSEM has extended the benefits of its

traditional microsimulation modelling to the health and aged care arenas, including the Australian Pharmaceutical Benefits Scheme, hospital and medical (including doctor) services usage and costs, chronic disease prevention, the need for aged care services and private health insurance.

One of the big advances in health care microsimulation modelling was undertaken by Schofield (1998b; 2000), Percival et al. (1997). The model used the National Health Survey (NHS) conducted by the Australian Bureau of Statistics as the base population. Data from other sources were also used when it was necessary to impute information not recorded in the NHS. The microsimulation techniques were used to create a dataset of individual's private health insurance information. They also described how to age the demographic, socioeconomic and insurance usage characteristics of the NHS records to the target year (Percival et al., 1997).

The first Australian Pharmaceutical Benefits Scheme (PBS) microsimulation model was developed by NATSEM in 1997-98. This was a static microsimulation model that used STINMOD as a base and then added data from the National Health Survey about usage of prescribed pharmaceuticals according to age, gender and concession cardholder status (Walker et al., 1998; Walker, 2000). The model simulated spending on PBS subsidised pharmaceuticals by different types of households; the resultant government outlays under the PBS; and the remaining out of pocket costs (patient co-payment contributions) to the two different classes of consumers in Australia (i.e., concessional patients and general patients).

Until recently, NATSEM's modelling of the PBS had focussed solely on issues of expenditure. Current and future use and costs of PBS medicines, under existing PBS and different policy settings, have been simulated and the distributional effects of policy changes estimated (see for example Abello et al., 2003; Brown et al., 2004; Harding et al., 2004). The current model, known as MediSim, builds on and extends earlier approaches and incorporates variation in the number of drugs used by age, sex and PBS beneficiary category. Significantly, the base data in the most recent model has been changed to the National Health Survey, so it relates use of medicines to health conditions. That was a major advance, which includes far more detailed imputation of drug prices within each of 19 drug groups and 157 drug subgroups; and incorporates a sophisticated forecasting capacity and the capacity to incorporate the impact of changes in drug prices or PBS policy settings (Harding et al., 2004; Brown et al., 2004).

Furthermore, the model investigates which Australian families are likely to be high users of PBS medicines and therefore benefit from the PBS safety net arrangements (Brown et al., 2006a).

Another major health services model developed at NATSEM is HealthMod, which simulates the use and costs of medical and related services by Australian families and individuals under the Australian universal social insurance scheme known as 'Medicare' (Lymer et al., 2007). The model focuses on the use and cost of medical services subsidised through the Medicare Benefits Schedule, especially doctors (both general practitioners and specialists) but also including diagnostic, pathology, imaging and a range of allied health services. The model can investigate and assess the likely distributional impacts of possible policy changes and their likely revenue or expenditure implications for the Australian Government.

The health research team at NATSEM are currently constructing another model called 'HospMod', which includes public acute care hospitals, private hospitals, psychiatric hospitals, and day surgery only clinics (private free-standing day hospital facilities). HospMod will have the capacity to apply alternative policy settings and then quantify the distributional and fiscal consequences associated with the change in the use of the hospital sector.

Apart from the above three models, which are all static microsimulation models, NATSEM developed a small area model for disability and aged care services known as CareMod (Lymer et al., 2006a) – a spatial microsimulation model. CareMod provides detailed regional estimates of the ability of older Australians to undertake various Activities of Daily Living, with the key innovation being the associated generation of small area estimates of the need for different types of formal and informal aged care services.

In addition, the health research team at NATSEM are working currently with two other health models – the Diabetes model and the Dementia model. The Diabetes Model investigates the possible effects of a secondary diabetes prevention program on health and economic outcomes, including the impact of diabetes on labour supply and wider aggregate economic measures (Brown et al., 2006b; Thurecht et al., 2007). Similar to the Diabetes model, the Dementia model projects chronic disease prevention programs for a 45 year period (Nepal et al., 2008). Both models are categorized as population projection, health and economic

outcome models. Furthermore, as a part of the dynamic model, APPSIM (mentioned above), a health module is under construction. NATSEM's first dynamic microsimulation model, DYNAMOD, built in the 1990s, included a health module (Walker, 2007).

In summary, NATSEM has three key kinds of health microsimulation models. First, static models involving MediSim, HealthMod and HospMod which correspond to pharmaceuticals, medical services and hospital services, respectively. In the near future it is expected that these three models will be linked so as to estimate an integrated behavioural model of Australia's health system. Second, a spatial model, CareMod, simulates the disability status of aged care services for elderly people (Lymer et al., 2008). Third, on the dynamic modelling front, NATSEM will have a sophisticated health module built within the APPSIM dynamic model. In addition, NATSEM has Diabetes and Dementia prevention models, which project populations for 45 years.

4.5 Microsimulation in Health Research Internationally

Besides Australia, several other countries have extended microsimulation to their health system and aged care research. This section briefly illustrates the development of health microsimulation models in Canada, the United Kingdom, the United States, Europe, and New Zealand. Canada has probably the longest history, along with Australia, in developing health microsimulation modelling. Traditionally, in countries or areas like the United Kingdom, the United States and Europe, their health and disability systems were crudely modelled in comparison with the taxation and social security type of microsimulation models. While the techniques of microsimulation in health areas are expanding, New Zealand is an example of a country that only recently started to develop a microsimulation model of its health and aged care systems.

4.5.1 Canada

Canada has long utilised microsimulation as a tool for policy analysis. Health Canada established a Microsimulation Modelling and Data Analysis Division (MSDAD) in 1999 (Health Canada, 2005) to enhance the evidence base for policy development and decision

making within Health Canada — in particular to provide data analysis, database construction, and modelling expertise to enable a greater more quantitative dimension to policy analysis.

In recent years, much of MSDAD's focus has been on health related human resource issues and Pharmacare issues, in building databases and related macro and microsimulation models, as well as contributing to other emerging policy issues. They have completed a set of health human resources demand and supply models for physicians and nurses, aiming to project future health human resources requirements as well as employment among physicians and nurses (Gupta and Basu, 2007).

Another major model, PHARMASIM which is an extension of the Canadian Health-Tax Microsimulation Model (CHTSIM), quantifies the impact of changes to provincial Pharmacare programs on households and government expenditures. The current PHARMASIM model has the capacity to simulate both prescription drug benefits and income tax/credit, to assess the interactions between the family/individual drug benefits and the federal and provincial revenues due to changes in either or both current health and tax policies (Nguyen and Gupta, 2007).

Statistics Canada also built a dynamic model, LifePaths, which is a longitudinal microsimulation model of individuals and families (Rowe and Gribble, 2007). First constructed in 1994, LifePaths is used in the areas of health policy, time use analysis and intergenerational equity. The model has evolved greatly since that time and a public release version of LifePaths is available on the Statistics Canada website (www.statcan.ca/english/spsd).

4.5.2 United Kingdom

Microsimulation models in the United Kingdom have been developed mainly for tax and transfer analyses. Researchers from the University of Leicester and London School of Economics have developed the Personal Social Services Research Unit (PSSRU) model and Nuffield Community Care Studies Unit (NCCSU) model of long-term care in the UK and the health care costs associated with the elderly, linking macro and micro simulations (Hancock et al., 2003; Hancock et al., 2007).

The PSSRU microsimulation model is a cell-based model. Cell-based models could be applied to biological and medical problems. Computational approaches used are Monte-Carlo simulations, energy minimisation techniques, solutions of the equations of motion for each individual cell or for each point on the cell membrane. The PSSRU microsimulation model makes projections of three key variables – the future numbers of dependent old; the future levels of long-term care services; and the future expenditure on long-term care. The first stage of the model classifies projected numbers of older people according to age bands, gender, dependency and dependency groups. The second part of the model projects the volume of services demanded, by combining the output of the first part of model with functions that assign receipt of services to each sub-group.

The NCCSU microsimulation model uses respondent-level data of the older population from the British Family Resources Survey to simulate what each older participant in the survey would have to pay towards home care fees. The model simulates single people aged 65 and over, and the older partner in couples where at least one partner is aged at least 65 years. The NCCSU model then passes two variables to the PSSRU model to predict the proportion of home care residents entitled to receive local authority financial support and the average proportionate contribution to home care fees made by such residents.

Most recently, in a program of research on modelling the needs and resources of older people in the United Kingdom to 2030, researchers are trying to combine the outputs from separate long-term care and pension financing simulation models and establish the compatibility of the models (Hancock et al., 2007).

Using a nationally representative sample of people aged 65 years and over, Jagger et al. (2006) explored the effect of different health scenarios on the future numbers of older people with disability at a level that needs social care and developed evidence-based scenarios for the health of the future older population. This research projected that ageing of the population alone, with no alteration in the prevalence of diseases or the age-specific rates of becoming disabled or recovering, would result in a 67 per cent increase in the numbers with disability over the next 20 years.

Using a spatial microsimulation approach, Williamson (1996) estimated the need for care of the elderly and concluded that the microlevel approach is the most suitable for identification

of the full range of circumstances in which individual elderly persons live. Using Geographical information systems, Ballas et al. (2006) analysed the health inequalities in British regions in a 30 year simulation. The SAGE (Simulating Social Policy for an Ageing Society) research group, established in November 1999 with the funding from the UK Economic and Social Research Council, has been constructing and using a dynamic microsimulation model (Evandrou et al., 2007), which generates projections regarding health and long term care needs (Evandrou and Falkingham, 2004).

4.5.3 United States

In the United States, the Transfer Income Model, version 3 (TRIM3) has been used since 1997. This is a comprehensive microsimulation model developed and maintained at the Urban Institute under primary funding from the Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation (refer to the website: http://trim3.urban.org/). Apart from simulating the governmental tax and transfer programs, health programs are a major part of the simulation in TRIM3. This involves simulating Medicare, Medicaid and Employer-Sponsored Health Insurance programs. It can produce results at the individual, family, state, and national levels.

TRIM3 is a descendent of the microsimulation model: the Reforms in Income Maintenance (RIM) model, first developed in 1969. It undergoes constant development and is updated annually to capture the latest changes in tax and transfer programs. Each year, a new input datafile is prepared from that year's March Current Population Survey, the model's code is updated as needed, the database of program rules is updated, and a baseline simulation is run and validated for each program.

The other PC-based simulation of the United States population, the dynamic CORSIM model (Spielauer, 2002), models the US population as well as large-scale government programs. Based at Cornell University and developed under the direction of Steven Caldwell, CORSIM began its development in 1987. Build 507 of CORSIM, the most recent version, was created in October 2007 and the installation program can be downloaded from the web http://mctrans.ce.ufl.edu/featured/tsis/CORSIMUpdate.htm.

As in the UK, the CORSIM model is particularly useful in the modelling of social security programs. Regarding health, CORSIM includes the modelling of four main risk factors for

health — namely smoking, alcohol consumption, sugar consumption and diabetes. It keeps track of disability status, and models institutionalization. With regard to health care finance, CORSIM has been applied to model dental conditions and health, services and expenditures (Caldwell, 1996). Information on conditions and services at the family and individual tooth level are dynamically updated with functions based largely upon the Health Insurance Experiment data. A dental condition is represented as an outcome of a complex sequence of various factors (Spielauer, 2007).

4.5.4 Europe

Across Europe, microsimulation has been used extensively in many areas, but only with limited applications in the health field. EUROMOD – the tax-benefit microsimulation model for the European Union (Sutherland, 2007), which is a unique multi-country microsimulation model across the European Union, focuses on social welfare and tax benefit type simulation. The EUROMOD database brings together micro data from each country within the European Community. The information is updated to a common base year because time periods of data collection varied between the different countries. Programs of health services and education are being added to derive estimates on the distributional effects of non-cash incomes. In addition, the model calculates cash benefit entitlements and liabilities for direct taxes and social insurance contributions on the basis of tax-benefit rules and a representative sample of microdata at the individual level (Figari et al., 2007).

4.5.5 New Zealand

New Zealand is a country with a small population (about 4 million), that has a strong social security heritage. As a tool to assist in assessing the impacts of social security programmes, the New Zealand Ministry of Social Development developed a model known as Microsim in 1997 (Bade and Stott, 2007). The model was based on social security administrative data with regular annual updates. Using administrative data can provide a very informative model for changes to the benefit system but falls down when the system is extended to groups of people not previously eligible. Hence, in the last couple of years, the New Zealand Ministry of Social Development has been developing a new static microsimulation model of the national tax and transfer system, Betsim (Ota and Stott, 2007), by using a rich source of information about income, employment, benefits and family structure changes over the interview year. The primary focus of the model is on benefit recipients and low income families.

Only recently, New Zealand has started to develop its microsimulation models in health services areas. Led by Peter Davis (Professor, Sociologist of Health and Well-Being), a research team at the University of Auckland are working to establish a computer-based model of the primary care system in New Zealand in its social context (Davis, 2008). The model will be used to evaluate systematically a range of scenarios derived from insights on demographic ageing, family and community capacity, and practitioner response. It is expected the model will be of significance not only for New Zealand but internationally as well.

4.6 Microsimulation Research in China

Microsimulation techniques were first introduced into China in the mid-1980s. In 1986, Guo Shaoxi, then a researcher in Chinese Academy of Sciences, published an article in China's Guangming Daily titled 'A widely used economical and mathematical model – an introduction of Microanalysis simulation model'. In that article, he introduced the basic idea and characteristics of the microsimulation methodology. Later on, he detailed the application and actual simulation techniques about microsimulation (Li and Gao, 1999).

After the introduction of microsimulation techniques to China, in the late 1980s, several models were constructed on topics of population simulation, re-employment forecast for urban elderly intellectuals, and education development using Monte Carlo methods (Li and Gao, 1999).

In 1994, funded by the National Natural Science Foundation of China, Li Shantong and Gao Jialing (the then researcher at the Chinese Academy of Social Sciences) developed a microsimulation model on pension insurance reform of enterprises' employees in China (Li and Gao, 1999). This model was a dynamic microsimulation model with process modules of population such as birth, education, marriage, employment, income and death. The model forecast the impacts of two different pension policy scenarios on urban employees in China.

Thus, since the mid-1980s, a few microsimulation models have been established in China, although they have not been widely recognized and used by Chinese governments. As elsewhere in the world for many years, microsimulation in China has been mainly used in the

fields of population, income and taxation, with limited application in health systems. Relatively recently, Xiong et al. (2005; 2007), co-operated with the Medical Insurance Management Bureau of Zhenjiang, Jiangsu Province, developed a microsimulation model for policy research of the urban medical insurance reform in Zhenjiang. The program was supported by the National Natural Science Foundation of China. The research used the methodology of microsimulation to simulate the implementation of the medical insurance scheme for all insured urban employees and retirees in Zhenjiang. As mentioned before in Chapter 3, Zhenjiang was chosen as one of two pilot programs for medical insurance reform in early 1995. Using the established model, three medical insurance policy settings were simulated over the five-year forecast period 2002-2006. The implementation effect of the medical insurance policy for urban employees was predicted on the basis of the microsimulation model (Xiong et al., 2007).

In the last couple of years, the Central Chinese government has realized the importance of using advanced techniques like microsimulation for assessing possible policy decisions in the areas of income, taxation and social security systems. The Chinese government sent two working visitor delegations in November 2006 and July 2007 respectively to Canberra, capital of Australia. The participants of the delegations included representatives from Chinese government agencies like the National Development and Reform Commission, Ministry of Finance, Ministry of Health, and the Ministry of Labour and Social Security. Their objectives were to better understand the Australian system of income distribution, income distribution analysis, advice and monitoring system and social security systems; and to start to gain the knowledge required to set up a static tax-benefit microsimulation model in China. Later on, in November 2007, two Chinese officials from the National Development and Reform Commission came to NATSEM – the National Centre for Social and Economic Modelling at the University of Canberra – to learn the microsimulation techniques used in income distribution modelling and to review and evaluate the availability or applicability of microsimulation models to China. These activities show positive signs that the Central Chinese Government has recognized that microsimulation techniques can be potentially powerful tools for policy making and that building policy-support microsimulation models in China is on the agenda.

4.7 Summary

This chapter provided an introduction to microsimulation and its application in different areas, such as income and tax distribution, social security systems and, in particular, health care systems. The application and development of health related microsimulation models was reviewed, first internationally and then in China. Australia and Canada are probably the leading countries in adopting microsimulation techniques in the health research area, with comprehensive models of health services and aged care. In countries and areas like the United Kingdom, the United States and Europe, traditionally, health and aged care projections have typically been crudely constructed in comparison to the sophistication of their static microsimulation models of taxation and social security. Very recently, countries like New Zealand and China have started to develop health microsimulation models.

Microsimulation modelling has traditionally been applied to income and tax distribution and social security systems and only recently – over the last ten years – to the health field. As a result, there are still only a few health microsimulation models developed worldwide. This research contributes to this growing body of work, both in terms of the ongoing development of microsimulation methodologies and techniques as well as to its application in new countries and policy settings. By creating a microsimulation model, this research aims to predict and evaluate the behaviour of individuals under the medical insurance system for Chinese urban employees and residents.

The current PhD project draws on the previous research on an urban medical insurance scheme for the city of Zhenjiang, as described in Section 4.6, where the author was a lead researcher on the project. This earlier work provided useful background and experience in modelling health policy settings. One of the objectives of the current PhD research is to expand this previous work to a larger city and a wider research area. Compared with the earlier Zhenjiang work, the current research has at least four significant advantages and improvements.

Firstly, this project is a new study area with specific characteristics, problems and challenges. As a capital city located in southwest China, Kunming is quite different from the city of Zhenjiang in both geographic and demographic terms. In addition, its health care services are much more complicated and diverse. This research aims to advance the modelling techniques

in a new area.

Secondly, the medical insurance policy in specific areas, such as Kunming, not only has similar properties to other urban areas in China, but also has its own characteristics. In principle, the Chinese Central Government has established the guidelines for the basic medical insurance system. However, due to variations in the organization and management of local governments, the implementation mode of medical insurance system in Kunming is different from Zhenjiang. In the implementation process of the medical insurance system, policy settings have varied with time. The policies associated with the medical insurance scheme are continuously responding to different problems which need to be considered in the research.

Thirdly, in this research, there are more challenging issues surrounding data sources, such as more complex and larger datasets. In addition, there are many more sophisticated and detailed variables to be considered. In addition to the administrative records data from the Bureau of Labour and Social Security of Kunming, this research blends data from the 2000 National Population Census, the compiled results from the 2005 Population Sample Survey, and the edited results of the second and the third National Household Health Surveys conducted in 1998 and 2003. The information from the population census and the sample survey help to predict the number and characteristics of potential employees in future years. Together with the health survey results, the project considers the impact of medical insurance policy on the distribution of families. This research is also expected to make an academic contribution by advancing methods in microsimulation.

Fourthly, the most important, this research expands the target population from employed individuals to urban residents who are not in the labour force. This research creates static microsimulation models to evaluate medical insurance schemes, not only for urban employees but also for urban residents. As early as 2005, the beginning of this research, modelling medical insurance scheme has been considered to expand to urban residents – the pilot program for urban residents only started in September 2007. The result is helpful for policy makers to make timely adjustments and improvements of the medical insurance scheme.

PART II CONSTRUCTION OF THE MODELS

CHAPTER 5 MODELLING MEDICAL INSURANCE FOR URBAN EMPLOYEES

5.1 Introduction

This chapter aims to model the medical insurance scheme for urban employees and retirees of Kunming. The model set up in this research takes each insured individual as a basic simulation unit and selects those items from the insured participants' personal record datasets that have a direct or indirect relationship with medical expenses as predictive variables. The basic time unit that the model simulates is a year. With 2006 as the commencement year, the model forecasts medical service expenses and medical insurance policy settings for five years until 2010.

To provide a brief overview, the model constructed in this project firstly considers monthly payments for the medical insurance premium, and simulates the insurance participants' medical services usage for the forecasting year. The model then considers changes in the participants' age group, new entry, income adjustment and increases in different types of medical expenses. The model then proceeds into the next year, until the end of the simulation period is reached. Finally, the model aggregates the annual participants' medical expenses according to different categories of medical services, total medical expenditure and balances of different kinds of medical insurance funds for the whole simulation period.

The parameters which have important relationships with the medical insurance policy settings considered in the research include: the assumed rates of increase in income for different age groups; the contribution rates by employees and employers to the medical insurance scheme; the proportion allocated to the social pool fund and the personal savings accounts; the distributions of different kinds of medical expenses; the threshold payment for hospitalization treatment; and the maximum coverage under the social pool fund or the serious illness fund.

The microsimulation base datasets come from the original administrative individual level data of urban employees and retirees provided by the Bureau of Labour and Social Security of Kunming. The model is mainly composed of the following five modules:

- Participant module – Simulates death cases, and new entries into the insurance scheme.
- Clinic module – Forecasts medical costs in clinic services and pharmacy medications.

- Chronic disease module – Predicts medical expenses due to chronic disease.
- Special check-up module – Predicts medical expenses due to special check-up.
- Hospitalization module – Projects medical costs in hospitalization treatments.

According to the characteristics, the above modules can be categorized into two parts: population estimates (the first module) and medical expenses (the other four modules). Regarding the validation of the established model, those parameters which have significant effects on policy settings – such as number of insured population, individual's age, monthly income, and distributions of different types of medical expenses – are adjusted annually. The output results from the simulation are compared with the actual data in 2006 and the model aligns to guarantee the precision of the simulation. If necessary, adjustments are made for the number of population, monthly income, clinic and pharmacy expenses, and hospitalization expenses, respectively.

The next section introduces Kunming's basic medical insurance system for urban employees. Then data sources to be used in constructing the model are uncovered, followed by the section of describing the framework of the model. The following sections in this chapter discuss the construction of the input base file, followed by the simulation processes in two parts as mentioned above: population estimates and simulation of medical expenses.

5.2 Medical Insurance System for Urban Employees

Kunming commenced its new basic medical insurance system of urban employees in April 2001. About 1.08 million urban employees in Kunming were covered by the scheme at the end of 2005, including employees and retirees of all government agencies, public institutions, enterprises, mass organizations and private non-enterprise units. By the rule of the scheme, individuals employed in a flexible manner can also participate in the medical insurance scheme. The number of insured members has been growing as the Kunming government tried to broaden the coverage of the medical insurance scheme.

After a couple of years of creating the medical insurance scheme, networks covering Kunming's administrative region and medical institutions have been established. In the meantime, to meet the medical demands of different groups of people covered by the medical

insurance, the Kunming's Municipal Government has established and improved a multi-level medical security system to reduce medical burdens of insured individuals (Kunming Medical Insurance Centre, 2005). Thus, a variety of medical insurances, such as insurance for large medical expenses, enterprises' supplementary medical insurance, insurance for work related injuries and maternity insurance, have been set up to guarantee reasonable health benefits to insured individuals.

Like other urban areas in China, the basic medical insurance funds in Kunming include the basic medical insurance pool fund (Social pool fund) and the basic medical insurance personal savings account (Personal savings account). In a whole, the payment mode for medical expenses in Kunming is like the Separate block pattern (as described in Section 3.3). The social pool fund – managed by the Bureau of Labour and Social Security – is mainly responsible for the hospitalization expenses, while the personal savings accounts – managed by individuals – for the outpatient treatment fees. Figure 1.2 in Chapter one presented the Kunming payment arrangements to medical costs, involving different health savings. From 2004 onwards, Kunming has been conducting the following medical insurance system for urban employees and retirees (Kunming Medical Insurance Association, 2004).

- **Levy of the medical insurance fund**

The medical insurance fund mainly comes from premiums contributed by both employers and employees under the medical insurance scheme.

The premium paid by the employers is 10 per cent of the employees' total wage bill in the previous year, while that paid by the employees is 2 per cent of their wages. For employees whose annual wages are more than 300 per cent of the average annual wage, their premium contribution is based on 300 per cent of the average annual wage. For employees whose annual wages are less than 60 per cent of the average annual wage, their premium contribution is based on 60 per cent of the average annual wage. For example, the average annual wage in 2005 was 14,500 Yuan, with 60 per cent of it being 8700 Yuan. If an individual's annual wage in 2005 was less than 8700 Yuan, then his or her premium contribution in 2006 would be 174 Yuan (2 per cent of 8700), and his or her employer would pay 870 Yuan (10 per cent of 8700) annually. Such rules prevent insured individuals from paying premiums too much or too little for. Retirees are exempted from paying the premiums. The medical insurance premiums do not pay the tax.

The contributions collected from the employers and employees are distributed to the personal savings account and the social pool fund.

- **Personal savings accounts**

The personal savings accounts are managed by individuals themselves. In addition to the individual's contribution, about 30 per cent of employer's contribution goes to the personal savings accounts. The percentage of the employer's premium which goes to personal savings accounts differs according to age: 1.5 per cent of the wage bill for participants under 35 years of age, 2 per cent of the wage bill for participants aged 35-49 years, and 2.5 per cent of the wage bill for participants aged 50 years and over. For retirees, 4.5 per cent of their pensions goes to their personal savings accounts. The allocation rules are detailed in Table 5.1.

Table 5.1 Composition of personal savings accounts

Individual status	Employer's premium	Individual's premium
Employee aged under 35 years	1.5% of annual wage	2.0% of annual wage
Employee aged 35-49 years	2.0% of annual wage	2.0% of annual wage
Employee aged 50 years and over	2.5% of annual wage	2.0% of annual wage
Retiree	4.5% of annual pension	

The personal savings accounts are for the payments of basic medical treatments, which include medical charges for clinic services and medications listed in the medical insurance scheme. In addition, the personal savings accounts are responsible for medical expenses of hospitalization services under the threshold payment (a certain amount of money should be paid by patients in order to trigger the social pool fund), and a small proportion shared with the social pool fund for hospitalisation expenses. When the personal savings accounts are exhausted, the excess fees should be paid by individuals directly.

- **Social pool fund**

After paying for the personal savings accounts, the remaining employers' contributions go to the social pool fund, which is managed by the local governments. The social pool fund covers different types of medical expenses, involving a large part of inpatient services expenses beyond the threshold payment, fees for clinic emergency services, and expenses incurred in treatments for chronic diseases and special clinic check-ups.

The threshold payment for hospitalisation is an individual payment required to trigger the social pool fund, which is about 8 per cent of the average annual wage in the previous year of employees for large hospitals. The same rates are 6 per cent for medium hospitals and 5 per cent for small hospitals respectively. Medical expenses less than the threshold are paid by the personal savings accounts or by the individuals concerned. The expenses that exceed the threshold are covered mainly by the social pool fund, of which the individual shares a small part of the bill (Table 5.2). The maximum annual medical expense (Ceiling) covered by the social pool fund per person is about four times the average annual wage of employees, which has been 49,000 Yuan from 2004 onwards.

Table 5.2 Proportion shared by individual after the threshold for hospitalization costs

Individual status	Large hospital	Medium hospital	Small hospital
Employee	15%	12%	9%
Retiree	11%	8%	5%

Setting the different threshold payments by hospital size is to encourage patients go to smaller hospitals for miner disease, which on average cost less than the larger hospitals. The policy settings also intend to ease the medical treatment pressure on the larger hospitals. When an insured individual is admitted to a hospital for a second time in a calendar year, the individual's threshold payment falls to 30 per cent of the initial threshold. When an individual has three times or more of hospitalisation services in a year, from the third time of hospitalization onwards, the individual does not need to pay the threshold any more.

Except for hospitalization services, the social pool fund also subsidises chronic diseases services (e.g. diabetes, high blood pressure, severe heart disease). In a year, a chronic disease patient pays 720 Yuan as a threshold to get reimbursement from the social pool fund. After the threshold, regardless of employee or retiree, for all level of hospitals, the social pool fund covers 80 per cent of the medication fees listed in the medical insurance scheme, while the patient contributes the remaining 20 per cent. The maximum payment covered by the social pool fund is 2,000 Yuan in a year.

- **Serious illness fund**

The social pool fund covers medical expenses up to four times the average annual wage of employees (49,000 Yuan from 2004 onwards). If the incurred expenses of hospitalization

exceed this maximum coverage, the insured patient may get a benefit from a large sum fund – serious illness fund. Participants (including both employees and retirees) submit 12 Yuan per person annually while employers submit 0.6 per cent of the previous annual average wage or pension for each individual to join this serious illness fund. As the natural extension of the social medical insurance scheme, all medical insurance participants are required to be written in the serious illness fund scheme.

The amount of hospitalization expenses beyond the coverage of the social pool fund are covered by the serious illness fund and the individual jointly, in which the individual contributes 10 per cent of the expenses. In one calendar year, the maximum expense covered by this large sum fund is up to about three times the ceiling of the social pool fund, which has been 150,000 Yuan from 2004 onwards.

- **Government official fund**

The Government official fund is a kind of medical supplement fund for government officials and civil servants, which is financed by Kunming Municipal Government or the town governments. Commenced simultaneously with the medical insurance scheme in April 2001, the amount of subsidies of the Government official fund varies with townships. Basically, the amount of medical subsidy for each official is 5 per cent of the individual's annual income, of which 4 per cent goes to the personal savings account, while the remaining 1 per cent goes into the Government official fund to subsidize officials' hospitalisation costs.

The inpatient services (including patient who has clinic services for special diseases) under the Government official fund beneficiary can claim the subsidies from this fund. For medical expenses within the ceiling of the social pool fund, 30 per cent of self payment for employees (40 per cent for retirees) can be reimbursed from the Government official fund. For hospitalisation expenses above the ceiling of the social pool fund but within the maximum coverage of the serious illness fund, the proportion of self payment is 10 per cent as mentioned above. For this part of medical expenses, employees can have 50 per cent of their self payments reimbursed from the Government official fund, whilst retirees can have 60 per cent.

5.3 Data Sources Used in the Model

The thesis focused on modelling participants under the medical insurance scheme. The main data used in modelling medical insurance for employees are administrative medical records of medical insurance participants of Kunming. In March 2005, the Bureau of Labour and Social Security of Kunming provided the personal information of the insured individuals and the expenditure records of their medical services for the period of 2001-2004. Later on, in August 2006, the Bureau provided the same datasets for the year 2005. The datasets basically include five kinds of medical insurance records for each insured individual, which are described briefly as below.

- Basic individual datasets

These datasets provide individuals' basic information over the period 2001-2005, include mainly the following variables: Personal identifier, Work unit identifier, Gender, Nationality, Date of birth, Date of initial job, Employment status, Education degree, Individual status, Date of entry to the medical insurance scheme, Blood type, Marital status. These variables provide the demographic information of individuals who joined the medical insurance scheme.

- Individual status alteration datasets

These datasets provide individual status alteration records of medical insurance scheme participants over the period of 2001-2005, include the following variables: Personal identifier, Type of alteration (e.g. newly registered participant, quit insurance scheme, retired), Reason of alteration, Date of alteration.

- Medical insurance premium datasets

These datasets record the amount of contributions by individuals and their employers to the medical insurance scheme over the period of 2001-2005. The datasets include the following variables: Personal identifier, Employment status, Corresponding period of premium, Monthly income of participants, Amount of money contributed by employees, Amount of money that went to the personal savings accounts from employers, Amount of money that went to the social pool fund from employers.

- Medical expenses datasets of hospitalization and special disease treatment

These datasets provide the medical expenditure records of insured participants in both hospitalization and special disease services for the year from 2002 to 2005. The datasets include mainly the following variables: Personal identifier, Employment status, Hospital identifier (used to distinguish the level of a hospital, like large, medium, or small), Total medical service cost, Expense shared by the social pool fund, Type of payment (e.g., admitted to hospital, special disease, emergency service, chronic disease treatment), Expense shared by the serious illness fund.

- Medical expenses records of general clinic services and medications

These datasets provide the medical expenditure records of clinic services and medications in pharmacies of insured participants over the period of 2001-2005. The datasets mainly have the following variables: Personal identifier, Employment status, Total medical services cost, Date of medical services, Types of payments (general clinic services or medications in a pharmacy).

The above five kinds of datasets were linked up with each other through the unique personal identifiers and formed the whole medical insurance data sources of the participants for the period of 2001-2005. This made up the detailed information for the modelling construction. In these five kinds of data sources, the first three provide the demographic information of medical insurance participants, individual status alteration and insurance premium contribution records, while the last two give the information on the medical expenses.

However, these raw datasets contained some errors and unreasonable records, especially for the personal information. It is necessary to check the errors and resolve the unreasonable problems in advance.

In the initial analysis for the raw datasets, the mistyping codes were corrected and some codes for one variable with a similar meaning were combined. For example, male in a variable of ‘Gender’ was coded ‘1’, but some records had code ‘01’ or character ‘male’. Similar problems were detected with variables of ‘Employment status’, ‘Blood type’ and ‘Marital status’. These problems needed to be resolved manually. Other data processing included the combination of some variable codes. For example, there were more than ten types of employment status in the raw datasets for the variable of ‘Employment status’. But the

frequency analysis showed that, in general, there are mainly two kinds of participants, that is, employees (may work in enterprises, self employed, employed in a flexible manner, self employed after retired etc.) and retirees (retired from work, settled in different places after retired). In the data processing, such variable codes were combined.

Primary settlement with the raw datasets for the year 2005 was then made, particularly for the individual's demographic information. Frequency procedures were used in SAS software to get distributions of variables such as 'Age', 'Gender', and 'Employment status', in order to find the percentage of missing records. For example, there were 28,308 records with their age missing (accounted for 3.22 per cent of the total participants) in the Basic individual dataset because of missing entry date (an individual's age was obtained by scheme entry date minus his or her date of birth). This problem was resolved by using the entry date records in the Status alteration dataset, which records the scheme entry date for each individual. In doing so, the two datasets (Basic individual dataset and Status alteration dataset) were sorted by the variable of 'Personal identifier' respectively and then merged by 'Personal identifier' to compensate for the missing scheme entry date.

After the initial analysis of the raw data, and deleting variables of no use because of the high frequency of missing values, the basic information for medical insurance participants and their medical expenses records were created for the period of 2001-2005. Finally, there were 793,987 personal records at the end of 2005 under the administration of the Kunming Municipal Government. Besides this population in the medical insurance scheme, there were about 282,900 participants under the same medical insurance scheme in Kunming, but managed independently by Provincial government. There is no information about this population of the Provincial participants. In modelling medical insurance policy for urban employees, the target population is medical insurance participants who are under the administration of the Kunming Municipal Government.

5.4 Framework of the Model

5.4.1 Construction of the Base File

This section discusses the framework of the model, with the construction of the base file coming first. The initial base file was constructed for 2005, with 2006 being the first

simulation year. The data sources used in this part of the model were administrative medical records of the basic medical insurance scheme participants provided by the Bureau of Labour and Social Security of Kunming. As mentioned in Section 5.3, a total of five kinds of medical insurance records for each insured individual, which are linked through the unique personal identifiers, were included in the administrative data sources which are outlined in Table 5.3.

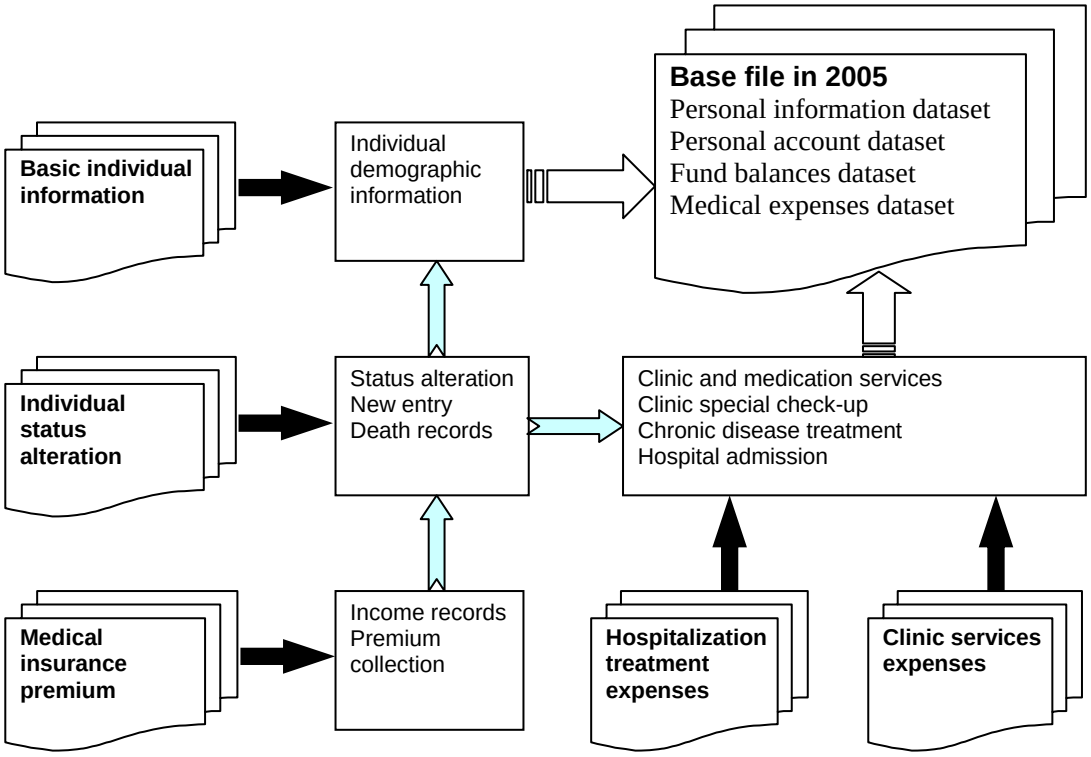
Regarding the corresponding years of these datasets, except for the hospitalization treatment expenses which were provided for the years from 2002 to 2005, the other four datasets were for the period 2001-2005. Due to the incomplete records of the dataset in 2001, and following the advice of the Bureau of Labour and Social Security of Kunming, datasets in 2002-2005 were used regularly when establishing the empirical parameters in modelling the medical insurance scheme. The process of combining these five datasets is outlined in Figure 5.1.

Table 5.3 Administrative datasets used in modelling medical insurance scheme

Datasets	**Description**
Basic individual information	Individuals' basic demographic information under the urban medical insurance scheme over the period of 2001-2005
Individual status alteration	Individual status alteration records of medical insurance scheme participants over the period of 2001-2005
Medical insurance premium	Amount of contributions by individuals and their employers to the basic medical insurance scheme over the period of 2001-2005
Hospitalization treatment expenses	Medical expenditure records of insured participants in both hospitalization and special disease services for the year 2002-2005
Clinic services expenses	Medical expenditure records of clinic services and medications in pharmacies of insured participants over the period of 2001-2005

The five data sources provided different information on demographic characteristics, insurance payments, and medical services. They were connected by the unique personal identifier contained in each dataset. Combining the five data sources, the main output data for 2005 was produced. This comprised four individual level datasets – personal information dataset, personal account dataset, fund balances dataset and medical expenses dataset. The output, as a base file in 2005, acts as input data for simulating the medical behaviour of urban employees and retirees under the medical insurance scheme over the period of 2006-2010.

Figure 5.1 Datasets used in the research and their functions



5.4.2 Simulation of Medical Services

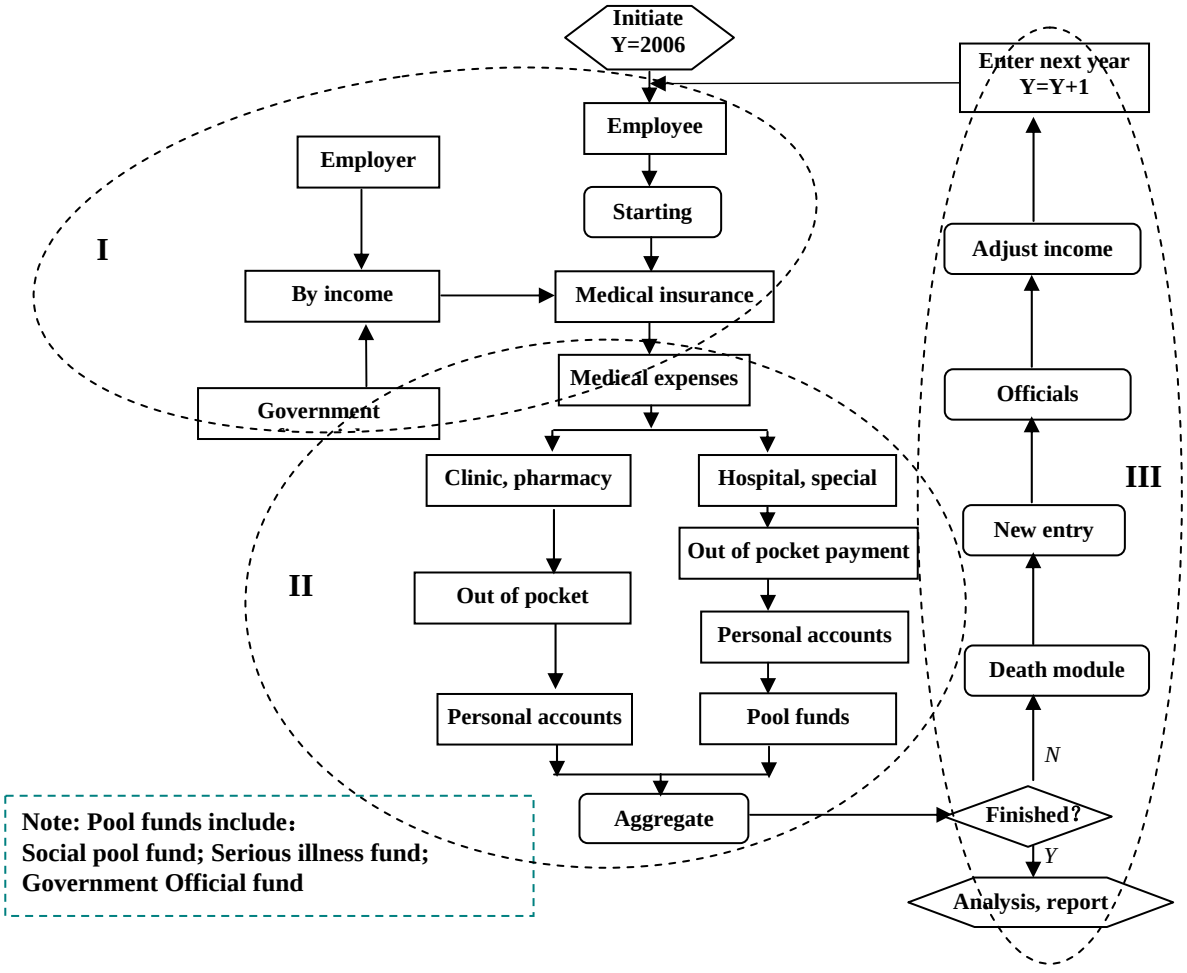
Based on the base file for the year 2005, the medical services behaviour of insured individuals under the medical insurance scheme was modelled, with 2006 as the first out-year. The modelling framework is divided into three parts, as shown in Figure 5.2. It should be noticed that the flow chart of medical services is for all insured employees and retirees, including officials. For officials, they can access to a further fund for their incurred medical expenses.

The first part (**I**) simulates the collection and allocation of the medical insurance premiums. The premiums, which are based on the individual's income, are contributed by employers, employees and governments following the medical insurance policy rules. After collecting the insurance premiums and depositing money into the social pool fund and the personal savings accounts, the social insurance system is ready to benefit the insured individuals.

The second part (**II**) predicts each individual's medical services usage in occurred medical expenses. These expenses are classified into two categories, clinic services and hospitalization services. Clinic services include clinic treatments (like seeing a General Practitioner) and medications provided through pharmacies, and are paid either by patients themselves or by their personal savings accounts. Hospitalization services mainly include hospital admission,

but also include some special diseases and chronic disease treatments. The costs of the hospitalization services are shared jointly by the different kinds of pool funds, out of pocket money or the personal savings accounts, in which the pool funds cover a large part of the bill. Here, the term 'pool funds' indicates the social pool fund, the serious illness fund and the Government official fund. After simulating the medical services usage of insured individuals for a financial year, the model goes to the third part.

Figure 5.2 Flow chart of medical services simulation



The third part (**III**) of the model is for adjustment and preparation of the dataset for the next year's simulation, and for the aggregation of results after completing the simulation. This part is responsible for simulating the events of death and new entries to the medical insurance scheme (according to the relative probabilities derived from the real information), and

adjusting insured individuals' annual income. After finishing the simulation, the model produces the output and aggregates the results.

5.5 Construction of Medical Insurance Micro Datasets

5.5.1 Medical Insurance Participants Micro Records in 2005

The starting point for the construction of the medical insurance micro datasets (or **base file**) is the basic information of medical insurance scheme participants at the end of 2005. In the individual basic information datasets, there were 813,801 persons registered in the medical insurance scheme in 2005 (which included the individuals who altered their insurance status in 2005). When constructing the basic individual dataset at the end of 2005, the records of individuals who quit the scheme need to be removed. This procedure was completed together, with the use of the individual status alteration dataset (Table 5.3) in 2005.

According to the individual status alteration dataset, a total of 359,187 individuals altered their insurance status in 2005, which included new scheme entry, scheme quit, retired and re-employed. The date and type of alteration were picked up according to the date of alteration. It was found that there were 231,189 persons who made a one time alteration, 95,308 persons who had a second alteration, and 18,009 who had a third alteration and so on. This sort of record detection terminated after 10 times of status alteration, which left only 6 remaining records. Then, by reversing the procedure 10 times, the scheme status of participants was decided due to their last status alteration. Eliminating the records of individuals who quit the scheme, a dataset containing 790,186 individual records was obtained. This dataset did not contain the records of individuals who died in 2005. However, when estimating the population of insurance participants and analysing the medical expenses in 2005, it is important to consider the individuals who died in that year.

After adding the death records onto the individual information dataset, the number of individual records at the end of 2005 totalled 793,987. This figure was very close to the target population of 794,130 at the end of 2005, which was reported by the Bureau of Labour and Social Security of Kunming (Kunming Medical Insurance Centre, 2006). So no further adjustment on the number of the scheme participants was needed. How the number and

distribution of death records for the period of 2001-2005 was obtained is discussed later in this section.

5.5.2 Age Processing and Adjustment for Insured Individuals

In the created dataset for the year 2005, there were quite a few records which had apparent mistakes about data entry/typing the age of participants. Some employees were under 15 years of age, some employees were above 85 years old but still at work, and some individuals were aged less than 35 years but had already retired. These events are assumed impossible in practice. Such mistakes were therefore checked and revised.

First, for individuals less than the legitimate age of the labour force, there were 118 records with age less than 15 years (some even as young as 7 years old). Such mistakes happened due to typing errors on variables of 'Date of birth' or 'Date of initial job'. The revision procedure first chose the smaller one of these two dates to be the date of birth of the individual. Together with the use of the variable of 'Date of entry scheme', the procedure got a new age variable, which was then updated to the end of 2005. This resolved the age problem of 41 records. Next assuming the later one between 'Date of birth' and 'Date of initial job' as the individuals' initial job date, the individuals' age was assigned randomly between 15 and 20 years old at the time when they started their initial job. Finally, two records with a date of birth in 2049, which was assumed to be 1949, were adjusted to the age of 56 at the end of 2005.

Second, it was assumed impossible in practice for participants aged over 85 years still to be in a state of employment. In the original dataset for 2005, 63 individuals were found to be greater than 85 years old and were still at work. The records on the medical insurance premiums indicate they were employed individuals, and errors occurred in their age. This problem was resolved by randomly making these records have an age between 50 and 80 years. In China, the mandatory retirement age is 60 years for male, 55 years for female. Some individuals may be self-employed or have a job after retirement. The model assumes a few of them may work until 80 years old.

Third, a further problem was for the participants who were aged less than 36 years and were in a state of retirement. In the original individual information dataset in 2005, there were 105 such records. It is supposed there were some typing mistakes about these records. First referring to the variables of 'Date of birth' and 'Date of initial job', the individual's age was

revised as for individuals less than 15 years old. This resolved the age problem of 40 records. For the remaining 65 records, the revision was achieved by assigning the records arbitrarily an age from 36 to 45 years.

5.5.3 Death Record Dataset for 2001-2005

In the initial individual records, there were no codes indicating the death of the medical insurance participants. However, in the variable of 'Reason of alteration', there were some words describing the reason of death, like 'dead of illness', 'dead at accident', 'dead on certain day'. By picking up these kinds of words manually, coding them in a new variable and deleting the repeated records based on their personal identifiers, 14,124 death records for the period of 2001-2005 were obtained. The events of the death records are summarised in Table 5.4. This gives an average annual death rate of 0.5007 per cent over the period of 2002-2005. Because of incomplete records of death, the annual death rate in 2001 was significantly less than the death rates of the following years. As a result, the death rate in 2001 was not included when calculating the average annual death rate.

Table 5.4 Death of medical insurance participants in 2001-2005

Year	Number of participants	Number of deaths	Accumulative frequency	Proportion of deaths (%)
2001	377676	291	291	0.0771
2002	532706	2373	2664	0.4455
2003	661038	3573	6237	0.5405
2004	756996	3823	10060	0.5050
2005	793987	4064	14124	0.5118

In addition to the total number of deaths, the death rates by gender across age groups were calculated (Table 5.5 and Table 5.6). Because of incomplete death information in 2001, due to the first year commencement of the scheme, the death rates by gender across age group in 2001 were quite different from the other four years. In forecasting personal medical behaviour and medical insurance policies over the period of 2006-2010, the average death rates over 2002-2005 were used to project the death events. On average, the death rate of males in each age group was greater than that of females. In total, the male death rate was 1.78 times the female rate.

Table 5.5 Age group death rates of males (2001-2005)

Year	Number					Rates (per thousand)				
	⩽34	35-49	50-64	⩾65	Total number	⩽34	35-49	50-64	⩾65	Total rate
2001	4	16	47	127	194	0.0804	0.2543	0.8673	4.3571	0.9899
2002	35	99	374	1095	1603	0.5003	1.0766	4.4636	23.1903	5.4724
2003	43	152	525	1653	2373	0.5057	1.3631	5.0157	27.3214	6.5605
2004	66	178	612	1808	2664	0.6881	1.4875	5.2957	27.7599	6.7226
2005	60	195	761	1725	2741	0.5678	1.5188	6.1504	23.6195	6.3623
Average death rate over 2002-2005 (0.1%)						0.5655	1.3615	5.2314	25.4728	6.2795

Table 5.6 Age group death rates of females (2001-2005)

Year	Number					Rates (per thousand)				
	⩽34	35-49	50-64	⩾65	Total number	⩽34	35-49	50-64	⩾65	Total rate
2001	2	11	23	61	97	0.0431	0.2008	0.4777	3.0511	0.5728
2002	16	57	160	537	770	0.2545	0.6833	2.2372	17.0563	3.0886
2003	29	77	248	846	1200	0.3892	0.7402	2.8507	20.7135	3.9168
2004	21	82	256	800	1159	0.2527	0.7132	2.7311	17.7054	3.4392
2005	21	83	335	884	1323	0.2312	0.6878	3.3030	17.6004	3.6430
Average death rate over 2002-2005 (0.1%)						0.2819	0.7061	2.7805	18.2689	3.5219

5.5.4 Add Extra Personal Information

After completing the construction of the 2005 basic individual information dataset, extra personal information (like individual incomes) was added to this dataset, and a personal savings account was set up for each insured participant. The average monthly income for each participant was added annually, referring to the datasets of collecting insurance premiums. The accumulative balance of the personal savings account at the end of 2005 was calculated according to the different allocation rates of the medical insurance scheme for different groups of people.

In determining the income information for each person, the frequency distribution of monthly premium payment for each year was analysed. Reversing from 2005 to 2001, the number of months per person for premium payment in each year was determined according to individual's entry date to the medical insurance scheme. Table 5.7 illustrates the records of the monthly premium payments and monthly income by age group in 2005. In 2005, there were a total of 793,987 participants, of which 777,117 had payment records, giving a payment rate of 97.88 per cent. Here the age group was classified into five categories — three age categories for employees in accordance with the age classification under the medical insurance scheme and two age categories for retirees.

Table 5.7 Monthly premium information by age group in 2005

Age group	Number of participants	Number of records	Payment rate (%)	Average monthly income (Yuan)	Minimum (Yuan)	Maximum (Yuan)
Emp≤34 years	196410	189614	96.54	1176	450	3342
Emp 35-49 years	243227	240111	98.72	1249	468	3342
Emp≥50 years	91893	91424	99.49	1179	336	3342
Ret ≤64 years	139362	137544	98.70	763	111	3320
Ret ≥65 years	123095	118424	96.21	760	108	3108
Total	793987	777117	97.88			

Note: Emp – Employee, Ret – Retiree

Table 5.8 presents the payment distribution of number of months to the scheme in 2005. The figure '99' in the first column indicates records with missing monthly income. Two things need to be done for these missing records: one is to compensate for the income, the other is to determine how many months the individual paid the premium in that year. The monthly income of these missing records was imputed by randomly picking up the records with known income by gender across age group. The number of months for premium payment for the missing income records was determined by the date of their entry to the scheme. Table 5.9 presents the results after compensation for the income missing records. After the imputation of the income missing records, the first two totals are exactly the same. Comparing the income on average, minimum and maximum with Table 5.7, the results are good and reasonable.

Table 5.8 Distribution of number of monthly payments to the scheme

Number of months	Participant frequency	Percentage	Accumulative	Accumulative percentage
1	5576	0.70	5576	0.70
2	4545	0.57	10121	1.27
3	6211	0.78	16332	2.06
4	5309	0.67	21641	2.73
5	4417	0.56	26058	3.28
6	4856	0.61	30914	3.89
7	4816	0.61	35730	4.50
8	9043	1.14	44773	5.64
9	4597	0.58	49370	6.22
10	5506	0.69	54876	6.91
11	12472	1.57	67348	8.48
12	709769	89.39	777117	97.88
99	16870	2.12	793987	100.00

Note: '99' in the first column indicates missing records.

One may notice that, there is a large leap in values between months 11 and 12 in Table 5.8. This is plausible, because a large part of individuals should contribute 12 months to the scheme for one year. While only a small proportion of individuals (such as new participants, quit the scheme due to death) would have less than 12 months contribution.

Table 5.9 Monthly income by age group in 2005 after imputation

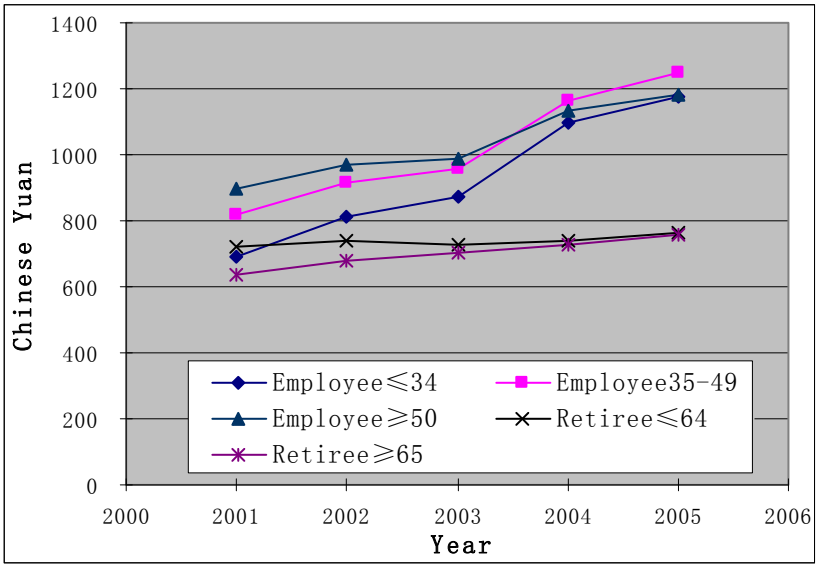
Age group	Actual population	Population after imputation	Average income (Yuan)	Minimum (Yuan)	Maximum (Yuan)
Emp≤34 years	196410	196410	1175.67	450.00	3342.25
Emp 35-49 years	243227	243227	1249.58	468.25	3342.25
Emp≥50 years	91893	91893	1179.26	336.00	3342.25
Ret ≤64 years	139362	139362	763.59	111.00	3319.71
Ret ≥65 years	123095	123095	760.58	108.00	3107.50
Total	793987	793987			

Note: Emp – Employee, Ret – Retiree

Similarly, the missing values of income were imputed for each year of 2002-2004, of which the number of payment months for each individual in 2002 was doubled (due to only the information at the first half of that year being provided). Regarding the year 2001, it was not possible to do the same compensation to estimate the income for individuals without income records because of very high income missing rate (83.5%). This problem was solved by using estimated adjustment coefficients through linear fitting incomes of 2002-2005 across each age group.

Figure 5.3 gives the average income trends over the period of 2001-2005. On average, the incomes of all age groups showed increases. However, both the amount and growth rate for each group of employees are bigger than those for the two groups of retirees. The income of retirees only showed a slight increase. The income gap between employees and retirees was broadened during this period. This, as a result, leads to low balances of the personal savings accounts for retirees.

Figure 5.3 Monthly individual income trends of 2001-2005 by age group



After fixing monthly income, a variable representing the personal savings account was created for each individual across five different age groups. This was done according to the allocation premium rules for each age group under the medical insurance scheme. Table 5.10 shows the accumulative (or cumulative) amount in personal savings accounts by age groups at the end of 2005.

Table 5.10 Accumulative amount in personal savings accounts at the end of 2005 (Yuan)

Age group	Population	Average accumulate	Standard deviation	Minimum	Maximum
Emp≤34 years	196410	1116	754	69	5014
Emp 35-49 years	243227	1698	900	69	5758
Emp≥50 years	91893	1989	1033	39	6484
Ret ≤64 years	139362	1402	766	28	6382
Ret ≥65 years	123095	1385	714	35	7257
Total	793987				

Notes: Emp – Employee, Ret – Retiree

In Table 5.10, the group of employees aged 50 years and over received the highest average accumulative amount (1989 Yuan) in their personal savings accounts, while the group of employees aged less than 35 years had the lowest. The accumulative balances of the personal savings accounts varied significantly among individuals, with some as high as more than 7000 Yuan (retirees aged 65 years or over), and others as low as 28 Yuan (retirees aged less than 65 years). In total, there were 5660 individuals whose personal savings accounts had accumulative deposits of less than 100 Yuan. This was due to their short time period of

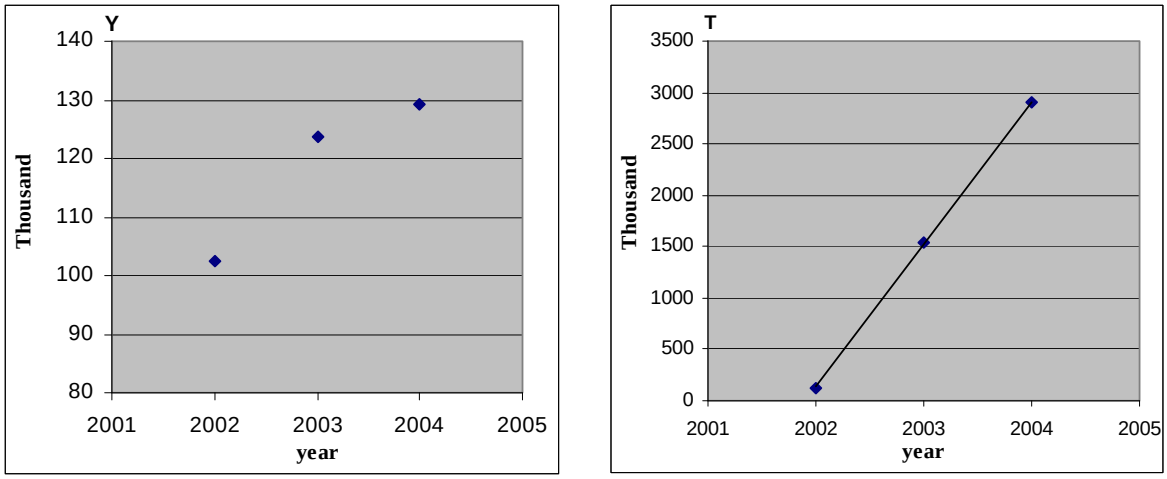
entering the medical insurance scheme and their low monthly income (which was under 1000 Yuan).

5.5.5 Determine the Government Officials

The Government official fund was established along with the commencement of the basic medical insurance system in Kunming in April 2001, which is financed by the local governments. Apart from the benefits from the social pool fund when medical services are needed, government officials can get further benefits from the Government official fund. There was no variable in the original datasets indicating which records belong to government officials. As a result, it was necessary to impute the population of government officials.

First, it was necessary to determine the number of government officials in 2005 and for the forecasting years of 2006-2010. The number of government officials in 2005 was estimated by referring to the medical insurance implementation report for the year of 2001-2004 by Kunming (Kunming Medical Insurance Centre, 2005),. Broadly, according to the actual number of officials over the period of 2002-2004, curve fitting (Figure 5.4) was conducted and the number of officials for each year of 2005-2010 was estimated (Table 5.11).

Figure 5.4 Exponential curve fitting for estimating the number of officials



In detail for the curve fitting, the scatter plot of the number of officials (Y) versus year (left side in Figure 5.4) shows an exponential curve trend. A new variable T was derived by transforming Y with an equation of $T = 10^{Y/20000}$. Then the linear regression method was used to fit a straight line of this new variable T versus year. The estimate function of T could be

obtained as, $\hat{T} = 1386610.769 year - 2775855553$. So, reversing the variable *T* to the number of officials *Y*, the estimates of *Y* can be expressed as the following equation.

$$\hat{Y} = 20000 \log_{10}(1386610.769 year - 277855553)$$

Using this estimated equation, the number of government officials for each year of 2005-2010 could be obtained, with the results shown in Table 5.11. The R square of the curve fitting was high at 0.9999. The comparison between the actual number and estimated number for the years of 2002-2004 was very close.

Table 5.11 Estimation of number of officials using exponential curve fitting

Year	Actual number	Estimated number	Relative errors (Estimated – Actual)/Actual * 100
2002	102310	102873	0.5503
2003	123769	123670	-0.0800
2004	129259	129285	0.0201
2005		132667	
2006		135096	
2007		136991	
2008		138546	
2009		139865	
2010		141009	
R^2 of Fitting		0.9999	

The next step was to determine the records of the government officials. In Table 5.11, the estimated number of the officials in 2005 was 132,667. Some clues to the identity of government officials could be found in the raw datasets of hospitalization services. By checking the medical expenditure records in 2002-2005, records with expenses subsidized by the Government official fund were allocated to be 'government officials'. This process determined a total number of 36,955 records as officials. Then, referring to the dataset of individual basic information in 2005, those records with a code of 'Cadre' in a variable 'Personal status' were treated as officials. In this way, an extra 86,823 records were picked up to be officials. The above two processes gave a total number of 113,778 officials. The remaining 18,889 officials in 2005 needed to be imputed. This was done by using discriminant analysis to identify the likely government officials in 2005.

The following steps were undertaken to identify government officials.

(1) In the created basic file for 2005, there were mainly two categories in a variable 'Personal status' – Cadre or Worker, with only 0.02 per cent of records indicated as 'Farmer labourer' and a large frequency (75.74 per cent) as missing records (Table 5.12). Many officials would be in the person status "missing category". Discriminant analysis would be used to find the potential officials in the person status "missing category".

Table 5.12 Distribution of personal status in 2005

Variable	Category	Frequency	Percentage	Accumulative frequency
Personal status	Cadre	105604	14.33	113778
	Worker	76308	9.90	192403
	Farmer labourer	137	0.02	192601
	Missing	601386	75.74	793987

For the records with identified personal status of 'Cadre' or 'Worker', binary discriminant analysis was conducted to create the discriminant functions. In this process, eight possible impact factors were considered: Gender, Nationality, Employment status, Education degree, Marital status, Age group, Age and Monthly income (Table 5.13).

Table 5.13 Impact factors of discriminant analysis in identifying officials

Factors	Category	Frequency	Percentage	Accumulative frequency
Gender	Male	416632	54.59	416632
	Female	346583	45.41	763215
Nationality	Han	698678	91.54	698678
	Minorities	64537	8.46	763215
Employment status	Employee	508400	66.61	508400
	Retiree	254815	33.39	763215
Education degree	Under primary	150333	19.70	150333
	Junior high school	181643	23.80	331976
	Senior high school	245124	32.12	577100
	University	186115	24.39	763215
Marital status	Single	175146	22.95	175146
	Married	588069	77.05	763215
Age group	Employee ⩽34 years	187106	24.52	187106
	Employee 35-49 years	232154	30.42	419260
	Employee ⩾50 years	89140	11.68	508400
	Retiree ⩽64 years	135959	17.81	644359
	Retiree ⩾65 years	118856	15.57	763215
Age	Continuous variable	763215		
Monthly income	Continuous variable	763215		

Note: the total number of frequency 763215 makes sure there is no missing value for all factors.

In Table 5.13, the first six of the factors are categorical variables, while the other two factors are continuous variables. Getting rid of the missing records among these factors, 763,215 records were left, which accounted for 96.12 per cent of the total records.
(2) For the identified population of 'Cadre' and 'Worker', which had 192,403 records (Table 5.12), binary discriminant functions were created by stepwise discriminant analysis to distinguish officials (Cadres) and workers. The constant items and coefficients of the linear discriminant functions are given in Table 5.14.

Table 5.14 Constants and Coefficients of discriminant functions

Classify	Constant	Gender	Nationality	Employment	Education	Marry	Age	Age group	Income
Official	-54.3071	6.16945	14.2724	25.45331	6.1558	5.37318	1.39241	-18.0713	0.00385
Worker	-48.8466	6.20641	14.15723	25.34738	4.69624	5.83103	1.36205	-18.1753	0.00351

The result of the binary discriminant analysis showed that all 8 considered factors had significant impact on the classification between officials and workers. The corresponding partial R-Square indicated that 'Education degree' was the most important impact factor, followed by Age, Marital status and Monthly income. The other four factors of Gender, Nationality, Employment status and Age group had less impact on the classification compared with the first four factors.

(3) Retrospective testing using the above linear discriminant functions indicates that the classification error was 28.62 per cent for 'Official' and 25.08 per cent for 'Worker', giving the total error of 27.13 per cent (Table 5.15). This classification result was deemed reasonable and therefore accepted.

Table 5.15 Number of Observations and Percent Classified into Cadre or Worker

Original classification	Classified into Official	Classified into Worker	Total
Official	75451	30153	105604
%	71.38	28.62	100.00
Worker	19206	57102	76308
%	25.08	74.92	100.00
Total	94657	87255	181912
%	51.96	48.04	100.00

(4) For the 601,386 records with no personal status (or missing, the last row in Table 5.12), the above linear discriminant functions were adopted to estimate who could potentially be officials. As a result, 240,280 individual records were classified into potential officials.

Finally, by using simple random sampling method, 18,889 individuals were picked up randomly from these potential officials and were made to be government officials. Thus, this summarises how the problem of identifying the records of the government officials in 2005 was resolved.

For the government officials in the following years of 2006-2010, which are estimated to have a small growth in the number of the population, the method of simplified random picking up was used to determine the officials (instead of using the discriminant analysis again). In addition, the variable of education degree is the most important impact factor. The new officials in each coming year were picked up arbitrarily among individuals who had an education qualification of at least senior high school (year 10 -12) and lived in urban areas. Rural residents were not considered when identifying the government officials because the actual data showed that there were only 0.16 per cent of medical insurance participants who registered as 'Cadre' living in rural areas.

After identifying the records of government officials, a certain percentage of their income was allocated to their personal savings accounts, according to the relative supplementary policy settings as described below.

- First, an amount equivalent to one month's income was put into the personal savings accounts once. The government official subsidy program has been implemented regularly since June 2002. So, for officials who joined the medical insurance scheme before June 2002, the amount of one month's income was put into their personal savings accounts in June 2002. For officials participating in the scheme after June 2002, the amount of one month's income was put into their personal savings accounts at the time they registered for the scheme.

- Second, after one month's income was put into the personal savings accounts, a certain percentage of monthly income was also allocated into the personal savings accounts. The subsidized allocation rates to the personal savings accounts varied with location (ranging from 2 to 4 per cent over the period of 2002-2005). According to the actual data analysis, 20 per cent of officials were picked up randomly to have 2 per cent of their incomes add to their personal savings accounts, while the remaining 80 per cent of officials had 4 per cent of their incomes added to their personal savings accounts. Such allocation rules would continue to be in effect until the end of 2007.

From 2008 onwards, all the government officials will have 4 per cent of monthly income put into their personal savings accounts.

After subsidizing their personal savings accounts, and then merging with the amount of allocation regulated by the medical insurance scheme, the final personal savings accounts for officials were established. So government officials' personal savings accounts consisted of two monetary parts: one comes from the income allocation under the medical insurance scheme, the other comes from the financial assistance by the local governments.

5.5.6 Medical Expenses for 2001-2005

This subsection describes the addition of the information on medical expenses to each individual's basic information records each year. The total medical expenses for individuals are covered jointly by the personal savings accounts or patients themselves, the social pool fund, the serious illness fund, and the Government official fund for officials. The medical expenses paid by participants themselves include the following four items.

- **Totally self payments.** These payments are for medical services not covered by the basic medical insurance scheme. Individuals need to pay all the costs of these kinds of services through out of pocket payments.
- **Payments for clinic treatments and medication in pharmacies.** These two kinds of medical expenditure should be paid through personal savings accounts. When the personal savings accounts are exhausted, patients must pay the excess fees directly from their own pockets.
- **Shared payments for hospitalisation and special diseases.** These payments include threshold fees when admitted to a hospital, amount of shared percentage for hospitalisation services, individual shared payment for special diseases and emergency services in clinic. These kinds of payments can be charged to the personal savings accounts or individuals concerned directly.
- **Self payments for special clinic check-up and chronic disease.** Usually 20-30 per cent of these kinds of expenses are shared by individuals, with the rest of the expenses being covered by the social pool fund. These kinds of expenses, shared by individuals, can be charged to the personal savings accounts or individuals directly concerned.

After finishing the calculation of these four items of medical expenses in 2001-2005, all of the expenses were summed up to get the total medical services cost borne by individuals. After deducting these medical services costs from the personal savings accounts, then the balances of the personal savings accounts for each person were obtained.

Except for the totally self payment and the payments by the personal savings account, the rest of the medical expenses are covered jointly by the social pool fund, the serious illness fund and the Government official fund. Table 5.16 presents the average results of different kinds of payments for each age group, and the accumulative amounts and balances of the personal savings accounts on average. Here the personal savings accounts covered all the payments shared by individuals, except for the medical services items out of the medical insurance scheme (which were paid totally by individuals themselves).

Table 5.16 Different kind of payments on average by age group at the end of 2005 (Yuan)

Age group	Average Payment for each insured individual by					Amount of Accumulate in PSA	Final Balance of PSA
	Self Totally	Personal savings account	Social pool fund	Serious illness fund	Government official fund		
Emp≤34 years	22	1050	283	19	3	1607	557
Emp 35-49 years	49	1640	724	47	9	2226	586
Emp≥50 years	81	1977	1361	126	12	2477	501
Ret ≤64 years	130	1961	2687	187	9	1639	-322
Ret ≥65 years	223	2578	5025	313	23	1614	-964

Note: Emp – Employee, Ret – Retiree, PSA – Personal savings account

Table 5.16 gives the analysis results from the administrative data over 2001-2005, on average, for each person. It shows five different ways to cover medical expenses. The balance of personal savings account (PSA) in the last column, e.g. 557 Yuan, means the accumulative amount of 1607 Yuan in PSA being taken out by 1050 Yuan (should be paid by personal savings account according). If the PSA could not cover the expenses due by PSA, the excess amount should be paid as out of pocket. This balance for all groups of employees is positive, while negative for retirees.

Hence, on average, the personal savings accounts of employees could cover all the medical services costs shared by individuals with some balances. However, for retirees, especially for retirees aged 65 years and over, the balances of their personal savings accounts were negative. Regarding retirees, the older the individuals, the bigger the gap to cover the medical treatment

fees which are supposed to be paid by their personal savings accounts. When the personal savings accounts are exhausted, the excess fees should be paid by individuals directly.

5.5.7 Data Sampling of the Medical Insurance Participants

Medical insurance schemes for urban employees and urban non-working residents are different, so two exclusive models are constructed in this thesis for different purposes. It is expected in the future these two insurance schemes be merged to one. This subsection is the preparation for modelling medical insurance scheme of urban residents out of the labour market. A random sample of employed individuals created in this subsection will be used in the next chapter.

For the created 2005 individual information base file, a stratified sampling method by gender across age group was adopted to acquire a 10 per cent sample of the insured individuals in 2005. Within each stratum, the method of completely random sampling was used to randomly select records with the same sampling ratio of 10 per cent. In the process of the sampling, each individual record was given a uniform random number between the interval of [0, 1]. If the random number was less than the sampling ratio then the corresponding individual was selected.

After undertaking the random sampling, the representativeness of the sample was checked. The distributions of gender, age group, monthly income, number of government officials and number of death records in the sample dataset were analysed respectively. Then the outcomes were compared with the original dataset of the whole insured population.

A weight variable was then added to the 10 per cent individual sample, with each record being assigned a weight of 10. As an important part of representing Kunming's population, this sample dataset was created in preparation for the statistical matching with the whole population in Kunming at the end of 2005. The aim of the statistical matching with the whole population is to model the medical behaviour of the whole urban resident population and relative medical insurance policies. This will be described in detail later in Chapter 6.

For modelling medical behaviour of urban employees and retirees under the medical insurance scheme in this chapter, the total records of insured employees and retirees as a

whole will be used. A microsimulation model is constructed for all of the individuals (793,987) who were covered by the medical insurance scheme in 2005. In doing so and in keeping with the original individual information, the modelling precision can be guaranteed. So now the 2005 base file has been created and the model is ready to simulate the medical services behaviour under the urban medical insurance scheme.

5.6 Simulation of Medical Insurance Participants for 2006-2010

5.6.1 Death Events

The simulation of medical services of medical insurance participants started in 2006, with a time sequence of one year as a simulation unit until 2010. This section discusses the simulation of the medical insurance participants – the 'participant module' as mentioned above. Simulation of deaths is the first event modelled for each forecasting year. At the beginning of the modelling in 2006, by deleting the records with a death index in the dataset of the basic individual information at the end of 2005, death simulation was completed for the year 2006. Because the death information was already included in the dataset in 2005, the model just eliminated these death records at the beginning of the simulation in 2006.

For modelling death events for the following years of 2007-2010, it was not as simple as for the beginning year 2006. The method of complete random sampling was used to randomly select individual records according to death rates by gender across age groups (see Table 5.5 and Table 5.6). The model then removed the selected records allocated as representing deaths in the forecasting year.

5.6.2 New Scheme Entry Events

After handling the death events, the participant module then simulated new participants into the scheme. This part of the module is for new entry insurance participants in each forecasting year, with the number of total insured individuals considered first. According to the trends of actual numbers of the scheme participants over the period of 2001-2005 (diamond dots in Figure 5.5) reported by the Bureau of Labour and Social Security of Kunming (2006), the number of population for each year of 2006-2010 was estimated (squire dots in Figure 5.5) by fitting an exponential curve. The estimated number of participants for each year is given in Table 5.17.

Figure 5.5 Estimation of number of participants over period of 2001-2010

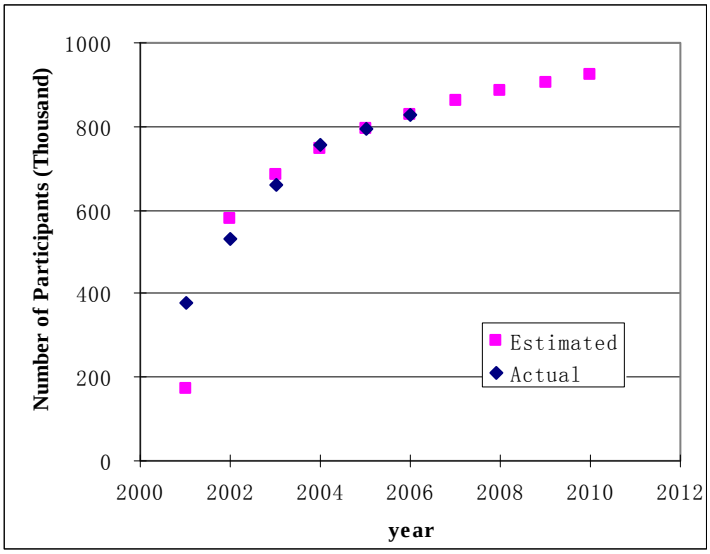


Table 5.17 Estimation of number of participants for the year 2006-2010

Year	Actual number of participants	Estimation of fit 1	Estimation of fit 2
2001	377676	172473	370918
2002	532706	577066	538311
2003	661038	683646	650521
2004	756996	747710	735047
2005	794130	793663	802882
2006	828811*	829518	859542
2007		858925	908193
2008		883852	950823
2009		905486	988758
2010		924596	1022931
Fitted R^2		0.9781	0.9889

* The number of population in 2006 was used as a check figure, not used in curve fitting.

In practice, two exponential curves were fitted to get the total number of participants for each forecasting year. In fitting curve 1, transformation $T_1 = 10^{N/377676}$ was used, in which 377,676 was the actual number of participants in 2001, and *N* indicates the number of participants in each year over the period of 2001-2005. Then using the method of linear regression on the new variable T_1 versus variable *Y* (Year) to get the linear estimated function as

$$\hat{T}_1 = 30.862Y - 61752, \quad \text{with } R^2 = 0.9781$$

Then reversing the variable T_1 to the variable *N*, the number of participants can be estimated through the following function.

$$\hat{N}_1 = Log_{10}(30.862Y - 61752) \times 377676$$

So by this function, the number of insured individuals for each year of 2006-2010 was estimated, with the results given in Table 5.17 (column of 'Estimation of fit 1').

Alternatively, in fitting curve 2, a transformation $T_2 = 10^{N/794130}$ was used to get a new variable T_2, in which 794,130 was the actual number of participants in 2005, and *N* indicates the number of participants in each year over the period of 2001-2005. The corresponding estimated functions for fitting curve 2 are as follows. By using these functions, another option of estimated number of insured individuals for each year of 2006-2010 was obtained, which is also given in Table 5.17 (column of 'Estimation of fit 2').

$\widehat{T}_2 = 1.8314Y - 3661.7$, with $R^2 = 0.9889$, and

$\widehat{N}_2 = Log_{10}(30.862Y - 61752) \times 794130$

Both estimations of fit 1 and fit 2 were close to the actual number in 2001-2005, with their determinant coefficients (R square) greater than 0.97. The estimated number 172,473 for the year 2001 given by fit 1 was not as close to the actual number 377,676 as fit 2, that is, the big gap occurred between the actual and the estimated for the first year. But this does not matter as long as the estimations are good for the coming years. For the forecasting years, fit 1 gives lower estimations in the number of insured population, while fit 2 offers higher estimations. The initial thought was that the weighted number of fit 1 and fit 2 for predicting the insured population would be used to avoid underestimating or overestimating the total population. While in October 2007, the Kunming Medical Insurance Centre (2007) reported that by the end of 2006, there were 828,811 insured employees and retirees. This reported figure was very close to the estimated figure 829,518 in curve fit 1 – with the difference of 707, accounting for just 0.085 per cent of the total population. So the estimation results of curve fit 1 were chosen as the final prediction of insured population over the period of 2006-2010.

After determining the whole population of insured individuals for each forecasting year, the next step was to determine the number of participants in each age group. The insured population by age group over the period of 2006-2010 was estimated by fitting curves similar to those for deriving the estimated total number of participants. By doing so, the summation of the estimated numbers of all age groups for each forecasting year did not exactly match the target total population. For example, the summation of the five age groups for the year 2006 was 856,460, which departed significantly from the target population of 829,518 (Table 5.17).

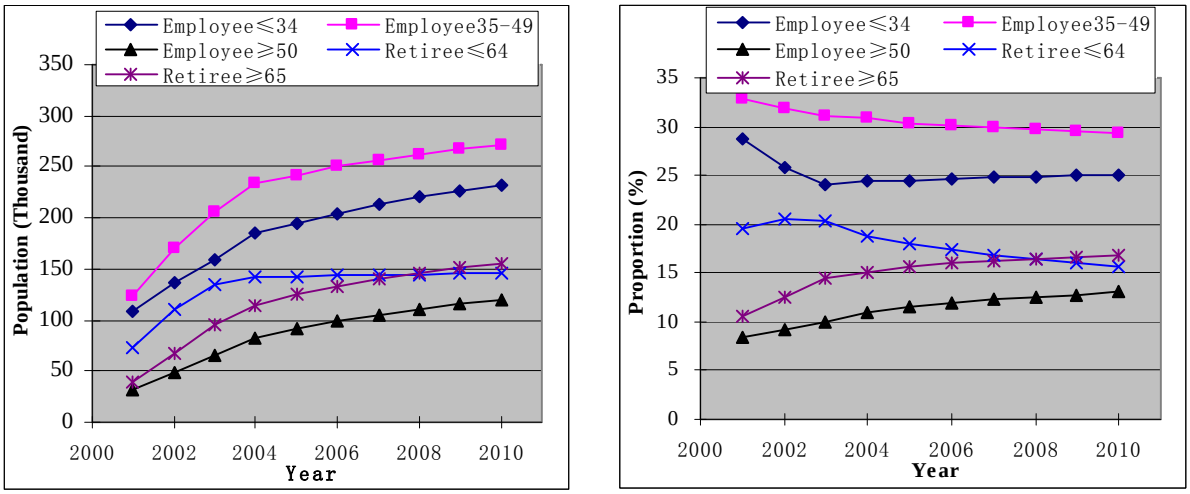
This problem was overcome by treating the target population as a marginal constraint, and compressing each age group proportionately to their estimated number. The final estimated figures for each age group for each forecasting year are presented in Table 5.18. The percentage of retirees in the total population in 2006 was estimated to be 33.34 per cent, which is very close to the actual figure of 33.4 per cent reported by the Bureau of Labour and Social Security of Kunming (Kunming Medical Insurance Centre, 2007).

Table 5.18 Estimated number of participants by age group for the year 2006-2010

Year	Employees age ⩽34	Employees age 35-49	Employees age ⩾50	Retirees age⩽64	Retirees age ⩾65	Total
2001	108820	123774	31402	73672	40008	377676
2002	137444	169848	49092	109537	66785	532706
2003	159521	205201	66240	134947	95129	661038
2004	184678	234230	82561	141872	113655	756996
2005	194842	241190	91158	142232	124708	794130
2006	204295	250157	98532	143734	132801	829518
2007	212661	256848	105101	144404	139910	858925
2008	219949	262348	110805	144850	145900	883852
2009	226406	267007	115841	145168	151064	905486
2010	232203	271045	120346	145407	155595	924596

Figure 5.6 illustrates the trends in population of the different age groups over the period 2001-2010, where the estimated figures are used for the years of 2006-2010. For the purpose of comparison, the percentage of each age group of participants is illustrated together (right side of Figure 5.6).

Figure 5.6 Estimated number and percentage of different type of participants



The population of all age groups shows an increased trend, although the group of retirees less than 65 years of age had a slower rate of increase from 2004 onwards than the other groups. The total number of retirees is estimated to account for 32.55 – 33.40 per cent of the total insured individuals during the period of 2006-2010. It is estimated that by the year 2008, the number of retirees aged 65 years and over will overtake the number of retirees aged less than 65 years, which means more risk for the medical insurance system. Moving away from the absolute numbers to look at the relative proportions, the proportion (in percentage) of age groups (right side of Figure 5.6) gives a quite different picture. The proportions of both employees aged 35-49 years and retirees aged less than 65 years are estimated to keep decreasing in the coming years. Conversely, the proportions of employees aged 50 years or over and retirees aged 65 years or over are expected to keep increasing. Only the proportion of employees aged less than 35 years is estimated to be stable in the coming years.

Table 5.19 shows the estimated distributions (percentage) of insured participants by gender across age groups over 2006-2010, with the results in 2005 as a comparison. For males, roughly speaking, three employed age groups are estimated to distribute evenly, with the highest proportion (around 28 per cent) employees aged between 35 to 49 years, followed by employees aged under 35 years (close to 25 per cent), and employees aged 50 years or over (around 20 per cent). Slightly more than 27 per cent of males are retired, while retirees aged 65 years or over make up about 1.7 times retirees aged under 65 years.

Table 5.19 Estimated proportion (%) by gender across age group, 2006-2010

Year	Employees age ⩽34	Employees age 35-49	Employees age ⩾50	Retirees age⩽64	Retirees age⩾65	Total
Male						
2005	24.51	29.49	18.47	10.60	16.93	100.00
2006	24.35	28.96	18.91	10.37	17.40	100.00
2007	24.38	28.61	19.41	10.01	17.59	100.00
2008	24.42	28.29	19.82	9.71	17.75	100.00
2009	24.48	28.04	20.17	9.47	17.84	100.00
2010	24.53	27.82	20.48	9.26	17.91	100.00
Female						
2005	25.00	31.99	3.40	25.80	13.81	100.00
2006	24.95	31.58	3.50	25.62	14.35	100.00
2007	25.22	31.46	3.62	24.99	14.72	100.00
2008	25.45	31.36	3.73	24.45	15.00	100.00
2009	25.65	31.25	3.84	24.00	15.27	100.00
2010	25.83	31.13	3.92	23.60	15.52	100.00

For females, the percentages of both employed age groups of less than 35 years and 35-49 years are similar to the male counterparts. However, the percentage of employees aged 50 years or over is quite low, at less than 4 per cent. This is because female's legitimate retirement age is usually 5 years earlier than male's. This results in a large proportion of retired females aged less than 65 years – around 24 per cent. Contrary to the male situation, female retirees aged 65 years or over account for about 15 per cent. Comparing the proportion of retirees between males and females, female retirees are estimated to be 12 percentage points higher than male retirees.

After achieving the population estimation for each age group for 2006-2010, the model then simulates new entries to the medical insurance scheme. According to the target population required in Table 5.18, new participants to the medical insurance scheme were selected by the method of simple random sampling for each age group from the population base file in the previous year. The date of entry scheme for each new individual was set in June of the forecasting year, and their personal savings accounts were set to 0. Their monthly income and medical expenses in the previous year are the same as for individuals who were randomly picked up from the base population base file. That is to say, in this way, the model effectively 'cloned' a certain number of individuals to create new participants in the medical insurance scheme. Then a certain number of new individuals, which was consistent with the target population of officials in Table 5.11, were selected randomly to be government officials. By combining the new entry individuals with the existing population under the medical insurance scheme in the previous year, the basic individual information dataset was created and updated for the forecasting year (say 2006).

5.6.3 Adjust Income and Set Funds

When forecasting an individual's medical expenditure and assessing the medical insurance scheme, the individual's income plays an important role (because both the social pool fund and the personal savings account are collected with the premium based on the individual's income). The adjustment of an individual's annual income is thus vital in the process of simulation, as it has direct effects on the results of the medical insurance policy simulation. So, after creating the basic individual information dataset for the forecasting year, the incomes of different age groups of individuals need to be adjusted.

Prior to doing this, certain criteria were created for the income adjustments to follow. Table 5.20 gives the estimated average wages and pensions for the forecasting years of 2006-2010 based on the actual figures in 2002-2005. For employees, the estimated average wages were the results of fitting a straight line. For retirees, two fittings were carried out because of instability in the actual figures – one fitted an exponential curve and the other fitted a straight line. The estimated average pensions were the weighted results of curve fitting (weight 0.5) and line fitting (weight 0.5), which aims to avoid estimations that are too large or too small. Late in October 2007, the Bureau of Labour and Social Security of Kunming reported the average wage and pension in 2006. It was reported that there was a large increase in average wages and pensions in 2006 compared with the previous years. The actual figures in 2006 were treated as a test to revise the estimated incomes for the period of 2006-2010. By dividing the actual average wage of 1422 Yuan in 2006 by its estimated one of 1318 Yuan, an adjusted coefficient 1.078907 was obtained. This was used to make adjustments to the estimated wages for the following years. Similar adjustments were done for the estimated pensions (Table 5.20). The adjusted average estimations of wages and pensions form the criteria when making adjustments for individuals' income for each forecasting year.

Table 5.20 Estimated average wage and pension for the period of 2002 – 2010

Year	Average wage of employees			Average pension of retirees				
	Actual	Estimated	Adjusted	Actual	Curve fit	Line fit	Estimated	Adjusted
2002	850	844		674	673	668	670	
2003	960	963		692	686	693	690	
2004	1068	1081		703	707	719	713	
2005	1209	1200		755	741	744	743	
2006	1422*	1318	1422	821*	796	769	782	821
2007		1437	1550		882	795	839	881
2008		1555	1678		1020	820	920	966
2009		1674	1806		1240	846	1043	1095
2010		1792	1933		1590	871	1231	1292
Fitting R^2		0.9957			0.9695	0.8887		

Notes: The actual incomes for 2002-2005 were used to estimate the income for 2006-2010; * the actual incomes for 2006 were used as a test to adjust the obtained estimation.

When predicting the income of individuals, the income increase parameters (or adjustment parameters) of the participants were obtained using the income information from 2002 to 2005. It is assumed that an individual's monthly income remains unchanged during the course of each particular forecasting year. Under this assumption, monthly income is the same for 12 months in one year (say 2006), and adjusting monthly income in 2007 is compared with the

previous year of 2006. The adjustment parameters were constructed by the following three steps:

- First, by categories of gender across age group, the incomes were split into several sections. The actual data analysis of 2002-2005 shows that the higher the income, the more variation occurs, so more classes should be used to catch the variation. As a result, the individual monthly incomes in each year of 2002-2004 were split into 9 classes according to income percentile: that is, Minimum-P5 (the fifth percentile of income, similar for the others), P5-P10, P10-P25, P25-P50, P50-P75, P75-P90, P90-P95, P95-P99, P99-Maximum. So the individual income was categorized into 2×5×9 = 90 groups, where 2 represents male and female, and 5 represents 5 age groups.
- Second, for each of the above categorized 90 income groups, increase rates of individual income were calculated for 2002-2003, 2003-2004 and 2004-2005. These rates of increase for each income group were further divided into 8 segments from the lowest to the highest: in detail, Lowest-P10 (the tenth percentile of increase rate), P10-P25, P25-P50, P50-P75, P75-P90, P90-P95, P95-P99, P99-Highest. In this way, 90×8 = 720 income cells were obtained. By the actual calculation, the rates of increase in those income cells for three different years of 2002-2003, 2003-2004 and 2004-2005 showed consistent trends.
- Third, in each income cell, the average rates of increase of the three years in a row were calculated. Such calculations were reasonable because the income cells stood for the same percentiles and had consistent trends. The results are illustrated in Table 5.21, where the first column indicates gender of male and female, the second column indicates 5 age groups, and the third column indicates 9 income sections in percentile. Rate1 – Rate8 at the first row means the different rates of increase, with the relative interval of frequency at the last row.

With the parameters of monthly income rates of increase in Table 5.21, each individual's monthly income in 2006-2010 can be projected. Table 5.21 listed the parameters for income projection to 2010. For example, for a male in age group 1 (employee aged less than 35 years), if his monthly wage fell into the lowest section (Income = '1'), then his monthly wage in the coming year would have an increase rate of 0.12266 with a chance of 10 per cent. In practice, a uniform random number was given to this person. If this person got a random number that

fell between 0≤random<0.10, then his monthly income would have an increase rate of 0.12266. Such income adjustment was carried out once a year in the model.

Table 5.21 Monthly income adjustment parameters

Sex	Group	Income	Rate1	Rate2	Rate3	Rate4	Rate5	Rate6	Rate7	Rate8
1	1	1	0.12266	0.14138	0.21787	0.47927	1.04961	1.73501	3.31952	4.66841
1	1	2	0.08690	0.11716	0.20500	0.42003	0.87130	1.47540	3.00536	4.31932
1	1	3	-0.00323	0.06362	0.13608	0.39481	0.81915	1.47868	2.85378	4.02337
1	1	4	-0.18203	-0.03832	0.03729	0.22041	0.49273	0.95651	2.01142	3.10143
1	1	5	-0.36013	-0.16767	0.01439	0.11296	0.30066	0.65700	1.38539	2.07747
1	1	6	-0.48373	-0.28098	-0.04153	0.08365	0.28106	0.52561	1.04572	1.53034
1	1	7	-0.61252	-0.42016	-0.15020	0.06411	0.25603	0.45087	0.66346	0.89255
1	1	8	-0.69212	-0.49179	-0.18298	0.05357	0.18571	0.27947	0.36918	0.47154
1	1	9	-0.70124	-0.45743	-0.20916	0.00736	0.02508	0.02691	0.00249	0.15586
1	2	1	0.09254	0.14038	0.21973	0.50458	1.17240	1.93866	3.50962	4.69382
1	2	2	0.04557	0.08680	0.15186	0.43602	0.99369	1.67413	2.98944	4.24908
:	:	:	:	:	:	:	:	:	:	:
2	5	8	-0.60547	-0.41587	-0.00792	0.03741	0.06543	0.11838	0.17226	0.27425
2	5	9	-0.68014	-0.47035	-0.16917	0.02955	0.05355	0.10269	0.13050	0.18214
Relative frequency			0–0.10	0.10–0.25	0.25–0.50	0.50–0.75	0.75–0.90	0.90–0.95	0.95–0.99	0.99–1.00

After calculating the adjustment of income for each individual, the average monthly wages and pensions were compared with the estimated figures (Table 5.20) as the criteria to see if further adjustments were needed. As an example, Table 5.22 gives the estimated average monthly income in 2006, with similar figures of 2001-2005 as comparison. The average monthly wage for employees was estimated to be 1340 Yuan, which is less than the target figure of 1422 Yuan. Further adjustment needs to be made for each employee — that is, the estimated wage of each employee in 2006 is multiplied by an adjustment coefficient a = 1.06119403 (1422/1340). The average monthly pension for retirees in 2006 was estimated to be 789 Yuan, which is less than the target figure of 821 Yuan. Similarly, further pension adjustment was done for retirees.

Table 5.22 Estimated average individual monthly income (Yuan) for 2006

Year	Employee by age group (Years)				Retiree by age group (Years)		
	Age ≤34	Age 35-49	Age ≥50	Total	age≤64	age≥65	Total
2001	688	817	900	801	721	639	681
2002	815	918	973	902	737	678	709
2003	875	957	986	939	725	705	716
2004	1099	1162	1134	1136	739	726	733
2005	1175	1250	1179	1210	764	762	763
2006	1336	1376	1253	1340	779	800	789

After completing the adjustment of individual's monthly income, the personal savings accounts and three different kinds of funds are allocated according to the certain percentage of individual's monthly income under the medical insurance scheme rules.

- The Personal savings accounts. Due to the allocation policy of the medical insurance scheme, a certain proportion of wages or pensions (varying by age group) is allocated to personal savings accounts. For new participants in the forecasting year, their personal savings accounts would commence in June of the forecast year.

  For government officials, an extra amount of money was put into their personal savings accounts, which are subsidized by local governments. According to the medical supplementary policy for government officials, 2 or 4 per cent of individual's monthly income (Kunming Medical Insurance Centre, 2005) would be deposited to the personal savings account for the year 2006 and 2007. From the year 2008 onwards, the supplementary rate would be 4 per cent for all government officials. For new scheme entry officials in the forecast year, an extra one month's income would be put into their personal savings accounts.
- The Social pool fund. A variable which represents the social pool fund was added to each individual record. A certain proportion of personal income was allocated to this fund according to the urban medical insurance policy. Under this medical insurance system, retirees are exempted from contributing to the insurance premiums.

- The Serious illness fund. A variable which represents the serious illness fund was added to each individual record. A certain amount of money was allocated to this variable, based on the corresponding serious illness insurance policy.

  According to the analysis reported by the Bureau of Labour and Social Security of Kunming, a total of 782,414 individuals in 2006 (not all the participants that year) were under-written by this serious illness fund. In the beginning of the projection in 2006, after removing the records with death index, there were 789,923 records left. These two numbers of the population are very close, with a small difference of 7,509 or only 0.96 per cent of the actual population. And

usually, at the beginning of each financial year, the Kunming Government signs a contract with commercial insurance companies for the social medical insurance participants to be under-written in the serious illness fund. Hence, it is reasonable to assume that at the beginning of each forecasting year, after randomly removing death records, all the remaining individuals (but not including the new participants in that year) are to be covered by the serious illness fund.

For the premiums to this serious illness fund, the reported average annual contribution per person in 2006 was 104.76 Yuan, and this is adjusted annually. In this projection, the contribution by the employer remains the same as in 2004, which is 0.6 per cent of the total annual wage bill. According to the medical insurance rule which takes effect in 2004, an individual's contribution is 12 Yuan annually. Comparing with the average monthly wage of 1068 Yuan in 2004 (Table 5.20), 12 Yuan accounted for around 0.1 per cent of the average annual wage. So it is assumed that the contribution by an individual to the serious illness fund is 0.1 per cent of the person's annual income for the forecasting years. In this way, the average contribution is estimated as 102.90 Yuan in 2006, which is very close to the actual figure of 104.76 Yuan.

- The Government official fund. A variable representing the Government official fund was established for each government official. One per cent of each official's monthly income was allocated to this pool fund. This pool fund is mainly used to compensate the expenses shared by officials in hospitalization treatments.

Table 5.23 gives the comparison of the different types of total funds, including total personal savings accounts, between the projection and the reported actual totals in 2006. The projections for the social pool fund and serious illness fund are very good, with both estimation relative errors less than 1 per cent. While the projected total fund of personal savings accounts is slightly further from the actual number (the second last column of Table 5.23), it is still within a very acceptable range, with a relative error of around 1.87 per cent.

However, if we were also considering the Bank interest for the personal savings accounts in 2006, the projection would then be a nearly perfect estimate of the actual figure. For

the year of 2006, according to the report by Kunming, a total of 10.7844 million Yuan of interests were put into the personal savings accounts. Plus the projected 572.6273 million Yuan, it gives 583.4117 million Yuan which gives a small difference of 0.0716 million Yuan to the actual figure of 583.3401 million Yuan (Table 5.23). By the projected total of 572.6273 million Yuan and the interest payment of 10.7844 million Yuan, an annual interest rate of 0.0188332 is obtained. This is used to add interest for insured individuals proportionately to the amount of their personal savings accounts. This annual interest rate will be adopted for the following forecasting years when considering interest received upon the personal savings accounts.

Table 5.23 Comparison between Projected and Reported funds in 2006 (million Yuan)

Item	Social pool fund	Serious illness fund	Government official fund	Personal savings account	Added interest
Projected	685.4504	81.2833	23.4272	572.6273	583.4117
Actual	683.5709	81.9657	–	583.3401	583.3401
Difference (Million)	1.8795	-0.6824	–	-10.7128	0.0716
Relative error (%)	0.2750	-0.8325	–	-1.8365	0.0123

Note: Relative error = (Projected - Actual)/Actual×100%

5.7 Forecasting Medical Expenses

5.7.1 Four Medical Services Items in the Model

After simulating the population of insurance participants for the forecasting year and setting up the different types of funds, the model predicts the medical expenses. Predicting medical expenses is one of the essential and very important parts in the simulation for the medical behaviour of medical insurance participants. This aspect of the simulation is also very complicated and difficult, because of the many medical service items that need to be included in the model. The different kinds of medical service items have different payment modes, which are listed in Table 5.24. An example for 2005 is provided to illustrate the frequencies and proportions of different medical services items.

According to the payment modes under the medical insurance scheme, four types of medical services should be considered in predicting individual's medical service usage.

- The first one to be considered is clinic services and pharmacy medication (No.1 and 2 in Table 5.24), which together accounted for 89.04 per cent of the total medical services items in 2005. Both of these medical services expenses are paid by personal savings accounts or by individuals directly out of their pockets.
- The second considered in the model is chronic disease clinic services (No.7 in Table 5.24), which accounted for 6.930 per cent of the total medical services items in 2005. The expenses of a patient are covered up to 2000 Yuan by the social pool fund annually. After the ceiling of 2000 Yuan, the patient pays the excess bill by either personal savings account or out of pocket directly.

Table 5.24 Medical services items considered in the simulation with an example of 2005

No.	Medical items	Payment mode	Frequency in 2005	Percentage in 2005 (%)
1	Ordinary clinic	Personal savings account or self pay	1306534	16.722
2	Pharmacy medication	Personal savings account or self pay	5650726	72.322
3	Admitted to Hospital	Large part by Social pool fund	103109	1.320
4	Special disease clinic	Same as admitted to hospital	161218	2.063
5	Clinic emergency	Same as admitted to hospital	20810	0.266
6	Hospital transfer	Same as admitted to hospital	179	0.002
7	Chronic disease	Social pool fund pay up to ￥2000	541457	6.930
8	Clinic special check	70% Social pool fund, 30% Self	27866	0.357
*	Other services	Not considered in the model	1439	0.018
Total			7813338	100.000

Note: * Other medical services include work related injuries, birth giving which are covered by other insurances

- The third is clinic special check-up (No.8 in Table 5.24), which accounted for 0.357 per cent of the total medical service items in 2005. For this kind of medical treatment, medical expenses are shared by the social pool fund and individuals concerned, where the social pool fund pays 70 per cent of the bill and the individuals contribute the rest (30 per cent).
- The fourth includes mainly four medical service items, i.e. admitted to hospital, special disease clinic treatment, clinic emergency, and hospital transfer, which are together summarised as ‘hospitalisation services’ (No.3 to 6 in Table 5.24). In addition, serious disease treatments are categorised into this part. All together these medical services items accounted for 3.652 per cent of the total service items in 2005. The payment mode under the medical insurance scheme for these services is the same, i.e. the social

pool fund covers the large part of the medical cost. If the medical cost exceeds the ceiling of the social pool fund, the excess cost will be covered largely by the serious illness fund.

The above four categories considered in the model would cover all the medical treatments (except work related injuries and maternity care services). As work related injuries and maternity care services are covered by their own insurance schemes, they are not included in the simulation. The following describes how each of these four parts of medical services is projected respectively for the period of 2006-2010.

5.7.2 Clinic treatment and medication in pharmacies.

The payment for both clinic treatment and medication in pharmacies is from personal savings accounts or patients' pockets. Such medical services are simulated annually. Categorical factors considered in the model include gender, age group, level of medical expenses and medical rates of increase.

Two steps are carried out in the simulation. The first step is to identify individuals who do not have such medical treatments in the forecasting year. The second step is to project the medical expenses for those who have such medical treatments.

For the first step, the proportion of individuals without medical treatments for each forecasting year of 2006-2010 was estimated by hyperbola curve fitting using the actual information from 2002-2005. The result is illustrated in Table 5.25. For example, there are about 16.22 per cent of individuals (population 134,571) without medical expenses in clinic and pharmacy in 2006.

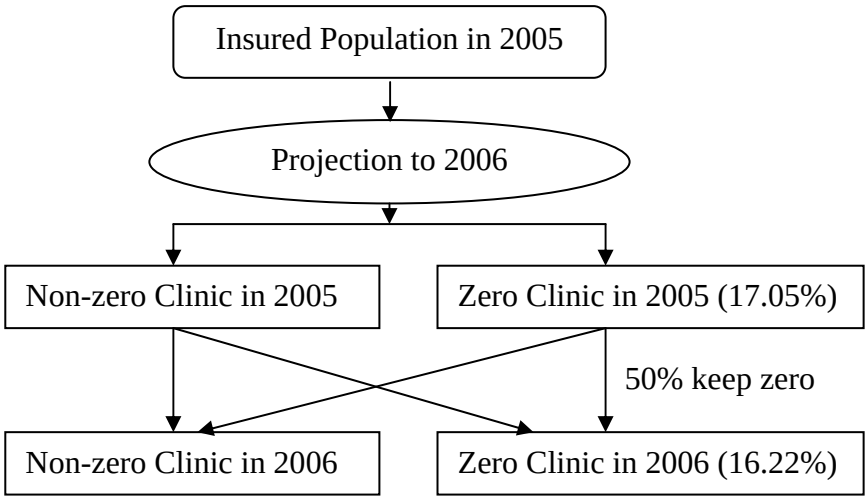
After getting the target number of individuals with zero expenses for each forecasting year, the next mission is to select individuals randomly from all records of individuals and set them to have no such medical expenses. Whether an individual has zero expense or not in the forecasting year is highly connected with the previous year's expenses of that individual. As Table 5.25 indicates, among the individuals who had no expenses in 2004, 48.14 per cent of them also had zero expenses in 2005, and it shows an increasing trend.

Table 5.25 Hyperbola fit proportion of individuals without medical expenses

Year	Number of participants	Number of no expenses	Percentage (%)	Estimated percentage (%)	Estimated number of no expenses	Proportion of continue zero expenses next year
2002	506318	223153	44.07	55.7863		31.42
2003	630108	154917	24.59	22.6278		38.91
2004	716828	131389	18.33	18.6161		48.14
2005	793987	135560	17.07	17.0541		
2006	829518			16.2228	134571	
2007	858925			15.7066	134908	
2008	883852			15.3550	135715	
2009	905486			15.1000	136728	
2010	924596			14.9067	137827	
R square				0.9964		

So when identifying individuals with zero expenses, 50 per cent of individuals with zero expenses in the previous year are assumed to keep zero expenses the next year. This is a reasonable assumption based on the increasing trend over 2002-2005, which showed in the last column in Table 5.25. The remaining individuals with zero expenses are picked up randomly from the population with non-zero expenses by considering factors of Gender across Age group. Figure 5.7 illustrates the projection process from 2005 to 2006.

Figure 5.7 Process of forecasting zero clinic visits from 2005 to 2006



After finishing selecting individuals with zero expenses, the model goes to the second step – forecasting the medical expenses for non-zero clinic individuals. This is done by using the empirical increase rates of medical expenses in clinic services as shown in Table 5.26. The construction of these increase rate parameters is similar to the construction of the individual monthly income parameters (Table 5.21).

In Table 5.26, the first two columns indicate gender and age group (five groups) respectively.

The third column represents 14 categories of medical expenses from lowest to highest by percentiles. Rate1 – Rate 7 in the first row gives the different rates of increase in medical expenses, with their relative frequencies in the last row. Negative increase rates mean that the expenses are predicted less than the previous year. When projecting medical expenses, with the year 2006 as an example, the medical expenses for each individual by gender, age group and medical expenses in 2005 is considered first. Then a uniform random number is assigned to each individual, on which the individual's expenses in 2006 will be projected. For example, suppose a male under 35 years of age had medical expenses in 2005 in the lowest category, then his increase rate of clinic medical expenses in 2006 would be 0.06589 with a chance of 25 percent. Hence his medical expense in 2006 is estimated to be his medical expense in 2005 multiplied by (1 + 0.06589).

Table 5.26 Medical expenses increase rates for clinic services and pharmacy medications

Sex	Group	Cost	Rate1	Rate2	Rate3	Rate4	Rate5	Rate6	Rate7
1	1	1	0.06589	16.60188	47.71548	95.43158	163.87904	277.31424	539.38778
1	1	2	-0.37050	6.76185	16.78486	31.32959	48.99126	71.97331	134.95649
1	1	3	-0.33942	3.55881	8.08568	14.61235	22.21332	32.55702	58.37946
1	1	4	-0.47770	1.48758	3.55289	6.60375	10.32175	15.66591	29.20982
1	1	5	-0.56435	0.48441	1.42341	2.97610	4.79053	7.11131	12.92351
1	1	6	-0.57651	0.11101	0.71417	1.74302	2.93974	4.44030	8.38105
1	1	7	-0.62256	-0.05839	0.48635	1.31866	2.27560	3.67814	6.91684
1	1	8	-0.64665	-0.10869	0.38601	1.07188	1.81113	2.91121	5.38280
1	1	9	-0.65501	-0.16639	0.26206	0.85369	1.52790	2.38663	5.24459
1	1	10	-0.63892	-0.20663	0.13969	0.65226	1.19682	1.81978	2.92919
1	1	11	-0.65448	-0.25010	0.08608	0.54084	1.02139	1.57918	2.54704
1	1	12	-0.66157	-0.29451	0.01916	0.39823	0.75627	1.10521	1.86536
1	1	13	-0.70415	-0.40259	-0.17291	0.09190	0.32238	0.57624	1.09536
1	1	14	-0.82402	-0.62506	-0.48819	-0.33402	-0.17547	-0.03108	0.18951
:	:	:	:	:	:	:	:	:	:
2	5	13	-0.74277	-0.36311	-0.05337	0.29175	0.59092	0.99288	1.79346
2	5	14	-0.83037	-0.58731	-0.39835	-0.16696	0.02399	0.20833	0.52567
Relative frequencies			0–0.25	0.25–0.50	0.50–0.75	0.75–0.90	0.90–0.95	0.95–0.99	0.99–1.00

Notes: Rate1 – Rate 7 in the first row are the rates of increase in medical expenses with relative frequencies in the last row, e.g. 0–0.25 for Rate1.

One problem needs to be resolved here. Since the model needs to refer to the previous year's medical expenses when doing the projection, what happens to individuals who had zero expenses in the previous year but will have expenses in the forecasting year? A certain amount of expenses in the previous year should be assigned to these individuals. This was imputed by randomly picking up the value of expenses from individuals, categorized by gender across age group, who had non-zero expenses in the previous year. Simultaneously, their imputed expenses were multiplied by the adjusted coefficient of 0.56778 (obtained by the actual data

analysis). This adjusted coefficient means that the zero-expense group of individuals in the previous year, on average, usually spends less in medical services than the other individuals.

5.7.3 Chronic disease clinic services

The items of chronic disease clinic services in 2005 accounted for 6.930 per cent of the total medical service items. The medical expenses of this kind of medical treatment are covered by the social pool fund up to 2000 Yuan annually. In the simulation of this kind of medical services, the first step is to confirm individuals with chronic diseases by gender across age group, then project their annual medical expenses. In simulating chronic disease services, the model isolates the costs for items which are not on the list of the medical insurance scheme. This part of costs is covered totally by individual payment.

Individuals with chronic diseases

Using the trends in the proportion of individuals with chronic diseases to the total population in 2002-2005 (Table 5.27), proportions and numbers of individuals with chronic diseases in 2006-2010 were estimated. In the actual data in 2002-2005, the proportion of individuals with chronic diseases each year was not stable, with an average increase rate of 0.0377. Halving this increase rate (advised by the Bureau of Labour and Social Security of Kunming), the corresponding proportions for the period of 2006-2010 could be obtained, and then the forecast population with chronic diseases. It is estimated that, in 2006, 31,418 medical insurance participants (about 3.79 per cent of the total population) will have chronic diseases, of which 23,734 patients will keep having chronic diseases in the following year.

On average, 80.41 per cent of chronic disease patients will keep having chronic diseases in the next year. This is consistent with the fact of most chronic disease is on-going by definition. So when determining the individuals with chronic diseases, this factor should be considered. Three impact factors were considered in projecting chronic disease patients — that is, gender, age group and index of chronic disease in the previous year or not. For the concern of the population ages over time, the model considered the population projection first (refer to subsection 5.6.2). The results in Figure 5.6 and Table 5.19 showed the population ages over time.

When considering the index of chronic disease, the average figure of 80.41 per cent will be used rather than the increase trends of three years (last column in Table 5.27). This is because

the three years' percentages were not stable. If using the increasing rate trend, in a couple of years, the rate could be as close as 100 per cent, which is unreasonable. The average of 80.41 per cent is already high enough and has good representativeness for the three years. In addition, the percentage of individuals with chronic diseases is quite small, and the impact of this assumption can be ignored.

Table 5.27 Composition and characteristics of chronic disease in 2002-2005

Year	population	Population with chronic diseases	%	Keep the disease to next year	%
2002	506258	17063	3.3704	11369	66.6296
2003	630108	19646	3.1179	16407	83.5132
2004	716828	22933	3.1992	20890	91.0914
2005	793987	29516	3.7174		
Average			3.3512		80.4114
Projection					
2006	829518	31418	3.7875	23734	
2007	858925	33146	3.8590	26653	
2008	883852	34751	3.9317	27944	
2009	905486	36273	4.0059	29167	
2010	924596	37737	4.0814	30345	

In projecting individuals for the forecasting year, the model randomly picked up 80.41 per cent of chronic disease patients in the previous year by gender and age group and selected them to be chronic disease patients. The remaining target number of chronic disease patients for the forecasting year was randomly picked up among the other insured individuals according to the corresponding transformation probabilities of chronic diseases by gender across age group. These transformation probabilities of chronic disease were established by analysing the actual data of 2002-2005.

Medical expenses of chronic disease patients

After identifying the individuals with chronic diseases, the next step was to project their medical expenses in the forecasting year. Medical expenses of chronic disease patients were projected for the period of 2006-2010 by using the annual empirical increase rates of medical expenses. In the same way as with clinic services and pharmacy medications, the empirical rates of increase of medical expenses for chronic diseases were established, as illustrated in Table 5.28. The first two columns in Table 5.28 indicate gender and age group respectively. The third column represents 10 categories of medical expenses from the lowest to the highest.

Rate1 – Rate4 in the first row gives different levels of increase rates for each category, with their relative frequencies in the last row.

Table 5.28 Increase rates parameters for the chronic expenses forecast

Sex	Group	Index	Rate1	Rate2	Rate3	Rate4
1	1	1	-0.29262	0.95449	2.91872	15.32512
1	1	2	-0.50781	0.25345	2.03163	4.15717
1	1	3	-0.37387	-0.16581	1.25495	1.36118
1	1	4	-0.15368	-0.22232	-0.05285	0.54442
1	1	5	-0.50996	0.29118	0.39830	0.45352
1	1	6	-0.03758	0.09753	-0.23085	0.28183
1	1	7	-0.37956	0.14624	0.21101	0.25347
1	1	8	0.07540	0.05144	0.05917	0.15037
1	1	9	-0.47460	-0.38978	-0.15438	0.08103
1	1	10	-0.25291	0.03303	0.07695	0.13436
:	:	:	:	:	:	:
2	5	9	-0.24559	0.06901	0.09567	0.16438
2	5	10	-0.24192	0.03784	0.06757	0.14849
Relative frequency			0–0.50	0.50–0.75	0.75–0.90	0.90–1.00

The medical expenses were projected by assigning a uniform random number to each individual who has chronic diseases. For example, for a male patient aged under 35 years old whose medical expenses in the previous year was in the lowest category, then his medical expenses in the forecast year would have an increase rate (-0.29262) with a chance of 50 per cent. And the medical expenses for his chronic disease would be estimated to be the average expense in his category multiplied by (1 + (-0.29262)).

Total self payment

Since the total self payments are for medical services which are not covered by the social medical insurance scheme, these need to be projected separately from the total medical expenses. Among all of the chronic disease patients in 2002-2005, on average, 24.73 per cent of patients had medical service items totally paid by themselves. Following the proportions of total self payments to their total medical expenses, the parameters were produced to be used to project the total self payments (Table 5.29). The first three columns in Table 5.29 represent gender, age group and 10 categories of medical expenses from the lowest to the highest, the same meaning as when considering the parameters for total expenses (Table 5.28). Rate1 – Rate3 in the first row are proportions of self payment to the total medical expenses from the lowest to the highest, with the relative frequencies in the last row. With these self payment

proportion parameters, the amount of total self payments were projected randomly, based on the total medical expenses for chronic diseases.

Table 5.29 Proportion parameters for totally self payments

Sex	Group	Index	Rate1	Rate2	Rate3
1	1	1	0.000000	0.000000	0.110362
1	1	2	0.000000	0.005269	0.123168
1	1	3	0.002124	0.030471	0.167213
1	1	4	0.000037	0.001140	0.009579
1	1	5	0.000000	0.000000	0.011280
1	1	6	0.000000	0.013362	0.021320
1	1	7	0.000000	0.011050	0.042477
1	1	8	0.000248	0.003349	0.044311
1	1	9	0.000453	0.003636	0.005241
1	1	10	0.000449	0.007341	0.016333
:	:	:	:	:	:
2	5	9	0.001119	0.012761	0.043944
2	5	10	0.003815	0.032590	0.102381
Relative frequency			0.00-0.75	0.75-0.90	0.90-1.00

5.7.4 Clinic special check-ups

The medical services items of ‘clinic special check-up’ in 2005 accounted for 0.357 per cent of the total number of medical services. The social pool fund covers 70 per cent of the medical expenses for this kind of medical service, while patients contribute the remaining 30 per cent of the bill. Similar to the simulation for the chronic disease patients, total medical expenses and total self payments are projected separately.

Determine the population of clinic special check-up for forecasting years

The first step in predicting the medical expenses is to identify individuals who have clinic special check-ups. By analysing the population who had the clinic special check-ups in 2002-2005, the percentage of these kind of patients in the total population was estimated for 2006-2010 (Table 5.30). It is estimated that 27,707 individuals (or 3.34 per cent of the total population) have clinic special check-ups in 2006. As in the forecasting of chronic disease patients, the simulation of expenses considered in the model is for total medical expenses and total self payments. When forecasting the medical expenses for the clinic special check-up, individuals, according to their gender and age group, were randomly selected by the estimated proportion of such patients to the total population.

Table 5.30 Estimated proportion of clinic special check-up and proportion of total self payments

Year	Population	Number of special check-up	% of number with special check-up	Number of persons had total self payment	Proportion to total expense
2002	506258	3119	0.616089	10	24.2278
2003	630108	11613	1.843017	3	25.1351
2004	716828	18919	2.639266	6	18.3215
2005	793987	23738	2.989721	45	25.2070
				Average	23.2229
Projection					
2006	829518	27707	3.340177		
2007	858925	31700	3.690632		
2008	883852	35717	4.041087		
2009	905486	39765	4.391542		
2010	924596	43844	4.741997		

Notes: Proportion to total expense in the last column means, for those who had services items of total self payment, the percentage of self payment to the total medical costs.

Unlike the characteristics of chronic diseases, based on the analysis of the actual data in 2002-2005, it was found that clinic special check-up has *no continuity* to medical services use in the following year. So the predictive factors considered in determining the patients who would have clinic special check-ups for the forecast year only included gender and age group. Table 5.31 gives the distribution of clinic special check-ups by gender across age group in 2002-2005. The first two columns indicate categories of gender and age group respectively. The last column shows the average proportion in the previous four years (which is used as the estimated percentage of patients in the forecasting years).

Table 5.31 Distribution of clinic special check-ups

Sex	Age group	2002	2003	2004	2005	Average
1	1	2.7252	3.8061	4.1968	4.8572	3.8963
1	2	7.7589	11.0566	11.0048	10.6496	10.1175
1	3	8.7528	9.5410	9.0068	8.1768	8.8694
1	4	6.9253	5.5972	5.1905	4.6803	5.5983
1	5	15.3254	11.5646	9.9688	9.6175	11.6191
2	1	4.0077	5.3475	7.3207	9.3395	6.5038
2	2	13.6903	17.7560	20.9578	22.8831	18.8218
2	3	3.9436	3.4616	3.6366	3.2269	3.5672
2	4	21.6416	20.0896	18.2621	17.0781	19.2678
2	5	15.2292	11.7799	10.4551	9.4911	11.7388
Total		100.0000	100.0000	100.0000	100.0000	100.0000

Notes: Sex – '1' for male, '2' for female; Age group – '1' for employee aged less than 35 years, '2' for employee aged 35-49 years, '3' for employee aged 50 years or over, '4' for retiree aged less than 65 years, '5' for retiree aged 65 years or over.

The medical expenses of special check-up

The medical expenses associated with special check-ups were predicted by using created cost distribution parameters. These parameters were constructed by using the information for 2002-2005. The result is presented in Table 5.32, where the first two columns are gender and age group respectively, and the third column represents 10 categories of medical expenses from the lowest to the highest (with their relative frequencies in the fourth column). The column of 'Average increase rate' means the average rate of increase for 2003-04 and 2004-05 combined.

With the average increase rates and the mean expenses in 2005, the mean of expenses in 2006 could be projected for each category of medical expenses (the last column in Table 5.32). The similar mean parameters for the year 2007 were obtained by using the average rates and the means in 2006. The same process was repeated for the following forecasting years until 2010.

Table 5.32 Distribution of expenses (Yuan) and rates of cost increases for special check-up

Sex	Age group	Expense	Relative frequency	Mean03	Mean04	Mean05	Average increase rate	Mean06
1	1	1	0.00 –	70.00	73.33	66.33	-0.0239	64.75
1	1	2	0.01 –	105.56	100.71	82.22	-0.1147	72.79
1	1	3	0.05 –	121.05	122.78	100.44	-0.0838	92.02
1	1	4	0.10 –	149.58	149.60	123.90	-0.0858	113.27
1	1	5	0.25 –	201.72	187.31	153.66	-0.1255	134.36
1	1	6	0.50 –	243.50	239.26	222.14	-0.0445	212.26
1	1	7	0.75 –	372.32	421.19	374.95	0.0107	378.98
1	1	8	0.90 –	750.59	806.59	764.56	0.0113	773.16
1	1	9	0.95 –	1140.71	1091.07	1081.48	-0.0262	1053.19
1	1	10	0.99 –	2210.16	2097.28	1776.50	-0.1020	1595.27
1	2	1	0.00 –	60.00	66.67	67.06	0.0585	70.98
1	2	2	0.01 –	100.00	100.16	76.63	-0.1167	67.69
:	:	:	:	:	:	:	:	:
2	5	9	0.95 –	944.64	896.18	1024.59	0.0460	1071.72
2	5	10	0.99 –	1878.44	1735.28	1815.54	-0.0150	1788.34

In the simulation using these parameters, for a patient who has special check-ups in the forecasting year (say 2006), the patient's annual medical expenses will be estimated as Exp = (0.5 + Randnum) × Mean06. Mean06 is the average expense of special check-ups in the patient's category, while Randnum is a uniform random number (ranged from 0 to 1) assigned to this patient. The purpose of adding such uniform random numbers is to broaden the diversity among patients' expenses while, at the same time, the figure '0.5' in the function guarantees the average of medical expenses is kept the same as Mean06.

Means are used here because, not like clinic services and medications, special check-ups only account for a small part of the total medical services. Using adjusted parameters like those for clinic services would result in lots of empty cells when considering sex across age group across medical expenses. Furthermore, in order to capture the distribution of benefits, one or two uniform random numbers were used in the model.

Total self payments

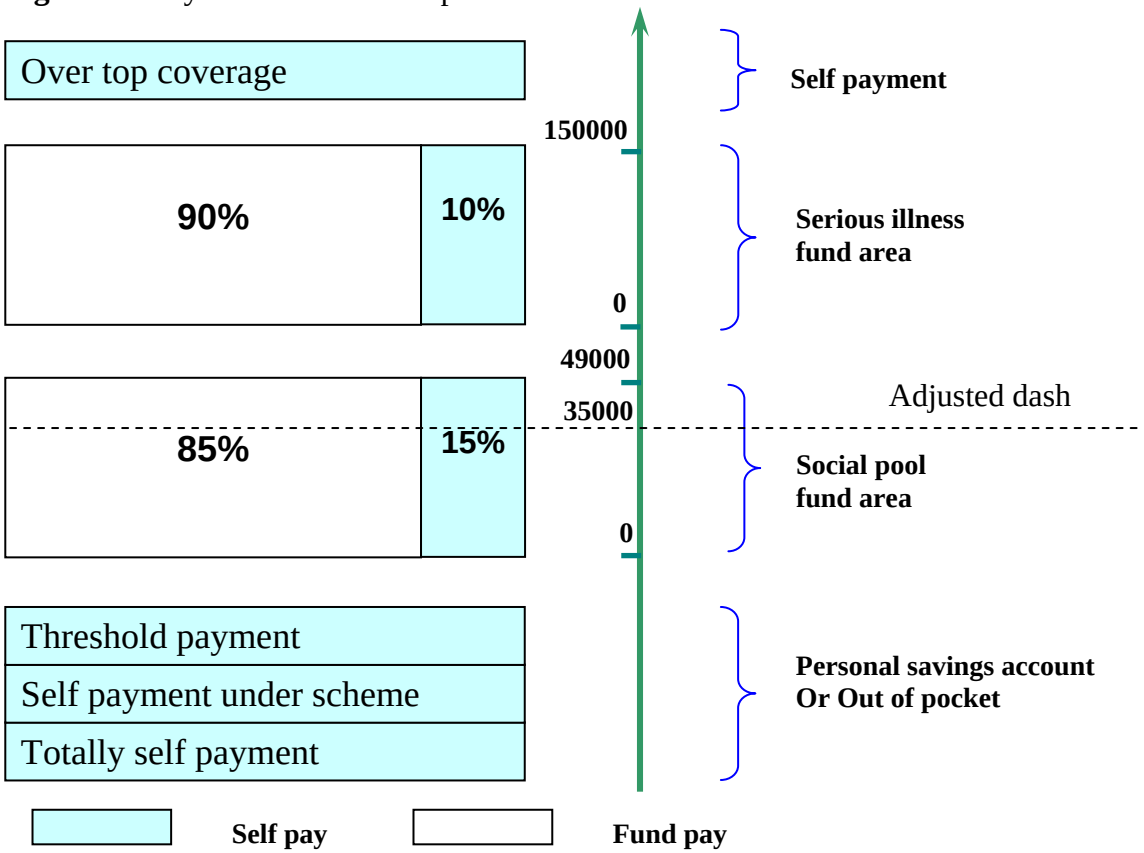
During the period of 2002-2005, the ratio of patients who had total self payment items compared with the total number of special check-up patients was very low — just 0.142 per cent on average — and their average total self payment was 23.2 per cent of their total check-up expenses (Table 5.30). So, in forecasting total self payments, the model randomly picked up 0.142 per cent of special check-up patients, and assigned their total self payments to be 23.2 per cent of their total medical expenses.

5.7.5 Hospitalisation services

Hospitalization services mainly include four medical service items — i.e. admitted to hospital, special disease clinic treatment, clinical emergency, hospital transfer. All of these medical services follow the same medical insurance payment mode, in which the social pool fund and the serious illness fund share a large part of meeting the medical expenses. Figure 5.8 illustrates the payment mode for hospitalization services. The total cost for an inpatient is split into four tiers. The first tier includes total self payment, self payment under the medical insurance scheme, and the threshold to trigger the social pool fund. The costs under this tier are paid either by personal savings accounts or by patients themselves. The next tier is the social pool fund area, immediately followed by the third tier – the serious illness fund area. Both of the funds cover a large part of medical expenses: the social pool fund is designed to cover the medical costs ranging 0 – 49,000 Yuan, while the serious illness fund covers costs ranging from 0 – 150,000 Yuan. When medical expenses exceed the ceiling of the serious illness fund, which is very rare, the excess medical bill is paid by patients themselves. In practice, in implementing the social insurance scheme, the Kunming Government set part of the social pool fund responsibility onto the serious illness fund – adjusted dash line in Figure 5.8. In 2006, the coverage of the social pool fund was up to 35,000 rather than 49,000 Yuan, with the excess 14,000 Yuan being covered by the serious illness fund.

If an individual should be admitted to a hospital a second time in a financial year, then the threshold for the hospital will reduce to 30 per cent of the regular threshold. If an individual should be admitted to a hospital a third time or more, then from the third time of hospitalization services onward, the patient does not need to pay the threshold any more. Consistent with these insurance payment rules, hospitalization services are predicted three times separately in the model– corresponding to the first, the second, and the third or more times admitted to hospital. For each time admitted to a hospital, hospitalization services are projected through five continuous procedures — that is, selecting inpatients randomly (after taking account of whether hospitalised in the preceding year and other characteristics), assigning the patients to different level of hospitals, forecasting the total medical expense for each patient, forecasting total self payment, and forecasting self payment under the medical insurance scheme.

Figure 5.8 Payment mode for hospitalization services



First time admitted to a hospital in a financial year

For simulating patients who were admitted to a hospital for the first time in a year, a certain number of insured population were randomly selected, according to hospitalisation rates, and

admitted to different levels of hospitals. Then certain amounts of medical expenses were imputed to them. The inpatients pay a threshold fee (trigger criteria) before triggering the social pool fund.

The analysis of hospitalization data in 2002-2005 showed that the hospitalization rate was highly connected with whether an individual was admitted to a hospital in the previous year or not. Individuals who were admitted to hospitals in the previous year are three times more likely to be admitted to a hospital than other individuals. So, when constructing the hospitalization parameters, whether an individual was admitted to a hospital in the previous year or not is considered, as well as the individual's gender and age group.

Table 5.33 shows the estimated parameters for the first time hospitalization rates in the year of 2006-2010, together with the actual rates for the years of 2003-2005. The first column indicates whether an individual was admitted to a hospital or not in the previous year. The second and third columns give categories of gender and age group respectively. Rate2003 – Rate2005 are the actual hospitalization rates for 2003-2005, while Rate2006 – Rate2010 are the estimated rates for the forecasting year of 2006-2010.

Table 5.33 Parameters for the first time hospitalization rates in each year

Index	Sex	Group	Rate2003	Rate2004	Rate2005	Rate2006	Rate2007	…	Rate2010
0	1	1	0.023327	0.025950	0.027700	0.028283	0.028478	:	0.028572
0	1	2	0.033334	0.038518	0.041722	0.042790	0.043146	:	0.043318
0	1	3	0.047908	0.052899	0.058000	0.059700	0.060267	:	0.060539
0	1	4	0.078557	0.077357	0.088173	0.091779	0.092981	:	0.093559
0	1	5	0.125970	0.136148	0.154028	0.159988	0.161974	:	0.162931
0	2	1	0.031279	0.037040	0.040390	0.041507	0.041879	:	0.042058
0	2	2	0.042331	0.047664	0.052278	0.053816	0.054329	:	0.054575
0	2	3	0.064007	0.071169	0.074335	0.075390	0.075742	:	0.075911
0	2	4	0.075889	0.080208	0.091679	0.095502	0.096777	:	0.097391
0	2	5	0.135262	0.148472	0.167971	0.174471	0.176637	:	0.177680
1	1	1	0.089641	0.141785	0.166131	0.174246	0.176951	:	0.178254
1	1	2	0.137416	0.189772	0.218969	0.228701	0.231945	:	0.233507
1	1	3	0.180979	0.208889	0.271389	0.292223	0.299167	:	0.302511
1	1	4	0.273476	0.337451	0.397770	0.417876	0.424578	:	0.427805
1	1	5	0.322764	0.408225	0.458999	0.475924	0.481566	:	0.484282
1	2	1	0.119195	0.133288	0.175097	0.189034	0.193679	:	0.195916
1	2	2	0.123231	0.181963	0.224158	0.238222	0.242911	:	0.245168
1	2	3	0.194737	0.244475	0.270789	0.279560	0.282484	:	0.283892
1	2	4	0.255583	0.295304	0.343846	0.360027	0.365421	:	0.368018
1	2	5	0.332346	0.397094	0.450842	0.468758	0.474731	:	0.477606

When constructing the rates for the forecasting years, a moderate increase was incorporated, reflecting the slow increase shown in Table 5.33 over the years — for example, Rate2006 = Rate2005 + (Rate2005 – Rate2004)/3. Similar methods were used to estimate the hospitalization rates for the following forecasting years. For each forecasting year of 2006-2010, a number of individuals were selected randomly as inpatients according to the relative hospitalization rates in Table 5.33. For example, a male under 35 years old who was not admitted to a hospital in 2005 would have a chance of 0.028283 of being admitted to a hospital in 2006.

Level of hospitals which patients are admitted to

Hospitals are categorized into three levels according to their size, medical facilities and services qualifications, noted as small hospital, medium hospital and large hospital. The percentage of hospitalization services expenses shared by patients varies with the level of hospital. The hospital level distribution of inpatients was constructed through the actual datasets in 2004 and 2005. Table 5.34 illustrates the distribution estimation for the year 2006 by patients' gender across age group, in which 'S' stands for Small hospital, 'M' for Medium hospital and 'L' for Large hospital. For example, for male inpatients who are aged less than 35 years in 2006, they would have a chance of 0.151465 of being admitted to a small hospital, a chance of 0.334527 to a medium hospital, and a chance of 0.514008 to a large hospital. Generally speaking, during the period of 2006-2010, the proportion of patients admitted to small hospitals shows a slight trend increase, and vice versa for large hospitals.

Table 5.34 Hospitalization distribution illustrated for the year 2005 and 2006

Gender	Age group	S05	M05	L05	S06	M06	L06
1	1	0.150455	0.336976	0.512568	0.151465	0.334527	0.514008
1	2	0.138469	0.349058	0.512472	0.141631	0.355970	0.502399
1	3	0.140328	0.291788	0.567883	0.143696	0.290334	0.565970
1	4	0.166955	0.339474	0.493571	0.169840	0.339035	0.491126
1	5	0.171865	0.337287	0.490848	0.173304	0.342087	0.484609
2	1	0.128009	0.299765	0.572225	0.129121	0.301136	0.569743
2	2	0.120071	0.267952	0.611978	0.121663	0.275191	0.603145
2	3	0.109476	0.247470	0.643054	0.105128	0.262541	0.632331
2	4	0.117348	0.260649	0.622003	0.113019	0.274890	0.612091
2	5	0.105965	0.273905	0.620130	0.101613	0.283977	0.614410

Notes: S05 = small hospital usage in 2005, M05 = medium hospital usage in 2005, L05 = large hospital usage in 2005, S05 + M05+L05=1; S06 = small hospital usage in 2006, etc. The data for 2005 are actual, for 2006 are estimated.

Total medical expenses in the first hospitalization

After allocating inpatients to different levels of hospitals, the model is ready to project the medical expenses. The medical expenses distributions for the forecasting years were established by analysing the data of 2002-2005. The impact factors considered here include hospital levels (3 categories), gender (2 categories), age group (5 categories), and the section of medical expenses from the lowest to the highest (14 categories). Combined together, all of these four factors made a total number of cells of 420. The average hospitalization expenses were calculated annually for each cell, and then the average increase rates of medical expenses in 2002-03, 2003-04 and 2004-05 were taken to be the forecasting increase rates. The expenses distribution in 2006 could be estimated by using both these increase rates and the expenses distribution in 2005. The expenses distributions for 2007-2010 could be obtained similarly. Table 5.35 illustrates the increase rates of medical expenses and the estimated average costs in 2006. The first three columns indicate hospital levels, gender, and age group respectively. The fourth column represents 14 categories of medical expenses from the lowest to the highest, with their relative frequencies in next column to them.

Table 5.35 Expenses increase rates and average estimated costs for 2006 in first hospitalization

Hosp level	Sex	Age group	Index	Frequency	Mean05	Increase Rate	Mean06
01	1	1	1	0.00 –	624.08	0.23299	769.48
01	1	1	2	0.05 –	1106.95	0.12407	1244.29
01	1	1	3	0.10 –	1395.38	-0.04138	1337.64
01	1	1	4	0.20 –	1724.76	-0.05106	1636.68
01	1	1	5	0.30 –	1949.31	-0.07044	1812.00
01	1	1	6	0.40 –	2165.07	-0.09580	1957.66
01	1	1	7	0.50 –	2415.32	-0.09372	2188.95
01	1	1	8	0.60 –	2717.61	-0.16621	2265.91
01	1	1	9	0.70 –	3193.48	-0.20805	2529.08
01	1	1	10	0.80 –	3727.36	-0.22008	2907.04
01	1	1	11	0.85 –	4156.22	-0.24541	3136.23
01	1	1	12	0.90 –	5288.43	-0.25105	3960.76
01	1	1	13	0.95 –	8494.09	-0.18392	6931.89
01	1	1	14	0.99 –	59441.30	0.43644	85384.09
01	1	2	1	0.00 –	520.24	0.16921	608.26
01	1	2	2	0.05 –	907.57	0.05757	959.82
:	:	:	:	:	:	:	:
03	2	5	12	0.90 –	16290.93	-0.03145	15778.50
03	2	5	13	0.95 –	29224.33	-0.04944	27779.52
03	2	5	14	0.99 –	76063.95	-0.06158	71380.10

Note: Frequency – relative frequencies for 14 indexes of medical expenses from the lowest to the highest.

In forecasting medical expenses for inpatients when using these parameters, two uniform random numbers were assigned to each inpatient, Ran01 and Ran02 (ranged from 0 to 1). For example, if a male inpatient under 35 years of age, was admitted to a small hospital in 2006, and the first random number assigned to him was between $0.00 \leqslant Ran1 < 0.05$, then his total hospitalization expenses would be estimated as $Cost06 = (Ran2+0.5)\times 769.48$. The function of Ran2 here is to give the estimated expenses in the same cell some diversity. The extra figure of 0.5 guarantees the average cost in this cell to be 769.48 Yuan.

Total self payment

The proportion distribution of total self payment to the total expenses was obtained by analysing the datasets of 2002-2005 (see Table 5.36). The first two columns are categories of gender and age group, respectively. The third column indicates the 14 categories of medical expenses which are the same as the categories for total medical expenses. Rate1 – Rate5 stand for the ratios of total self payment to the total medical expenses, with the relative frequencies in the last row. Using these ratio parameters, the total self payments for each inpatient were predicted.

Table 5.36 Proportion distribution of total self payment to the total expense

Sex	Group	Index	Rate1	Rate2	Rate3	Rate4	Rate5
1	1	1	0.004606	0.030751	0.070440	0.132446	0.267309
1	1	2	0.009049	0.036818	0.074879	0.135047	0.251836
1	1	3	0.008836	0.038574	0.083607	0.150785	0.257810
1	1	4	0.009997	0.045644	0.095336	0.147619	0.244883
1	1	5	0.008794	0.044535	0.093837	0.149726	0.232605
1	1	6	0.007610	0.033649	0.068852	0.107431	0.213792
1	1	7	0.007335	0.039560	0.083174	0.134690	0.216620
1	1	8	0.010397	0.043728	0.080928	0.121925	0.196040
1	1	9	0.006801	0.035762	0.069015	0.106396	0.168058
1	1	10	0.007268	0.028676	0.063568	0.107021	0.217879
1	1	11	0.007962	0.039297	0.069130	0.095568	0.148878
1	1	12	0.009122	0.034623	0.066410	0.109658	0.198896
1	1	13	0.010652	0.037260	0.071001	0.138702	0.232901
1	1	14	0.014070	0.046227	0.102251	0.137808	0.249974
1	2	1	0.003123	0.024584	0.066031	0.117863	0.218332
1	2	2	0.007042	0.033686	0.073412	0.119577	0.236281
:	:	:	:	:	:	:	:
Relative frequency			0.00-0.50	0.50-0.75	0.75-0.90	0.90-0.95	0.95-1.00

Self payment under the social insurance scheme

Similar to the simulation of total self payments, this part of the payment was projected using the ratio distribution of self payment to the total expenses.

Second time admitted to a hospital in a year

For patients admitted to hospital a second time in a year, the patients only pay 30 per cent of the trigger criteria for the admitted hospital before they trigger the social pool fund. A certain number of inpatients who have been admitted once to hospital were picked up randomly as the patients who were admitted to hospital a second time. Similar to the first time hospitalization service, the procedures of forecasting medical behaviour for the second time hospitalization service involved allocating to different levels of hospitals, predicting total medical expenses, predicting total self payments, and predicting self payments under the insurance scheme. The construction of the relative parameters is similar to the first time hospitalization services.

Admitted to a hospital three times or more in a year

In a financial year from 1 January to 31 December, if an individual is admitted to hospital three times or more, the individual does not need to pay for the trigger criteria any more. In the simulation for this sort of patient, a certain number of inpatients who were admitted to hospital twice in the forecasting year were selected randomly as the patients to be admitted to a hospital three times or more. Similarly to the first and the second time hospitalization services, the procedures of hospital level, total medical expenses, total self payment, and self payment under the insurance scheme were all subsequently projected.

Until now, all the four items of medical services for medical insurance participants were projected for 2006-2010. The following sections discuss the results of predicted medical expenses and payments.

5.8 Summary

This chapter described the use of microsimulation technologies to predict the medical expenses of urban employees and retirees under the urban social medical insurance system. In cooperation with the Bureau of Labour and Social Security of Kunming, Yunnan Province, this chapter reported on the construction of a microsimulation model for the medical insurance system in China. The model created can be used to forecast medical expenses of medical insurance participants, and assess the distributional impacts of the medical insurance policy settings on the different types of participants.

The model described in this chapter took each insured individual as a basic simulation unit, with a year as the basic simulation period. With 2006 as the commencement year, the model forecast the urban medical insurance policies and their settings for five years until 2010. The model mainly consisted of five modules. The first module is for simulating death cases and new entries into the medical insurance scheme, and setting the personal savings accounts and three pool funds (Section 5.6). The other four modules are for forecasting four items of medical services (Section 5.7) – clinic services and medications, chronic disease services, clinic special check-ups, and hospitalization treatments, which are essential parts in the model.

For the validation of the model, some of the predicted values based on 2001-2005 were compared and adjusted with the reported values in 2006. For example, the results from the population projection (Figure 5.5, Table 5.17), the estimates of individual income (Table 5.20) and the estimates of the medical insurance funds (Table 5.23) were highly consistent with the actual values in 2006. Rates of death events in the model were referred to the original data source of insurance participants.

Based on forecasting medical expenses and medical insurance payments of 2006-2010, the balances of the personal savings accounts for each individual can be obtained. This will help to estimate the distributional impacts of the medical insurance system on participants and to explore the benefit or burden under the medical insurance scheme. By analysing the balances of the social pool fund, the serious illness fund and the Government official fund at the end of each forecast year, the assistance capacity and sustainable development of these pool funds can be examined. These forecasting results are discussed later in Chapter 7. Chapter 7 will also discuss the impact of the urban medical insurance system on urban employees and employers, such as the distribution of personal savings accounts and the medical services burden for different age groups of the population.

Combining the other information about the medical services needs of urban residents, the results from this model are valuable preparation for estimating medical expenses for urban residents out of the labour force. This will be the main topic in the next chapter.

CHAPTER 6 MODEL OF MEDICAL INSURANCE FOR URBAN RESIDENTS

6.1 Introduction

As mentioned in Chapter 3, after establishing a medical insurance system for the urban employed population in 1998 and founding a new cooperative medical care system in rural regions in 2002, China launched a pilot project of medical insurance reform in September 2007 to cover urban residents outside of the workforce. The pilot project has been carried out in 79 cities to cover non-working urban residents, including children, students and elderly people. Both the Central Government and local governments fund the subsidies. The target has been set of establishing a medical service system which covers all urban residents by 2010.

As one of the 79 pilot cities chosen by the Central Government, Kunming began its urban residents' medical insurance scheme in October 2007. Participation in this medical insurance plan is voluntary. The premiums are paid by households or families, instead of individuals. The government gives subsidies of at least 70 per cent of the insurance premiums annually to each participant, with higher subsidies going to families who are low income earners or with disabled individuals. By the end of February 2008, several months since the scheme's commencement, 0.207 million urban residents had been covered by the medical insurance scheme. The goal is to cover 0.90 million urban residents who are out of labour workforce by 2009, and to cover all urban residents of Kunming (around 1.2 million) by 2010.

This chapter focuses on modelling medical services use and forecasting medical expenses on hospitalization treatments as well as clinic services for serious illnesses for non-working urban residents in Kunming. The key aims of this research are to assess the distributional impacts of the medical insurance policies and to predict the medical expenses for urban residents from the aspects of: collecting the insurance premiums; establishing a social pool fund; and paying for the incurred medical costs. The amounts of subsidies by the various levels of government are estimated, as well as the medical costs of hospitalization services for different levels of family income. The research creates a static microsimulation model to project the impact of the medical insurance scheme in an urban area of China to assist in setting future policy.

The datasets used in this chapter mainly include two parts: a sample dataset from the 2000 national population Census for all urban individuals in Kunming; and datasets from the social medical insurance scheme for urban employees and retirees in Kunming. The former dataset has the complete household or family structure, which is useful for estimating and evaluating the impact of the medical insurance plan on individuals and families. The latter datasets provide comprehensive medical services information and the corresponding individual records. The population in the latter datasets is, of course, a subset of the former dataset, as it does not include non-working residents.

In this chapter, the population of interest is non-working residents. Then why is the model to use the datasets for urban employees and retirees? Because no individual level medical costs information is available for the group of non-working residents, the model needs to “borrow” the relevant information from the employed individuals. In fact, the total urban population is made up of three groups, that is, non-working residents, employed people with social medical insurance and employed people without social medical insurance. The group of non-working residents accounts for about one third of the total population. Approximately half of the remaining employed people are covered by the social medical insurance. The medical insurance database is only available for insured employees and retirees. The model is going to create synthetic information for non-working residents by “borrowing” medical services costs and monthly incomes from the insured employees and retirees. Statistical matching methodology is used to achieve this goal. The records of individuals with insurance are for giving estimates of service use of adult residents, not for children in the model construction. The relative estimates of children are referred to the National Health Survey data.

In the following sections, the medical insurance scheme for urban residents is briefly introduced, followed by the research framework on the medical insurance system of urban residents and overview of data sources used in the model. Then the records of the population in 2000 will be updated to the target years of 2005-2010. This updated population will then be statistically matched with the dataset of the urban employees and retirees. By combining information from the National Health Services Surveys (conducted in 1998 and 2003), insurance coverage and medical services costs on hospitalization will be projected over the period of 2008-2010. For the simplification in the model, in this chapter, unless specification, urban residents mean urban resident who are not in the labour force (NILF).

6.2 Medical Insurance Plan and Framework of the Model

6.2.1 Medical Insurance Plan for Urban Residents

The medical insurance pilot program in Kunming for its urban residents, who are not covered by the medical insurance scheme for employed individuals, was established in October 2007 (Kunming Municipal Government, 2007). The plan aims to provide basic medical insurance for children, students and adult residents who are out of the labour force. The medical insurance premiums come from the governments and insured families, with the governments having the main responsibility. The medical insurance premiums are not subject to tax. A medical insurance pool fund has been set up to assist with the costs of hospital services as well as serious illness clinic treatments.

1) Medical insurance premium

The medical insurance premium of urban residents consists predominantly of the following three parts:

- the basic medical insurance premium paid by insured families;
- subsidies from the various levels of government; and
- bank interest upon the medical insurance premiums.

The designated medical insurance premium in 2007 and 2008 is 240 Yuan for an urban resident aged 18 years or over who has no job and 100 Yuan for a student or a child. The Kunming Municipal Government has planned that, after two years of implementation of this pilot program, the premium criteria may be appropriately adjusted according to the annual average disposable income per person and the balance of the medical insurance pool fund.

2) Subsidy by government

The Central government, the Yunnan Provincial Government and the Kunming Municipal Government together subsidize a large part of the medical insurance premiums. The amount of subsidies varies among the three groups of the population, i.e., adult residents, children and students in primary or secondary schools, and students in tertiary education, as illustrated in Table 6.1.

For adult residents aged 18 years or over, the governments subsidizes 170 Yuan per person annually; and an insured individual pays the remaining 70 Yuan. For the

concession residents in this group – residents receiving the lowest living allowances from the governments, people with disabilities without labour abilities and elders aged over 60 years in lower income families – the remaining 70 Yuan is further subsidized by government. In other words, for the concession residents, individuals are exempted from paying any premiums.

Table 6.1 Medical insurance premiums for urban residents (Yuan)

Individual category	Government subsidies			Levy of individual	Total premium
	Central	Provincial	Municipal		
Adult residents	20	50	100	70	240
Concession individuals	50	80	110	–	240
Children and students	20	30	40	10	100
Concession individuals	25	35	40	–	100
Students in tertiary education	–	–	90	10	100
Concession individuals	–	–	100	–	100

For children and students in primary or secondary schools, the subsidy for the premium from the governments is 90 Yuan per person annually; and individuals pay the remaining 10 Yuan. Children and students whose families receive the lowest living allowances or have disabilities without labour abilities, have the remaining 10 Yuan subsidized by the government.

For students in tertiary education – most are undergraduate students – an individual pays 10 Yuan for the medical insurance premium with the remaining 90 Yuan subsidized jointly by the Municipal government (60 Yuan) and the corresponding university (30 Yuan). These subsidies have been put together into the Municipal government in Table 6.1. Concession students do not need to pay the insurance premium.

3) Beneficiary under the medical insurance scheme

The basic medical insurance fund covers medical costs incurred in hospitalization services, clinic services for serious illnesses and clinic emergencies. The patient needs to pay a certain amount of medial costs, called ‘criteria payment’, before the benefits from the social pool fund can be accessed/triggered. This criteria payment is consistent with the situation for employees and retirees under the social pool fund (for example, 720 Yuan for a medium sized hospital). For concession patients, this criteria payment is half of that for the general patients.

The payment proportion by the social pool fund varies with level or size of hospitals, which is 75 per cent for small hospitals, 60 per cent for medium sized hospitals and 50 per cent for large hospitals. The payment rules for the urban residents' medical insurance scheme also state that, after two years of consecutive coverage, these payment proportions by the social pool fund will be raised up to 80 per cent, 65 per cent and 55 per cent for small, medium and large hospitals, respectively. These payment regulations are summarised in Table 6.2. These measures encourage residents to keep insured under this urban medical insurance scheme – and when they get sick, patients are encouraged to use the lower level of hospitals which usually cost less than the higher level of hospitals.

Table 6.2 Payment proportions shared by the social pool fund

Coverage period	Small hospital	Medium hospital	Large hospital
In the first two years	75%	60%	50%
After two years	80%	65%	55%

In a calendar year from the 1st January to the 31st December, the maximum coverage for hospitalization treatments per person by the social pool fund is set at 16,000 Yuan. For those patients having clinic services for serious illnesses, the coverage payment by the social pool fund in a year is up to 20,000 Yuan.

6.2.2 Framework of the Model

Because the medical insurance scheme for urban residents in Kunming only started at the end of 2007, the microsimulation model to be created in this research focuses on the period of 2008-2010. This subsection describes an overview of the framework of the model; detailed explanation will be given later in this chapter. The processes of the model in this chapter mainly involve the following three modules:

- **Population module**: Update the 2000 Kunming population Census records of residents to the year 2005; estimate the population structures for the period of 2006-2010; and then update the population for each year of 2008-2010 respectively.
- **Matching module**: Prepare the population of insured individuals in 2005 under the medical insurance scheme for employees and retirees, and statistically match this population with the updated population for urban residents in 2005.

- **Prediction module**: Estimate the premium subsidies by the government. Using two medical insurance scenarios, project medical services and medical costs of hospitalization services of insured urban residents.

6.2.3 Data Sources in the Model

As mentioned at the introduction, two main data sources are used in the model: a sample from the 2000 national population Census of Kunming; and datasets from the social medical insurance scheme for urban employed individuals in Kunming. Apart from these data sources, summarised dataset from the 1 per cent population survey conducted in 2005, and results from the second and the third National Health Services Survey conducted in 1998 and 2003 respectively are also used in the model.

A sample of individual records from China's 2000 national population Census was obtained by selecting households randomly. The sample contains demographic information of individuals and households, involving variables on household identifier, individual code, sex, date of birth, nationality, degree of education, employment status, type of income, migration record, marital status, birth giving, etc. According to the Census, Kunming had a population of 5.77 million.

At the end of 2005, China conducted a 1 per cent nationwide population Survey. According to the Survey report, Kunming had a population of 6.08 million at the end of 2005. Based on this Survey, the assembled information on total population, gender, age group, nationality, education degree and residential status can be acted as benchmarks when updating the population records from 2000 to 2005.

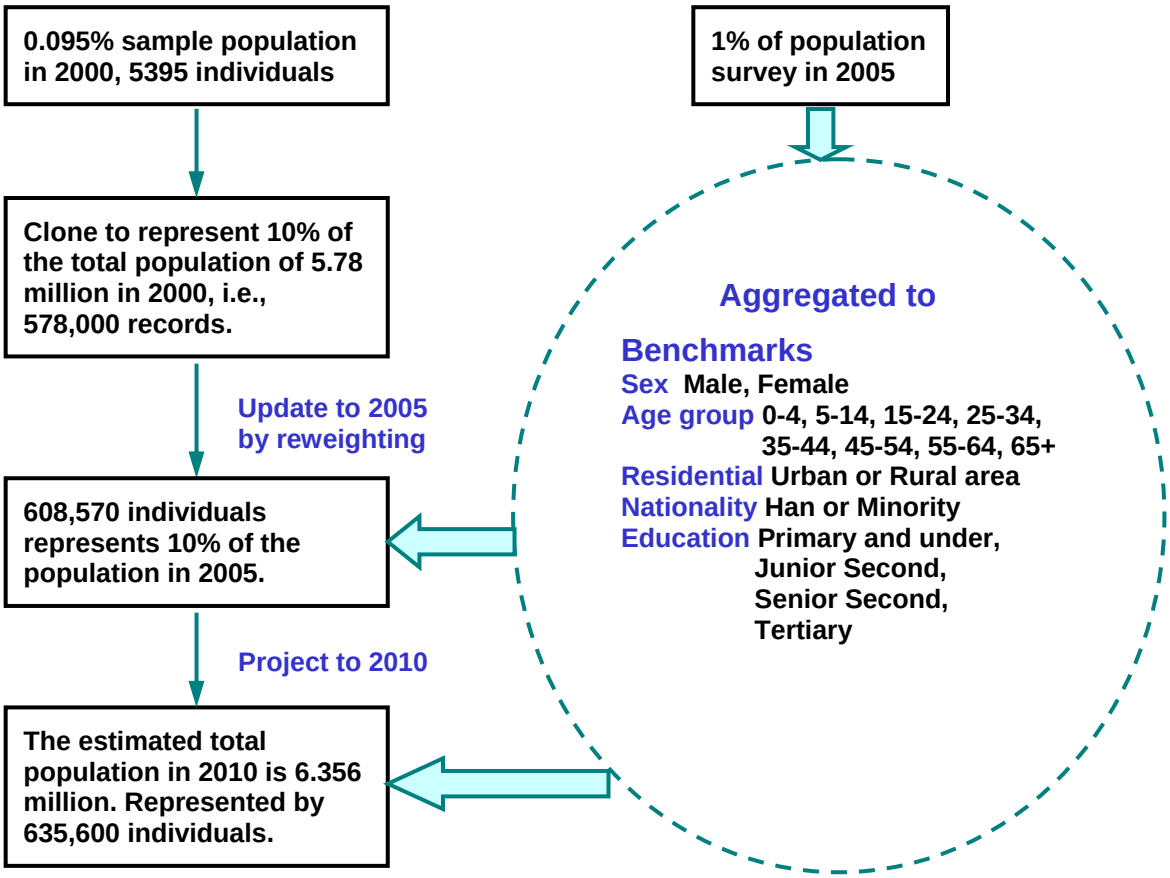
The other data source comes from the National Health Services Surveys conducted every five years. China conducted the third nationwide survey of health services during September and October of 2003 (Centre for Health Statistics and Information, 2004), sampled total of 57,023 households which contained 193,689 individuals, giving the average number of 3.4 people in each household. Individuals were chosen to report their health services and feedbacks on health services. The information gathered from the Survey assemblies makes it possible to model medical expenses of urban residents of Kunming.

6.3 Population Update to 2005

As mentioned in Section 6.2, modelling medical insurance scheme for urban residents consists of three modules. This section and next section discuss the first module – Population module.

In the Population module, the 0.095 per cent sample of the population records in the 2000 Census for Kunming is enlarged (or cloned) to represent about 10 per cent of the total population in 2000. Then, using the information compiled from the 1 per cent population survey conducted in 2005, the individual records in the 2000 population sample are re-weighted and the population is updated to the year 2005, as Figure 6.1 shows.

Figure 6.1 Update the 2000 Census data to 2005 and target years



The benchmarks to be used in the population update involve the five variables: Sex, Age group, Residential status, Nationality and Education. Then the population structures are

projected to the period of 2006-2010. The population is updated to 2008-2010 (that is, the target population years), using reweighting techniques; ready to implement the medical insurance scheme for urban residents.

This section discusses updating or re-weighting the population records in the base file. The base file is a sample from the National Population Census in 2000 for Kunming city, while the updating benchmarks come from the 1 per cent of the population survey in 2005. The method of the generalised regression estimator re-weighting (Tao, 2004) is used to update the population records.

6.3.1 Sample of the Population Census in 2000

China conducted its fifth population Census on the 1st November 2000. A sample of the 2000 population Census data records for the capital city of Kunming was kindly provided by Ms. Gao Jialing, a senior researcher of the Chinese Social Academy of Science, in late 2004. The sample was obtained by selecting households randomly, with a sample rate of 0.095 per cent. Each person in the sample corresponded to an individual record. All of the variables in the sample are character variables, involving individual information on sex, date of birth, ethnic nationality, degree of education, employment status, industry and occupation, migration record, marriage status, birth and housing, etc.

Focusing on Kunming's population, the sample contains 5395 individuals' records from 1761 households. The actual population of Kunming reported by the Census in 2000 was 5.78 million. In editing and processing the sample dataset, the first step was to eliminate the unrelated variables to the medical insurance scheme such as housing and migration records. The form of variables that are used to create the static microsimulation model for urban residents under the medical insurance scheme and their explanations are illustrated in Appendix B.1. This information is combined with the health services information of urban residents to estimate and forecast the impact of medical insurance policies on urban residents. To achieve this goal, the 2000 population sample needs to be updated to the year 2005. Then the updated population dataset is statistically matched with the individual records of employees and retirees who are covered by the social medical insurance scheme.

The total individual records for urban employees and retirees under the social medical insurance scheme are available, as discussed in Chapter 5, while the original population

dataset obtained was a 0.1 per cent sample of the Census in 2000. In order to keep as much information as possible on individual records, it is planned to match approximately 10 per cent of the population sample with 10 per cent of the insured employees' records. So the 0.095 per cent population sample in 2000 is enlarged to create around a 10 per cent sample of the total population. To do this, the 5395 original individual records were cloned 115 times, and the households' structures were kept unchanged. The new sample has 5395×116 = 625,820 individual records. This figure is 10.82 per cent of 5,781,300, the reported population in the 2000 Census. Hence each record in the cloned sample was provided with a weight of 9.23796.

6.3.2 Population Survey in 2005

At the end of 2005, China conducted a nationwide survey of 1 per cent of its population. According to the Survey report, Kunming had a population of 6.0857 million at the end of 2005. The aggregated results on Kunming's population are summarised in Table 6.3.

Table 6.3 Population structures of Kunming in the 2005 population Survey

Items	In 2005	Percentage (%)	Compared with 2000
Total population	6.0857 million		Increased 58,700 annually
Natural growth rate	0.743%		Down 0.114%
Sex			
Male	3.1096 million	51.19%	
Female	2.9651 million	48.81%	
Age			
0-14 years	1.0825 million	17.82%	Net reduction of 21,500
15-64 years	4.4722 million	73.62%	
65 years and over	0.52 million	8.65%	Net increase of 146,000
Education			
Primary	1,994,500	35.41%	
Junior secondary	---	---	
Senior secondary	973,500	17.28%	
Tertiary	455,700	8.09%	
Nationality			
Han nationality	5.2558 million	86.52%	Increased 4.41%
Minority	0.8189 million	13.48%	Increased 9.63%
Residential status			
Urban area	3.5264 million	58.05%	Up 350,400
Rural area	2.5483 million	41.95%	Down 56,700

The detailed assembly of the Survey on Kunming's population can be found at the Chinese Population Network (China Population, 2006), which contains information on the total

population, natural growth rate, and population structures by sex, age group, ethnic nationality, education and residential status.

The information gathered from this population Survey provided very useful data sources for updating the sample individual records from 2000 to 2005. It was found that there was a small difference between the reported total population and the summations of different categories. For example, when totalling categories on sex, age group, residential status and ethnic nationality, the total number was 6.0747 million, rather than the reported population of 6.0857 million. This is not a significant difference. In creating a model for the medical services for urban residents, the reported population of 6.0857 million is adopted as well as the percentages of the different categories.

6.3.3 Updating the Population to the End of 2005

The aggregated results of the population in 2005 act as benchmarks in updating the 2000 population Census data to the 2005 population records. The generalised regression estimator re-weighting techniques (Tao, 2004) are used to update the Census individual records. When updating the population records in 2000 to the year 2005, the structures of the households remain the same as in 2000. The benchmark variables in updating the population include Sex, Age group, Residential status, Ethnic nationality, and Education degrees, which are summarised in Table 6.4.

In Table 6.4, the information for the year 2000 is the summed results from the individual sample records of the 2000 population Census, while the information in 2005 is summarised from the 2005 population Survey. For comparison purposes, the estimated population distributions for the year 2010 are also collated in Table 6.4. The estimation processes for 2010 will be discussed below in Section 6.4.

In processing the population structures in 2005, missing items such as the number of individuals with junior secondary education and number of children aged less than 6 years need to be calculated. As there was no information indicating the proportion with junior secondary education in the 2005 population Survey, it assumed it had the same proportion as in 2000 (i.e., 29.97 per cent of the total population aged 6 years or over). The number of children aged less than 6 years could be estimated based on the total population and the education distribution, because the Survey on education was restricted to people aged 6 years or over. Hence,

Number of children less than 6 years = total population – number of people in education

Table 6.4 Population distribution in 2000 and benchmarks in 2005 and 2010

Items	2000	Percentage	2005	Percentage	2010	Percentage
Total population	5772650		6085700		6355960	
Natural growth rate	0.857%		0.743%		0.629%	
Adjust growth rate			1.031%		0.873%	
Sex						
Male	2994930	51.88	3115270	51.19	3253620	51.19
Female	2777720	48.12	2970430	48.81	3102340	48.81
Age group						
0-4	387340	6.71	365120	6.00	338980	5.33
5-14	762910	13.22	719130	11.82	712930	11.22
15-24	1068940	18.52	1088360	17.88	1117380	17.58
25-34	1230500	21.32	1280240	21.04	1316000	20.71
35-44	900940	15.61	953170	15.66	1001060	15.75
45-54	645210	11.18	704260	11.57	756680	11.91
55-64	384130	6.65	449010	7.38	488140	7.68
65 and over	392690	6.80	526410	8.65	624790	9.83
Residential status						
Urban area	3046230	52.77	3532750	58.05	3886030	61.14
Rural area	2726420	47.23	2552950	41.95	2469930	38.86
Nationality						
Han	5025790	87.06	5265350	86.52	5462370	85.94
Minority	746860	12.94	820350	13.48	893590	14.06
Education						
Tertiary	404200	7.63	455700	8.09	507290	8.55
Senior secondary	778740	14.70	973360	17.28	1178330	19.86
Junior secondary	1587680	29.97	1688170	29.97	1837500	30.97
Primary	2030030	38.32	1994600	35.41	1928280	32.50
Other *	496910	9.38	521040	9.25	481770	8.12
Under 6 years	475080		452830		422790	

Note: *'Other' means illiteracy or semiliterate aged 6 years and over.

In processing the population structures in 2005, the reported total population of 6.0857 million was kept and the numbers of the different categories were adjusted due to the corresponding proportions. For example, the reported number of males was 3.1096 million (accounting for 51.19%) and females 2.9651 million (accounting for 48.81%). Based on the total population of 6.0857 million and the corresponding proportions, the number of males was adjusted to 3,115,270 and females to 2,970,430.

Regarding the distribution of age groups in 2005, originally only three age groups (i.e., 0-14 years, 15-64 years, 65 years and over), were available (Table 6.3). The detailed information on age groups was estimated using the information in the 2000 Census sample and following

the principle of an ageing population. Based on the age group distribution in 2000, the proportion in age group 15-24 years in 2005 was supposed to reduce by 0.6696 per cent compared with that in 2000 (half of the reduction of age group 5-14 years). And this reduced figure of 0.6696 per cent was added to the proportion of age group 55-64 years. Similarly, the proportion of age group 25-34 years was supposed to reduce by 0.3552 per cent (half of the reduction of age group 0-4 years) and the reduced figure was added to the proportion of age group 45-54 years. The adjustment is for the population distribution of age. After the age group distribution adjustments, the population of each age group were determined (Table 6.4).

Based on the population benchmarks in 2005, the individual records in 2000 were updated to the end of 2005. In updating the individual records by using the generalised regression estimator re-weighting techniques, a SAS macro called GREGWT was adopted in the model. The macro GREGWT was originally created by the Australian Bureau of Statistics in 2000 and was provided to the National Centre for Social and Economic Modelling (NATSEM). The SAS codes for calling the macro GREGWT when updating the individual records to the year of 2005, with the parameter explanations, are illustrated in Appendix B.3.

In the similar way, after updating the 2000 population records to the year 2005, the population units were updated to each year of 2008-2010 respectively by using the estimated population benchmarks. The benchmarks for the period of 2008-2010 were estimated by using the information collected from the 2000 Census and the 2005 Survey; and this will be discussed in the next section. Then the updated individual records are statistically matched with the individual records of the employees and retirees under the urban medical insurance scheme, which add the missing information on using medical services and medical expenses. This is the main purpose in the Matching module.

6.4 Projecting the Population for 2006-2010

As part of the Population Module, this section reports the projection of the population for the period of 2006-2010. The projection starts with the total population estimations for each year of 2006-2010, then the population structure for the year 2010, followed by the population distribution estimations for the other four years.

6.4.1 Estimate the Total Population for 2006-2010

The target total population for each year of 2006-2010 was estimated first by using the information from the 2000 Census and the 2005 population Survey. According to the population Survey in 2005, the annual natural growth rate of Kunming was 0.743 per cent over the period of 2000-2005. However, when using this growth rate, the total population in 2005 was estimated to be under 6 million (the third column in Table 6.5), which varies from the target population of 6.0857 million. This underestimation possibly occurred because the natural growth rate did not consider the migration population of 86,400. By adjusting the natural growth rate to 1.031 per cent and re-calculating, the estimated population of 6.0855 million in 2005 was obtained (the fourth column in Table 6.5), which is quite close to the target population of 6.0857 million. So the figure 1.031 per cent was assumed to be the natural population growth rate over the period of 2000-2005.

Table 6.5 Estimating the population for the period of 2006-2010

Year	Actual population	Natural growth rate (%)		
		Survey 0.743	Adjusted 1.031	Estimated 0.873
2000	5781300	5781300	5781300	
2001		5824255	5840905	
2002		5867529	5901125	
2003		5911125	5961966	
2004		5955045	6023433	
2005	6085700	5999291	6085535	6085700
2006				6138817
2007				6192397
2008				6246445
2009				6300965
2010				6355960

Based on the population of 6.0857 million in 2005, the total population in 2006-2010 was estimated. The 2005 population Survey concluded ‘compared with the year 2000, the natural growth rate in 2005 decreased by 0.114 per cent’. So it is assumed in the model that the natural growth rate in 2010 will decrease by a similar proportion compared with 2005 – that is,

Decrease by (0.114%×1.031%/0.743%) = 0.158%

Where 0.743% is the reported natural population growth rate in the 2005 Survey and 1.031% is the adjusted natural growth rate. So the natural population growth rate in 2010 is estimated to be

1.031% – 0.158% = 0.873%

This growth rate is made to be the average natural growth rate over 2006-2010. Then the total population for each year of 2006-2010 can be estimated (last column in Table 6.5). It is estimated that Kunming will have a population of 6.3560 million in 2010.

6.4.2 Estimate the Structure of Population in 2010

After resolving the population estimation for the period of 2006-2010, the population structures on sex, age group, education degree, ethnic nationality and residential status are determined.

First, the proportion of sex distribution is supposed to follow the results in 2005, with 51.19 per cent of males and 48.81 per cent of females.

Next, the structure of the age groups is assumed to follow the trend over the period of 2000-2005. The proportion of age group 0-14 years is supposed to reduce 1.27 per cent by the end of 2010 compared with 2005, and the age group 15-64 years in 2010 keeps the same proportion as in the total population as in 2005. Hence, the proportion of people aged 65 years and over is estimated to be up from 8.65 per cent in 2005 to 9.83 per cent in 2010. The more detailed age group distribution will be discussed in the next subsection.

For education, the proportion of children aged less than 6 years was estimated first (Table 6.6). Then, following the trends over the period of 2000-2005, the proportions of people with different education categories can be estimated. The 2005 population Survey stated that ‘the population with junior high school education or over has kept increasing and the education for the whole population has further improved’. In the meantime the proportion with the primary school as the “highest level of education” has reduced slightly. Following these principles, the distribution of education degree for individuals aged six years or over in 2010 was estimated (Table 6.7).

Table 6.6 Estimated population aged under six years

Items	**2000**	**2005**	**2010**
Total population	5772650	6085700	6355960
Population aged under 6	475080	452830	422790
% of under 6 years to total	8.23	7.44	6.65

Ethnic nationalities are categorised into two groups – the Han nationality and the Minority nationality. Following the trends over the period of 2000-2005, the population of the Han nationality in 2010 is assumed to increase 4.41 per cent compared with 2005, while the Minority population in 2010 is estimated to increase 9.63 per cent compared with 2005.

Table 6.7 Estimated proportion of education for individuals aged 6 years or over(%)

Year	Tertiary	Senior high	Junior high	Primary	Other*	Total
2000	7.63	14.70	29.97	38.32	9.38	100.00
2005	8.09	17.28	29.97	35.41	9.25	100.00
2010	8.55	19.86	30.97	32.50	8.12	100.00
2010 – 2005	0.46	2.58	1.00	-2.91	-1.13	

Note: *'Other' means illiteracy or semiliterate aged 6 years and over.

For individual's residential status, following the trends of 2000-2005, the proportion of population living in urban areas is assumed to increase from 58.05 per cent in 2005 to 61.14 per cent in 2010. Then the proportion of population living in rural areas is estimated to be 38.86 per cent in 2010.

6.4.3 Population Structure for Each Year of 2006-2010

Based on the population distributions in 2005 and the estimated population structures in 2010, population structures for each year of 2006-2009 by sex, age group, residential status, ethnic nationality and education can be estimated by using the corresponding average increase rates for each population item. The estimated results are presented in Table 6.8.

Table 6.8 only contains three age groups, that is, 0-14 years, 15-64 years and 65 years or over, rather than the usually used eight age groups. In order to get detailed age group estimation, the process goes to the year 2010 first, and then expands the results to the other years in the period of 2006-2010.

Creating the detailed age groups in 2010 involves two parts. One is to split the age group of 0-14 years into two age groups of 0-4 years and 5-14 years. The other is to decompose the age group of 15-64 years into five groups of 15-24 years, 25-34 years, 35-44 years, 45-54 years and 55-64 years.

The process of decomposing the age group 0-14 years in 2010 into two age groups of 0-4 years and 5-14 years is illustrated in Table 6.9. Apart from the population of children aged 0-

14 years, the number of children under 6 years of age (shown by dashed ellipses in Table 6.9) is also known from the above discussion. The decomposition process is in three steps. The first is to estimate the ratio of the number of 0-4 years to the number of 0-6 years. The second step is to get the number of 0-4 years in 2010 by the estimated ratio and the known population of 0-6 years in 2010. Finally, the number of 5-14 years is achieved by subtraction from the number of 0-14 years.

Table 6.8 Population structure estimation for each year of 2006-2010

Items	2005	2006	2007	2008	2009	2010	Increase rates (%)
population	6085700	6138820	6192400	6246440	6300960	6355960	0.8728
Sex							
Male	3115270	3142460	3169890	3197550	3225460	3253610	0.8728
Female	2970430	2996360	3022510	3048890	3075500	3102340	0.8728
Age group							
0-14	1084470	1077880	1071330	1064820	1058340	1051910	-0.6078
15-64	4474820	4514980	4555500	4596390	4637640	4679260	0.8975
65 and over	526410	544760	563750	583400	603740	624790	3.4860
Residential status							
Urban area	3532750	3601880	3671780	3742440	3813860	3886030	1.9245
Rural area	2552950	2536930	2520610	2504000	2487100	2469930	-0.6590
Nationality							
Han	5265350	5304300	5343470	5382870	5422510	5462370	0.7374
Minority	820350	834520	848920	863570	878460	893590	1.7250
Education							
Tertiary	455700	465900	476160	486480	496860	507290	2.1680
Senior secondary	973360	1011970	1051760	1092730	1134920	1178330	3.8960
Junior secondary	1688170	1718200	1748170	1778060	1807850	1837500	1.7097
Primary	1994600	1982500	1969810	1956540	1942690	1928280	-0.6740
Other *	521040	513290	505480	497620	489710	481770	-1.5551
Under 6 years	452830	446960	441020	435000	428930	422790	-1.3635

Note: *'Other' means illiteracy or semiliterate aged 6 years and over.

Table 6.9 Decomposition estimate of age group 0-14 years for 2010

Items	2000	2005	2010
Population aged 0-4	387340	365120	338980
Population aged under 6	475080	452830	422790
Ratio of age 0-4 to age under 6	0.815315	0.806285	0.80177
Population aged 0-14	1150250	1084470	1051910
Population aged 5-14	762910	719360	712930

- Estimating the ratio. Considering the population of age group 0-4 years and children under 6 years of age for both years of 2000 and 2005, the ratios of the number of these two age groups can be calculated for 2000 and 2005 respectively (Table 6.9). Then the

similar ratio in 2010 can be estimated following the trend from 2000 to 2005. It is estimated the ratio in 2010 will be 0.80177.

- Estimating the number of 0-4 years of age. Using the estimated ratio and the known population aged less than 6 years in 2010, the number of children aged 0-4 years can be obtained.
- Calculating the number of 5-14 years of age. Subtracting the estimated number of 0-4 years of age from the known number of 0-14 years of age, the population in age group 5-14 years in 2010 is then determined.

The decomposition of aged 15-64 years into 5 age groups in 2010 can be carried out similarly as the estimation of detailed age groups in 2005. The results are shown in Table 6.10, together with age groups of 0-4 years and 5-14 years. For convenience of comparison, the age group distributions for the year of 2000 and 2005 are also presented in Table 6.10.

Table 6.10 Estimation results of age groups for 2010

Age group	2000	Percentage	2005	Percentage	2010	Percentage
0-4	387340	6.71	365110	6.00	338980	5.33
5-14	762910	13.22	719130	11.82	712930	11.22
15-24	1068940	18.52	1088360	17.88	1117380	17.58
25-34	1230500	21.32	1280240	21.04	1316000	20.705
35-44	900940	15.61	953170	15.66	1001060	15.75
45-54	645210	11.18	704260	11.57	756680	11.905
55-64	384130	6.65	449010	7.38	488140	7.68
65 or over	392690	6.80	526410	8.65	624790	9.83
Total	5772660	100.01	6085690	100.00	6355960	100.00

The estimation of the detailed age group distribution for the year 2010, together with the known population structures in 2000 and 2005, can be used to project the age group distributions for the other years between 2000 and 2010 (Table 6.11). Figure 6.2 presents the trends of the eight age groups over the period of 2000-2010, in which the left side highlights the numbers of the various age group populations and the right side the percentage of each age group.

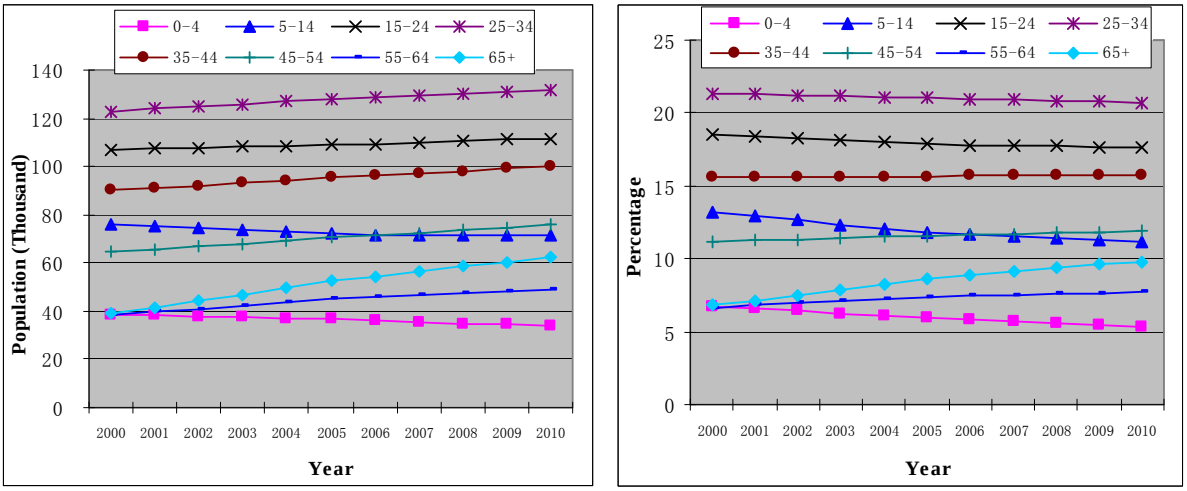
From the perspective of both population and percentage, the age groups of 0-4 years (square dot line) and 5-14 years (triangle dot line) show significant downwards trends. The proportion of age groups of 15-24 years and 25-34 years show a slight downwards trend, whereas the

proportion of people aged over 55 years, especially aged over 65 years (diamond dot line), grows rapidly, indicating that Kunming population is ageing as elsewhere in China.

Table 6.11 Age group of population for the period of 2000-2010 (10% of population)

Year	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65 and over	Total
2000	38734	76291	106894	123050	90094	64521	38413	39269	577266
2001	38279	75395	107280	124029	91115	65661	39631	41639	583029
2002	37829	74509	107667	125016	92148	66821	40887	44153	589030
2003	37385	73633	108055	126011	93192	68002	42184	46818	595280
2004	36945	72768	108445	127013	94249	69203	43521	49644	601789
2005	36511	71913	108836	128024	95317	70426	44901	52641	608569
2006	35981	71805	109436	128762	96279	71461	45668	54489	613882
2007	35455	71690	110026	129488	97239	72503	46443	56395	619240
2008	34932	71566	110607	130204	98197	73552	47226	58361	624645
2009	34413	71433	111178	130908	99153	74607	48016	60389	630097
2010	33898	71293	111738	131600	100106	75668	48814	62479	635596

Figure 6.2 Trends of Age groups over the period of 2000 – 2010

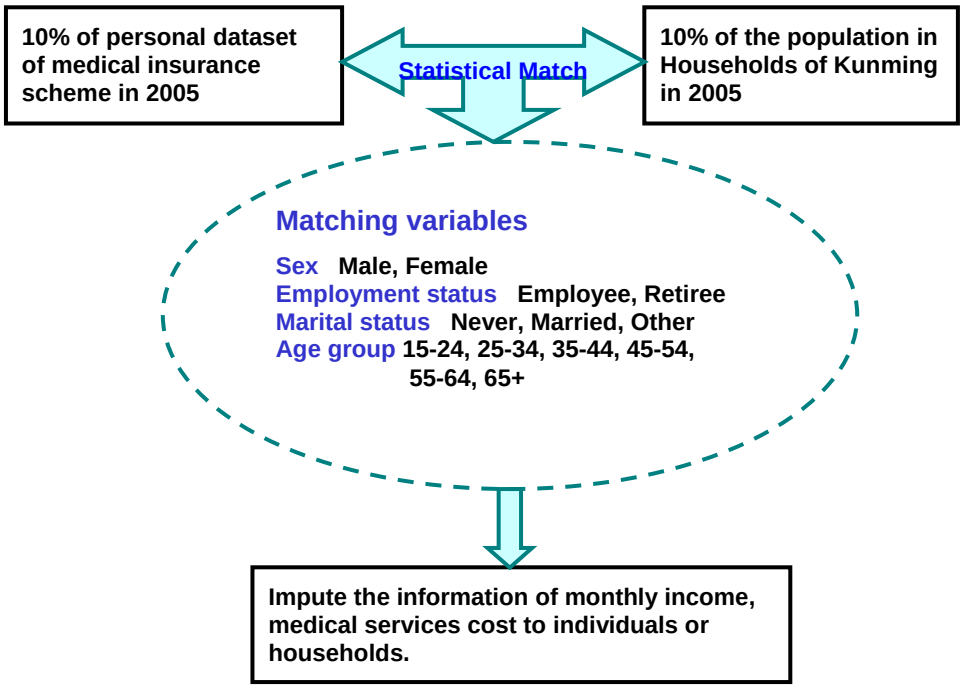


6.5 Statistically Match Population Records with Insurance Records

After finishing the Population module, the model then goes to Matching module. In the Matching module, the individual record dataset for the medical insurance system for urban employees and retirees is statistically matched with the updated total population dataset in households. The first dataset is a sample of the actual individual records of the insured employees and retirees. The second dataset is the updated population records from the above Population module. Both of the datasets are from 2005 and represent around 10 per cent of the

corresponding population. The matching variables to be contained in the process are four variables of Sex, Age group, Employment status, and Marital status (Figure 6.3).

Figure 6.3 Match the medical insured with the population sample

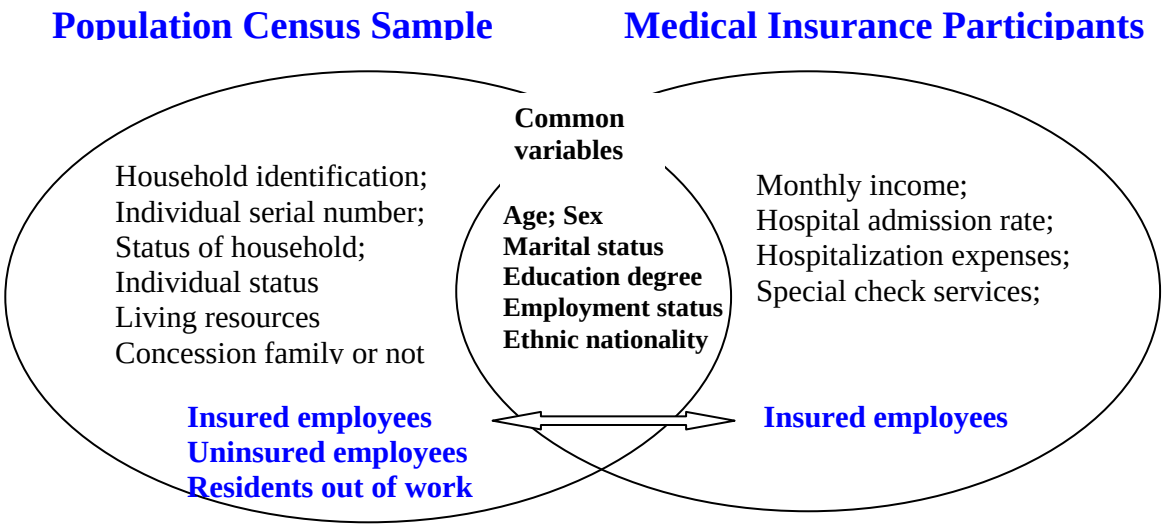


As described in Section 6.3, the information gathered from the 1 per cent population survey in 2005 for Kunming acted as benchmarks to update the individual records of the 0.095 per cent sample from the 2000 Census to the end of 2005. The updated population records kept the same households' or families' structures as the Census sample. This became the base data file that was statistically matched with the individual records of urban employees under the social medical insurance scheme for the same year, that is 2005.

Statistical matching is a procedure used to link two files or datasets where each record from one of the files is matched with a record from the second file that generally does not represent the same unit, but does represent a similar unit. Here the aim of statistical matching is to add income information, medical services information and medical expenses to the Census individual records of urban residents. This is because, as discussed in Chapter 5, comprehensive information on income and medical services under the social medical insurance scheme for urban employees and retirees has been made available and estimated.

Figure 6.4 presents the main variables in the datasets of the Population Census sample and the Medical insurance participants. The Population Census sample provides information on household structure, status of household, individual status, and living resources for urban residents. The Medical insurance participants' dataset provides information on monthly income and different kinds of medical services costs. Common variables in both datasets include: Age, Sex, Marital status, Education degree, Employment status and Ethnic nationality. Some or all of the common variables can act as matching variables when linking the two datasets.

Figure 6.4 Variables on Population Census sample and Medical insurance participants file



The dataset of the Population Census sample consists of three kinds of populations – insured employees (include retirees), uninsured employees (include retirees), and non-working residents – while the dataset of the Medical insurance participants only contains insured employees (include retirees). The population of employees (both insured and uninsured) in the Census sample is approximately double the population of the Medical insurance participants (insured employees). This is because a large number of employees and retirees are not insured under the medical insurance scheme. Therefore, in matching the two datasets, the dataset of Medical insurance participants only matches part of the Population Census sample.

6.5.1 Basic Dataset of Population under Medical Insurance Scheme in 2005

In 2005 the basic dataset under the medical insurance scheme for urban employees in Kunming contained 794,100 individual records. The dataset includes individual information

on demography, income, personal savings accounts, and medical treatment expenses. The 2005 basic medical insurance participants' dataset is the primary data file for simulating the medical services of medical insurance participants (see Chapter 5). Meanwhile, the urban employee records can be statistically matched with the individual records of the whole population in order to model the medical services of the urban residents out of the workforce.

Apart from the above mentioned insured employees and retirees numbering 794,100 who were under the administrative of the Kunming Municipal Government, there were two other parts of the population who also came under the social medical insurance coverage. The first one is a group of medical insurance participants in Kunming that is administered directly by the Yunnan Provincial Government (Kunming is the capital city of Yunnan Province). In 2005, this component of the group numbered 282,900 (Table 6.12). They enjoy the same social medical insurance scheme but receive greater benefits from the scheme than Municipal participants. However, individual records were not available for this group. Therefore, imputation was used to compensate for the lack of individual records for Provincial participants. In detail, 282,900 randomly selected records from the Municipal individual dataset in 2005 were used as the individual records managed by the Provincial Government.

Table 6.12 Number of basic medical insurance participants of Kunming

Year	Total population	Municipal	Provincial
2004	1039530	756996	282534
2005	1077000	794100	282900
Increase rate (%)	3.6045	4.9015	0.1295

Data source: The analysis report by the Bureau of Labour and Social Security of Kunming.

The second group of insured population are senior retirees who are predominantly war veterans and their dependents. This is a special group of people who made contributions to the country before the establishment of the People's Republic of China in 1949. In 2004, their average age was 77 years (ranging from 68 to 101 years).This group of people can have all their medical expenses reimbursed from the local governments.

Table 6.13 presents the information about this group of senior retirees provided in a report on the 2002-2004 period medical insurance scheme by the Bureau of Labour and Social Security of Kunming (Kunming Medical Insurance Centre, 2005).

In Table 6.13, the number of the senior retirees for each year is the population at the end of

that year. The information on the Kunming Municipal administered senior retirees over the period 2002-2004 and the whole Kunming's senior retirees in 2004 was provided. The reported number of senior retirees in 2004 was 4553. Based on this information, the number of senior retirees over the period of 2005-2010 can be estimated.

Table 6.13 Population estimation of senior retirees in Kunming over 2005-2010

Year	Whole city of Kunming			Under the Municipal Government		
	Population	Number of death	Decrease rate (%)	Population	Number of death	Decrease rate (%)
2002				2936	95	3.13
2003				2830	85	2.94
2004	4553	138	3.08	2745	93	3.28
Estimated						
2005	4403	150	3.28			
2006	4250	153	3.48			
2007	4093	156	3.68			
2008	3935	159	3.88			
2009	3774	161	4.08			
2010	3613	162	4.28			

Note: The data of 2002-2004 came from the report by Kunming. The data of 2005-2010 was estimated result.

The relative information for 2005 was estimated first, then the estimation for the other years of 2006-2010 was carried out. The Kunming report stated that the reduction of the population due to death would be higher because their average age of 77 years was greater than the life expectancy of the local residents, which was 74.9 years in 2006 (Zhang, 2007). In estimating the number of senior retirees for the period of 2005-2010, it was assumed that the actual death rate (rate of reduction in population) of 3.28 per cent under the Municipal Government in 2004 would be the rate for the whole of Kunming city in 2005. So the estimated number of senior retirees in 2005 was 4403 (Table 6.13). This decrease of 3.28 per cent in 2005 was 0.20 per cent higher than that for the whole city (3.08 per cent) in 2004. The decrease for the population over 2006-2010 is assumed to follow this trend, that is,

Estimated decrease rate = Decrease rate in the previous year + 0.20%

Hence, the population of senior retirees in each year of 2006-2010 can be estimated. It is estimated that the number of senior retirees in 2010 is reduced to 3613.

Because there are no individual records for this population group, their records are created by using the available records under the social medical insurance scheme. Based on restricting the individual dataset of the Municipal medical insurance participants in 2005 to individuals

aged above 68 years old, 4403 individual records were selected randomly and used to represent the population of senior retirees. In modelling medical expenses, this part of individual records is simulated independently later in the model.
Combining the above mentioned three datasets of different types of populations – insured individuals under the Municipal Government, insured individuals under the Provincial Government and senior retirees, the final dataset in 2005 contained a total of 1,081,403 (= 794100 + 282900 + 4403) insured individuals.

6.5.2 Statistical Matching of Medical Insurance File and Census File

For the social medical insurance dataset created above, approximately a 10 per cent sample was obtained by using simple random selection, depending on the weights of individuals representing employees and retirees in the Census sample file. This sample of the medical insurance dataset contains 97,484 individual records, which represents individuals who are under the social medical insurance scheme for urban employees and retirees. This medical insurance dataset is statistically matched with the updated urban resident population in 2005, compensating for information deficits on household's structure and medical services in either original dataset. Based on this matched file, the disposable income, medical expenses and payments over the period of 2008-2010 can be projected on the basis of the individual or the family. As almost all the information in the medical insurance dataset is for individuals living in urban areas, the matching is constrained to the urban population in the Census data file. Five steps are processed to match the two data files.

(1) Records Sampling From the Medical Insurance File
Sampling from the medical insurance file in 2005 is used to match the updated population file in 2005. By calculation, it is found that the average weights in the updated population file are:
wt2005=10.485083034 for employees; wt2005=12.542439139 for retirees.

So for the group of senior retirees, the sampling number should be
4403/12.542439139 = 351 individuals
Where 4403 is the number of senior retirees in 2005. The sampling was done for this group by using uniform random numbers to pick up 351 senior retirees.

Insured individuals under both Municipal and Provincial administration were put together maintaining the differentiation between employees and retirees. The sampling number for

employees and retirees were determined according to the above average weights. Then considering employment status across sex and age group, 68,755 employees and 28,378 retirees were sampled. Together with 351 senior retirees, a total of 97,484 insured individuals were selected randomly.

For the records with missing marital status in this sample dataset, the marital status of 'Never married', 'Married' and 'Divorced or other' were randomly assigned according to the distributions from the known records.

(2) Classify Records in Matching Files into Cell Groups

The method used for statistically matching is that the individual records are randomly matched within homogeneous cell groups. These homogeneous cell groups are based on records that have common variables in both of two matched files. The common variables used in this model, called matching variables, include the four variables – Sex, Age group, Employment status and Marital status, as shown in Table 6.14. Based on all the possible combinations of the matching variables, there should be 72 unique cell groups. However, in reality, lower age groups such as those aged less than 34 years are unlikely to contain retired individuals. Therefore, the number of unique cell groups could be less than 72. Records in the same cell group are matched based on a measure of closeness between individual records, which is explained in the following sub-sections.

Table 6.14 Matching variables

Variables	Groups	Explanation
Sex	2	Male, Female
Age group	6	15-24, 25-34, 35-44, 45-54, 55-64, 65 and over
Employment status	2	Employee, Retiree
Marital status	3	Never married, Married, Divorced or other

(3) Select the Match Sample from the Population Census File

For insured individuals in each group cell, the same number of records from the population Census file is selected randomly to match them. Theoretically, the number of population census records in each cell should be greater than the number of insured records, because the latter is part of the former. But the situation is actually not like that, as illustrated in Table 6.15. The first column indicates the number of cell groups, followed by the variables of Sex, Age group, Employment status and Marital status. The sixth column lists the distribution of the labour records in the Census file, while the seventh column presents the distribution of

insured employees. Here labour records indicate employed population of both insured and uninsured individuals.

Table 6.15 Number distribution of matching group cells

No.	Sex	Age group	Employ	Marry	Labour	Insured	Differ	Rate	Adjust
1	1	1	1	1	20416	2229	18187		
2	1	1	1	2	4060	122	3938		
3	1	1	1	3	116	2	114		
4	1	2	1	1	7076	6468	608		
5	1	2	1	2	27376	4830	22546		
6	1	2	1	3	464	29	435		
7	1	3	1	1	232	1833	-1601		1610
8	1	3	1	2	23896	9501	14395	0.9581	1543
9	1	3	1	3	1044	177	867	0.0419	67
10	1	3	2	1	0	20	-20		20
11	1	3	2	2	0	40	-40		40
12	1	3	2	3	0	5	-5		5
	:	:	:	:	:	:	:	:	:
58	2	6	2	2	4477	4816	-339		339
59	2	6	2	3	2270	267	2003		

Most of the differences (column ‘Differ’) between these two numbers are positive as expected, however, there are a few negative numbers. Adjustment to the closest cell groups for these negative ones needs to be made. For example, for group cell number 7, there are only 232 records (never married) in the population file, which is not enough to match the 1833 records (never married) in the insured file. In such cases, 1610 records (never married) in the insured file would be randomly picked up and then assigned proportionately to the other two Marital statuses. That is, 1543 records were adjusted into cell group 8 (married) and 67 into group 9 (the other). Another example of a negative difference is for cell group 10, where there are no matched records in the population file for the 20 records in the insured file. These 20 records in the insured file were adjusted to the nearest age group.

For such adjustment, one may ask that why not clone where there are fewer donor records? This is because some donor records can be cloned, while some others can not be cloned due to empty cell of records. After the adjustment for the matching numbers in these two data files, a dataset was created by randomly picking up the target number of records (required in each cell group in the insured file) from the population census file. This dataset is ready to be matched with the insured file.

(4) Match Records by Minimising the Distance

The initial and simplest approach is to match each medical insurance record to the closest

matching census record. The Mahalanobis distance function (Lymer, etc., 2006b) was used based on an individual's age. Generally, the selected match minimises the following distance function:

$$d_{i,k} = \sqrt{\sum_j a_{x_j} (X_{MIP,i,j,k} - X_{CP,i,j,k})^2 / \sigma^2_{x_j,CP}}$$

The subscript *i* relates to person records, *j* to the matching variable, and *k* to the cell group. $X_{MIP,i,j,k}$ is the age of a medical insurance participant, $X_{CP,i,j,k}$ is the age of a population census person. $\sigma^2_{x_,CP}$ is the variance of the matching variable (here is age). a_{x_j} is the user defined relative importance, or weight given to each matching variable. Because only one matching variable of age was used in the distance function, the value of this weight is one. Also for the same reason, the variance factor $\sigma^2_{x_,CP}$ has no impact on the matching distance.

As the two datasets with the exact same group cells and the same number of records in each cell group (based on the common variables: Sex, Age group, Employment status and Marital status) were already created, it is easy to match them by sorting the records by the individual's age in each cell group. And then the corresponding records in the two datasets were matched. Table 6.16 summarizes the absolute age difference for each cell group in the matched dataset. In total, the average difference of age is only 1 year; the largest age gap in the matched dataset is 20 years, which occurred in the oldest age group of 65 years or over.

Table 6.16 Summary of the matched files on age

Sex	Age group	Employment status	Marital status	Number of records	Mean	Minimum	Maximum
1	1	1	1	2229	1.76	0	4
1	1	1	2	122	0.27	0	2
1	1	1	3	2	0.50	0	1
1	2	1	1	6468	1.44	0	2
1	2	1	2	4830	1.32	0	2
1	2	1	3	29	0.76	0	4
1	3	1	1	223	1.76	0	5
:	:	:	:	:	:	:	:
2	6	1	3	1	2.00	2	2
2	6	2	2	4456	1.47	0	20
2	6	2	3	1091	1.59	0	8
Total				97484	1.00	0	20

Table 6.17 gives the distribution of age differences of two matched data files. 99.31 per cent of records have an age gap of less than 4 years, which shows that the matching result is reasonable.

Table 6.17 Frequency distribution of absolute age gap in the matched file

Age difference	Number of records	Percent	Cumulative percent	Age difference	Number of records	Percent	Cumulative percent
0	35353	36.265	36.265	8	35	0.036	99.974
1	36835	37.786	74.051	9	10	0.010	99.985
2	18886	19.373	93.425	10	8	0.008	99.993
3	4385	4.498	97.923	11	3	0.003	99.996
4	1352	1.387	99.310	12	1	0.001	99.997
5	451	0.463	99.772	14	1	0.001	99.998
6	108	0.111	99.883	19	1	0.001	99.999
7	54	0.055	99.938	20	1	0.001	100.000

(5) Weighting Adjustment

After matching the population file with the insured file, further adjustments need to be made to reach the target population of the employed and retired. For example, a big difference occurs between senior retirees in the target population and the estimated population when using the population weights (Table 6.18). The target population of senior retirees (they receive special medical beneficiary from the government) in 2008 should be 3935, rather than the estimated 5750. The other two years, 2009 and 2010, have the same problem. Because of their old age, the number of the senior retirees is declining with years (see Table 6.13). The weights for the group of senior retirees were changed using the relative adjusted coefficients (the last column in Table 6.18) for each year over the period 2008-2010, That is,

New weight for senior retirees = Old weight × Adjusted coefficient

Also, slight weight adjustments were made to the employees and retirees.

Table 6.18 Adjust the weight to meet the target population for the senior retirees

Year	Weight parameter	Target population	Estimated	Adjusted coefficient
2008	Wt2008	3935	5750	0.6843
2009	Wt2009	3774	6037	0.6251
2010	Wt2010	3613	6340	0.5699

6.5.3 Income Imputation

Because income information has not been provided in the population census data file, the individual's monthly income needs to be projected through imputing income of the insured records onto the population records. Fortunately, the Census data file offered some information which could be useful in estimating an individual's income. Table 6.19 provides the distributions of different groups of individual records on their employment status. Individuals who have paid jobs, defined in the Census as having worked at least one hour in the week prior to the Census, accounted for 53.14 per cent of the total urban population.

Children aged less than 15 years accounted for 14.32 per cent of the total population. The remaining 32.63 per cent of the population are residents who are not in the workforce, including students, pensioners, disabled persons, individuals doing housework, and persons looking for work.

Table 6.19 Categories of population by employment status

Population category	Frequency	Percent
Individuals who have paid job	175508	53.14
Residents who are not at workforce	107764	32.63
Children less than 15 years old	46980	14.23
Total records	330252	100.00

For non-working residents aged 15 years or over, their living resources (Table 6.20) largely come from family members (54.36 per cent) or pensions (33.37 per cent). For the rest, living resources include the basic living allowances provided by the governments (3.66 per cent), property income (3.23 per cent) and other income sources (5.38 per cent). When setting the incomes for the individual records, the individuals receiving basic living allowances are assigned 210 Yuan each month as their monthly income (Zhu, 2007), so do individuals with property income or other income sources, while the income of individuals who are looked after by their family members are set to zero.

Table 6.20 Main living sources for non-working individuals aged 15 years old or above

Main income	Frequency	Percent
Pension	35960	33.37
Basic living allowance by government	3944	3.66
Looked after by family members	58580	54.36
Property income	3480	3.23
Other source	5800	5.38
Total records	107764	100.00

In processing the monthly income, individuals are categorised into three groups, that is, low income earners, general income earners and other income earners, as Table 6.21 indicates. It is assumed that if there is at least one person in a family receiving the basic living allowances from the governments, then any employee or retiree in such a family is treated as low income earners. Apart from low income earners, other employees and retirees are treated as general income earners. The general income earners formed a large part of individuals with incomes (94.08 per cent of the total records). The third group, individuals with regular income, is composed of persons receiving the basic living allowances from the governments, persons

having income from their property, insurance or other means. This group of individuals plus the low income earners account for 5.92 per cent of the total income earner records.

Table 6.21 Categories of income earners in the Census dataset

Category	Number of records	Percentage	Income sources
Low income	4872	2.11	Wages or pensions
General income	217384	94.08	Wages or pensions
Other income	8816	3.82	Living allowance, property or insurance
Total	231072	100.00	

- Low income earners

Two steps are required to impute income for low income earners. The first step is determining those low income earners in the population of the insured employees in 2008. The second step involves randomly selecting the target number of low income earners, whose monthly incomes are imputed onto the low income earners. Table 6.22 gives the distribution of low income earners and their relative ratios in the corresponding population. In addition, the second last column of 'Records of insured' gives the distribution of the number of employees and retirees in 2008. A total of 4,872 individuals out of 222,256 records represent low income earners, giving the ratio 0.0219. By the ratios of low income earners to the corresponding total cell group records, the numbers of corresponding low income earners in the insured population in 2008 are calculated (last column) and then are randomly selected by Sex across Age group across Employment status. Consequently, insured records are split into two parts – the low income dataset and the general income dataset. Then from this low income sampling dataset, the same number of records as the low income earners in the Census dataset is sampled randomly to impute the income for the low income earners.

- General Income Earners

For the remaining employees and retirees (apart from the low income earners), their monthly income was imputed using the general income dataset mentioned above for the corresponding year. Similar to the low income earners, factors considered when estimating the income involved Sex, Age group and Employment status.

- Other Income Earners

Other income earners are individuals receiving basic living allowances, having income from their properties or insurances. According to the reported basic living standard by the Kunming

Municipal Government (Zhu, 2007), the monthly incomes for this group of income earners are consistently assigned 210 Yuan per person in 2008.

Table 6.22 Target low income earners and sampling framework

Sex	Age group	Employ status	Low income	Total records	Ratio of low to total	Records of insured	Sampling number
1	1	1	232	24592	0.0094	26732	252
1	2	1	232	34916	0.0066	91373	607
1	3	1	928	25172	0.0369	96510	3558
1	3	2	0	0	0.0000	651	0
1	4	1	696	18444	0.0377	96403	3638
1	4	2	0	1508	0.0000	3754	0
1	5	1	116	4527	0.0256	39730	1018
1	5	2	0	7073	0.0000	42581	0
1	6	1	0	617	0.0000	77	0
1	6	2	464	9359	0.0496	85857	4257
2	1	1	348	17168	0.0203	24378	494
2	2	1	464	27260	0.0170	77466	1319
2	3	1	580	21460	0.0270	88339	2388
2	3	2	116	580	0.2000	746	149
2	4	1	0	8352	0.0000	50850	0
2	4	2	464	6496	0.0714	40016	2858
2	5	1	0	854	0.0000	1175	0
2	5	2	0	7034	0.0000	57102	0
2	6	1	0	97	0.0000	69	0
2	6	2	232	6747	0.0344	60043	2065
Total			4872	222256	0.0219	883852	22602

Similarly, income imputations were done for the other two years of 2009 and 2010. Table 6.23 presents the income estimation results for the period of 2008-2010. In imputing the individual's income, variables of sex, age group and employment status are the most important factors. Individual incomes are categorised into three groups based on individual income characteristics. The accuracy of the result is tested with the reported figure by the Kunming government.

Table 6.23 Forecast average annual disposable income per individual over 2008-2010

Year	Total population	Number of Income earners	Average annual disposable income per person (Yuan)
2005	3538211	2505937	9340
2008	3747528	2661861	12538
2009	3818995	2714862	13659
2010	3891201	2768542	14918

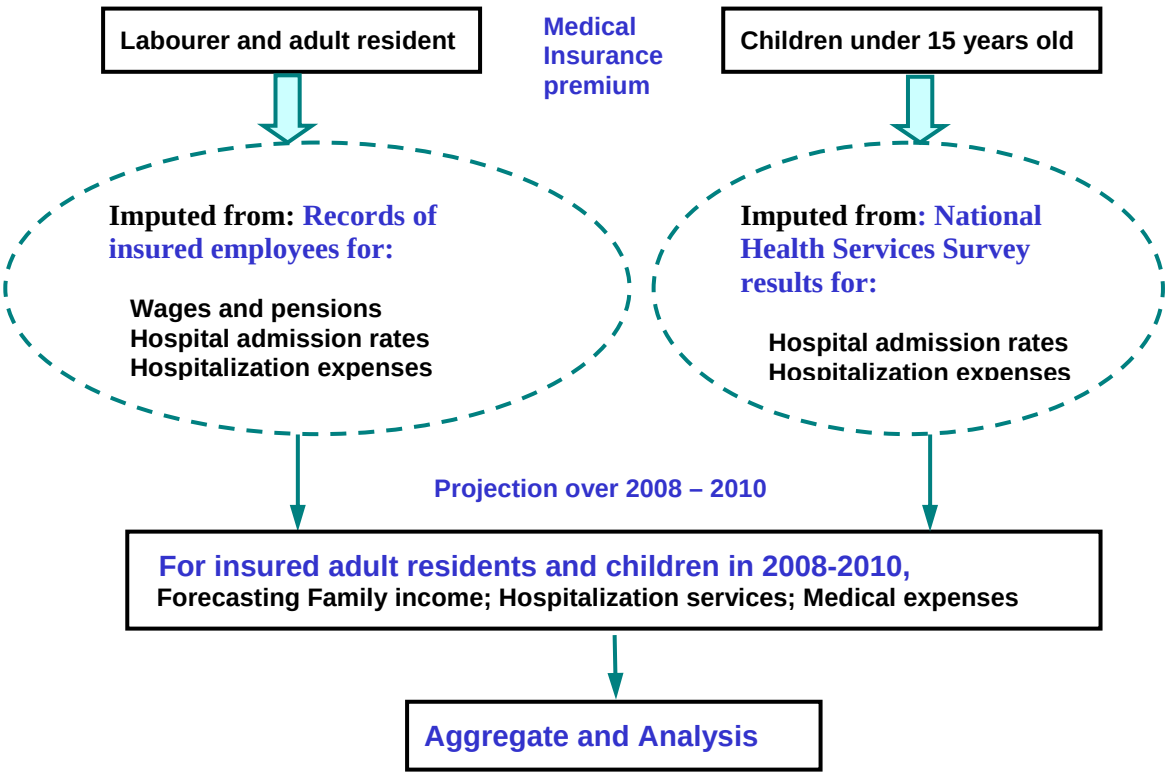
The estimated average annual disposable income per person in 2008 is 12,538 Yuan. This is very consistent with the reported figure by the Kunming Municipal Government (Kunming

Bureau of Statistics, 2008), which was 12,083 Yuan in 2007, with an increase rate of 6.1 per cent compared with the previous year. If this rate of increase of 6.1 per cent is maintained, the annual disposable income per person should be 12,818 Yuan in 2008, which is close to the estimated 12,538 Yuan.

6.6 Medical Insurance Scheme for Urban Residents

After matching the datasets statistically, together with the health services information on hospitalization which came from the National Health Services Surveys conducted in 1998 and 2003 respectively, the medical services of urban residents on hospitalization services is projected over the 2008-2010 period. This work is the main task in the Prediction module (Figure 6.5) of the model.

Figure 6.5 Projecting hospitalization behaviour for urban residents



In the Prediction module of the research, the model randomly chooses 0.207 million people from the base file in 2008 which was created in the Matching module as the medical insurance covered residents in 2008. For this population of insured residents, the contributions

by the governments' subsidies, and the premiums paid by individuals or families, are estimated. Then the medical expenses of hospitalization services for adult residents and children who are less than 15 years of age are projected. The records of the insured employees and retirees in 2005-2010 provide distributions on hospital admission rates and hospitalization treatment expenses for adult residents. In addition, the insured records of employees and retirees help to set up incomes for labourers and pensioners. Regarding children less than 15 years of age, the results from the National Health Services Surveys are used to impute the usage and spending on hospitalization services. Then the model aggregates and analyses the forecasting results.

The model then processes to the year 2009, in which a population of 0.9 million residents is projected to be covered by the medical insurance scheme. Processing to the year 2010 has all urban residents covered by the medical insurance scheme.

This section mainly discusses the medical services usage and medical expenses under the medical insurance scheme for urban residents who are out of the labour market. Beginning in October 2007, the medical insurance scheme covers medical expenses on hospital admissions as well as clinic services for serious illnesses in Kunming. So the model created in this research focuses on hospital and clinic serious illness services; with the simulation starting in 2008 and running until 2010. The first issue considered in modelling this medical insurance process is to randomly select urban residents covered by the medical insurance scheme over this period. The model then simulates the medical insurance premium according to relative medical insurance rules. Finally, the model estimates the medical expenses that occur in hospital services and clinic serious illnesses by insured urban residents.

6.6.1 Medical Insurance Sampling

The Chinese Central Government has pledged to have the medical insurance scheme, incrementally cover all urban residents out of the labour force by 2010. In the case of Kunming, starting in October 2007, the medical insurance scheme had covered 207,000 urban residents by the end of February 2008. The Kunming government has planned to cover 900,000 of its urban residents by 2009, and all residents (about 1.2 million) by 2010. Under the current medical insurance rule, urban residents are encouraged to join the medical insurance scheme by families. Because joining this medical insurance scheme is voluntary, it

is assumed in the model that 90 per cent of all urban residents will be covered by the scheme in 2010.

In sampling individual records, the model first determines the target number of families to be picked up to join the scheme. In the sampling process in 2008, the average number of individuals without jobs in a family is estimated to be 0.89091. So the target number of families needed to be picked up is 207000/0.89091 = 232347, where 207,000 is the number of residents covered by the scheme in 2008. Dividing 232,347 by the mean weight of 10.98241 in 2008, gives a total of 21,156 family records to be randomly selected. As a result, 208,300 residents were randomly selected for the year of 2008 (Table 6.24). In sampling 2009 residents, keeping those insured in 2008 under the scheme, certain extra families were randomly picked up to meet the target insured population of 900,000. The same sampling process was made for the year of 2010. Table 6.24 gives the sample results for the period of 2008-2010. The ratios of insured residents to the target population of residents are estimated to be 17.56 per cent in 2008, 74.66 per cent in 2009 and 90.28 per cent in 2010.

Table 6.24 Estimated insured population of residents over 2008-2010

Year	Target residents	Planned population to be insured	Number of randomly selected	Ratio of selected to target residents
2008	1186056	207000	208300	17.56%
2009	1206081	900000	900410	74.66%
2010	1226169	1103552	1107008	90.28%

6.6.2 Set Medical Insurance Premium

According to the medical insurance plan for urban residents, which is described in Section 6.2, the medical insurance premium is set for insured individuals who are not in the labour market. In setting the medical insurance premiums, qualified individuals are categorised into three groups by age and other characteristics – that is, adults aged 18 years or over, children and students under 18 years of age, and university students. The original Census dataset does not identify if a student is at a university education or not. University students were identified by the following arguments. In China, in early September each year, students usually enter universities between 18 and 19 years. As the 2000 population Census was conducted in November, if a student is older than 18 years, the model treats him or her as a University student. In addition, half of the students aged 18 years go to university, while the other half

remain in secondary high school education. In practice, Chinese students graduated from a high school need to pass the entrance examination before attending the university.

In each category of residents, certain concession individuals are recognised. According to the medical insurance rules, concession individuals either do not need to pay the insurance premium or pay less than that for the general residents. In general, if a person is in a family that receives the basic living allowances from the governments, then any member in the family is treated as a concession individual. Furthermore, disabled individuals without labour capability are also treated as concession individuals according to the medical insurance plan.

6.6.3 Forecast Medical Expenses

Forecasting the medical expenses for non-working residents could be achieved by picking up the insured residents first, then simulating their medical costs. This model did this in a broader way. That is, instead of being limited to the insured residents, the estimation process on medical expenses extends to the whole urban residents and then aggregates the results on the insured residents. This allows the majority of medical expense resources to come from the records of the insured employees and retirees. A few of the medical expenses are derived from the results of the National Health Services surveys conducted in 1998 and 2003. The estimating process for medical expenses is conducted in three steps, which correspond to three groups of the population; that is, employed individuals of both employees and retirees, residents aged 15 years or over who are out of the work force, and children less than 15 years old.

- Medical Expenses for Employed Individuals

Employed individuals (employees and retirees) accounted for around 67 per cent of the total urban population in Kunming in 2008. This is the easiest group to estimate their medical expenses. As mentioned before, this group of individuals had their annual income estimated; so already had their medical expenses linked by their unique identification numbers. They have all kinds of medical service costs estimated, including clinic services and pharmacies, chronic disease services, special check-up clinics and hospitalization treatments.

- Medical Expenses for Adult Residents

Adult residents here are individuals aged 15 years or over, who are not in the workforce. For this group of people, little information is available on their medical services. The estimation

of their medical expenses is made by "borrowing" the medical costs from insured employed individuals under the social medical insurance scheme. In doing so, after filling up the employed individual records, the remaining individual records are used to compensate for the medical expenses for the adult residents. The same numbers of records by Sex across Age group from insured employee dataset are randomly picked up. The model then matches them with the adult resident records by closest age in each cell of sex and age group.

The medical expenses of the adult residents are imputed by using the information of insured employees and retirees. However, medical behaviours between insured and uninsured individuals in both admission rates and costs on hospitalization services are significantly different. According to the reports on the Second and Third National Health Services Surveys conducted in 1998 and 2003, respectively (Centre for Health Statistics and Information, 1999; 2004), the annual admission rate to a hospital for an uninsured person is about half of that for insured individuals. With the establishment of the medical insurance scheme for urban residents, their hospital admission rates are expected to increase. In the modelling research, for adult residents, two scenarios will be considered for their hospitalization services. One is to assume their hospitalization rates increases from half to 70 per cent of that for insured employees. The other is to raise the hospitalization rates to 85 per cent of that for the insured employees. This is because, once covered by the medical insurance scheme, people may change their medical behaviour and be admitted to a hospital when they need to be. On the other hand, the proportion of patient's co-payment (25 – 50%) for insured residents is higher than that for insured employees (15 – 25%), and the maximum coverage (16,000 Yuan) annually scheduled for insured residents is much lower than that for insured employees (49,000 Yuan). So the use of hospital services is expected to increase, but not at the same rate as for insured employees.

- Medical Expenses for Children under 15 Years Old

For children under 15 years old, no individual medical expenses information is available to forecast the hospitalization cost over 2008-2010. The National Health Services Surveys conducted in 1998 and 2003 are used to estimate hospitalization services. Table 6.25 illustrates number of surveyed individuals, number of hospital admissions in the previous year and the admission rates of children under 15 years of age. In the 1998 survey, 1054 out of 20,775 surveyed individuals in all big cities (city with a population more than one million) had hospitalization experiences in the previous year. For the city of Kunming, the relative

number is 117 out of 1794 surveyed individuals. Unfortunately in Kunming, both surveys in 1998 and 2003 did not provide admission rates for children less than 15 years of age.

Table 6.25 Surveyed hospitalization rates on sex and age group

Year and Area	Number of individuals	Number of hospitalization	Rate of aged 0-4 years (%)	Rate of aged 5-14 years (%)
Survey in 1998				
All big cities	20775	1054	1.85	1.08
Kunming	1794	117	---	---
Survey in 2003				
All big cities	18746	756	2.58	0.64
Kunming	1709	51	---	---
Average			2.215	0.860

Data Source: The analysis of the Health Services Survey in 1998 and 2003

In identifying the admission rate to a hospital for children aged less than 15 years, the corresponding hospitalization rates for big cities as a whole are borrowed. The average of hospitalization rates in 1998 and 2003 are taken to be the rates for children – that is, the rate of 2.215 per cent for 0-4 years old, and 0.860 per cent for 5-14 years old (last row in Table 6.25). Regarding the sex distribution in hospitalization rates, because of the very large variation in age group 0-4 years (4.60 per cent for male, 0.40 per cent for female, see Table 6.26) in 2003, which is not considered reasonable, the rates in 1998 are adopted.

Table 6.26 Hospitalization rates by sex across age group under 15 years old

Sex of children	In 1998		In 2003	
	Aged 0-4 years	Aged 5-14 years	Aged 0-4 years	Aged 5-14 years
Male	2.40	0.71	4.60	0.50
Female	1.32	1.45	0.40	0.80

Adjusting the rates by sex according to the proportion of the total rates, the final hospitalization rates for children less than 15 years of age are estimated as shown in Table 6.27.

Table 6.27 Estimating percentage of hospitalization rates for children

Sex	0-4 years old	5-14 years old	Adjusted to =>	0-4 years old	5-14 years old
Male	2.40	0.71	⇨	2.858	0.565
Female	1.32	1.45		1.572	1.155
Total	2.215	0.860		2.215	0.860

Using these estimated hospitalization rates for children less than 15 years old, random sampling methods are adopted to select children to be admitted to a hospital. Regarding the cost of hospitalization for children, the average costs by sex across age group over 2006-2007 provided incurred in a public general hospital in Kunming are referred to project the cost for hospital services for each inpatient.

6.7 Summary

This chapter modelled the medical services and expenses for urban residents without jobs in Kunming in relation to hospital services as well as serious illness clinic services. Two main datasets were used in constructing the model – a population sample dataset from the 2000 Census for all individuals; and a dataset of employees and retirees under the social medical insurance scheme. The other information used in the model involves the aggregated results of the 1 per cent population survey of Kunming conducted in 2005, and results from the National Health Services Surveys in 1998 and 2003. In addition, the medical costs information on hospitalization services for the last couple of years incurred in one of public general hospitals in Kunming were also used in the model.

Three major steps were conducted to create the model, each of which corresponds to a module. The first step was to project the population structure for the period of 2005-2010, and update the Census sample population in 2000 to 2005-2010 respectively according to the target population structure. In the second step, the updated Census dataset was statistically matched with the individual dataset of insured employees and retirees, which provided information on hospital services usage and medical expenses. The last step was to set up the medical expenses of general hospital services as well as serious illness clinic services and forecast the different kinds of payments. Because the medical insurance scheme for urban residents out of the labour force only started in October 2007, the model simulated hospitalization for the period of 2008-2010.

The modelling results of urban residents who out of the labour force will be discussed in Chapter 8.

PART III RESULTS

CHAPTER 7 OUTCOMES FOR URBAN EMPLOYEES

7.1 Introduction

Chapter 5 described the construction of a static microsimulation model to predict the medical insurance scheme for urban employees and retirees in Kunming city of China. The model aims to forecast medical expenses of medical insurance participants, and assess the distributional impacts of the medical insurance policy settings on the different types of participants. With 2006 as the commencement year, the model simulated different kinds of medical services and medical expenses for five years until 2010. The items of medical services simulated in the model include clinic services and medications, chronic disease services, clinic special check-ups, and hospitalization treatments.

This chapter summarizes the forecasting results and discusses the impacts of the urban medical insurance system on urban employees and retirees, such as distributions of personal savings accounts and amount of self payments for medical services among different age groups. Based on forecasting medical expenses and medical insurance payments of 2006-2010, the balances of the social pool fund, the serious illness fund and the Government official fund can be estimated. Apart from forecasting the current medical insurance policy setting, the model also evaluates the distributional effects of one policy scenario for urban employees and retirees.

7.2 Predicted Medical Expenses

After simulating medical service usage and medical expenses of the urban medical insurance participants, the results were then aggregated. This section summarizes the simulated results for medical expenses for the forecasting years of 2006-2010. As a comparison, the corresponding data in 2002-2005 are also shown.

Table 7.1 summarizes the different kinds of medical expenses and the total medical costs. The medical services, as mentioned earlier, are categorized into four items – clinic services and medications in pharmacies, chronic disease services, clinic special check-ups, and

hospitalization services. Dividing the total medical cost by the total number of the insured population, the average medical cost for each individual was obtained and estimated (the second last column in Table 7.1). It is estimated that the amount of annual medical services used by each individual would be about 1819 Yuan in 2010. In the first couple of years after commencing the medical insurance scheme, the annual increase in average individual medical costs was quite high (the last column in Table 7.1). After the first three years, the annual rates of increase per person became more stable — around 3.1-6.3 per cent — and showed a slight slowing trend. The absolute costs in all four different kinds of medical services show increase trends. These results reflect the facts of both a growing number of insured population and increased annual individual demand for medical services. In Table 7.1, 'Average cost per person' is a derived item by dividing 'Total cost' by 'Insured population', so there is no need to present the estimate of variance.

Table 7.1 Estimated total medical expenses (Million Yuan) and the average individual cost (Yuan)

Year	Insured Population	Clinic services	Chronic disease	Special check-up	Hospital admission	Total cost	Average cost per person	Increase rate per person (%)
2002	506258	101.81	28.05	1.21	200.98	332.06	656	---
2003	630108	214.11	51.15	3.76	467.85	736.87	1169	78.29
2004	716828	285.26	58.57	5.57	616.57	965.96	1348	15.23
2005	793987	339.71	83.55	6.60	724.44	1154.30	1454	7.88
2006	829518	370.77	94.30	7.47	808.88	1281.43	1545	6.26
2007	858925	411.94	101.26	8.28	879.92	1401.39	1632	5.62
2008	883852	458.43	107.42	9.13	927.03	1502.01	1699	4.16
2009	905486	503.22	113.09	10.07	960.55	1586.93	1753	3.13
2010	924596	548.68	118.75	11.12	1003.63	1682.18	1819	3.81

Note: Increase rate per person in the last column means growth rate compared with the year before.

Table 7.2 gives the relative contribution of each of the different kinds of medical expenses to total annual expenditure, where the inpatient services were split into three items corresponding to the first, the second or the third time or more admissions to a hospital. Figure 7.1 shows the percentage trends of different kinds of medical expenses with years corresponding to the data in Table 7.2.

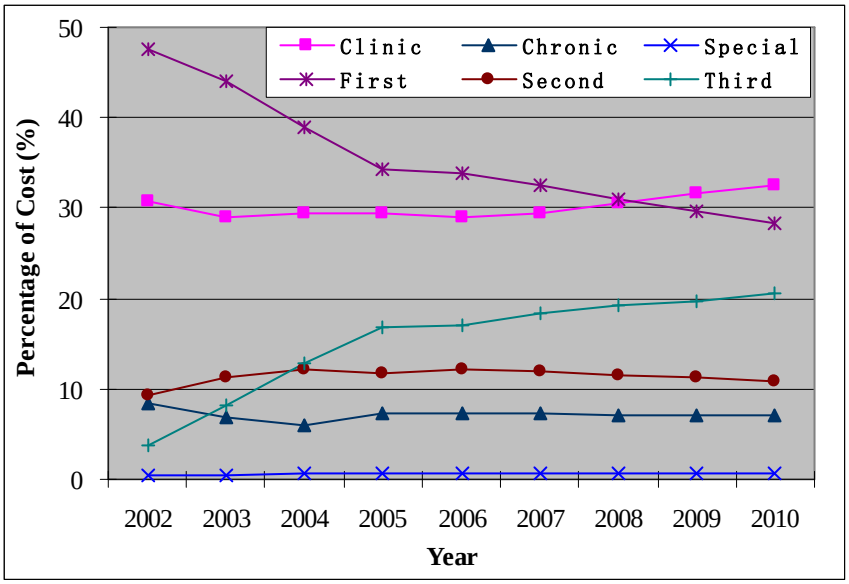
The ratio of medical expenses of clinic services (including medications in pharmacies) to total medical expenses displays a slight increase trend, while the percentages of medical costs of

both chronic diseases and clinic special check-ups have remained stable as a share of total expenditures, at around 7.10 and 0.60 per cent of the total cost respectively. In contrast to clinic services, the cost of hospitalization services as a proportion of total expenses has a slight downward trend in 2010 compared with 2005, from 62.76 per cent down to 59.66 per cent.

Table 7.2 Estimated percentage contribution of different kind of medical services to total expenses

Year	Clinic services	Chronic disease	Special check-up	First inpatients	Second inpatients	Third or more inpatients	Total hospital admission	Total
2002	30.66	8.45	0.37	47.60	9.19	3.73	60.52	100.00
2003	29.06	6.94	0.51	44.08	11.29	8.12	63.49	100.00
2004	29.53	6.06	0.58	38.91	12.08	12.84	63.83	100.00
2005	29.43	7.24	0.57	34.19	11.67	16.90	62.76	100.00
2006	28.93	7.36	0.58	33.82	12.16	17.14	63.12	100.00
2007	29.39	7.23	0.59	32.50	11.90	18.40	62.79	100.00
2008	30.52	7.15	0.61	30.93	11.54	19.24	61.72	100.00
2009	31.71	7.13	0.63	29.65	11.19	19.69	60.53	100.00
2010	32.62	7.06	0.66	28.39	10.79	20.48	59.66	100.00

Figure 7.1 Estimated percentage distribution of medical expenses over 2002-2010



Notes:
Clinic – Clinic services and medication in pharmacy;
Chronic – Chronic disease services;
Special – Clinic special check-up;
First – First time admitted to a hospital in a year;
Second – Second time admitted to a hospital in a year;
Third – Third time or more admitted to a hospital.

Annually, the proportion of hospitalization expenses to total expenditure remains the largest part (around 60 – 64 per cent). However, the relative cost of first time hospitalizations in a year reduces significantly over time. In the mean time, the expenses of the three or more

admissions to hospital are estimated to increase dramatically. It was reported (Kunming Medical Insurance Centre, 2007) that some inpatients were admitted to hospitals more times than needed, which reflected that hospitals wanted to keep the one time inpatient cost under control. As a result, both rates and costs in the third and more times hospitalization services have been increasing. So for the administrative purpose, the hospitalization medical expenditure should be seen as an important part in controlling total medical expenditure. While in controlling the single hospitalization expenses, more work needs to be done in inspecting frequent cases of hospitalization in a year.

Figure 7.1 shows significant increase for those hospitalised three times or more. This is probably because of the ethical dilemma. According to the rules under the medical insurance scheme, patients who are admitted to hospital third time or more do not need to pay the threshold any more before they can benefit from the social pool fund. The other possible reason is that hospitals are shifting the costs in the first or the second hospitalization episode to the third time or more hospitalization. The government set a cap (maximum control line) for controlling the total payment to each hospital. In order to be consistent with this cap, the hospital sometimes discharges a patient before the patient is completely recovered. Then the patient would be admitted to the hospital later on. Anyway, regardless of the high increase for those hospitalised three times or more, the percentage of total cost in hospitalization services is under control, which is estimated to be around 60 per cent of the total medical expenses.

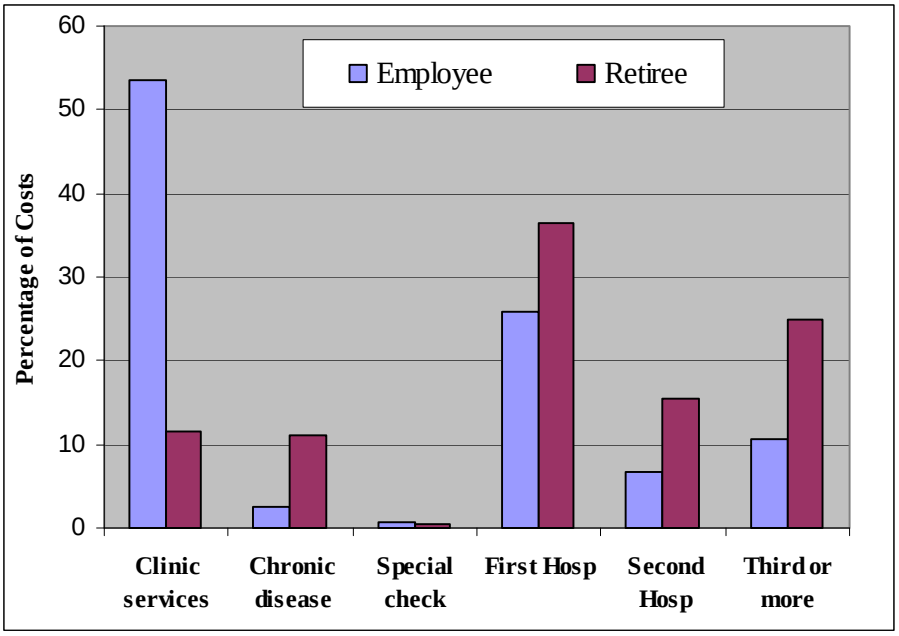
When considering the medical cost distributions for employees and retirees separately, completely different pictures emerge (Table 7.3). For employees, more than half of their medical services costs (54.1 per cent) come from clinic services and medications. The second largest medical cost is estimated to occur in hospitalization services, which is around 42.8 per cent of the total cost. The remaining 3.1 per cent of the medical cost comes from the treatments for chronic diseases and clinic special check-ups. For retirees, more than three quarters (77.3 per cent) of their medical costs come from hospitalization treatments. Only around 10 per cent of retirees' medical costs come from the general clinic services and medications. In the hospitalization treatments for retirees, the percentage of the costs for three or more times of hospitalization events in a financial year is estimated to increase significantly from 20.29 per cent in 2005 to 29.44 per cent in 2010. The medical cost for chronic diseases accounts for around 11 per cent of the total medical expenses, which is quadruple that of employees. The average percentage of clinic special check-ups for retirees

over 2006-2010 (0.60 per cent) is not much different from that of employees (0.64 per cent). Figure 7.2 presents the percentage distribution of spending on different items of medical services, on average, over 2005-2010.

Table 7.3 Estimated percentage of medical costs for employees and retirees

Year	Clinic services	Chronic disease	Special check-ups	First inpatients	Second inpatients	Third or more inpatients	Total	Percent of inpatient cost
Employees								
2005	51.07	3.21	0.79	28.00	7.02	9.90	100.00	44.92
2006	50.85	2.70	0.68	28.34	7.12	10.31	100.00	45.77
2007	52.17	2.54	0.66	27.06	6.72	10.86	100.00	44.64
2008	54.22	2.45	0.64	25.48	6.40	10.81	100.00	42.70
2009	55.92	2.38	0.63	23.90	6.43	10.75	100.00	41.08
2010	57.22	2.28	0.61	22.48	6.38	11.02	100.00	39.89
Retirees								
2005	14.11	10.43	0.42	40.19	14.54	20.29	100.00	75.03
2006	12.75	10.80	0.51	37.87	15.88	22.19	100.00	75.94
2007	11.76	10.86	0.54	36.70	15.91	24.23	100.00	76.85
2008	10.98	11.03	0.58	35.43	15.78	26.20	100.00	77.40
2009	10.21	11.35	0.64	34.75	15.41	27.64	100.00	77.80
2010	9.31	11.59	0.71	33.99	14.97	29.44	100.00	78.40

Figure 7.2 Estimated percentage distribution of spending on medical services, on average, over 2005-2010



One more issue should be made clear. Table 7.3 describes the cost distributions of different medical services, no matter who pays for the costs. It explains the different pattern of medical usage between employees and retirees. The last column gives a percentage of hospitalization cost to the total expenses, including costs incurred in hospitalization services in the first, the second and the third time or more.

Table 7.4 presents the medical cost distributions by gender. Unlike differences between employees and retirees, the medical cost distribution does not differ greatly between males and females. The largest medical cost, for both males and females, is for hospitalization services, which is around 61 per cent of the total medical cost. It seems females are more likely to spend more on chronic diseases services (around 9.4 per cent of the total cost) than males (around 5.3 per cent of the total cost). Except for this difference, the other significant difference occurs in general clinic services. Males are estimated to spend more on clinic services than females, which are 32.1 per cent and 28.5 per cent to the relevant total costs respectively. The average percentage of clinic special check-ups for females (0.74 per cent) is slightly higher than that for males (0.50 per cent).

Table 7.4 Estimated percentage of medical costs for males and females

Year	Clinic services	Chronic disease	Special check-ups	First inpatients	Second inpatients	Third or more inpatients	Total	Percent of inpatient cost
Male								
2005	30.95	6.04	0.45	35.37	11.93	15.25	100.00	62.55
2006	30.57	5.62	0.48	34.43	12.62	16.29	100.00	63.34
2007	31.03	5.36	0.49	33.53	12.19	17.41	100.00	63.13
2008	32.13	5.15	0.50	32.51	11.65	18.07	100.00	62.23
2009	33.47	5.07	0.53	31.76	11.09	18.08	100.00	60.93
2010	34.44	4.84	0.56	31.03	10.58	18.55	100.00	60.16
Female								
2005	27.98	9.00	0.72	34.77	10.77	16.75	100.00	62.29
2006	27.04	9.38	0.71	33.12	11.62	18.13	100.00	62.87
2007	27.49	9.41	0.71	31.29	11.56	19.54	100.00	62.39
2008	28.63	9.51	0.74	29.07	11.42	20.63	100.00	61.12
2009	29.65	9.53	0.76	27.18	11.30	21.58	100.00	60.06
2010	30.50	9.63	0.78	25.32	11.04	22.73	100.00	59.09

Table 7.5 gives the percentage distribution of medical costs by age groups for males and females respectively. For both males and females, the proportion of total medical costs consumed by the two employed age groups less than 50 years old are similar (i.e. there is little differentiation by gender). While the estimated percentage of medical costs consumed by female employees aged 50 years or over (around 4 per cent) is much lower than males (around 20 per cent), this simply reflects the different retirement patterns of males and females. Thus, this phenomenon is in consistent with the proportion of employed females aged 50 years or over, which is less than 4 per cent (refer to Table 5.19 in Chapter 5) of the total female participants. For females, the proportions of medical costs for two age groups of retirees are the same, at around 30 per cent. In contrast, for males, retirees aged 65 years or over cost more than double that for retirees aged less than 65 years. For retired individuals as a whole (summing retirees aged ⩽64 years with aged ⩾65 years), females are estimated to spend more on medical services (around 60 per cent) than males (around 48 per cent).

Table 7.5 Estimated percentage of medical costs by gender across age group

Year	Employees age ⩽34	Employees age 35-49	Employees age ⩾50	Retirees age⩽64	Retirees age ⩾65	Total
Male						
2005	9.59	19.78	17.74	15.60	37.28	100.00
2006	10.63	19.16	18.52	14.60	37.08	100.00
2007	11.48	19.02	18.86	14.24	36.40	100.00
2008	12.55	19.06	19.27	13.70	35.41	100.00
2009	13.86	19.17	19.81	12.82	34.33	100.00
2010	15.15	19.03	20.26	12.14	33.43	100.00
Female						
2005	10.37	21.61	3.74	32.96	31.31	100.00
2006	11.02	21.14	3.55	32.73	31.56	100.00
2007	11.86	21.43	3.66	31.59	31.46	100.00
2008	12.98	21.59	3.92	30.54	30.97	100.00
2009	14.28	21.81	4.16	29.80	29.95	100.00
2010	15.42	22.17	4.35	29.12	28.95	100.00

7.3 Different Payments for Medical Expenses

For the results of medical expenses for the year 2006 -2010, the balances of the personal savings accounts and the three kinds of pool funds (the social pool fund, the serious illness fund and the Government official fund) are aggregated. The balances of the pool funds are put

together with the accumulative balances in 2005 which were reported by the Bureau of Labour and Social Security of Kunming (Kunming Medical Insurance Centre, 2006). Following the social insurance scheme in Kunming, the payments for incurred medical expenses are categorized into the following seven parts.

- Expenses totally paid by patients themselves. This part of expenditure is for medical services that are not listed under the medical insurance scheme. The incurred medical expenses should be paid by patients themselves and are calculated independently from the other parts of expenditure.

- Personal savings accounts. Personal savings accounts are managed by insured individuals themselves under the social medical insurance system. For officials, their personal savings accounts also include a certain amount of money subsidized by local governments. Individual shared expenses of medical services listed in the social medical insurance scheme can be charged from the personal savings accounts. It goes into a deficit when the balances of a personal savings account are negative at the end of each forecasting year. In such cases, the balances of personal savings accounts are assigned back to zero in the model.

- Self payments. This part of the payments is shared medical expenses by individuals within the coverage of the medical insurance scheme. The expenses are first paid by the personal savings accounts. When the personal savings accounts are exhausted, the excess amount of medical expenses should be paid by the patients concerned directly.

- Social pool fund. The social pool fund covers a certain proportion of expenses incurred in chronic diseases and clinic special check-ups and a large part of hospitalization costs. According to the current medical insurance payment policy, the social pool fund covers an individual's hospitalization expenses up to 49,000 Yuan in a financial year. The results of modelling medical treatment expenses and medical insurance payments of 2006-2010 give the balances of the social pool fund achieved for each of the forecasting years.

- Serious illness fund. For hospitalization treatments, the serious illness fund is the supplementary security fund following the social pool fund. After reaching the ceiling payment of the social pool fund (49,000 Yuan for a year), the serious illness fund covers

90 percent of the excess hospitalization expenses from 0 up to 150,000 Yuan, the remaining 10 per cent to be shared by the individual concerned. For this part of the payment, the balances of the serious illness fund for each year of 2006-2010 are aggregated.

- Government official fund. The Government official fund subsidizes a certain proportion of medical expenses shared by government officials when they are admitted to hospitals. This part of expenditure is calculated according to the relative government official compensation policy.

- Overtop payment. This is the self payment after the serious illness fund. This part of payments is for hospitalization expenses that exceed the coverage of the serious illness fund. The payments are calculated independently in the model.

In processing the incurred medical expenses, the revenues and balances of the social pool fund and the serious illness fund in 2001-2005 referred to the 2006 report by the Bureau of Labour and Social Security of Kunming (Kunming Medical Insurance Centre, 2006). For the Government official fund, the revenues and balances in 2001-2004 were taken from the 2005 report by the Bureau of Labour and Social Security of Kunming, while the revenue and balance in 2005 was imputed by using the actual data in 2005.

Table 7.6 gives the results of revenues, payouts and balances for these three kinds of pool funds over the period of 2001-2005.

Table 7.6 Revenues and balances of three kinds of pool funds (Million Yuan)

Year	Social pool fund			Serious illness fund			Government official fund		
	Revenue	**Payout**	**Balance**	**Revenue**	**Payout**	**Balance**	**Revenue**	**Payout**	**Balance**
2001	78.18	26.02	52.16	6.40	1.88	4.53	4.53	0.03	4.50
2002	206.51	183.27	23.24	28.83	21.18	7.66	28.82	0.50	28.31
2003	284.00	318.26	-34.26	45.01	43.15	1.86	16.69	4.04	12.65
2004	402.50	387.35	15.15	59.60	48.15	11.45	22.45	8.32	14.12
2005	563.68	541.71	21.97	71.13	70.07	1.07	20.17	5.62	14.56
Total	1534.87	1456.61	78.26	210.98	184.43	26.56	92.65	18.51	74.14

Notes: Values for social pool fund and serious illness fund in 2001-2005, values for Government official fund in 2001-2004 came from the report by the Bureau of Labour and Social Security of Kunming. Values for Government official fund in 2005 were estimated (revenue) and calculated (payout).

Table 7.7 presents the estimated payment distribution among the seven different kinds of payments over the period of 2006-2010. During the period of 2006-2010, it is estimated that the total medical cost of insured individuals in Kunming would, on average, increase 7.05 per cent annually. The social pool fund and the serious illness fund together cover annually around 48-51 per cent of the total medical cost. Among the different kinds of payments, proportions shared by the personal savings accounts would increase significantly, from 28.41 per cent in 2006 up to 33.37 per cent in 2010. The percentage paid by the serious illness fund also shows an upward trend, from 5.81 per cent in 2006 to 7.98 per cent in 2010. In contrast, the payment proportions shared by the social pool fund would decrease, apparently from 44.97 per cent in 2006 down to 40.15 per cent in 2010. This probably can be explained as the following. The medical costs are estimated to keep increasing annually, while at the same time, the maximum funds' payments remain the same as initially designed. These changes result in the payment by the social pool fund being shifted to the serious illness fund. The Government official fund contributes about 0.62 per cent of the total cost. About 17 per cent of the medical costs are paid by individuals themselves, while a little more than 2 per cent of medical cost is out of the coverage of the social insurance scheme. Very few medical costs (0.003 per cent in 2010) are beyond the coverage of the serious illness fund.

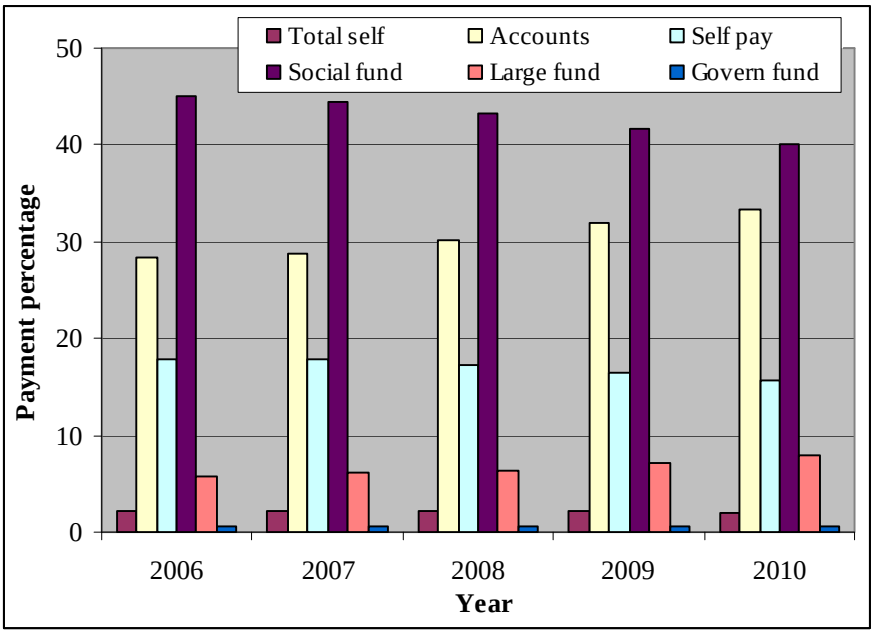
Table 7.7 Forecast total medical expenses and different kind of payments (million)

Year	Total self	Personal savings accounts	Self payment	Social pool fund	Serious illness fund	Govern official fund	Overtop	Total cost
Amount of Payment (million)								
2006	28.79	364.01	229.36	576.26	74.48	8.74	0.00	1281.43
2007	31.05	403.13	250.52	623.19	86.61	9.08	0.00	1401.39
2008	32.89	454.10	259.27	649.00	96.22	9.30	0.00	1502.01
2009	33.53	506.40	262.15	660.65	113.35	9.18	0.00	1586.93
2010	34.97	561.35	264.37	675.41	134.19	9.39	0.05	1682.18
Percentage of Payment（%）								
2006	2.25	28.41	17.90	44.97	5.81	0.68	0.00	100.00
2007	2.22	28.77	17.88	44.47	6.18	0.65	0.00	100.00
2008	2.19	30.23	17.26	43.21	6.41	0.62	0.00	100.00
2009	2.11	31.91	16.52	41.63	7.14	0.58	0.00	100.00
2010	2.08	33.37	15.72	40.15	7.98	0.56	0.00	100.00

Figure 7.3 shows the percentage distribution of the different kinds of payments, according to the corresponding data in Table 7.7. In Figure 7.3, the part of the overtop self payment was combined into the part of self payment. This gives the total picture when considering the total medical cost and the different kinds of payments. A key question then is: is there any

difference among the payment distributions when considering employees and retirees separately?

Figure 7.3 Estimated percentage distribution of the different kinds of payments



Notes:

Total self – Self payment for items which are not at the insurance list;
Accounts – Personal savings accounts;
Self pay – Individual out of pocket payment;
Social fund – Social pool fund;
Large fund – Serious illness fund;
Govern fund – Government official fund.

Table 7.8 presents the payment distributions in percentages for employees and retirees separately. As with the difference of medical expenses between employees and retirees, the payment distributions differ significantly. The social pool fund and serious illness fund cover a large part of the medical costs for retirees.

For employees, nearly half of their medical costs are estimated to be covered by their personal savings accounts, while both the social pool fund and the serious illness fund together handle about 31 per cent of their medical services bill. Retirees have 63 per cent of their medical costs paid as a benefit from the social pool fund and the serious illness fund, while their personal savings accounts only cover 15 per cent of their total medical costs. Self payment for retirees is estimated to be about 2 per cent higher than that for employees. The percentage payment of subsidies from the Government official fund remains nearly the same for both employees and retirees, which is estimated to be 0.60 per cent and 0.71 per cent respectively. The percentage of total self payment for retirees is 1.56 times that for employees. This means that retirees use a wider range of medical services and facilities than employees.

Table 7.8 Forecast percentage payment distribution for employees and retirees

Year	Total self	Personal savings accounts	Self payment	Social pool fund	Serious illness fund	Govern official fund	Overtop	Total cost
Employees – Percentage of Payment (%)								
2006	1.80	47.65	16.02	29.72	4.30	0.66	0.00	100.00
2007	1.73	47.92	16.62	28.77	4.38	0.61	0.00	100.00
2008	1.65	49.53	16.50	27.22	4.45	0.56	0.00	100.00
2009	1.58	50.87	16.34	25.56	5.17	0.53	0.00	100.00
2010	1.52	51.78	16.27	24.18	5.83	0.48	0.01	100.00
Retirees – Percentage of Payment (%)								
2006	2.57	14.20	19.28	56.24	6.93	0.70	0.00	100.00
2007	2.59	13.93	18.85	56.63	7.57	0.68	0.00	100.00
2008	2.63	14.32	17.89	56.39	8.02	0.66	0.00	100.00
2009	2.58	15.08	16.68	55.90	8.89	0.62	0.00	100.00
2010	2.61	15.93	15.19	55.29	10.01	0.63	0.00	100.00

7.4 Balances of the Personal Savings Accounts and Self Payments

After the medical cost subsidies from the above mentioned three pool funds, the remaining medical expenses are paid by the personal savings accounts or individuals themselves. Table 7.9 gives the revenue and balance of the personal savings accounts, total medical expenses and the amount of individual self payments for incurred medical costs. For the personal savings accounts, the amounts of the balances are estimated to increase annually, with the estimated accumulative balance of 1938.08 million Yuan by 2010. The percentage of medical expenses not covered by the social medical insurance scheme as a proportion of total medical costs ranges between 2.0 and 2.4 per cent. In practice, in implementing the medical insurance scheme, this part of total self costs can be paid though the personal savings accounts. Deducting the total self costs (230.49 million) from the accumulative personal savings accounts (1938.08 million), and then dividing the result by the total population of the insured individuals of 924,596 in 2010, the average balance of the personal savings account per person can be estimated as 1846 Yuan. Apart from these payments, around 17 per cent of the medical expenses are estimated to be paid by individuals' out of pockets (the items 'Self for expenses' in Table 7.9), and it shows a slight downwards trends.

Table 7.9 Forecast balance of personal savings accounts and self payments (million Yuan)

Year	Personal savings accounts			Total costs	Total self pay		Self for expenses		Overtop pay
	Revenue	Payout	Balance		Payment	%	Payment	%	
2005	1510.76	917.64	593.12	2895.87	69.26	2.39			
2006	583.41	364.01	219.40	1281.43	28.79	2.25	229.36	17.90	0.00
2007	631.56	403.13	228.43	1401.39	31.05	2.22	250.52	17.88	0.00
2008	721.11	454.10	267.01	1502.01	32.89	2.19	259.27	17.26	0.00
2009	802.23	506.40	295.83	1586.93	33.53	2.11	262.15	16.52	0.00
2010	895.64	561.35	334.29	1682.18	34.97	2.08	264.37	15.72	0.05
Total	5144.71	3206.63	1938.08		230.49				

Note: Data for 2005 are accumulated results for 2002-2005.

Although the average accumulative balance of the personal savings account could be as high as 1840 Yuan in 2010, by differentiating employment status and income levels, the balances give a totally different story. Table 7.10 estimates the deficit distributions in using the personal savings accounts in 2010, and the results are presented for employees and retirees respectively.

Table 7.10 Deficit estimation of personal savings accounts in 2010 (Yuan)

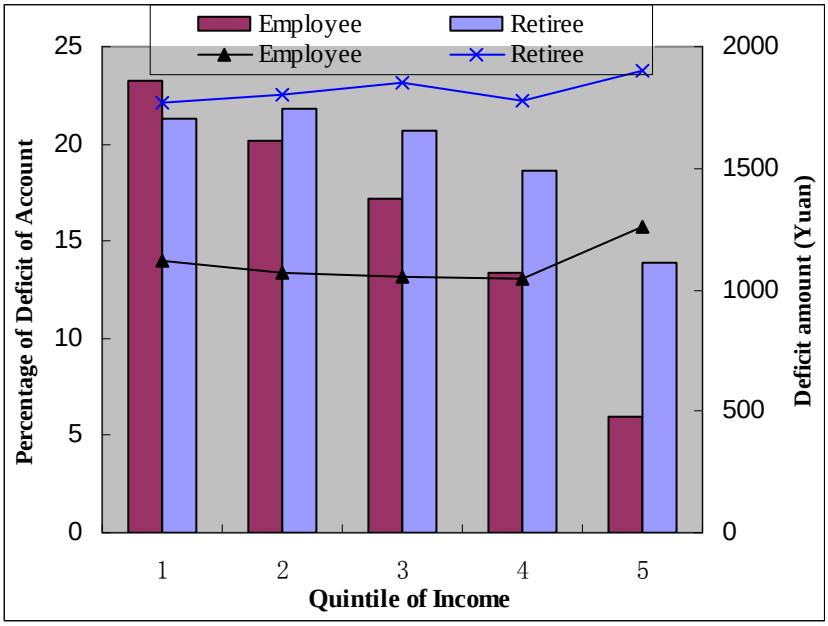
Income quintile	Average annual income	Percentage of deficit*	Average amount of deficit**	Deficit amount/annual income×100%		
				P75	Median	P25
Employees						
1	12033	23.30	1116	11.39	5.65	2.28
2	15607	20.18	1072	8.26	4.27	1.90
3	19484	17.13	1052	6.60	3.39	1.51
4	24833	13.35	1044	5.18	2.55	1.10
5	41563	5.95	1260	3.81	1.80	0.71
Subtotal	22704	16.40	1089	7.97	3.83	1.58
Retirees						
1	9603	21.31	1773	22.61	10.57	4.53
2	11838	21.81	1806	18.96	8.96	4.02
3	13596	20.67	1852	16.83	7.92	3.49
4	16855	18.66	1777	13.33	6.09	2.52
5	25628	13.84	1902	9.44	4.35	1.71
Subtotal	15504	19.36	1815	16.79	7.65	3.16

Notes: * Percentage of individuals with their personal savings accounts deficit in the relevant income group; ** Annual amount, for those who have a deficit only. P75 – the 75th percentile; P25 – the 25th percentile.

In Table 7.10, the insured population was categorized into 5 quintile groups according to individual's annual income, from the lowest 20 per cent to the highest 20 per cent. The quintiles are for each group determined separately. For both employees and retirees, the lower the income, the more possibility there is of negative balances in the personal savings accounts in a financial year. For employees, the percentage of people with deficit in the lowest quintile

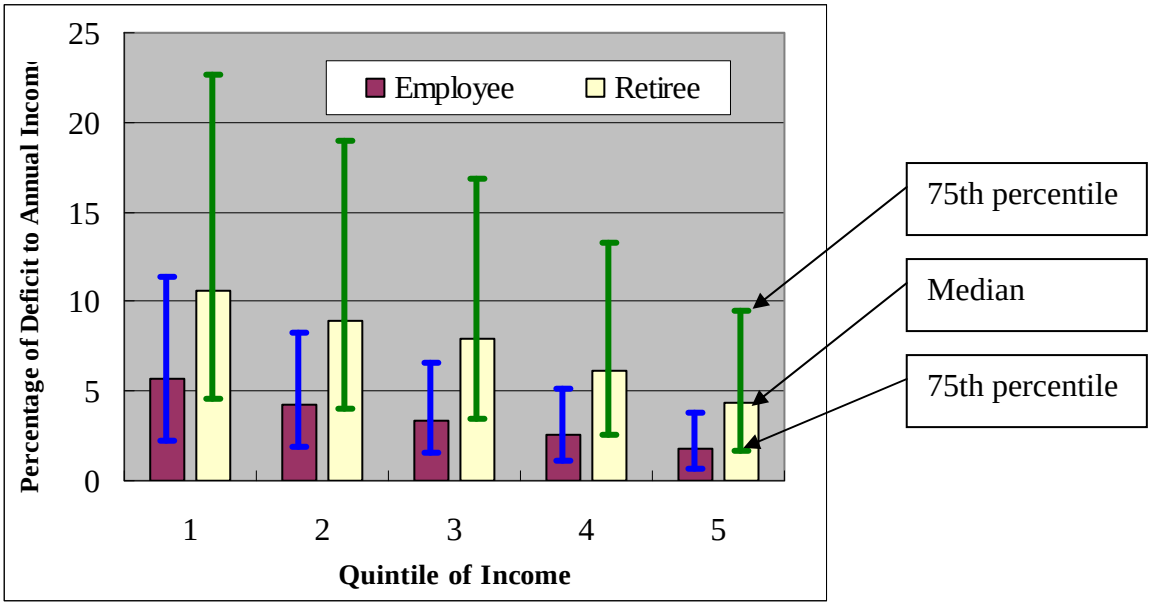
income group is estimated to be nearly 4 times that in the highest quintile income group. That is, for almost one-quarter of employees in the lowest income quintile, their medical expenses are projected to exceed the funds residing in their personal savings accounts. In contrast, for the top quintile of employees, the comparable figure is less than six per cent. The corresponding percentage gap for retirees, which is from 21.31 per cent in the lowest quintile to 13.84 per cent in the highest quintile, is smaller than that for employees. The results show the big difference between the two groups. The proportion of retirees with their accounts going into deficit is 3 percentage points higher than employees. In addition, the average deficit amount for retirees is 74.14 per cent higher than that for employees (Figure 7.4).

Figure 7.4 Deficit estimations of personal savings accounts by income quintiles in 2010



From the perspective of ratio of deficit amount to the annual income, it varies among the income groups. For example, 25 per cent of employees, in the lowest income quintile, whose accounts go into a deficit will have a deficit amount equivalent to 11.39 per cent of their annual income, while the figure is just 3.81 per cent for the highest quintile group (the third last column in Table 7.10). For retirees, the corresponding proportion, on average, is estimated to be double that for employees. Figure 7.5 shows the percent of deficit in personal savings accounts to annual income in 2010 across income quintiles. It gives comparisons between employees and retirees for three measures: the 75th percentile, the median and the 25th percentile. When personal savings accounts go into deficit, patients pay the bill by out of pocket payments.

Figure 7.5 Estimated percent of deficit in personal savings accounts to annual income in 2010



7.5 Balances of the Three Pool Funds under the Current Policy

As previously stated, under the social medical insurance scheme in Kunming, three different kinds of medical pool funds have been established. The social pool fund is for the basic medical insurance, largely subsidizing hospitalization services. The serious illness fund is a supplementary fund for serious diseases, right after the social pool fund. And, finally, the Government official fund compensates the medical costs for government officials. Among these three funds, the first two funds are vital for the medical insurance scheme. Table 7.11 gives the revenues and balances of these three pool funds under the current medical insurance policy.

For the convenience of comparison, the actual results for the period of 2001-2005 are also presented in Table 7.11. The forecasting results show that if the maximum payments of the social pool fund and serious illness fund remain unchanged, but the total medical expenses keep increasing annually, this would result in pressure on the social pool fund being transferred to the serious illness fund. Although with a glance at the forecasting result, it is clear that there is still some accumulative balance in the serious illness fund at the end of 2010 (the last row in Table 7.11), it shows evidence of financial risk from the year 2009.

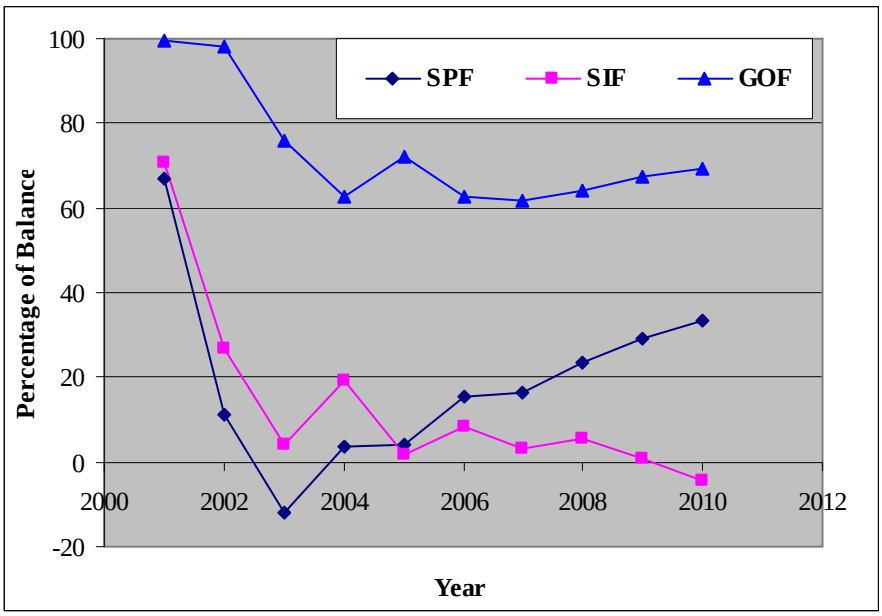
Table 7.11 Simulated revenue and balance of different kinds of funds (Million Yuan)

Year	Social pool fund			Serious illness fund			Official subsidy fund		
	Revenue	Payout	Balance	Revenue	Payout	Balance	Revenue	Payout	Balance
2001	78.18	26.02	52.16	6.40	1.88	4.53	4.53	0.03	4.50
2002	206.51	183.27	23.24	28.83	21.18	7.66	28.82	0.50	28.31
2003	284.00	318.26	-34.26	45.01	43.15	1.86	16.69	4.04	12.65
2004	402.50	387.35	15.15	59.60	48.15	11.45	22.45	8.32	14.12
2005	563.68	541.71	21.97	71.13	70.07	1.07	20.17	5.62	14.56
2006	682.97	576.26	106.71	81.31	74.48	6.83	23.44	8.74	14.70
2007	744.24	623.19	121.05	89.51	86.61	2.91	23.83	9.08	14.75
2008	847.59	649.00	198.59	101.92	96.22	5.70	26.02	9.30	16.72
2009	935.24	660.65	274.59	114.35	113.35	1.01	28.23	9.18	19.05
2010	1016.03	675.41	340.62	128.41	134.19	-5.78	30.76	9.39	21.37
Total	5760.94	4641.12	1119.82	726.47	689.28	37.24	224.94	64.2	160.73

Notes: Data for 2001-2005 are analysis results for 2001-2005, the rest are results of the simulation.

This financial risk can be seen more clearly from Figure 7.6, which presents the percentage of balances of the three different kinds of pool funds. In the meantime, the Government official fund and the social pool fund keep relatively high percentages of balances, respectively. The percentage of balances of the serious illness fund shows a downward trend from the year of 2009.

Figure 7.6 Forecast percentage of balances of different kinds of pool funds (Base case)



Notes: SPF – Social pool fund; SIF – Serious illness fund; GOF – Government official fund.
Percentage of balance for a fund = annual balance/annual revenue ×100%.

7.6 Forecasting Results for a Policy Scenario

Section 7.5 discussed the balances of three pool funds under the current policy settings. The forecasting results showed a financial risk for the serious illness fund from the year 2009 (Figure 7.6). The serious illness fund is estimated to have a negative balance at the end of 2010. This phenomenon can be explained as: if the maximum payments of the social pool fund and serious illness fund remain unchanged, but medical expenses keep increasing annually, this would result in pressure on the social pool fund being transferred to the serious illness fund.

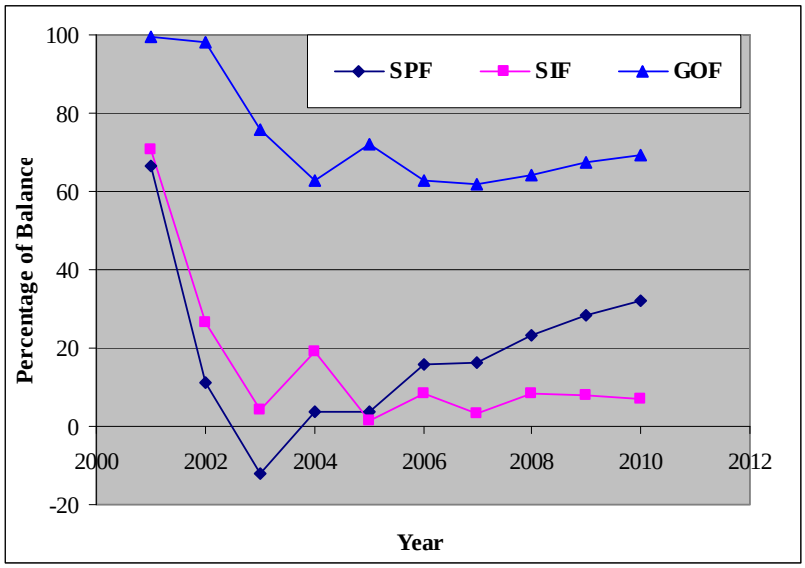
As mentioned in Section 5.7, both of the pool funds are responsible for a large part of hospitalization costs: the social pool fund covers the costs ranging 0 – 49,000 Yuan, while the serious illness fund covers costs ranging 0 – 150,000 Yuan (refer to Figure 5.8). In practice, in implementing the social insurance scheme, the Kunming Government set part of the social pool fund responsibility onto the serious illness fund. From 2006 onwards, the coverage of the social pool fund is up to 35,000 rather than 49,000 Yuan, with the excess 14,000 Yuan being covered by the serious illness fund.

Based on the above forecasting results and analysis, the modelling adjusted the payment policy settings on the medical expenses. Maximum payment by the social pool fund was adjusted. The principle of this adjustment is to raise the maximum payment of the social pool fund by 2.5 per cent annually. It assumed that this adjustment is commenced from the year 2008 until 2010. The maximum payment by the social pool fund is raised from 35,000 Yuan in 2007, step by step, up to 37,700 Yuan in 2010. The other payment rules remain unchanged. That is, the model considers the following medical insurance policy scenario:

Scenario One: raise the maximum payment of the social pool fund by 2.5 per cent annually from 2008 until 2010.

After such adjustment of the maximum payment by the social pool fund, both the social pool fund and the serious illness fund would maintain reasonable percentages of balances on average (Figure 7.7). At the same time, such an adjustment has not had much impact on the proportion of balance of the government official fund.

Figure 7.7 Forecast percentage of balances of different kinds of pool funds (Scenario One)



Notes: SPF – Social pool fund; SIF – Serious illness fund; GOF – Government official fund. Percentage of balance for a fund = annual balance/annual revenue ×100%.

Furthermore, such maximum payment adjustment has very few effects on the payment distributions of the personal savings accounts. Table 7.12 estimates the deficit distributions in using the personal savings accounts in 2010, and the results are presented for employees and retirees respectively.

Table 7.12 Deficit estimation of personal savings accounts in 2010 (Scenario One)

Income quintile	Average annual income	Percentage of deficit*	Average amount of deficit**	Deficit amount/annual income*100%		
				P75	Median	P25
Employees						
1	12033	23.30	1115	11.39	5.65	2.28
2	15607	20.18	1071	8.26	4.27	1.90
3	19484	17.13	1050	6.60	3.39	1.51
4	24833	13.35	1043	5.18	2.55	1.10
5	41563	5.95	1258	3.81	1.80	0.71
Subtotal	22704	16.40	1088	7.97	3.83	1.58
Retirees						
1	9603	21.31	1770	22.61	10.57	4.53
2	11838	21.81	1803	18.96	8.96	4.02
3	13596	20.67	1846	16.83	7.92	3.49
4	16855	18.66	1772	13.33	6.09	2.52
5	25628	13.84	1897	9.44	4.35	1.71
Subtotal	15504	19.36	1811	16.79	7.65	3.16

Notes: * Percentage of individuals with their personal savings accounts deficit in the relevant income group; ** Annual amount, for those who have a deficit only. P75 – the 75th percentile; P25 – the 25th percentile.

Except for a slight decline on the average amount of deficit (the fourth column), the measurements are unchanged compared with the results in Table 7.10. This is reasonable, because Scenario One only adjusts the payment responsibilities among the social pool fund and the serious illness fund. Medical insurance participants will experience no impact from this policy adjustment.

7.7 Summary

This chapter discussed the modelling results based on the construction of a model of the medical insurance scheme for urban employees and retirees. Based on the forecasting results of the medical expenses and medical insurance payments of 2006-2010, the balances of the personal savings accounts for each individual were obtained. This helped to estimate the distributional impacts of the medical insurance system on participants and to explore the benefits or burdens under the medical insurance scheme. By analysing the balances of the social pool fund, the serious illness fund and the Government official fund at the end of each forecast year, the assistance capacity and sustainable development of these pool funds was examined. Except for the base case of the medical insurance scheme, the model simulated one scenario changing the medical insurance policy settings.

The main findings in the model are summarized briefly as below.

1. Medical cost distribution

It is estimated that the average medical cost per person in Kunming increases 4.6 per cent annually over 2006-2010. When considering the four different kinds of medical services, the ratio of medical expenses of clinic services and medications in pharmacies to the total medical expenses displays a slight increase trend over the period of 2006-2010. The percentages of medical costs of both chronic diseases and clinic special check-ups are estimated to remain stable in their relative expenditures. In contrast to the clinic services, the cost proportion of hospitalization services to total expenses has a slight downward trend in 2010 compared with 2005, from 62.76 per cent down to 59.66 per cent.

When considering the medical cost distributions for employees and retirees separately, completely different pictures emerge. For employees, more than half of their medical services costs (54.1 per cent) come from clinic services and medications. The second largest medical

cost is estimated to occur in hospitalization services, which is around 42.8 per cent of the total cost. For retirees, more than three quarters (77.3 per cent) of their medical costs come from hospitalization treatments. Only around 10 per cent of retirees' medical costs come from the general clinic services and medications. The medical cost for chronic diseases accounts for around 11 per cent of the total medical expenses, which is quadruple that of employees.

2. Payments for medical costs

The social pool fund and the serious illness fund together cover annually around 48-51 per cent of the total incurred medical costs over the period of 2006-2010. It is estimated that the payment proportions shared by personal savings accounts would increase significantly from 28.41 per cent in 2006 to 33.37 per cent in 2010. The Government official fund contributes about 0.62 per cent of the total cost. About 17 per cent of the medical costs are paid by individuals themselves, and a little more than 2 per cent of medical costs are out of the coverage of the social insurance scheme.

As with the difference of medical expenses between employees and retirees, the payment distributions differ significantly. For employees, nearly half of their medical costs are estimated to be covered by their personal savings accounts, while both the social pool fund and the serious illness fund together handle about 31 per cent of their medical services bill. Retirees have 63 per cent of their medical costs paid as a benefit from the social pool fund and the serious illness fund, while their personal savings accounts only cover 15 per cent of their total medical costs.

3. Balances of personal savings accounts and self payments

The amounts of balances of the personal savings accounts are estimated to increase annually, with the estimated accumulative balance of 1938.08 million Yuan by 2010, giving the average balance per person of 1846 Yuan. Although the average accumulative balance of the personal savings account could be as high as 1846 Yuan in 2010, by differentiating employment status and income levels, the balances give a totally different story.

From the viewpoint of an individual's annual income, for both employees and retirees, the lower the income, the more possibility there is of negative balances in the personal savings accounts. For employees, the percentage of deficit in the lowest quintile income group is estimated to be nearly 4 times that in the highest quintile income group. The corresponding

percentage gap for retirees, which is from 21.31 per cent in the lowest quintile to 13.84 per cent in the top quintile, is smaller than that for employees. The proportion of retirees with their accounts going into deficit is 3 percentage points higher than employees. In addition, the average deficit amount for retirees is 74.14 per cent higher than that for employees.

4. Balances of three funds

The forecasting results show that if the maximum payments of the social pool fund and the serious illness fund remain unchanged, then the social pool fund will have an increasing percentage of balance, but not for the serious illness fund. Because of the continuing increase in the total medical expenses annually, unchanged maximum payments means that the extra burden of medical expenditure will shift from the social pool fund to the serious illness fund. Under the current payment policy, the serious illness fund is estimated to have a financial risk from the year of 2009, and the situation could be even worse by 2010.

In summary, as the basic foundation, the social pool fund is estimated to have a sustainable development capacity over the period of 2006-2010, but the serious illness fund does not appear financially sustainable over this period. Under such circumstances, the model adjusted the payment responsibilities among the social pool fund and the serious illness fund. The adjustment made was to raise the maximum payment of the social pool fund by 2.5 per cent annually, from 2008 to 2010. After such adjustment, both the social pool fund and the serious illness fund would maintain reasonable percentages of balances. At the same time, such an adjustment does not have much impact on the balance of the Government official fund.

CHAPTER 8 OUTCOMES FOR NON-WORKING RESIDENTS

8.1 Introduction

As mentioned in Chapter 6, a static microsimulation model was created to forecast the medical insurance scheme for non-working urban residents in Kunming. The model simulated medical services and expenses for urban residents in relation to hospital services as well as serious illness clinic services. In construction of the model, two main datasets were used – a sample from the 2000 Population Census; and medical insurance records of employees and retirees under the social medical insurance scheme. Three major steps were conducted to construct the model, each of which corresponds to a module, that is, Population module, Matching module and Prediction module. Consistent with the medical insurance scheme for urban residents which was started in October 2007, the model simulated hospitalization services for the period of 2008-2010.

This chapter presents the results of forecasting medical expenses on hospitalization treatments as well as clinic services for serious illnesses for non-working urban residents in Kunming. This chapter assesses the distributional impacts of the medical insurance policies and predicts the medical expenses for urban residents from the aspects of: forecasting the distributions of different kinds of population; collecting the insurance premiums; establishing a social pool fund; and paying for the incurred medical costs. The amounts of subsidies by the various levels of government are estimated, as well as the medical costs of hospitalization services for different levels of family income. For three policy scenarios, the research evaluates the distributional impacts of the medical insurance scheme on urban residents. In this chapter, unless otherwise specified, ‘urban residents’ indicates urban residents who are not in the labour force (NILF).

8.2 Population Distribution of Urban Employees and Residents

Table 8.1 summarizes the distribution of urban employees and retirees in Kunming city who are covered by the medical insurance scheme for urban employees over the period of 2008-2010. As a comparison, the result in 2005 is also provided in Table 8.1. It is estimated that a

total of 1.27 million individuals will be insured under the medical insurance scheme for urban employees and retirees in 2010. They are administered differently in three ways. The insured individuals under the Municipal administration are about 73.5 per cent of the total insured population. The next largest part of the group consisted of individuals under the Provincial administration, which account for about 26.2 per cent of the total population. The rest and quite small part of less than 0.3 per cent is for senior retirees. As mentioned before, this group of people is usually made up of war veterans and their dependents and their population number is decreasing over time because of their old age. The number of insured individuals under the social medical insurance scheme for urban employees is about 33 per cent of the total population in urban areas of Kunming (Table 8.2).

Table 8.1 Estimated distribution of insured employees and retirees over 2005-2010

Year	Number of Population				Percentage			
	City	Province	Senior	Total	City	Province	Senior	Total
2005	793453	283435	4403	1081290	73.38	26.21	0.41	100.00
2008	885397	315574	3935	1204906	73.48	26.19	0.33	100.00
2009	909780	324153	3774	1237706	73.51	26.19	0.30	100.00
2010	934643	332896	3610	1271149	73.53	26.19	0.28	100.00

Notes: City means under Municipal administration; Province means under Provincial administration; Senior means senior retirees.

Table 8.2 gives a picture for all the different groups of the population, namely insured employees, uninsured employees, and residents out of the labour market. Apart from 33 per cent of the insured individuals under the medical insurance scheme for urban employees and retirees, around 36 per cent of the total population are employed or retired but are not covered by the social medical insurance scheme, which is supposed to be a universal plan for all urban employees and retirees. The item ‘uninsured’ here means not under the social medical insurance scheme for urban employees, but they might have alternative medical insurance. Such a large percentage of people who are in the labour market but not joining the social medical insurance indicates that a lot of work needs to be done by the local governments to encourage them to be covered by the social medical insurance system. For insured individuals, the ratio of employees to retirees is about 2:1, while the relative ratio for uninsured individuals is about 8:1. These figures indicate that retirees are more eager than employees to join the medical insurance scheme. From another point of view, if the governments can encourage more employees to join the social medical insurance scheme, then it would significantly decrease the risk of running the medical insurance pool fund.

Table 8.2 Forecast population distribution of employed and residents

Year	Insured		Uninsured			Residents*	Total
	Employed	Retired	Employed	Unemployed	Retired		
Population							
2005	720938	360352	1115677	67976	116664	1128020	3441651
2008	803247	401659	1140241	70330	145995	1186056	3677198
2009	825088	412619	1147621	71063	156523	1206081	3747932
2010	847360	423788	1154660	71766	167456	1226169	3819434
Percentage							
2005	20.95	10.47	32.42	1.98	3.39	32.78	100.00
2008	21.84	10.92	31.01	1.91	3.97	32.25	100.00
2009	22.01	11.01	30.62	1.90	4.18	32.18	100.00
2010	22.19	11.10	30.23	1.88	4.38	32.10	100.00

Note: * Residents who are not in the labour force.

Unemployed individuals are people who are out of the labour market and looking for jobs. They are included in the summary of the uninsured employees and retirees. The unemployed individuals account for about 2 per cent of the total urban population. It can be estimated from this group of individuals that the unemployment rate will be around 3.63 per cent for Kunming city over the period of 2008-2010.

Apart from the insured and uninsured employees and retirees, the remaining population is residents who are out of the labour market, and are to be covered by the social medical insurance scheme for urban residents. This group of people is estimated to be 1.18 million in 2008 and 1.22 million in 2010, which accounts for more than 32 per cent of the total urban population. As previously stated, this group of people consists of adults without jobs, students and children.

Table 8.3 focuses on the population of urban residents out of the labour market. The urban residents are categorized into three groups – that is, adults aged 18 years or above, children or students in their primary or secondary education who are less than 18 years of age, or students at the universities. Each category is differentiated into two parts: general and concession. Concession means disabled people or families receiving the basic living allowances from the governments. Children and students less than 18 years of age comprise about 56.6 per cent of the urban residents who are not in jobs. Adult residents account for another 30.5 per cent and the remaining 12.9 per cent are university students. About a quarter of adult residents are

categorised into concession, with children and university students making up 2.82 per cent and 1.47 per cent of the category, respectively.

Table 8.3 Forecast population and percentage of urban residents out of labour market

Year	Adults		Children		Uni-students		Total
	General	Concession	General	Concession	General	Concession	
Population							
2005	264146	82409	617370	17949	144026	2121	1128020
2008	274085	88013	651795	18911	150829	2423	1186056
2009	277363	89958	663919	19240	153071	2530	1206081
2010	280606	91931	676264	19569	155160	2639	1226169
Percentage							
2005	23.42	7.31	54.73	1.59	12.77	0.19	100.00
2008	23.11	7.42	54.95	1.59	12.72	0.20	100.00
2009	23.00	7.46	55.05	1.60	12.69	0.21	100.00
2010	22.88	7.50	55.15	1.60	12.65	0.22	100.00

Table 8.4 gives the population estimates for four age groups for adult residents by general and concessional status. Figure 8.1 presents the relative percentages of age groups, with the left side for general residents and the right side for concessional residents. Individuals aged 18-34 years dominate the general residents component, which is about 45 per cent of the total general residents. The other two age groups of 35-49 years and 50-64 years account for 20 per cent each. The remaining 15 per cent of the general population is for individuals aged 65 years or over.

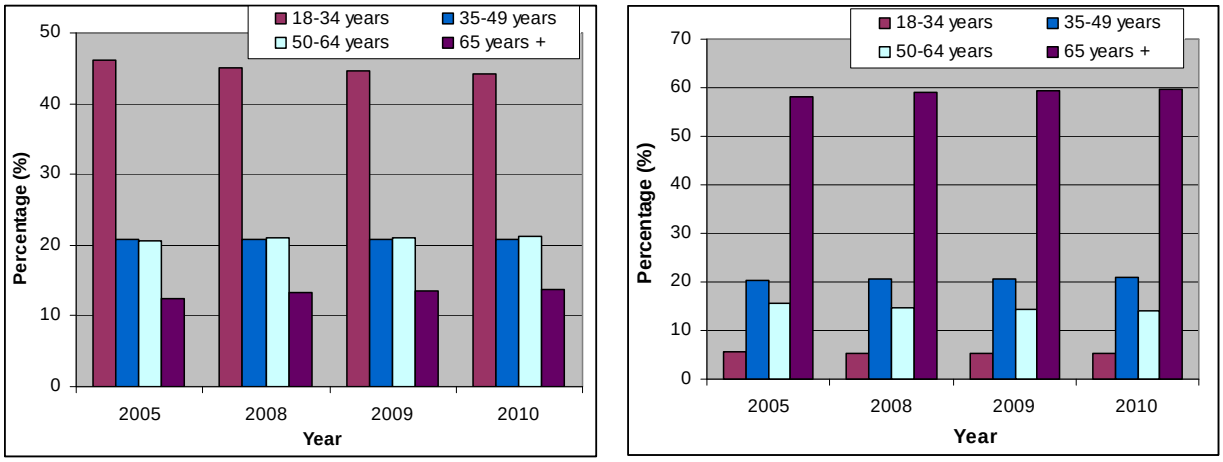
Table 8.4 Forecast distribution of age groups by concession for adult residents

Year	18-34 years old	35-49 years old	50-64 years old	65 years old or over	Total
General adults					
2005	122151	55044	54254	32696	264146
2008	123479	56968	57450	36188	274085
2009	123833	57592	58520	37417	277363
2010	124126	58200	59597	38684	280606
Concession adults					
2005	4722	16743	12936	48008	82409
2008	4798	18171	12949	52095	88013
2009	4824	18666	12944	53525	89958
2010	4847	19170	12929	54985	91931

For concessional residents, elderly people aged 65 years or over account for the greatest proportion of the population, which is close to 60 per cent. This group is followed by individuals aged 35-49 years at 20 per cent, and then 15 per cent are 50-64 years of age, and 5

per cent aged18-34 years. This also indicates that the elderly people in the concession part, or even adult residents, might be a large part of those using medical services.

Figure 8.1 Forecast percentage of age groups of adult residents



Note: Left side for general residents and right side for concession residents.

8.3 Estimation of Family Income and Insurance Premium Payments

This section discusses the estimation of family income and the premium payment to the medical insurance scheme for urban residents. This section also presents the distribution of subsidies by different levels of governments. Table 8.5 presents the annual average family income by quintile over 2005-2010. It is estimated that the middle quintile family income is 15,793 Yuan in 2008 and will increase by about 9.3 per cent in the next couple of years. The family annual income in the highest quintile is 4.71 times the least quintile in 2005. The gap between the richest and the poorest is estimated to be wider by 2010, where the relative ratio is 5.34. Figure 8.2 illustrates the family annual income by quintile in 2005 and 2010.

Table 8.5 Estimated annual average family income by quintile

Year	Lowest	Second lowest	Medium	Second highest	Highest	Highest/Lowest
2005	5310	8986	11659	14158	25031	4.71
2008	6592	12424	15793	20467	35424	5.37
2009	7165	13566	17247	22424	38562	5.38
2010	7895	14883	18864	24532	42183	5.34

Figure 8.2 Estimated average annual family income by quintile over 2005-2010

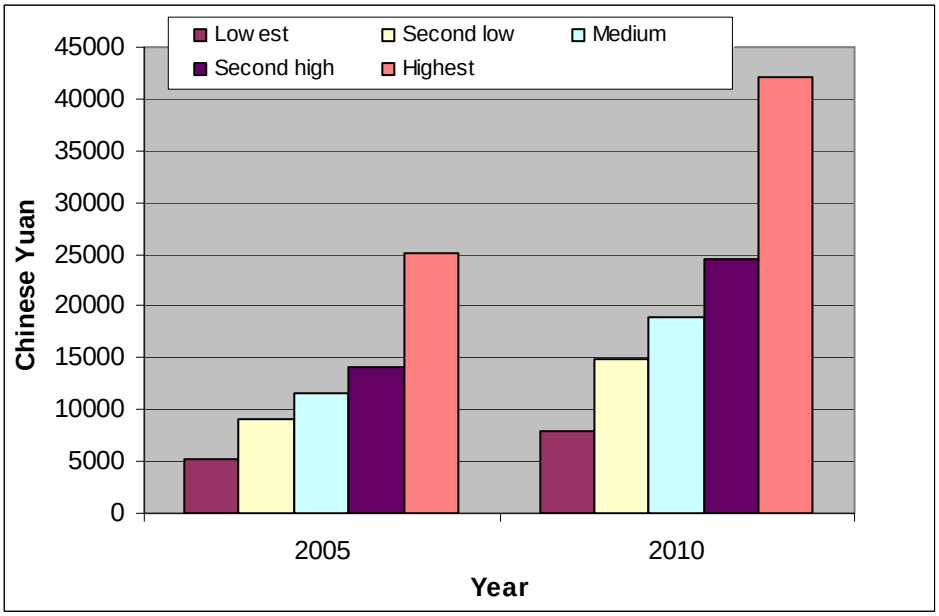


Table 8.6 presents the estimated distribution of the medical insurance premium among governments and individuals over 2008-2010. The average annual premium is just a little more than 140 Yuan for each individual. Various levels of governments are responsible for covering 81.3 per cent of the total insurance premium payment, in which the Central government provides 13.9 per cent, the Provincial government 24.3 per cent and the Municipal government 43.1 per cent. Universities share around 2.7 per cent of the premium. The remaining16 per cent of the premium is contributed by the insured individuals.

Table 8.6 Estimated premium distribution among governments and individuals

Year	Insured population	Governments and University				Individual	Total	Per person (Yuan)
		Central	Provincial	Municipal	University			
Premium (Million Yuan)								
2008	208300	4.10	7.14	12.66	0.78	4.69	29.37	141.00
2009	900410	17.77	31.08	55.37	3.45	20.56	128.24	142.42
2010	1107008	21.88	38.24	68.12	4.26	25.20	157.70	142.46
Percentage (%)								
2008	208300	13.96	24.33	43.11	2.65	15.96	100.00	
2009	900410	13.86	24.24	43.18	2.69	16.04	100.00	
2010	1107008	13.87	24.25	43.19	2.70	15.98	100.00	

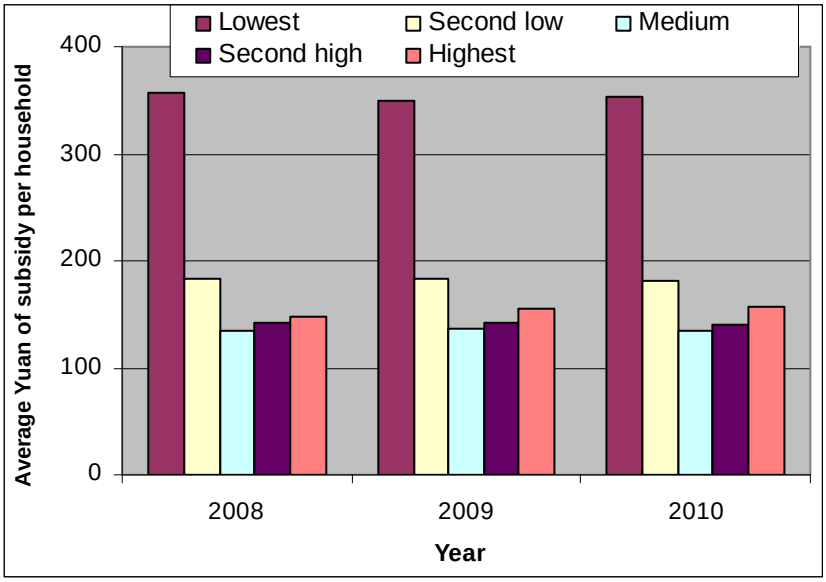
Table 8.7 and Figure 8.3 present the estimated average government subsidies of insurance premium per household by income quintile. The 20 per cent lowest income group benefits the

most of the subsidies from the government, which are estimated around 354 Yuan annually, followed by the second lowest group of around 182 Yuan. The government subsidies to the other three income groups range from 135-158 Yuan annually, and do not show significant difference among them. The average premium subsidy to the lowest income group is about 2.3 times that to the highest income group.

Table 8.7 Forecast average government subsidies per family (Yuan) by income quintile

Year	Lowest	Second lowest	Medium	Second highest	Highest	Highest/Lowest
2008	358	184	134	142	148	2.41
2009	350	184	136	142	156	2.25
2010	353	181	135	140	157	2.25

Figure 8.3 Forecast average government subsidies per family by income quintile



8.4 Forecast Medical Expenses for Insured Residents

According to the rules of the medical insurance scheme for non-working urban residents, hospital services as well as clinic serious illness services are simulated. The relative costs of the insured employees and retirees are adopted to impute hospitalization costs to non-employed urban residents. As modelled in Chapter 5 on the medical insurance scheme for urban employees and retirees, several types of medical treatments – admitted to hospital,

hospital transfer, clinic emergency and special disease clinic – are simulated. These follow the same insurance payment rules for insured employees and retirees.

However, in non-working residents' case, the treatment for special diseases in clinic services needs to be separated from hospitalization services, because there are two different payment methods. First, the criteria payment (patient self payment before triggering the social pool fund) not only depends on the hospital level, but also depends on whether the treatment is general hospitalization or serious illness in clinic services, as Table 8.8 shows. Second, the maximum payment for special disease clinic services (20,000 Yuan) is higher than that for general hospital treatments (16,000 Yuan). The separation of special disease clinic services refers to the distribution of actual medical service items in 2005 (last two columns in Table 8.8), which had 56.51 per cent of hospital treatment for insured employees belonging to special disease clinic services. Because special diseases usually occur in adult patients, it is assumed in the model that children less than 15 years old are exempted from special diseases.

Table 8.8 Medical services items considered in the simulation with an example in 2005

Medical items	Criteria payment (Yuan)	Maximum coverage (Yuan)	Frequency in 2005	Percentage in 2005 (%)
Admitted to Hospital	Same for employees	16,000	103109	36.14
Hospital transform	Same for employees	16,000	179	0.06
Clinic emergency	Same for employees	16,000	20810	7.29
Special disease clinic	720	20,000	161218	56.51
Total			285316	100.00

Table 8.9 gives a comparison of the medical insurance plan for the employed and non-working residents. Apart from the above mentioned differences on the criteria payment and the maximum payment, there are further differences between employed individuals and residents. The proportion paid by the social pool fund for the employed is much higher than that paid for residents. For example, for patients in a big hospital, the social pool fund pays 85 per cent of the total bill for an employed patient while it only pays 50 per cent for a resident patient. In addition, the maximum ceiling under the social medical insurance for employed (49,000 Yuan) is more than double that for residents (20,000 Yuan). After the payment ceiling under the social medical insurance scheme is reached, a further insurance scheme called the serious illness fund is available for employed individuals, while it is not currently available for residents.

Table 8.9 Comparison of insurance plan for employed and residents

Items	**Employees hospitalization**	**Residents hospitalization**	**Residents special disease clinic**
Criteria payment – before trigger the Fund*	First time 720; Second time 720×30%; Third time or more nil	First time 720; Second time 720×30%; Third time or more nil.	720 Yuan
Proportion paid by the pool fund**	Big hospital – 85%; Medium hospital – 88%; small hospital – 91%	Big hospital – 50%; Medium hospital – 60%; small hospital – 75%	Big hospital – 50%; Medium hospital – 60%; small hospital – 75%
Ceiling by the social pool fund	49,000 Yuan	16,000 Yuan	20,000 Yuan
Ceiling by the serious illness fund	150,000 Yuan	Not applicable	Not applicable

Notes: * Concession patients half the criteria payment; ** Proportion paid by the fund up 4 percentages for retirees.

Forecasting hospitalization expenses is carried out for adult residents aged 15 years or over and children separately. The medical expenses on hospitalization for adult residents are borrowed from the insured employees and retirees by matched records. The spending is adjusted by the actual differences between insured and uninsured individuals – using the information provided by a large public general hospital in Kunming.

All of the children under 15 years old are modelled for their use of hospital services. Their hospital admission rates follow the results of the National Health Services Surveys conducted in 1998 and 2003. Because no information on level of hospitals, where children are admitted to, is available, the level of hospitals that patients are admitted to refer to the distribution for employed individuals (Table 8.10). The estimated results over 2008-2010 are not much different, so the hospital distribution in 2008 is adopted for children less than 15 years of age when they are admitted to hospitals. That is, it is assumed that 55.46 per cent of hospital services occur in large hospitals, 31.02 per cent in medium size hospitals and 13.52 per cent in small hospitals. The average spending on one hospitalization treatment by sex across age group refers to the information provided by a public general hospital in Kunming.

Table 8.10 Estimated hospital admission distribution by hospital level

Year	**Small hospital**	**Medium hospital**	**Large hospital**
2008	0.135189	0.310235	0.554576
2009	0.135214	0.310956	0.553830
2010	0.135227	0.311317	0.553455

The National Health Services Surveys conducted in both 1998 and 2003 showed that the hospital admission rate for insured individuals was double that for uninsured individuals. The relative rate for individuals may increase due to having medical insurance coverage, but this rate may not rise to equal the level of the insured employed individuals because of the lower guarantee for urban residents (as discussed above). Hence, in modelling hospitalization services and medical expenses for urban residents under the medical insurance scheme, two scenarios are considered in the model.

- First scenario – Insured adult residents have their hospital admission rate equal to 70 per cent of that for the insured employed individuals.
- Second scenario – Insured adult residents have their hospital admission rate equal to 85 per cent of that for the insured employed individuals.

Apart from the above two policy scenarios, another policy setting is considered in the model, based on the principle of financial assistance to the concessional families. That is:

- Third scenario – Based on the assumption of the second scenario, the social pool fund assists financially the concessional families on their hospitalization services for up to 2,000 Yuan annually.

It should be noticed that, three policy scenarios are considered here for non-working residents, while two scenarios in Chapter 7 were discussed for modelling medical insurance scheme of employees. The two models are different. Under the medical insurance scheme, no personal savings accounts have been established for insured residents, so only the social pool fund has been set up. So the payments for incurred hospitalization expenses, as well as serious illness clinic services, involve the following three categories.

- Payment by the individual concerned. This part of the payment includes the criteria payment needed to trigger the social pool fund, and fees shared by individuals within the social medical insurance scheme.
- Payment by the social pool fund. This part of the payment is shared by the social pool fund under the maximum coverage of the medical insurance scheme.
- Payment over the maximum ceiling of the social pool fund. This payment is for the incurred hospitalization fees exceeding the maximum ceiling – and it is charged directly from the patients concerned.

8.5 Results under Three Policy Scenarios

- Results for scenario one

Table 8.11 presents the estimated total hospitalization costs over the period of 2008-2010 and the distribution of different payments. The estimated insured population of residents for each year (refer to Table 6.24 in Chapter 6) is also shown in the Table. Under the first scenario, for incurred hospitalization costs, around 36-41 per cent is estimated to be covered by the social pool fund; the remaining 59-64 per cent of the cost is paid by the patients themselves. The estimated results for 2008 are very close to the real figure revealed by the Kunming Medical Insurance Centre, which said in May 2008 that the medical bill payment by the social pool fund was around 42 per cent. For the balance of the social pool fund, it is estimated to have a large positive balance, which is around 30-38 per cent over 2008-2010 (Table 8.12).

Table 8.11 Forecast total costs and distribution of different payments (Scenario One)

Year	Insured population	Total cost	Self payment	Fund payment	Over payment
Cost (Million)					
2008	208300	45.09	21.52	18.22	5.35
2009	900410	242.85	103.60	89.42	49.83
2010	1107008	300.11	122.85	108.51	68.74
Percentage					
2008	208300	100.00	47.72	40.41	11.87
2009	900410	100.00	42.66	36.82	20.52
2010	1107008	100.00	40.94	36.16	22.91

Table 8.12 Forecast balances of social pool fund and individual spend (Scenario One)

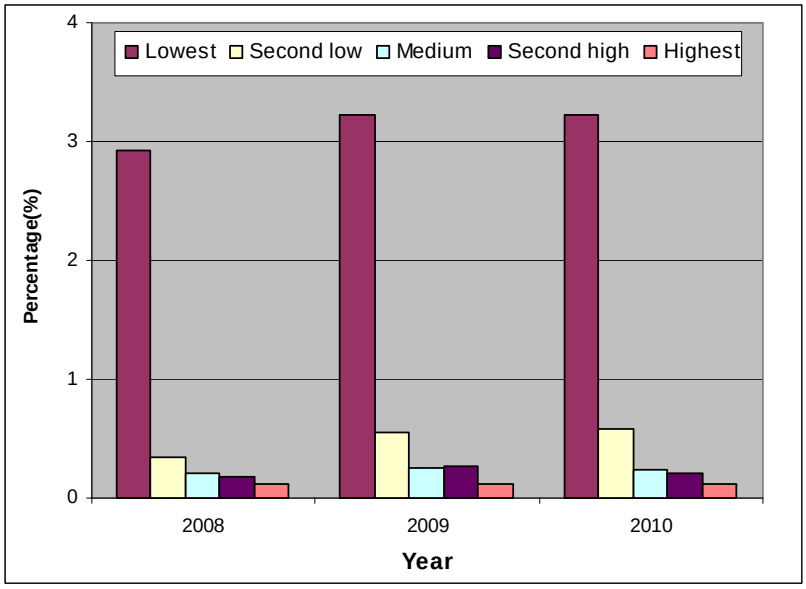
Year	Social pool fund (million)				Individual payment		
	Levy	Payment	Balance	Percentage*	Number of population	Payment (million)	Average (Yuan)
2008	29.37	18.22	11.15	37.96	208300	26.87	129
2009	128.24	89.42	38.82	30.27	900410	153.43	170
2010	157.70	108.51	49.19	31.19	1107008	191.59	173

Note: * Percentage of balance of the social pool fund; this percentage = Balance/Levy×100%.

The average individual payment contribution for hospitalization treatment (including serious illness clinic services) is around 129 – 173 Yuan each year. Generally speaking, this amount of money is not a heavy burden for a family. However, when considered against family annual income, the distributions are quite unbalanced.

Figure 8.4 gives the proportion of annual family income spent on hospitalization treatment by quintile. For the 20 per cent of lowest income families, the proportion of family expenditure on hospitalization is between 2.9-3.3 per cent, while the other quintile groups are estimated to be less than 1 per cent. It is a big financial problem for a low income family when someone in the family needs to be admitted to a hospital. The governments need to pay more attention to this group of the population when making policy decisions on the medical insurance system.

Figure 8.4 Estimated proportion of annual family income on hospitalization treatment (Scenario One)



The proportion of family spending on hospitalization for the lowest income quintile is significantly larger than that of the other four quintile groups, due to two main reasons. First, all the concession families who are receiving the basic living allowances from governments are in the poorest family group. Their annual family income (for example in 2008, 2520 Yuan) is much lower than the average annual family income (6592 Yuan) in this quintile. Second, the ratio of the elderly people aged 65 years or over (who need more hospitalization treatments than the average person) is close to 60 per cent of the concession adult residents.

In summary, Scenario one modelled a hospitalization admission rate of 70 per cent of that for insured employees and retirees. The results show that the social pool fund will have around 30 per cent of positive balances. The lowest quintile of family income group needs more government attention and more government financial assistance.

- Results for scenario two

Under Scenario two, the model raised the hospitalization admission rate to 85 per cent of that for the insured employees and retirees. Compared with Scenario one, both the annual total cost of hospitalization and different ways of payments are all increased (Table 8.13). Regarding the payment proportion, the percentage of payment shared by the social pool fund remains almost the same as in Scenario one, which is around 36-40 per cent of the total spending over the period of 2008-2010.

Table 8.13 Forecast total costs and distribution of different payments (Scenario Two)

Year	Insured population	Total cost	Self payment	Fund payment	Over payment
Million					
2008	208300	58.67	26.53	23.04	9.10
2009	900410	293.92	124.27	107.02	62.63
2010	1107008	355.24	146.14	128.74	80.35
Percentage					
2008	208300	100.00	45.23	39.26	15.51
2009	900410	100.00	42.28	36.41	21.31
2010	1107008	100.00	41.14	36.24	22.62

Under the policy of Scenario two, the amount of payment by the social pool fund on hospitalization is estimated to increase significantly, leaving the social pool fund with a reasonable positive balance of around 16-22 per cent (Table 8.14). In the mean time, the average individual shared payment on hospitalization treatment is also expected to increase, to around 170 – 210 Yuan each year.

Table 8.14 Forecast balances of social pool fund and individual spend (Scenario Two)

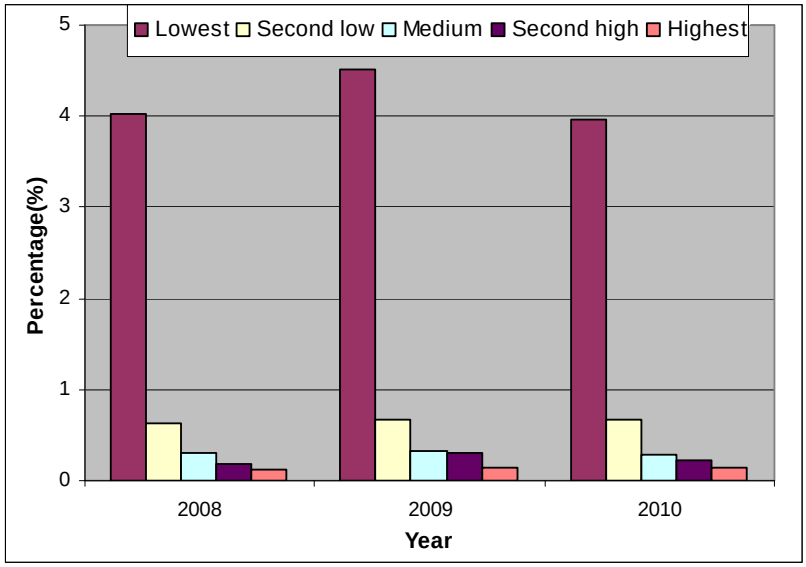
Year	Social pool fund (million)				Individual payment		
	Levy	Payment	Balance	Percentage*	Number of population	Payment (million)	Average (Yuan)
2008	29.37	23.04	6.33	21.57	208300	35.63	171
2009	128.24	107.02	21.22	16.55	900410	186.90	208
2010	157.70	128.74	28.96	18.37	1107008	226.50	205

Note: * Percentage of balance of the social pool fund; this percentage = Balance/Levy×100%.

Similarly to Scenario One, when considering the proportion of family annual income spent on hospitalization, the distribution is quite unbalanced among the different kinds of income families (Figure 8.5). For the lowest income families, the burden on these families is even higher than that for Scenario one, with the proportion of family income being 3.9-4.6 per cent

spent on hospitalization treatment. For the other four income groups, their annual spending on hospitalization is less than 1 per cent of their annual family income. The results for Scenario two also support the idea that the lowest quintile of families need extra government assistance in meeting the cost of hospital care.

Figure 8.5 Estimated proportion of annual family income on hospitalization treatment (Scenario Two)



In summary, Scenario two in the model controlled the hospitalization admission rate for urban residents at 85 per cent of that for insured employees and retirees. It is estimated that the social pool fund will have a reasonable balance for each year of 2008-2010, which is around 18 per cent of the total levy. The gap in the proportion of family income expenditure on hospitalization between the lowest 20 per cent income families and the other income families is quite large. Similarly to Scenario one, it is concluded that the lowest income families need more government attention and more government financial assistance.

- Results for scenario three

Under Scenario three, the model considered the implication from the results of the first two scenarios, by providing moderate financial assistance to those families who need subsidies when they are admitted to hospitals. In detail, based on the assumption of the second scenario, the insured inpatients in concessional families can get up to 2,000 Yuan subsidies annually from the social pool fund. So, under Scenario three, the results are compared with those under Scenario two. Table 8.15 summarizes the total hospitalization costs and distribution of different kinds of payments. Compared with the Scenario two, the payment by the social pool

fund is estimated to increase significantly over the period of 2008-2010, from around 36-40 per cent to around 42-45 per cent of the total spending. The proportion of payment by the social pool fund increased, on average, by 5.75 percentage points compared with that in Scenario two.

Table 8.15 Forecast total hospitalization costs and different payments (Scenario Three)

Year	Insured population	Total cost	Self payment	Fund payment	Over payment
Million					
2008	208300	58.67	23.47	26.10	9.10
2009	900410	293.92	106.59	124.70	62.63
2010	1107008	355.24	124.89	149.99	80.35
Percentage					
2008	208300	100.00	40.01	44.49	15.51
2009	900410	100.00	36.27	42.43	21.31
2010	1107008	100.00	35.16	42.22	22.62

Under this “extra assistance to poor” scenario, the amount of payment by the social pool fund on hospitalization is estimated to increase significantly. However, the percentage of the balance of the social pool fund is expected to decrease dramatically (Table 8.16), from a reasonable level of around 16-22 per cent (Table 8.14) to a lower level of 2-12 per cent of the total insurance levy.

Table 8.16 Forecast balances of social pool fund and individual spend (Scenario Three)

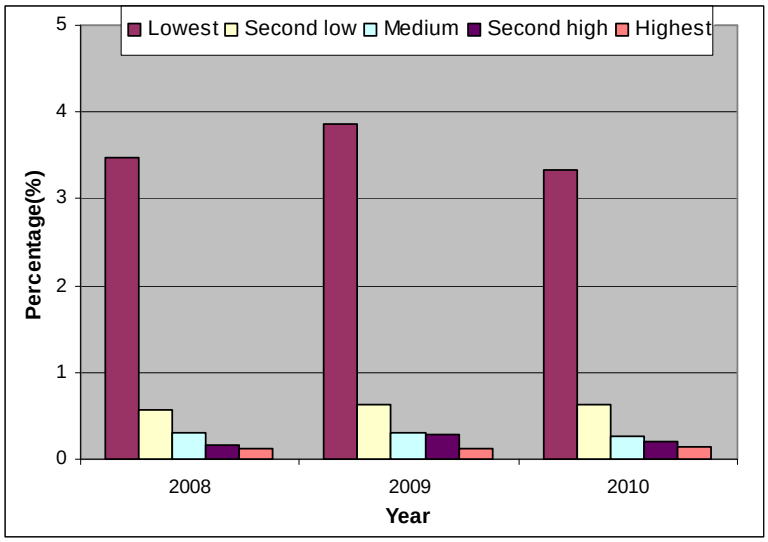
Year	Social pool fund (million)				Individual payment		
	Levy	Payment	Balance	Percentage*	Number of population	Payment (million)	Average (Yuan)
2008	29.37	26.10	3.27	11.14	208300	32.57	156
2009	128.24	124.70	3.54	2.76	900410	169.22	188
2010	157.70	149.99	7.71	4.89	1107008	205.24	185

Note: * Percentage of balance of the social pool fund; this percentage = Balance/Levy×100%.

However, the average individual shared payment on hospitalization treatment, compared with Scenario two, is expected to decrease from around 170 – 210 Yuan to around 156 – 188 Yuan each year. Furthermore, when considering the proportion of family annual income spent on hospitalization, the gap among the different kinds of income families is reduced (Figure 8.6) compared with that under Scenario two. For the lowest 20 per cent income families, the burden on these families is eased from the average of 4.17 per cent spent on hospitalization treatment to 3.56 per cent, decreasing 14.63 per cent on average. Because the Scenario three

mainly focuses on concessional (most of them are low income) families, the other four income groups are not basically impacted by the policy change, their annual spending on hospitalization remaining at less than 1 per cent of their annual family income.

Figure 8.6 Estimated proportion of annual family income on hospitalization treatment (Scenario Three)



In summary, Scenario three in the model focused on assisting inpatients in the concessional families financially. The burden on the lowest 20 per cent income families, as a whole, is estimated to be eased. Although the balance of the social pool fund is estimated to have a significant decrease, both the average individual payment and the proportion of payment of the lowest quintile income families on hospitalization services are expected to decrease significantly.

8.6 Summary

This chapter presented results of modelling the medical services and expenses for urban residents without employment in Kunming in relation to hospital services, as well as serious illness clinic services, based on the construction of a static microsimulation model as described in Chapter 6.

Apart from presenting the population distributions of the different kinds of groups, estimating medical expenses for urban residents, the model carried out three policy scenarios under the

medical insurance scheme. One is to suppose that residents have their hospital admission rate at 70 per cent of the corresponding rate of the insured employees and retirees. The second scenario is to raise this hospital admission rate to 85 per cent of that of the insured employees and retirees. Both of the scenarios indicate that the lowest 20 per cent income families need more government subsidies of their hospitalization costs. Both scenarios show the social pool fund implements well and has some balances at the end of each forecasting year over 2008-2010. The experience of the insured employees and retirees under the medical insurance scheme which started in April 2001 indicates that individuals tend to keep their medical behaviour as before the beginning of the medical insurance scheme then, after a year or two, they get accustomed to the medical insurance system. So it is reasonable to suppose that urban residents' demands for hospital services will gradually increase to a certain percentage of that for the insured employees and retirees, perhaps from 70 per cent to 85 per cent. Because of a much lower guarantee capacity for insured residents than that for insured employed individuals, it is not expected that the hospitalization service demands of residents out of the work force will be as fully met as the insured employees. The third policy scenario is based on the assumption of the second scenario, but provides greater assistance to low income families. It is designed so that the inpatients in concessional families can have up to 2,000 Yuan subsidies from the social pool fund annually.

In summary, four achievements have been made in this chapter, which may help government officials to make their policy decisions.

First, the model obtained the distribution of different types of population in the urban area in Kunming, involving insured or uninsured employees, and residents out of the labour force. For each kind of resident, the number of individuals in general or concession status was estimated. This helps to provide the possible population to be insured in the medical insurance scheme.

Second, different kinds of contributions for the medical insurance premium were projected. This includes the amount of subsidies by the Central government, the Provincial government, the Municipal government and universities, as well as the insured individuals' own contributions.

Third, the incomes of the units of individuals and families were estimated. This provides a picture of the average income by individual or family, as well as the gap between the richest and the poorest.

Finally, the model projected the usage of general hospital services, as well as serious illness clinic services, for potential insured residents. For three different scenarios, the model predicted the hospitalization services costs and payments, as well as the balance of the social pool fund and the medical burden on families.

CHAPTER 9 CONCLUSION

9.1 Aim of the Research

The ongoing health care system reform in China is a hot topic among governments and the ordinary population. After nearly two decades of trials and practices, the Chinese Government has set a goal to provide basic medical services for both urban and rural residents by 2010. Regarding the urban area, following the nationwide medical insurance scheme established for employed individuals in 1998, the Central Chinese government chose 79 pilot cities to launch a pilot program for urban residents not in the labour force. This system is expected to cover all urban residents in China by 2010.

However, the implementation of China's health insurance reform faces many problems and challenges. Especially in recent years, debates and controversies on the reform of the medical insurance system have become more common. In July 2005, the Development Research Centre of State Council and the World Health Organization concluded that the reform of China's medical system and health system lagged behind the reform of its economic system and the reform was "basically unsuccessful." In May 2006, the research group of "the report of China's medical and health reform" believed that the ten-year medical insurance reform had led to many problems, especially lack of fairness in access to medical services and poor efficiency in funding of health care. China is trying to tackle these policy challenges that have occurred in the medical insurance reform. The Chinese Government needs urgently to prove whether the medical insurance scheme is sustainable in the coming years. This thesis attempts to analyse and evaluate the sustainability and the distributional impact of the medical insurance policy settings.

Selecting one of the southwest capital cities in China, Kunming, Yunnan Province and using static microsimulation modelling techniques, the research of this thesis focused on the urban medical insurance system reform, involving both urban employed individuals and residents who are not in the labour force. A goal of the research was to greatly improve the decision support tools available to Chinese medical insurance policy makers.

As described earlier, this thesis project drew on the previous research on an urban medical insurance scheme of employees and retirees for the city of Zhenjiang, where the author was a lead researcher on the project. The earlier work provided useful background and experience in modelling health policy settings. The current thesis research expanded the previous work to a wider research area and modelled the whole urban population (involving both employed individuals and non-working residents). Compared with the earlier research, the current research has at least four significant advantages and improvements, which were summarised on Page 79.

Specifically, the research had two aims. The first was to assess the distributional impacts of medical insurance policies and to predict medical expenses for urban employees and employers, and to see if the current social medical insurance policy for urban employed individuals could be sustained during the relatively short period of 2006-2010. The model construction was presented in Chapter 5, with the simulation results in Chapter 7, and the summary in Section 9.2. The second aim was to explore the medical cost of expanding the social medical insurance to all urban residents not in the labour force and to predict the medical insurance policy effects on urban individuals and families. These topics were discussed in Chapter 6 (model construction) and Chapter 8 (simulation results) and are summarised in Section 9.3.

9.2 Modelling Medical Insurance Scheme for Employed Individuals

The city of Kunming started its medical insurance reform for urban employees and retirees in April 2001. The static microsimulation model created in this thesis took each insured individual as a basic simulation unit, and set a year as the basic simulation time unit. The data used in this research came from the original administrative individual level data of urban employees and retirees provided by the Bureau of Labour and Social Security of Kunming. With 2006 as the commencement year, the model forecast the medical service expenses and medical insurance policy settings for five years, until 2010.

The model consisted of five modules, the first one dealing with the insured population estimation and individual's annual income, and the other four focused on the various medical

care services. In total, the modelling framework was divided into three parts. The first part simulated the collection and allocation of the medical insurance premiums. The premiums, which are based on the individual's income, are contributed by employers, employees and governments following the medical insurance policy rules. The second part predicted individual's medical services behaviour in occurring medical expenses. These expenses were basically classified into two categories, clinic services and hospitalization services. The third part of the model was for adjustment and preparation for the next year's simulation, and the aggregation of results after completing the simulation.

Predicting medical services behaviour of individuals is the most vital and important part of the model. According to the payment settings under the medical insurance scheme, medical services were divided into four parts when predicting individual's medical behaviour. They were clinic services and pharmacy medication, chronic disease clinic services, clinic special check-up and hospitalisation services.

Finally, based on the forecasting results of the medical expenses and medical insurance payments of 2006-2010, the balances of the personal saving accounts for each individual were obtained. This helped to estimate the distributional impacts of the medical insurance system on participants and to explore the benefit or burden under the medical insurance scheme. By analysing the balances of the social pool fund, the serious illness fund and the Government official fund at the end of each forecast year, the assistance capacity and sustainable development of these pool funds could also be examined.

It is estimated that the average medical cost per person in Kunming for employed individuals increases 4.6 per cent annually over 2006-2010. When considering the medical cost distributions for employees and retirees separately, completely different pictures emerge. For employees, more than half of their medical services costs (54.1 per cent) come from clinic services and medications. The second largest medical cost is estimated to occur in hospitalization services, which is around 42.8 per cent of the total cost. While for retirees, more than three quarters (77.3 per cent) of their medical costs come from hospitalization treatments. Only around 10 per cent of retirees' medical costs come from the general clinic services and medications. The medical cost for chronic diseases accounts for around 11 per cent of the total medical expenses, which is quadruple that of employees.

As for the payments, the social pool fund and the serious illness fund together cover annually around 48-51 per cent of the total incurred medical costs over the period of 2006-2010. It is estimated that the payment proportions shared by personal savings accounts would increase significantly from 28.41 per cent in 2006 to 33.37 per cent in 2010. From the viewpoint of an individual's annual income, for both employees and retirees, the lower the income, the more possibility there is of negative balances in the personal savings accounts. For employees, the percentage of deficit in the lowest quintile income group is estimated to be nearly 4 times that in the highest quintile income group. The corresponding percentage gap for retirees, which is from 21.31 per cent in the lowest quintile to 13.84 per cent in the top quintile, is smaller than that for employees. The proportion of retirees with their accounts going into deficit is 3 percentage points higher than employees. In addition, the average deficit amount for retirees is 74.14 per cent higher than that for employees.

The forecasting results showed that, if the maximum payments of the social pool fund and the serious illness fund were unchanged, the social pool fund would have an increasing percentage of balance, but not the serious illness fund. Because of the continuing increase of total medical expenses annually, unchanged maximum payments means that the extra burden of medical expenditure will shift from the social pool fund to the serious illness fund. Under the current payment policy, the serious illness fund was estimated to have a financial risk from the year of 2009, and the situation could be even worse by 2010. That is to say, the key finding is that the social pool fund looks like it is sustainable over the period of 2006-2010, but the serious illness fund does not appear financially sustainable over this period. Given this, and to illustrate the policy simulation capacity of the model, another policy scenario was run – adjusting the maximum payment by the social pool fund to see what might happen after such a change. The results of the scenario indicated that both the social pool fund and serious illness fund would maintain reasonably high percentages of balances on average. At the same time, such a change does not have much impact on the balance of the government official fund.

Compared with the earlier work described in Section 4.6, the model of medical insurance for urban employees in this thesis has made great advances and contributions in both constructing the base file and simulating medical services processes. The model constructed in this thesis handled more complicated and larger datasets. More detailed medical services categories were considered in the model, coping with the special check-up and chronic disease services

separately. Most importantly, the model techniques are more advanced in aspects of: creating annual death rates by gender across age group; determining the government officials using the binary discriminant analysis; predicting the total number and construction of insurance participants by fitting exponential curves; and establishing rational parameters for individual income adjustments, and for different kinds of medical services items.

Based on this static microsimulation model, more work could be done to analyse the impact of the urban medical insurance system on urban employees and employers, such as the distribution of personal saving accounts and the medical services burden for different age groups of the population. Furthermore, after combining the other information about the medical services needs of urban residents, the results from this model provided valuable preparation for subsequently estimating the medical expenses of all urban residents.

9.3 Modelling Medical Insurance Scheme for Urban Residents

China launched a pilot project of medical insurance in September 2007 to cover urban residents who are outside the workforce. The pilot project has been carried out in 79 cities to cover non-working urban residents, involving children, students and elderly people. As one of the 79 pilot cities chosen by the Central Government, Kunming began its urban residents' medical insurance scheme in October 2007. The premiums are paid by households or families, instead of individuals, and the governments give subsidies of at least 70 per cent of insurance premiums annually to each participant.

A static microsimulation model was created to model medical services usage and to forecast medical expenses on hospitalization services for urban residents who are out of the labour force in Kunming. The model was used to assess the distributional impacts of medical insurance policies and to predict the medical expenses for urban residents. The insurance coverage and medical services costs on hospitalization over the period of 2008-2010 were projected. Two main datasets were used in constructing the model – the population sample dataset from the 2000 Census for all individuals; and a dataset of employees and retirees under the social medical insurance. The other information used in the model involved the assembly of results of the 1 per cent population survey of Kunming in 2005, and results from the National Health Services Surveys in 1998 and 2003 respectively.

Three consecutive steps were conducted to create the model for urban residents without jobs. The first step was to project the population structure for the period of 2005-2010, and update the Census sample population in 2000 to 2005-2010 according to the target population structure. In the second step, the updated Census dataset was statistically matched with the individual dataset of insured employees and retirees, which "donated" hospital service usage and medical expenses information. The last step was to set up the medical expenses on general hospital services as well as serious illness clinic services and forecast the different kinds of payments.

It is estimated (Section 8.2) that 1.18 million people in 2008 (about one third of the total urban population in Kunming) are residents who are out of the labour market, and who will be covered by the medical insurance scheme for urban residents. Among this segment, children and students less than 18 years of age are the biggest group, comprising about 56.6 per cent of the urban residents who are not in jobs. Adult residents account for another 30.5 per cent and the remaining 12.9 per cent are university students. About a quarter of adult residents are categorised into the 'concession' group, with children and university students making up 2.82 per cent and 1.47 per cent of the category, respectively. For concessional residents, elderly people aged 65 years or over account for the greatest proportion of the population, which is close to 60 per cent. This indicates that the elderly people in the concession part, or even adult residents, might be a large part of those using medical services. The elderly people need more care and financial support from the government.

Simultaneously, it was found that among the total urban population, apart from the 33 per cent of the insured individuals under the medical insurance scheme, around 36 per cent of the total population are employed or retired but are not covered by the social medical insurance scheme, which is supposed to be a universal plan for all urban employees and retirees. This indicates that a lot of work needs to be done by the local governments to encourage citizens to be covered by the social medical insurance system. For insured individuals, the ratio of employees to retirees is about 2:1, while the relative ratio for uninsured individuals is about 8:1. These figures indicate that retirees are more eager than employees to join the medical insurance scheme. From another point of view, if the governments can encourage more employees to join the social medical insurance scheme, then it would significantly decrease the risk of running the medical insurance pool fund.

There is, of course, considerable uncertainty involved with attempting to predict the medical service use of previously uninsured non-working urban residents. The model simulated three policy scenarios for the medical insurance scheme for urban residents. One was to suppose that residents have their hospital admission rate at 70 per cent of the corresponding rate of the insured employees and retirees. The second scenario was to raise this hospital admission rate to 85 per cent of that of the insured employees and retirees. Both of the scenarios indicate that the 20 per cent of lowest income families need more government subsidies on their hospitalization demands. To address this problem of high financial burdens for the bottom income quintile, the third scenario subsidizes up to 2,000 Yuan annually to inpatients of concessional families by the social pool fund. The simulation results showed that the social pool fund under the first two policy scenarios would be in good standing, having some balance at the end of each forecasting year over 2008-2010. Under the third scenario, the proportion of the balance in the social pool fund is expected to decrease significantly, but the financial burden on lowest quintile income families is eased. This suggests that the government can afford to provide the extra and much needed assistance to the poorest families without endangering the financial sustainability of the scheme.

The model provides the first estimates for China of whether the medical insurance scheme for urban residents is financially sustainable, of how the urban poor are likely to be affected by the scheme and how much they have to pay, and of whether the contribution rates look appropriate.

Building the first microsimulation model for urban residents out of the workforce was extremely challenging. Because of data deficiencies, the model had to do complicated statistical matching to borrow information from the administrative data. Generalised regression re-weighting techniques were adopted to update the urban population. The model projected the medical services by making assumptions about medical services usage patterns and combining different kinds of data sources. Without doubt, part of the contribution of this thesis has been to construct the complicated medical insurance microsimulation model for China with all the incredible complexities it involved.

In summary, this thesis provides four key outcomes for the medical insurance scheme for urban residents who are out of the work force, which may help government officials in making their challenging policy decisions about how to balance the long-term financial

sustainability of the new scheme while assisting Chinese families in meeting their medical costs.

First, the model obtained the distribution of different types of population in the urban area in Kunming, involving insured or uninsured employees, and residents out of the labour force. For each kind of resident, the number of individuals in general or concession status was estimated. This helps to provide the possible population to be insured in the medical insurance scheme.

Second, different kinds of contributions for the medical insurance premium were projected. This includes the amount of subsidies by the Central government, the Provincial government, the Municipal government and universities, as well as the insured individuals' contribution.

Third, the incomes of the units of individuals and families were estimated. This provides a picture of the average income by individual or family and, importantly, the gap between the richest and the poorest.

Finally, the model projected the usage of the general hospital services, as well serious illness clinic services, for potential insured residents. For three different scenarios, the model predicted the hospitalization services costs and payments, as well as the balance of the social pool fund and the medical burden on families.

9.4 Final Comments and Possible Future Research

Any government seeking to introduce a medical insurance scheme faces a host of difficult questions, including some of those outlined here. Should different types of medical expenses be covered or treated differently - for example, should pharmaceutical expenses be treated differently to critical illness expenses? How high should the co-payment by consumers be for access to medical services to be affordable and equitable? Should there be a maximum cap on out-of –pocket expenses and how often should the accounting period for calculating the cumulative value of out-of-pocket expenses be reset? What population sub-groups should be covered by the scheme and should varying sub-groups be treated differently (such as employees vs children). These are challenging questions for governments and the answers

chosen have a direct impact on whether the medical insurance scheme is financially sustainable for governments – while also still providing affordable and equitable access for the population of a country.

In such an environment of uncertainty, microsimulation modelling provides an immensely useful tool to help governments tackle such issues. Microsimulation models, by replicating the behaviour of individuals and the proposed rules of a medical insurance scheme and possible alternative policy settings, can play an important role in illuminating the trade-offs and choices that policy makers face. Such models can help illustrate to governments the likely consequences of policy decisions that they make, before such policies become locked into legislation and programs and go 'live' in the field. As illustrated earlier in the results reported in this chapter, microsimulation models provide a unique opportunity to examine the distributional consequences of existing or possible alternative medical insurance policies, as well as the aggregate fiscal impacts.

Microsimulation modelling has traditionally been applied to income and tax distribution and social security systems and only recently – over the last ten years – to the health field. As a result, there are still only a few health microsimulation models developed worldwide. This thesis contributed to this growing body of work, both in terms of the ongoing development of microsimulation methodologies and techniques as well as to its application in new country and policy settings. By creating microsimulation models, this thesis predicted and evaluated the medical care services of individuals under the medical insurance system for Chinese urban employees and residents.

The static microsimulation model for urban employees and retirees created in this thesis modelled the total medical care process for both inpatients and outpatients. In contrast, the microsimulation modelling for urban residents without jobs only considered hospitalization services and serious illnesses in clinic services, which is consistent with the current medical insurance scheme. In addition, due to lack of the requisite information, constructing the second model had to refer to the results from the first model. This thesis made a major contribution of providing some proof that, in general, both medical insurance schemes for urban employees and urban residents are sustainable. The results of this thesis do suggest that poor Chinese will continue to face challenges in meeting their medical costs. But, on the other hand, changes in the scheme are not going to send the government broke.

The research described in this thesis illustrates well some of the challenges facing health microsimulation modellers. Perhaps the foremost among these, as widely recognised by microsimulation modellers across the world, concern the issues associated with obtaining appropriate microdata upon which to construct the microsimulation models. The quality of the microdata available, and its comprehensiveness, have a fundamental impact upon the ability of the model to adequately replicate the real world situation. This thesis described some of the technically challenging steps required to build the base data for the model (such as the statistical matching outlined in Chapter 6). This thesis has also highlighted the importance of government providing access to administrative data, with the Bureau of Labour and Social Security in Kunming playing a significant role in facilitating access to the data required for this thesis. For other modellers, this underlines the crucial role that administrative data can play in health microsimulation modelling endeavours.

In this thesis, modelling medical services for urban residents only considered hospitalization treatments as well as clinic services for serious illnesses, not considered clinic services for minor illnesses. In addition, the modelling in this thesis did not extend to projecting the medical expenditure payments of uninsured employees and retirees – that is, those who are potentially eligible to take up the insurance for employees but who have chosen not to. These are put forward as further research topics.

First, for the medical insured urban residents out of the labour force, with their medical expenses data becoming available in the coming years, more work can be done on predicting more precisely the medical expenses associated with utilising hospital services as well as clinic services for serious illnesses. Furthermore, general clinic services for minor illnesses need to be evaluated and predicted when relevant medical records are available. This may help the governments to estimate the costs if both inpatient and outpatient services are covered for urban residents by the medical insurance scheme.

Second, the guarantee of the current medical insurance scheme for urban residents is inferior to that for employed individuals. Employed individuals not only enjoy both inpatient and outpatient medical insurance coverage, but also have higher sharing rates and higher maximum payments by the social pool fund than do urban residents. It is expected that these two medical insurance systems in urban areas might be combined in the future. This suggests

new research to evaluate the medical costs and predict various kinds of payments under such a unified scheme.

As mentioned in Section 3.5, the Chinese government set up a cooperative medical care system for rural residents. Under this system a pool fund has been created in which the governments subsidise around 80 per cent of the premiums. Like the medical insurance scheme for urban residents who are out of the labour force, the fund mainly covers expenses for hospitalisation services as well as serious illness services. So compared with the medical insurance scheme for urban employees, the cooperative medical care system for rural residents is more akin to the scheme for urban residents. It is quite possible to use microsimulation techniques to see what the government needs to do if combining the policies for both urban and rural residents.

What is presented above are just a couple of options for future research. The models constructed in this thesis provide lots of new opportunities; either the Chinese government or other researchers could carry on or use the infrastructure. Under the extended infrastructure established during this thesis research, the government or researchers may look at the distributional impacts of the policy scenarios by testing what happens under different policy settings. But the major opportunity to use this modelling infrastructure now is to help inform ongoing reform of China's medical insurance scheme by running policy scenario settings. The model constructed for this thesis is a new and significant step for China, providing some critical first steps in China's journey to establish a sophisticated microsimulation modelling infrastructure to help underpin the major policy decisions that it faces as it introduces substantial policy reforms for its people.

APPENDIX A STATIC MODEL FOR EMPLOYED POPULATION

A.1 SAS codes guideline for preparing simulation parameters

Code Name	Description	Input	Output
Data process from dbf file.sas	Process the original data of dBASE format file by dropping the non-useful parameters. The codes Can be acted as reference Codes.		
Macro analysis code.sas	Analysis SAS macro codes		
Data process for year 2005.sas	Rearrange premium contribution datasets, and set medical expenses datasets for 2005.	Kc03_2005_1_6_1, Kc03_2005_7_9_1, Kc03_2005_10_12_1. Fyjs200501_12	Prem2005, Cymx200501_03, Cymx200501_03, Cymx200501_03, Cymx200501_03
Data process rename and label.sas	Process the raw Kunming datasets by assigning new names for variables and also assigning variable labels for the 5 main datasets.		
Basic analysis 24 Nov 2006.sas	Original data analysis. Revised and made manual pick up death records.	Person2001_2005, Alter2001_2005, Prem2002. etc. Fymx2002, fymx2003, cymx2002_04. etc.	Alter2001_2005, Person2001_2005
Basic analysis 02 Feb 2007.sas	Data analysis from the processed basic datasets. Involving five kinds of datasets.	Person2005, Alter2001_2005, Prem2003, prem2004, prem2005, Cymx2002, cymx2003, cymx2004, Mzmx2002, mzmx2003, mzmx2004	
Medical Expenses analysis for 2002-2005.sas	Create five different kind of medical service data files. Calculate medical expenses for each insured participant in 2002-2005.	Cymx2005, Mzmx2004, Cymx2004, Mzmx2003, Cymx2003, Mzmx2002, Cymx2002, Account2005, person2005, Balance_upto2005,	clin05, pharm05, hosp05, chron05, spexam05, expens2005, clin04, pharm04, hosp04, chron04, spexam04, expens2004. etc. balance, Totexpense
pick up officials.sas	Identify the government officials using discriminate analysis	Cymx2005, cymx2004, cymx2003, cymx2002, person2005, account2005	person2005
Get distribution of Age Group.sas	Prepare for creating the age group distribution for 2006-2010. Adjust number of population for different age groups.	person2001, person2002, person2003, person2004, person2005	

A.1 SAS codes guideline for preparing simulation parameters (continued)

Code Name	Description	Input	Output
Create the Death records.sas	Create the death records dataset for 2001-2005. Merge the death records with the basic information dataset.	Alter2001_2005, Person2001_2005	Death2001_2005
Personal information 03 Feb 2007.sas	Pick up the first to the tenth time alteration. Classify the alteration type into 4 categories step by step in reverse.	Alter2001_2005, person2005	person2005
Create expense dataset for 2005.sas	Create expense dataset for the year 2005.	person2005, clin05, pharm05, Chron05, Spexam05, Hosp05	Expense2005
Premium analysis 18 Mar 2007.sas	Premium analysis, get monthly average income for each person for 2001-2005.	prem2005, prem2004, prem2003, prem2002, prem2001	Income2005, Income2004, Income2003, Income2002, Income2001, Account2005
Create wage increase rate.sas	Create the monthly income adjustment parameters	Account2005	wagerate
Parameters of clinical treatments.sas	Create medical expenses increase rates for clinic services and medications in pharmacies.	clin02, clin03, clin04, clin05, pharm02, pharm03, pharm04, pharm05, person2005	ClinRate
Parameters of chronic disease.sas	Create increase rates parameters and self cost rate for chronic expenses.	Chron02, Chron03, Chron04, Chron05 Person2005, Account2005	ChronicRate, ChronRate, ChronicSelf
Parameters of special examination.sas	Create parameter distribution for clinic special check-ups	Spexam02, Spexam03, Spexam04, Spexam05, Person2005, Account2005	Specrate
Parameters of hospitalization.sas	Create Distributions of hospitalization treatments for the first, the second, the third or more admitted to a hospital respectively.	Hosp02, Hosp03, Hosp04, Hosp05, hospcodes, Account2005	Hosprate, Levelrate, hospcost01, TotalSelf01, PartSelf01, SecondRate, LevelRate02, hospcost02, TotalSelf02, PartSelf02 ThirdRate, LevelRate03, HospCost03, TotalSelf03, PartSelf03

A.2 Four main input datasets used in simulating medical services for urban employees

NAME	FORMAT	EXPLANATION	Values
Person2005.sas7bdat		Located at: \Basic Information	
Percod	$	Personal Code	
Unicod	$	Code of employers	
Sex	$	Sex of participant	1=Male, 2=female
Nality	$	Nationality	1=Han, 2=Menggu, and so on. Total of 56 Minorities.
Birth	MMDDYY	Date of birth	
Jobdate	MMDDYY	Date of job commencement	
Employ	$	State of employment	1=employee, 2=retired, 4=terminate
ResCateg	$	Residential category	1=urban area, 2=rural area
Education	$	Degree of education	11, 12= postgraduate; 21, 31=university; 40, 50, 61, 62=senior high school; 70=junior high school; 80=elementary; 90=illiteracy.
PerState	$	Government employee, worker or farmer labourer	1=cadre, 2=worker, 3=farmer labourer
Entrydate	MMDDYY	Date of entry scheme	
Blood	$	Blood Type	1=A, 2=B, 3=AB, 4=O, 5=not stated
MarryS	$	Marital state	1=not married, 2=married, 3=not stated
Age	COMMA	Age of participant	
Death		Index of death or not	1=death
AgeGrp		Age group of participant	1, 2, 3=employee; 4, 5=retiree
Wage05		Average monthly income in 2005	
Govern		Index of government officials	1=official
Account2005.sas7bdat		Located at: \Basic Information	
Percod	$	Personal Code	
Sex	$	Sex of participant	
Entrydate	MMDDYY	Date of entry scheme	
Age	COMMA	Age of participant	
AgeGrp		Age group of participant	
Govern		Index of government official	1=official
Count05		Number of months joined the scheme in 2005	
Wage05		Average monthly income in 2005	
Count04		Number of months joined the scheme in 2004	
Wage04		Average monthly income in 2004	
Count03		Number of months joined the scheme in 2003	
Wage03		Average monthly income in 2003	
Count02		Number of months joined the scheme in 2002	
Wage02		Average monthly income in 2002	
Count01		Number of months joined the scheme in 2001	
Wage01		Average monthly income in 2001	
Account		Accumulative amount in Personal Account	
Rate		Allocation rate to Subsidized Personal Savings Account for Officials	Rate 0.02 for 20% of officials, 0.04 for the rest of officials.
Subgov		Accumulative amount in Subsidized Personal Savings Account for officials	

A.2 Four main input datasets used in simulating medical services for urban employees (continued)

NAME	FORMAT	EXPLANATION	Values
Balance2005.sas7bdat		Located at: \Basic Information	
Percod	$	Personal Code	
Sex	$	Sex of participant	
Entrydate	MMDDYY	Date of entry scheme	
Age	COMMA	Age of participant	
AgeGrp		Age group of participant	1, 2, 3=employee; 4, 5=retiree
Govern		Index of government official	1=officials
Account		Accumulative amount in Personal Account	
Subgov		Accumulative amount of Subsidized Personal Savings Account for officials	
Alltot		Total medical expenses in 2001-2005	
Allself		Totally self payments for medical expenses	
Allwithin		Self payments within the Scheme	
Allfund		Payments by Social Pool Fund	
Allserious		Payments by Serious Illness Fund	
Allgovern		Subsidized Payments by Government Official Fund for officials	
Saving		Personal Savings Account plus Official Personal Account	If not officials, the Official Personal Account equal to zero.
Balance		Savings minus Expenses shared by selves	
Expense2005.sas7bdat		Located at: \Interim Result	
Percod	$	Personal Code	
Sex	$	Sex of participant	
Age	COMMA	Age of participant	
AgeGrp		Age group of participant	1, 2, 3=employee; 4, 5=retiree
Govern		Index of government official	
ClinicExp		Expenses in clinic services and pharmacies	Occurred in 2005
ChronTotal		Total Expenses in Chronic diseases	Occurred in 2005
ChronTotSelf		Total self payment for Chronic diseases	
ChronPartSelf		Part self pay for Chronic diseases	
SpecTotal		Total Expenses of Clinic special check-up	Occurred in 2005
SpecTotSelf		Total self payment for special check-up	
SpecPartSelf		Part self pay for special check-up	
HospTot01		Total expenses in the first Hospitalization	Occurred in 2005
TotSelf01		Totally self pay for the first Hospitalization	
PartSelf01		Part self pay for the first Hospitalization	
F_Hosp		Index of the first admission to hospital	
HospTot02		Total expenses in the second Hospitalization	
TotSelf02		Totally self pay for second Hospitalization	
PartSelf02		Part self pay for second Hospitalization	
S_Hosp		Index of the second admission to hospital	
HospTot03		Total expense in third/more Hospitalization	
TotSelf03		Totally self pay for third/more Hospital	
PartSelf03		Part self pay for third/more Hospital	
T_Hosp		Index of third/more admission to hospital	

Notes: the Table presents the input datasets in the beginning of the simulation, that is, 2005. For each forecasting year over 2006-2010, the output datasets are the same sorts of structure as in 2005. The output datasets in current year are treated as the input datasets for next year's simulation.

A.3 Simulation parameter datasets used in the model of urban employees

Dataset	Description of Function
1. Insured population and income adjustment	
Targetpopu	Target insured population for each forecasting year 2006-2010
Govpopu	Target population of the government officials over period of 2006-2010
Deathrate	Death rates by Sex and Age group
Wagerate	Income increase rates by Sex, Age group and Level of monthly income
2. Clinic services and medication in pharmacies	
ZeroClinic	Rates of individuals who have no clinic services in a forecasting year
Clinrate	Costs distribution of clinic services by Sex, Age group and Index in last year
3. Chronic disease treatments	
Chronicrate	Chronic services rates for 2006-2010 by Sex and Age group
Chronrate	Medical costs distribution of chronic diseases by Sex and Age group
Chronicself	Rate distribution of total self payments for chronic diseases
4. Clinic special check-ups	
Specnum	Target population of special check-ups in 2006-2010 by Sex and Age group
Specrate	Cost distribution of special check-up for 2006, those for following years are estimated in the process of the model.
5. First time admitted to a hospital in a year	
Hosprate	First hospitalization rates in a financial year by Sex, Age group and Index
Levelrate	Distribution to different level of hospitals when admitted to a hospital
Hospcost01	Medical cost distribution in the first hospitalization treatment
Totalself01	Rate distribution of total self payments in the first hospitalization
Partself01	Rate distribution of part self payments in the first hospitalization
Selfrate*	Rates of patient self co-payments shared with the Social pool fund
6. Second time admitted to a hospital in a year	
Secondrate	Second hospitalization rates in a financial year by Sex, Age group and Index
Levelrate02	Distribution to different level of hospitals when second admitted to a hospital
Hospcost02	Medical cost distribution in the second hospitalization treatment
Totalself02	Rate distribution of total self payments in the second hospitalization
Partself02	Rate distribution of part self payments in the second hospitalization
7. Third time or more admitted to a hospital in a year	
Thirdrate	Third hospitalization rates in a financial year by Sex, Age group and Index
Levelrate03	Distribution to different level of hospitals when third admitted to a hospital
Hospcost03	Medical cost distribution in the third hospitalization treatment
Totalself03	Rate distribution of total self payments in the third hospitalization
Partself03	Rate distribution of part self payments in the third hospitalization

Note: *Applicable for all hospitalization services

A.4 SAS codes guideline for forecasting medical services of urban employees

Code Name	Description	Input	Output
Control program projections 06-10.sas	Control program for the medical insurance simulation - current policy		
Simulation 2006.sas	Medical behaviour simulation for 2006, forecast insured participants, income adjustment and funds setting. Call seven Macro codes.	Person2005 Account2005 Expense2005 Balance2005	Person2006 Account2006 Expense2006 Balance2006
Simulation 2007.sas	Medical behaviour simulation for 2007. Similar as in 2006.	Person2006 Account2006 Expense2006 Balance2006	Person2007 Account2007 Expense2007 Balance2007
Simulation 2008.sas	Medical behaviour simulation for 2008. Similar as the previous forecasting year.	Person2007 Account2007 Expense2007 Balance2007	Person2008 Account2008 Expense2008 Balance2008
Simulation 2009.sas	Medical behaviour simulation for 2009. Similar as the previous forecasting year.	Person2008 Account2008 Expense2008 Balance2008	Person2009 Account2009 Expense2009 Balance2009
Simulation 2010.sas	Medical behaviour simulation for 2010. Similar as the previous forecasting year.	Person2009 Account2009 Expense2009 Balance2009	Person2010 Account2010 Expense2010 Balance2010
Payment aggregation and set ceilings 06_10.sas	Calculate and aggregate the different types of payments, set ceilings of the funds.	expense2006 person2006 account2006 balance2005 selfrate, etc.	balance2006 largepay2006 balance2007 largepay2007 etc.
Payment summary for medical costs 06-10.sas	Aggregate the different types of payments for 2006-2010, mainly the funds payment summary.	balance2006 balance2007 balance2008, etc.	Excel file: Payment Summary.xls
Payment summary for Employee 06-10.sas	Aggregate the different types of payment for employees over 2006-2010	balance2006 balance2007 balance2008, etc.	Excel file: Payment Summary for Employee.xls
Payment summary for Retiree 06-10.sas	Aggregate the different types of payment for retirees over 2006-2010	balance2006 balance2007 balance2008, etc.	Excel file: Payment Summary for retiree.xls
Analysis and estimation of medical expenses.sas	Summarize the different kinds of medical expenses over 2002-2010	Expense2006 Expense2007 Expense2008, etc.	Excel file: Expenses Summary.xls
Summary expenses for employee.sas	Summarize the medical expenses for employees	Expense2006 Expense2007 Expense2008, etc.	Excel file: Expenses Summary for Employee.xls

A.4 SAS codes guideline for forecasting medical services of urban employees (continued)

Code Name	Description	Input	Output
Summary expenses for retiree.sas	Summarize the medical expenses for retirees over 2002-2010	Expense2006 Expense2007 Expense2008, etc.	Excel file: Expenses Summary for Retiree.xls
Analysis of personal savings accounts for 2006-2010.sas	Analysis of personal savings account for 2006-2010	Person2006 Balance2006 Person2007 Balance2007, etc.	Excel file: Account Balance 2006-10.xls
Macro SAS codes used in the simulation model			
Macro for Clinic expenses.sas	Simulate clinic services and pharmacy medication over 2006-2010	person2006, ZeroClinic, clinrate expense2005	expens001
Macro for Chronic disease expenses.sas	Simulate medical services for chronic diseases over 2006-2010	person2006, Chronicrate, chronrate, Chronicself expense2005	expens002
Macro for Special check up expenses.sas	Simulate medical services of clinic special check-ups over 2006-2010	person2006, Specnum, specrate, etc.	expens003 specrate
Macro for simulating first hospital services.sas	Simulate the first time hospital admission over 2006-2010	person2006, hosprate, levelrate, hospcost01, totalself01, partself01 expense2005	hosp01 hospcost01
Macro for simulating second hospital services.sas	Simulate the second time hospital admission over 2006-2010	hosp01 secondrate, levelrate02, hospcost02, hospcost02, totalself02, partself02	hosp02 hospcost02
Macro for third hospitalization and aggregate.sas	Simulate the third time or more hospital admission over 2006-2010, aggregate the whole hospitalization services	hosp02 thirdrate, levelrate03, hospcost03, totalself03, partself03	expens004 HospCost03
Macro for output of expense result.sas	Aggregate the results of four types of medical expenses over 2006-2010	expens001 expens002 expens003 expens004	expense2006 expense2007 expense2008 expense2009 expense2010

APPENDIX B STATIC MODEL FOR URBAN RESIDENTS

B.1 Variables and descriptions of the 2000 Census used in the model

No.	Variable	Notes in Chinese	Description
1	PROVINCE	省代码:见地址码.xls 文件	Code of Province
2	REGION	地区代码:见地址码.xls 文件	Code of Region
3	FAMILY	户代码:本地市的户顺序号	Serial number of household
4	H2	户别：1=家庭户，2=集体户	1=household, 2=residents together
5	H31	本户普查登记人数	Number of registered people in household: H31=male number, H32=female number
6	H32	H31=男性数，H32=女性数	
7	H41	本户户籍人口中外出不满半年人数	Registered people go outside less than half year: H41=male number, H42=female number
8	H42	H41=男性数，H42=女性数	
9	H51	本户户籍人口中外出半年以上人数	Registered people go outside more than half year: H51=male number, H52=female number
10	H52	H51=男性数，H52=女性数	
11	H61	暂住本乡镇街道，离开户口登记地不满半年人数	People as temperate residents living here for less than half year: H61=male number, H62=female number
12	H62	H61=男性数，H62=女性数	
13	H71	本户 1999.11.1－2000.10.31 出生人数	Number of baby birth last year: H71=male number, H72=female number
14	H72	H71=男性数，H72=女性数	
15	H81	本户 1999.11.1－2000.10.31 死亡人数	Number of death last year: H81=male number, H82=female number
16	H82	H81=男性数，H82=女性数	
32	R1	户籍中个人序号	Person’s serial number in Household
33	R2	与户主关系：0=户主，1=配偶，2=子女，3=父母，4=岳父母或公婆，5=祖父母，6=媳婿，7=孙子女，8=兄弟姐妹，9=其他	Relationship to the head of the house: 0=head, 1=spouse, 2,6=child/child in low, 3,4 = parent/ parent in low, 5=grand parent, 7=grand child, 8=brother or sister
34	R3	性别：1=男，2=女	Sex: 1=male, 2=female
35	R41	出生年份	Year of birth
36	R42	出生月份	Month of birth
37	R5	民族：1=汉族，其他=少数民族	Nationality: 1=Han nationality, other=minority.
41	R7	户口性质：1=农业，2=非农业	Status of household: 1=agriculture, 2=town
53	R14	是否识字：1=是，2=否	Illiteracy or not: 1=yes, 2=no
54	R151	受教育程度：1=未上过学，2=扫盲班，3=小学，4=初中，5=高中，6=中专，7=大专，8=本科，9=研究生	Degree of education: 1, 2=no or a little, 3= primary, 4=secondary junior, 5, 6=senior, 7, 8= undergraduate, 9=postgraduate
57	R17	调查前一周是否从事过一小时以上有收入的工作：1=是，2=在职休假、培训、季节性歇业未工作，3=其他原因未工作	Last week, any kind of paid job for more than one hour: 1=yes; 2=yes, but on holidays, training session etc; 3=no job
58	R18	调查前一周从事有收入的工作时间：1=一天，2=二天，3=三天，4=四天，5=五天，6=六天，7=七天	Last week, days of paid job: 1=one day, 2=two days, 3=three days, 4=four days, 5=five days, 6=six days, 7=seven days

B.1 Variables and descriptions of the 2000 Census used in the model (continued)

No.	Variable	Notes in Chinese	Description
61	R211	未工作状况：1=在校学生，2=料理家务，3=离退休，4=丧失工作能力，5、6=正在找工作，7=其他	For no job person: 1=study at school, 2=working at home, 3=retired, 4=disabled, 5,6=looking for a job, 7=other reason no job
63	R22	未工作者主要生活来源：1=退休金，2=领取基本生活费，3=家庭其他成员供养，4=财产性收入，5=保险，6=其他	Main income for no job person: 1=pension, 2=basic living standard, 3=looked after by family, 4=property, 5=insurance, 6=other
64	R23	婚姻状况：1=未婚，2=初婚有配偶，3=再婚有配偶，4=离婚，5=丧偶	Marital status: 1=never married, 2=initial marriage, 3=remarried, 4=divorced, 5=widowed
67	R251	15 至 50 周岁妇女生育子女数，男性人数	For female aged 15-50, how many babies given: R251= male number, R252= female number
68	R252	女性人数	
69	R253	现在存活男性人数	Live at present: R253= male number, R254= female number
70	R254	现在存活女性人数	
71	R261	1999.11.1 － 2000.10.31 生育状况：1=未，2=有	Last year, have female given birth? 1=no, 2=yes
74	R264	12 个月以内生育两个以上的第二个孩子的生育时间：月	Birth month of the second baby within twelve months.
76	TOWN	城镇代码:1.城市 2.镇 3.乡村	Code of town

B.2 SAS codes guideline for modelling medical services of urban residents

Name	**1. Census population update to 2005-2010.sas**
Description	Processing sample dataset of the 2000 Census and doing population update for Kunming. First enlarge or clone the 0.95% of the sample to about 10% of the population. Then using re-weight macro SAS codes, update the 2000 Census population to 2005, 2008, 2009 and 2010 respectively.
Input	kunm2000 --- Census sample records of Kunming in 2000 gregwt.sas --- Reweight Macro SAS codes five Population benchmarks for 2005 five Population benchmarks for 2008, 2009 and 2010 respectively
Output	updatpop --- whole population update urbanpop --- population update for urban area
Name	**2. Prepare two datasets to be matched.sas**
Description	Preparation for the insured employees and retirees to be statistically matched with the total urban population – the former is the part of latter. Both of the insured and the total population are for the year of 2005. For inured individuals, about 10% of a random sample will be created in 2005, which is ready to be aligned into the 2005 updated urban population.
Input	Person2005 --- Insured Employee Personal information at the end of 2005 Urbanpop --- Updated urban population sample over 2005-2010
Output	mip_emp --- 10% medical insurance participants; pcs_emp --- 10% population census sample of employees and retirees; mip --- 10% employee personal information pcs --- 10% population of employee and retiree in the Census pcs_nojob --- 10% population of residents not in the labour force pcs_town --- 10% population of urban residents

B.2 SAS codes guideline for modelling medical services of urban residents (continued)

Name	**3. Matching and adjustment.sas**
Description	Statistical matching the insured individual records with urban population records in 2005 by Sex, Age group, Employment status and Marital status. After matching, adjust the weight for senior retirees and employees and retirees to meet the target population. This process is to identify the insured employees and retirees.
Input	mip_emp --- 10% of medical insurance participants pcs_emp --- 10% of employees and retirees in Census data
Output	Match2005 --- matched datasets for 2005
Name	**4. Set premium and sample insurance.sas**
Description	Following the medical insurance rules, to set the insurance premium to residents out of the labour market. Sampling the residents to be covered by the new medical insurance scheme in 2008, 2009 and 2010 respectively.
Input	Match2005 – matched individual dataset categorized into employed, adult and child.
Output	Scheme2008 – dataset with insurance premium and insured index for 2008-2010; Insured residents and premium – result file in Excel format
Name	**5. Assign income and medical expense 2008.sas (or 2009, 2010)**
Description	Imputing monthly income for employees and retirees based on the insured individual records under medical insurance scheme for urban employees. Imputing individual income for low income earners. Imputing medical expenses for individuals aged 15 years and over; imputing hospitalization costs for children under 15 years old by using the information from the National health services survey.
Input	Scheme2008 - dataset with insurance premium and insured index for 2008-2010;
Output	Income2008; income2009; income2010; med2008; med2009; med2010

B.2 SAS codes guideline for modelling medical services of urban residents (continued)

Name	**6. Payment simulation 2008.sas (or 2009, 2010)**
Description	Based on the payment scheme for the hospitalization cost, set different kinds of payments for adult residents and children respectively. For adult patients, hospitalization and special disease clinic considered separately; for children, only hospitalization concerned.
Input	med2008; med2009; med2010
Output	Pay2008; pay2009; pay2010
Name	**7. Control program for policy scenarios 08-10.sas**
Description	Summarize the payment results for hospitalization costs according to three medical insurance scenarios – one is 70% of the hospital admission rate compared with the insured employees and retirees; and the other is 85% of the admission; and the third is to assist inpatients in concessional families up to 2,000 Yuan for their hospitalization services.
Input	Pay2008; pay2009; pay2010
Output	Payment scenario simulation – summary of the simulation results in Excel format.
Name	**8. Family income analysis.sas**
Description	Family income analysis in quintile.
Input	income2005; income2008; income2009; income2010
Output	Family income 2005-10 – family income in quintile in Excel format.
Name	**9. Analysis of population distribution.sas**
Description	Analyzing the population distributions on the total urban population, insured employees and retirees, urban residents with or without concession, and adult residents.
Input	match2005 – matched data file with weights for 2005, 2008-2010.
Output	Population distribution – summarized results for population on insured, employed, residents and adults without jobs.

B.3 SAS codes calling macro GREGWT to update individual records to 2005

```
%INCLUDE "D:\Kunming Residents Project\Sas Codes\...\gregwt.sas" ;

%GREGWT
      (UNITDSN = Unit2000
      ,OUTDSN  = Unit2005
      ,GROUP   = FamID
      ,UNIT    =
      ,ID      =
      ,PENALTY =
      ,BY      =
      ,INWEIGHT= wt2000
      ,WEIGHT  = wt2005
      ,INREPWTS=
      ,REPWTS  =

      ,B1DSN   = census.Bench_Age05 ,B1CLASS = AgeGrp    ,B1TOT = Age_Num
      ,B2DSN   = census.Bench_Sex05 ,B2CLASS = Sex       ,B2TOT = Sex_Num
      ,B3DSN   = census.Bench_Nat05 ,B3CLASS = Nation    ,B3TOT = Nat_Num
      ,B4DSN   = census.Bench_Edu05 ,B4CLASS = Education ,B4TOT = Edu_Num
      ,B5DSN   = census.Bench_Twn05 ,B5CLASS = Resident  ,B5TOT = Twn_Num

      ,MAXITER = 50
      ,UPPER   =
      ,LOWER   =
      ,EPSILON = 0.001
      ,OPTIONS =
      );
```

Note: parameters explanation in this SAS codes refer to Appendix B.4.

B.4 Parameter specification and explanation in using GREGWT macro

Parameter	Specification	Explanation
UNITDSN =	Unit2000	Name of dataset to be weighted
OUTDSN =	Unit2005	Name for output weighted unit dataset
GROUP =	FamID	Level for weighting of groups rather than units, all individuals in a family will have the same final weight
UNIT =		Other variables in the sort order below GROUP level, optional
ID		Output dataset will include variables used by the macro plus any additional variables named in ID. To get all variables specify ID =_ALL_
PENALTY =		Variable used to specify a weighted distance function. Default is to use 1
BY =		As for BY statement in SAS – optional
INWEIGHT=	wt2000	Input weight – compulsory, here is for 2000
WEIGHT =	wt2005	Output weight, default is &INWEIGHT, here is for 2005
INREPWTS=		Lists 2 or more replicate input weights
REPWTS =		Name for output replicate weights, default &INREPWTS
B1DSN =	census.Bench_Age05	Name of the first dataset containing benchmarks of Age. The macro allow to specify for up to 30 datasets of benchmarks.
B1CLASS =	AgeGrp	Variable defining category for these benchmarks
B1TOT =	Age_Num	Variable on B1DSN giving the benchmarks
MAXITER =	50	Maximum numer of iterations in restricted version. Default is 10
UPPER =		Largest value which weights can take
LOWER =		Smallest value which weights can take
EPSILON =	0.001	Convergence criterion: how closely must benchmarks be met, expressed as the discrepancy of estimate from benchmark divided by benchmark
OPTIONS =		List of options, like Noprint, Badprint

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