

## Research Article

# Modelling Medical Insurance Scheme in China for Urban Employees and Residents

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As the world's biggest developing country with a large population, building a sound medical care system in China is a very difficult task, in particular the ageing population imposes a heavy burden on medical insurance. It is important to analyse and evaluate the impact of the ongoing medical insurance system on individuals' health care benefits. This article reviewed the project on modelling medical insurance systems for urban employees and residents. Selecting one of the southwest capital cities in China, the project created two static micro simulation models of the medical insurance system in China. Using three kinds of data in the project for different purposes, the research investigated the sustainability of the urban medical insurance system, involving both urban employed individuals and non-working residents. The first model predicted the medical insurance scheme for urban employees and retirees. With 2006 as the commencement year, the model forecasted the medical service expenses and medical insurance policy settings for five years until 2010. The model for non-working urban residents estimated the potential urban resident population entering the medical insurance scheme, predicted the distributional impacts on families over 2008-2010. It also estimated the medical expenses and evaluated the insurance capacity of the social pool fund. These two models are connected with each other by the methodology of statistical matching.

**Keywords:** Employees; Urban residents; Medical insurance; Micro simulation model

## Introduction and Background

### China's medical insurance system

Deepening the reform of the medical and health system is an important measure to guarantee and improve people's livelihood, related to people's wellbeing and the future of the nation [1]. As the world's biggest developing country with a large population, establishing a sound medical care system in China is an important guarantee of social stability. In 1998, on the basis of several rounds of pilot programs and experimental implementation, the Chinese government established the medical insurance scheme for urban employees and retirees [2]. Then, in 2003, a new rural co-operative medical insurance scheme was set up for rural areas in China [3]. Then in late 2007, a medical insurance program has been inaugurated in 79 pilot cities which aimed to cover all the urban residents who are out of the labour market [4].

Building a sound medical system in a country of 1.3 billion people, admittedly, is a very difficult task. In addition, the ageing population in China imposes a heavy burden on medical insurance. It is important to analyse and evaluate the impact of the ongoing medical insurance system on individuals' health care benefits — in particular, on their financial burden due to medical expenses. The Chinese Government needs urgently to prove whether the medical insurance scheme is sustainable in the coming years.

### Aim of the research

This research focused on the urban medical insurance system, involving both urban employees and residents who are out of the

labour market. The key aims 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, and to see if the medical insurance policy for urban employed individuals could be sustained during the relatively short period of 2006-2010. 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 a word, this research aimed to advance the understanding and impact of health insurance system in China, and to assist in future policy formulation and implementation.

Selecting one of the southwest capital cities in China, Kunming, Yunnan Province, and this project created two static micro simulation 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. The work had been finished in 2008. The project answered 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?

### Framework of the models

The projections of the above mentioned models stop at 2010, the point where there was close to 100 per cent coverage of medical insurance scheme for urban non-working residents. The two static

microsimulation models were created for urban employees and non-working residents respectively. Figure 1 gives an overview of the research framework used in creating the two models. In the model of simulating medical services of urban employees (left hand side of Figure 1), administrative data over 2001-2005 were used. Based on these administrative data sources, a base file for insurance participants in 2005 was 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) was 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 were updated to the target years. Then, along with the supplementary information on medical expenses, the model predicted medical insurance policy distributional effects on non-working residents (Figure 1).

These 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.

In the context of this article, unless otherwise specified, 'urban employees' includes both employees and retirees. 'Urban residents' indicates residents who are not in the labour force, involving children, students and non-working adults.

### Kunming's Medical Insurance Project

In cooperation with the Bureau of Labour and Social Security of Kunming, this project was focused on the medical insurance system of the city of Kunming. Kunming had a total population of 6.08 million at the end of 2005 [5].

#### 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. Like other urban areas in China, the medical insurance funds in Kunming, contributed jointly by employers and employees, include the social pool fund and the personal savings accounts. 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 2 shows. One is clinic services involving clinic treatment and medications in pharmacies; the other is hospitalization services involving hospital admission, special disease, 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 (Figure 2).

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.

#### 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 [6]. Participation in the medical insurance plan is on a voluntary basis. The plan provides 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.

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. 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 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 in 2005 for the employed (49,000 Yuan) was more than double that for residents (20,000 Yuan). Finally, after the payment ceiling under the medical insurance scheme is depleted, a further insurance scheme called serious illness fund is available for employed individuals, but is not applicable for residents.

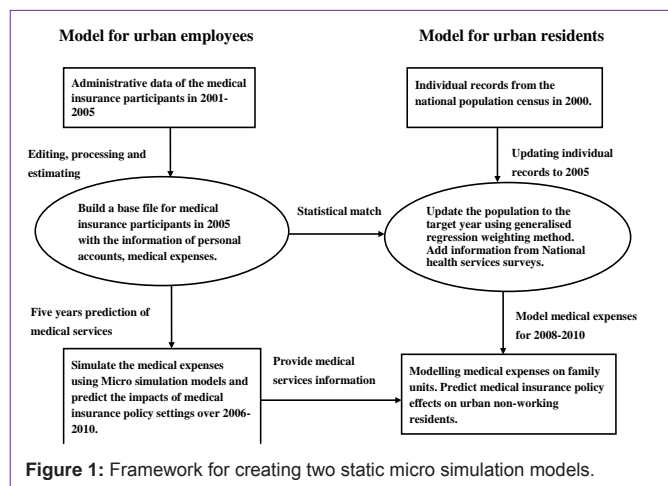


Figure 1: Framework for creating two static micro simulation models.

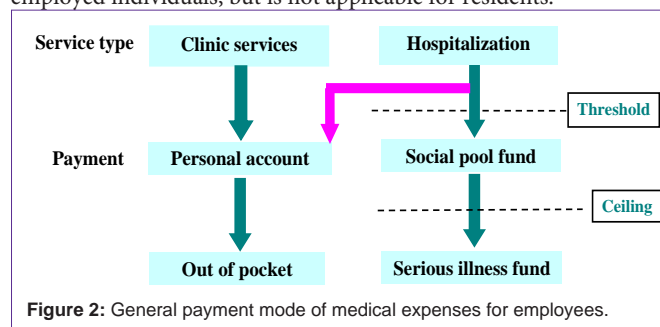


Figure 2: General payment mode of medical expenses for employees.

### Data sources in the research

To build micro simulation models of the medical insurance system requires individual level medical data. Three kinds of data were 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 help to create the microsimulation model for urban employees and retirees for the period of 2006-2010. The second data is the information on Kunming's population, involving a 0.1 per cent sample of the National Population Census 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 came from the second and the third National Household Health Surveys, conducted in 1998 and 2003 [7], respectively.

### Administrative medical care records

The main data used in creating the static microsimulation model for urban employees are administrative medical records under the 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.

### Data sources of population

There are two kinds of population information about Kunming – 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 [8], 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.

### Health expenses resources

The health expenses information for urban residents came 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. As a big city, Kunming had a county selected in the second and the third Health Services Surveys, which sampled 600 households. Together with the information gathered from the Surveys, it is then possible to model medical expenses of all urban residents in Kunming.

## Research Methods and Model Construction

### Microsimulation models

As mentioned above, the main method 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 [9], Gupta and Kapur [10] and Harding and Gupta [11]. Microsimulation models have been traditionally divided into two broad categories – static and dynamic. Static models typically use static ageing techniques to update cross-sectional micro data up to the required point in time. These techniques usually involve re-weighting the micro-data and up-rating monetary values.

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 [12].

Microsimulation modelling has traditionally been applied to income and tax policies and social security systems. 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 [13,14]. 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 aimed to predict and evaluate medical services of individuals under the medical insurance system for Chinese urban employees and residents.

### Modeling medical insurance scheme for employees

As described in Section 1.3, the first model created is to predict the medical insurance scheme for urban employees and retirees of Kunming. The model took each insured individual as a basic simulation unit, and selected 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 simulated is a year. With 2006 as the commencement year, the model forecasted the medical service expenses and medical insurance policy settings for five years until 2010. The following presents briefly the model construction and some selected results, while detailed information can be referred to the previous work [15,16].

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.

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.

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 [16]. When considering the medical cost distributions for employees and retirees separately, completely different pictures emerge (Figure 3). For employees, more than half of their medical services costs (54.1 per cent) come from clinic services and

medications. 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 (Figure 3).

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 forecasting results showed that [16], 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.

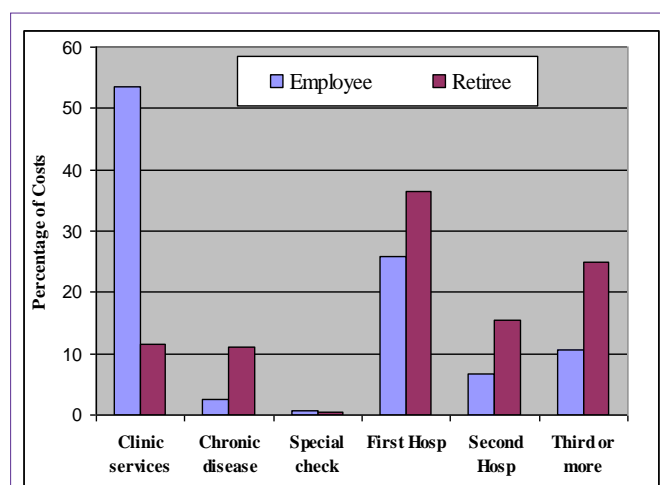


Figure 3: Estimated percentage distribution of spending on medical services, on average, over 2005-2010.

## Modeling medical insurance scheme for residents

The second model is to predict the medical behaviour and forecast medical expenses for urban residents in Kunming in using hospital services. 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 were estimated, as well as the medical costs of hospitalization for different levels of income families. The research created 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. This Section gives a brief description of developing such a model for urban residents and some selected results. Detailed information is referred to the previously published work [17,18].

The model provided 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.

The datasets 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, is 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 involved in establishing the microsimulation model for urban residents. First, the records of the population in 2000 were updated to the target year 2005-2010 according to the target population structure. Second, the updated population was then statistically matched with the dataset of the urban employees and retirees, which “donated” hospital service usage and medical expenses information. Finally, the insurance coverage and medical services costs on hospitalization over the period of 2008-2010 were projected.

It was estimated that Kunming would have a population of 6.3560 million in 2010. While the reported population of Kunming in the 6<sup>th</sup> national census in 2010 was 6.4322 million [19], which is close to the estimated figure of 6.3560 million, with the relative error of 1.18 percent.

**Table 1:** Forecast population and percentage of urban residents out of labour market.

Year	Adults		Children		Uni-students		Total
	General	Concession	General	Concession	General	Concession	
<b>Population</b>							
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
<b>Percentage</b>							
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

As Table 1 shows, it was estimated 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 would 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. 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 (Table 1).

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. 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.

Building the first microsimulation model for urban residents out of the workforce was extremely challenging. Because of data deficiencies, the model had to do complicate 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.

## Conclusion

This article presented briefly the research background of China's medical care system and the objectives in this research. Two static microsimulation models were created 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.

Any government seeking to introduce a medical insurance scheme faces a host of difficult questions. Should different types of medical expenses be covered or treated differently - for example, should chronic disease expenses be treated differently to special check-up expenses? How high should the co-payment by patients be for access to medical services to be affordable and equitable? Should there be a maximum cap on out-of-pocket expenses? 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, the static microsimulation model for urban employees and retirees created in this research 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 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 research 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 project 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.

In this research, 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 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. However, this research provided several key

outcomes for the medical insurance scheme for urban residents, 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.

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. Different kinds of contributions for the medical insurance premium were projected. The incomes of the units of individuals and families were estimated. And the model projected the usage of the general hospital services, as well serious illness clinic services, for potential insured residents. Also, 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.

The models constructed in this research provided 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 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 is to help inform ongoing medical insurance scheme by running policy scenario settings. The model constructed for this research 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 in medical insurance scheme.

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