

Health Care Expenditure over Life Cycle in the People's Republic of China

JIN FENG, PINGYI LOU, AND YANGYANG YU*

We use individual level data from eight waves of the China Health and Nutrition Survey during 1991–2011 to investigate age profiles of health expenditure for rural and urban residents in the People's Republic of China (PRC). Employing a two-part model, we find that health expenditure of rural residents is averagely 33% lower than that of urban residents and age–expenditure profile is much steeper in urban areas than in rural areas. However, there is no evidence that the health status of the rural elderly is better than that of the urban elderly. The findings imply that health spending of the rural elderly may increase more during the process of rural–urban integration. In addition, we find a significant difference in age–expenditure profiles across time. Compared with expenditure during 1991–2000, the estimated age–expenditure profile becomes steeper during 2004–2011 in both urban and rural areas.

Keywords: health expenditure, age-expenditure profile, rural–urban integration
JEL codes: I10, J11

I. Introduction

With rapid population aging, there is growing concern about its impact on health care expenditure in the People's Republic of China (Peng 2011; Chen, Eggleston, and Li 2011). Since people tend to use more health care as they age, many people are concerned that an aging population will accelerate growth in health care spending. The share of the population age 65 and over is a common indicator used to measure population aging. Data from the Chinese national census show that the share of this age group was 5.9% in 1990 and 7% in 2000, increasing to 8.4% in 2010. According to projections of the United Nations (medium variant), the population age 65 and over will be around 230 million, or about 16.2% of the total.¹

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¹United Nations, Department of Economic and Social Affairs. World Population Prospects: The 2012 Revision. Available online: <http://esa.un.org/unpd/wpp/index.htm>.

In order to have a correct judgment of the growth in aggregate health spending during population aging, we need to understand how age influences the demand for health care. Constructing life-cycle profiles of health expenditure is a primary step towards this goal.

There are only a few studies in the literature analyzing life-cycle health expenditure in the PRC. It is reported that per capita health spending for people age 65 and over was 2.56 times the amount for that under age 65 in 2002 (Li and Chen 2006). For public health care spending per capita, Shen and Lee (2014) using micro data find that the age profile has a J-shape curve in both urban and rural areas. The peak value occurs at around age 80.

Most studies on the United States (US) and other Organisation for Economic Co-operation and Development (OECD) countries conclude that population aging has not been a significant driver of health spending in contrast to growing demand for health care and rising costs due to technology progress in the health care sector, which have had a more significant influence (Newhouse 1992, Getzen 1992, Gerdtham and Jönsson 2000, Baltagi and Moscone 2010). Another line of studies states that health expenditures are mainly driven by time to death, not only age per se (Zweifel, Felder, and Meiers 1999; Seshamani and Gray 2004).

The findings in developed countries may not directly apply to the PRC. First of all, health expenditure in the PRC lags far behind OECD countries and many countries with comparable gross domestic product (GDP) per capita, though it has been increasing for decades. One of the important reasons for low health spending in the PRC is the lack of rural health care consumption. For example, per capita health expenditure of rural residents was only one-third of that of urban residents in 2012. Rural–urban integration during urbanization increases the demand for health care generally, but expenditures by elderly people may increase more than other groups. Whether population aging accompanied by urbanization leads to larger age effects in the PRC than in OECD countries is an unanswered question.

Another remarkable fact is that the Chinese economy and health care system have gone through fundamental reforms in the past years. The reforms have exerted various influences on people born in different times, with diverse life experiences due to “the timing of lives.” For example, compared with people of the same age 20 years ago, individuals nowadays have greater access to health care and enjoy more advanced technologies in health care. Furthermore, since the elderly have the highest demand for health care, improving accessibility favors them the most. Hence, the age–expenditure profile today may be steeper than it was before. Testing whether age effects vary across periods in the PRC is a way to illustrate the so-called cohort effect.

We use data from eight waves of the China and Health Nutrition Survey (CHNS) during 1991–2011. The data include information on the health care of individuals of all age ranges across different periods. Employing a two-part model, we find that health care expenditure of rural residents is lower than that of urban

residents in all age groups. We also find the age–expenditure profile to be much steeper in urban areas than in rural areas. However, there is no evidence that the health status of the rural elderly is significantly better than that of the urban elderly. The findings imply that health spending of the rural elderly may increase more during the process of rural–urban integration compared with the urban elderly. We also find a significant difference in age–expenditure profiles across time in both urban and rural areas.

Based on the above estimation, we estimate the contribution of population aging to growth of aggregate health spending and show that the growth rate accounted for by population aging during the urbanization period between 1990 and 2010 is about 2.8%. This accounts for about a fifth of total real annual growth.

In the future, population aging and urbanization will likely continue to drive health expenditure. It is worth noting, however, that the growth of health spending has different meanings in the PRC than in OECD countries. While developed nations struggle with rising health spending, increased expenditure in the PRC during urbanization is encouraging to a large extent, as more people receive much-needed health care.

II. Literature Review

Our paper is related to empirical studies on the life cycle aspect of demand for health care. On average, health care spending is higher for older people than for younger people. Studies on OECD countries show that per capita health spending for people age 65 and over was 2.7 to 4.8 times the amount of those under age 65 in the mid-1990s (Anderson and Hussey 2000). In developing countries, the ratio was 2.9 in Sri Lanka during the same period (Reinharde 2003) and 2.56 in the PRC in 2002 (Li and Chen 2006). More detailed information on the PRC is presented by Meng and Yeo (2006) using household survey data from the China Household Income Project in 2002. They show that, in urban areas of the PRC, an individual in her 60s spends 50% to 100% more on health care than a 40-year old, while an individual in her 80s spends 100% to 170% more than a 40-year old. Shen and Lee (2014) use China Family Panel Studies data to show that per capita public health care spending is high in infancy, decreases for the teenage years, then increases again at middle age. The peak of public health spending occurs at around age 80.

However, several studies find that in rural areas of the PRC, age–expenditure profiles are different from normal patterns, as the elderly spend less on health care. According to a survey done in the 1990s covering 8,414 individuals and 1,428 households in 8 provinces, the 2-week hospitalizing probability and expenditure of people age 65 and over are lower than those of middle-age people (Gao and Yao 2006). A more recent survey comprising 50,357 observations in 4 counties in Hubei and Sichuan provinces finds that self-reported morbidity of the elderly is 30

points higher than for the non-elderly, while inpatient admission is 5 points lower. In addition, per capita inpatient and outpatient spending for the elderly are lower than for the non-elderly, by CNY775 and CNY328, respectively (Yan and Chen 2010).

While per capita spending for health care is consistently higher for older people in most countries, a set of studies indicate that population aging is a relatively minor factor in the growth of national spending for health care. Other factors, including rising per capita income, the availability of new health care products and services, health insurance coverage, and characteristics of the health care system play much bigger roles (Newhouse 1992, Gerdtham and Jönsson 2000, White 2007, Baltagi and Moscone 2010). Population changes occur gradually, while health care spending has grown rapidly.²

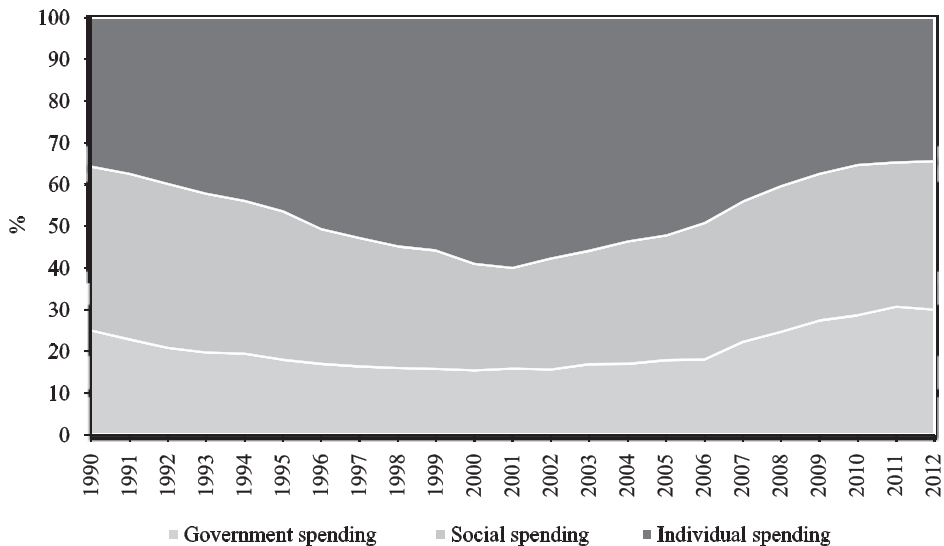
Newhouse (1992) argues that population aging can only explain 2% of the growth of national spending during 1940–1990 in the US. During 1970–2002, real growth of per capita health spending averaged 4.3% per year in the US and 3.8% in a subset of OECD countries. Population aging accounts for 0.3 percentage points of growth in health spending in the US and 0.5 percentage points in OECD countries, about a tenth of total annual growth (White 2007). Cross-country analyses find that age structure (e.g., proportion of the population age 75 and older, and proportion of the population under 4 years old) has no significant effect on national health spending (Gerdtham and Jönsson 2000). Baltagi and Moscone (2010) use a panel of 20 OECD countries over the period 1971–2004 to show that average annual growth rate of health spending is 11.5%, but do not find aging to be the most important contributing factor.³

There is also evidence that health expenditure for the elderly may be increasing at a different rate than that for the non-elderly. The ratio of per capita spending of the elderly to the non-elderly in the US was 3.0 in 1987, climbing to 3.9 in the mid-1990s (Anderson and Hussey 2000). Cutler and Meara (1997) find that during 1953–1987, annual growth of per capita spending on the elderly was about 8%, significantly higher than the estimated 4.7% annual growth for those age 1 to 64 years, but the trend reversed after 1996. Other researchers have shown that elderly spending rose at about the same rate as non-elderly spending on health care in the 1960s to the 1990s (Boccuti and Moon 2003). The annual growth rate of per capita spending for the elderly was lower than other age groups in the more recent period in the US, partly because of the reform in Medicare, which aimed to control the growth of spending for the elderly (Meara, White, and Cutler 2004). In the PRC, public health insurance has been proven to be a valid policy to increase the demand for

²According to *World Population Prospects*, the share of the population age 65 and over was 8.26%, increasing to 9.76% in 1970, 12.47% in 1990, and 13.06% in 2010. In most developed countries, the population has been aging for many decades, while in developing countries, population aging has taken place relatively recently (United Nations 2013).

³Baltagi and Moscone (2010) reconsider the long-run economic relationship between health care expenditure and income, and suggest that health care is a necessity rather than a luxury, with an elasticity much smaller than that estimated in previous studies.

Figure 1. **Structure of Health Care Spending in the People's Republic of China**
(1990–2012)



Source: Ministry of Health of the People's Republic of China. 2013. *China Health Statistics Yearbook*.

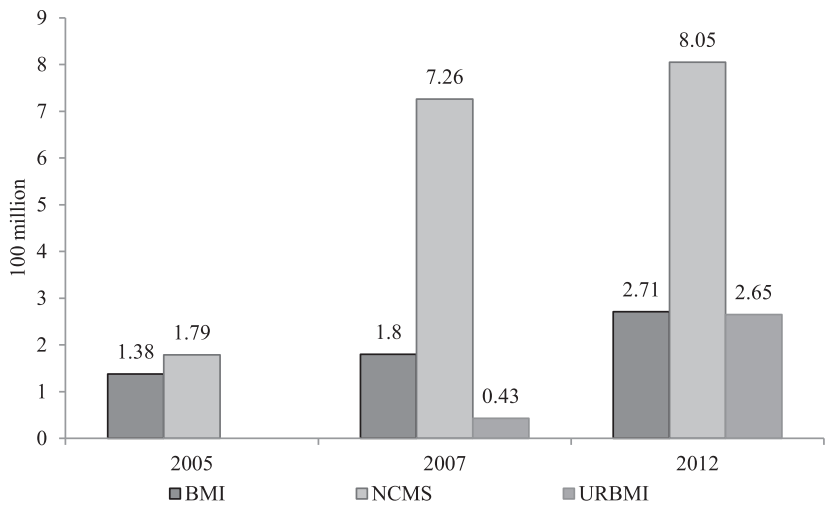
health care of the elderly. Liu, Cai, and Li (2011) find that health insurance coverage significantly increases the utilization of health care of the elderly in both rural and urban areas.

III. The Health Care System in the People's Republic of China

Health care spending as a share of GDP has been increasing in the PRC, from 4% in 1990 to 5.36% in 2012. Three parties are involved in the determination of health care spending in the country. They are government, the social insurance programs, and the individual. The spending driven by each party has been increasing over time but at different speeds. As a result, the structure of the three parties has changed over time (Figure 1). Government and social spending increased gradually prior to 2003. During 1990–2003, individuals' share increased continuously. In the peak year, individual out-of-pocket spending accounted for 60% of total health care spending. In 1990, individual health care spending was 1.4 times the amount spent by government, with the ratio increasing to 3.8 in 2003. After 2003, the growth of government spending and social spending started to exceed the growth of individual spending. The share of individual out-of-pocket spending fell to 34% in 2012. During the same period, government's share rose from 16% to 30%.

The changing pattern has been widely discussed in literature (e.g., Hu et al. 2008, Yip and Hsiao 2008). The evolving role of government in health care financing

Figure 2. Number of Participants in Health Insurance Programs

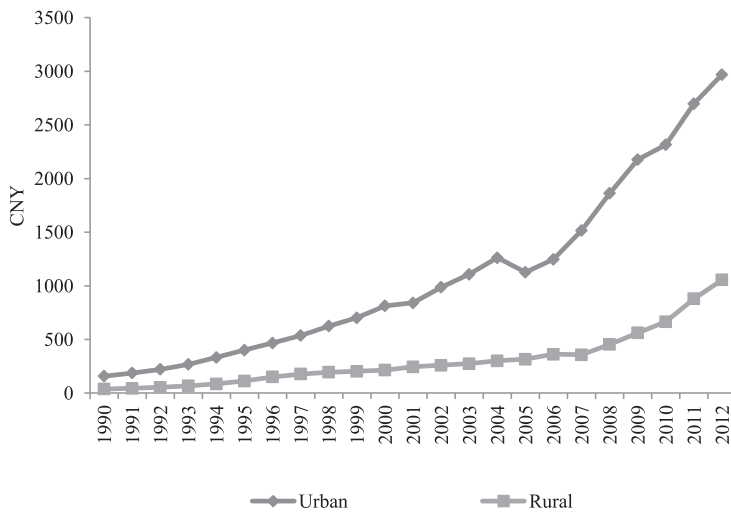


BMI = basic medical insurance, NCMS = new cooperative medical system, URBMI = urban residents basic medical insurance.
Source: Ministry of Health of the People’s Republic of China. 2013. China Health Statistics Yearbook.

reflects the direction of health care reform of the PRC. Since the middle of the 1980s, the main reform in the health care sector has been to reduce the state subsidy to public hospitals and encourage hospitals to raise their own funds to cover costs. In the 1990s, hospitals were allowed to generate profit from selling medicines and providing high-tech examinations. The direction of reform was reversed after 2003. Government inputs to health care increased significantly, and new social insurance programs were introduced in 2003 and 2007. A nationwide systemic reform was launched in 2009, supported by substantial public funding. The reform reinstated the government’s role in the financing of health care and the provision of public goods.

Social health care expenditure mainly refers to spending paid from social insurance programs. Since the end of the 1990s, public health care has been reformed to favor health insurance programs, and the number of participants therefore expanded dramatically (Figure 2). There is now a variety of health insurance for different population groups. The government introduced the basic medical insurance scheme (BMI) for urban employees in 1998 and the new cooperative medical system (NCMS) for farmers in 2003. In 2007, another health insurance program known as the Urban Resident Basic Medical Insurance scheme (URBMI), which covers urban residents not included in the BMI, was introduced. This new scheme covers children, the elderly, the disabled, and other non-working urban residents. As in the NCMS, there is a government subsidy for the premium payment in the URBMI. By 2012, out of the total population of 1.35 billion, 805 million people were covered by the NCMS, 271 million by the BMI, and 265 million by the URBMI.

Figure 3. Urban and Rural Per Capita Health Spending



Source: Ministry of Health of the People's Republic of China. 2013. *China Health Statistics Yearbook*.

It is worth mentioning that benefit packages differ substantially among the three programs. The BMI is more generous than the other two programs. For example, while the average inpatient reimbursement rate was only 41% in 2009 under the NCMS, the rate was 65% for urban employees in 2008 and 45% for urban residents in 2007 (Shen and Lee 2014).

An important characteristic of the PRC is the large urban and rural disparity—per capita health spending of rural residents has been much lower than that of urban residents. Data in Figure 3 show that the gap has continued to widen. In 2010, per capita health care expenditure of urban residents was 3.79 times as much as that of rural residents.⁴ However, there is no evidence that the health status of rural residents is better. On the contrary, the 2008 *China National Maternal and Child Surveillance* reports that the 2007 rates for maternal, infant, and under-5 mortality in rural areas were twice as high as those in urban areas (0.04%, 1.9%, and 2.2% vs. 0.02%, 0.8%, and 0.9%, respectively).⁵ The disparity is a consequence of insufficient health care supply, poor health care insurance, and low household income in rural areas. According to Shen and Lee (2014), urban residents benefit more from public health care funding than rural residents at all ages, especially after age 60. According to the *China Health Statistics Yearbook* (2013), the number of professional health staff for every 1,000 persons is 3 times lower in rural areas than in urban areas during the 2000s.

⁴Data on urban and rural health spending available since 1990 in the *China Health Statistics Yearbook* (2013).

⁵"China National Maternal and Child Surveillance" is a national database that includes newborn, infant, and under-5 mortality rates by sex and urban or rural areas.

IV. Data and Summary Statistics

A. Data

We use eight waves of the CHNS survey during 1991–2011. These were conducted in 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. Adopting the multi-stage stratified cluster sampling method, the survey obtains random samples from nine provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong.⁶ The survey contains comprehensive information on households and individuals, including demographic and socioeconomic information of family members, health status, utilization of health facilities, health care expenditure, and insurance participation of each family member. To reduce noise due to outliers, we drop the 0.5% lowest and highest expenditures for each year. This leaves a total of 94,271 observations for the eight waves.

The observations are evenly distributed among the waves. Urban and rural observations on average account for 32.4% and 67.6%, respectively.⁷ We divide the observations into eight age groups (i.e., according to the age in the survey year): 0–9 years, 10–19 years, 20–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, and 70 and over. In the PRC, the share of population age 60 and over also measures population aging, as the retirement age is 60 for men and 55 or 50 for women. The share of observations for age 60 and over increased from 11% in 1991 to 26% in 2011, while that for age 70 and over increased from 4% to 10% during the same period.

Each interviewee reported whether he or she had been ill in the past 4 weeks. If he was ill, the survey asked whether he went to a hospital, how much he spent, and how much was covered by health insurance. Expenditure here includes fees for outpatient care, cost of inpatient care in various levels of health care facilities, and consumption of drugs. We sum up all spending items paid out-of-pocket and by insurance of each interviewee who had been sick during the last 4 weeks and adjust the spending to 2011 prices using the price index provided by the CHNS dataset.⁸

Table 1 summarizes the relevant variables for the full sample by waves of the survey.

⁶ Available online: <http://www.cpc.unc.edu/projects/china>. The survey is jointly implemented by the Carolina Population Center at the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety of the US, and the Chinese Center for Disease Control and Prevention.

⁷ Urban and rural are classified by the location of the survey. If the location is a rural community, the sample in the community is defined as a rural resident. If the location is an urban community, the sample is defined as an urban resident.

⁸ We estimate an expenditure function to predict health care expenditure for those who failed to report spending but were ill and went to a hospital. The dependent variable is expenditure in log form. Explanatory variables include age, gender, type of disease, severity of disease, provincial dummies, and year dummies. Such observations account for about 10% of total observations.

Table 1. Summary Statistics for the Full Sample

Variables	1991	1993	1997	2000	2004	2006	2009	2011
Having expenditure	0.074	0.041	0.050	0.052	0.125	0.120	0.130	0.148
Health expenditure (conditional, CNY)	743.6	775.1	876.5	924.4	925.9	780.1	1104.9	1166.0
Rural	0.696	0.717	0.684	0.697	0.665	0.667	0.666	0.600
0–9	0.104	0.124	0.087	0.053	0.036	0.037	0.035	0.041
10–19	0.195	0.189	0.186	0.189	0.126	0.098	0.083	0.078
20–29	0.194	0.167	0.168	0.151	0.094	0.080	0.086	0.081
30–39	0.168	0.169	0.159	0.173	0.160	0.156	0.140	0.128
40–49	0.132	0.147	0.167	0.174	0.199	0.200	0.202	0.206
50–59	0.098	0.093	0.106	0.123	0.189	0.209	0.209	0.207
60–69	0.070	0.074	0.080	0.084	0.113	0.125	0.140	0.157
70+	0.040	0.038	0.047	0.053	0.082	0.095	0.105	0.103
Male	0.493	0.498	0.502	0.505	0.487	0.484	0.488	0.475
Per capita income inflated (CNY, 1000)	3.622	4.079	4.996	6.304	8.253	9.756	13.751	16.326
Years of schooling	5.598	6.005	6.138	6.872	7.180	7.221	7.300	7.906
Insurance	0.280	0.229	0.236	0.206	0.269	0.489	0.906	0.951
Observations	12,393	12,048	12,390	12,956	10,511	10,154	10,407	13,412

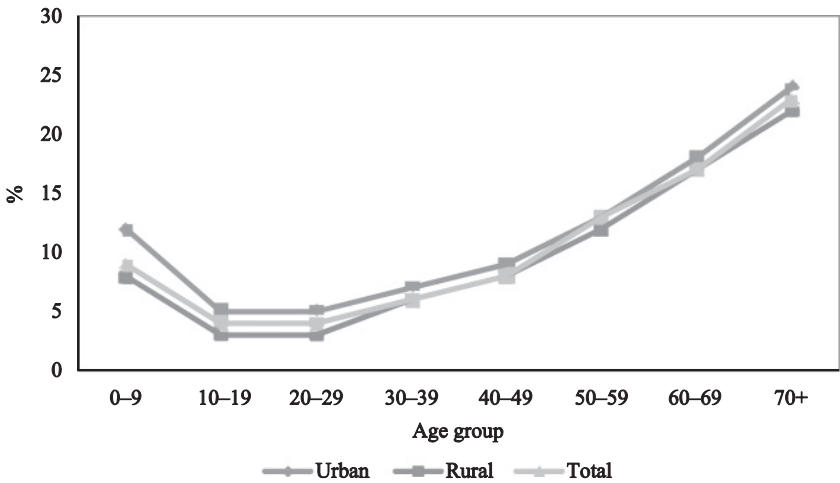
Source: Authors’ computations.

B. Health Expenditure across Age Groups and Cohorts

We first present results from a cross-section analysis where we average the probability of expenditure and the level of health expenditure by age group. Health spending of those who were not ill during the past 4 weeks is counted as zero when averaging the expenditure for each age group. These profiles do not distinguish age, cohort, or period effects and therefore may introduce bias into health spending estimates over age groups. Figure 4 shows that the incidence of health spending during the 4 weeks is lowest in the 10–19 and 20–29 age groups. The incidence increases with age, reaching 23% in the group age 70 and over. Average health spending during the 4 weeks is lowest for the 10–19 age group (Figure 5a). The expected spending of those age 60 and over is 4.2 times as much as the rest, while for the elderly age 70 and over, it is 4.3 times as much. Incidence and level of health expenditure across age groups is similar for urban and rural residents (i.e., the older, the wider the gap), although spending of urban residents is significantly higher than that of rural residents.

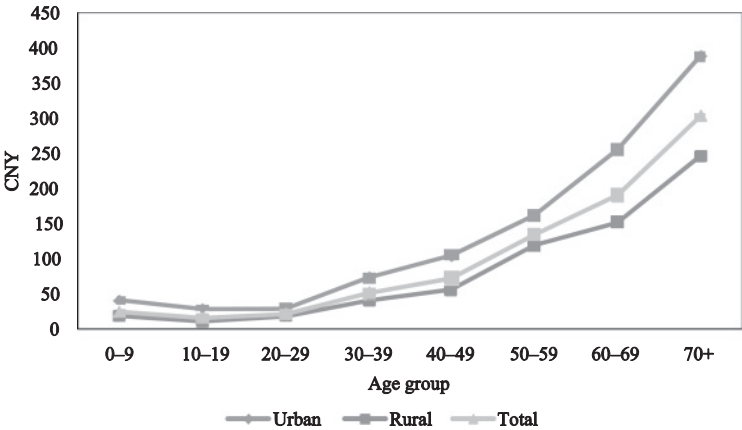
It is helpful to present health expenditure profiles for different cohorts. Cohorts vary in initial conditions—e.g., those who experienced war or famine or encountered various influences during the life cycle—which have a long-lasting impact on health (Ryder 1965). Cohorts here are divided by observation’s birth year. The first cohort consists of people born after 1990, the second cohort comprises those with birth years from 1980 to 1989, the third cohort covers those with birth years from 1970 to 1979, etc. The eighth cohort covers people with birth years before

Figure 4. **Health Care Expenditure Incidence in 4 Weeks**
(1991–2011)



Source: Authors’ calculations using data from the China and Health Nutrition Survey (CHNS).

Figure 5a. **Health Expenditure in 4 Weeks**
(1991–2011)



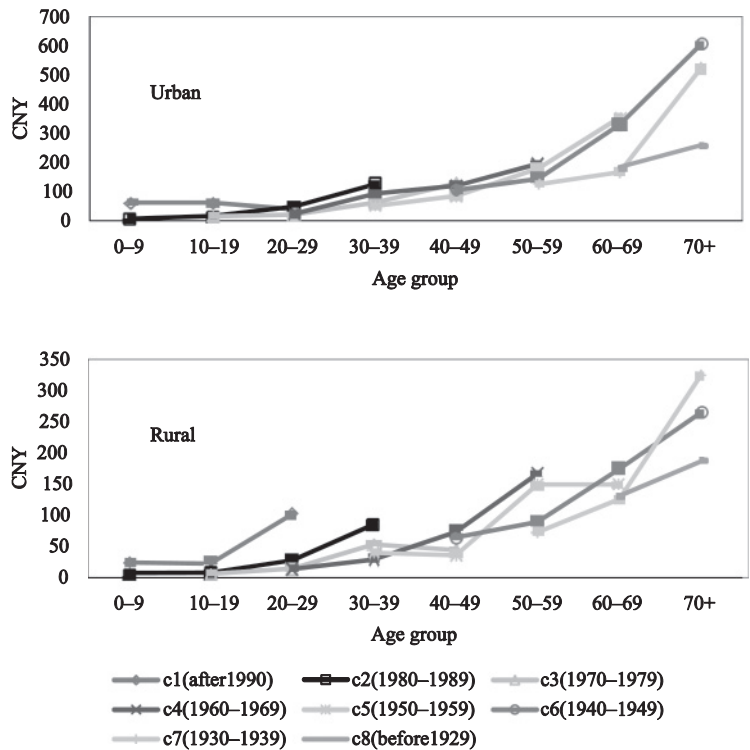
Note: Data are adjusted to 2011 CNY values.

Source: Authors’ calculations using data from the China and Health Nutrition Survey (CHNS).

1930. Average health expenditures across age groups and cohorts are reported in Figure 5b. Results show that even in the same age group, cohorts with a later birth year tend to have greater health spending.

As there are fundamental changes in the health care system after 2003, we split the samples into two periods: 1991–2000 and 2004–2011. Each period contains information including the role of government, extension of health insurance coverage, improvement of health care technology, and level of income. All these

Figure 5b. **Health Expenditure by Cohort**
(1991–2011)



Note: Data are adjusted to 2011 CNY values.
Source: Authors’ calculations using data from the China and Health Nutrition Survey (CHNS).

factors have some impact on health expenditure. As a result, spending increased significantly in the later period, especially the expenditures of the elderly (Figure 6a and 6b).

C. **Gender and Health Expenditure**

We present health expenditure profiles by gender in Figures 7a and 7b. In urban areas, it is shown that women spend a little more than men from age 20 to 69. Specifically, women age 30 to 39 spend on average 10.6% more on health care than men of the same age group. This is consistent with reports in the literature that women outspend men, especially during their prime childbearing years. In rural areas, men spend a little more than women in health care in most age groups. The special pattern is consistent with the observation that resource allocation within a household is male-biased in rural areas of the PRC. The significance of the difference will be tested in our regressions.

Figure 6a. **Health Expenditure by Period**
(urban residents, both sick and non-sick samples)

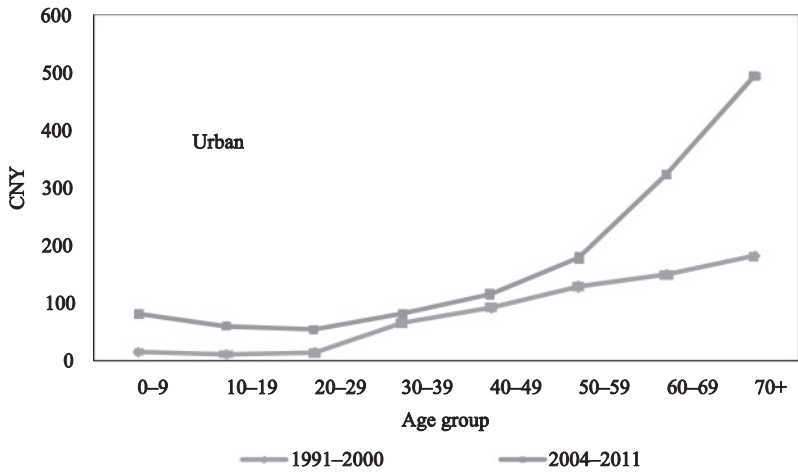
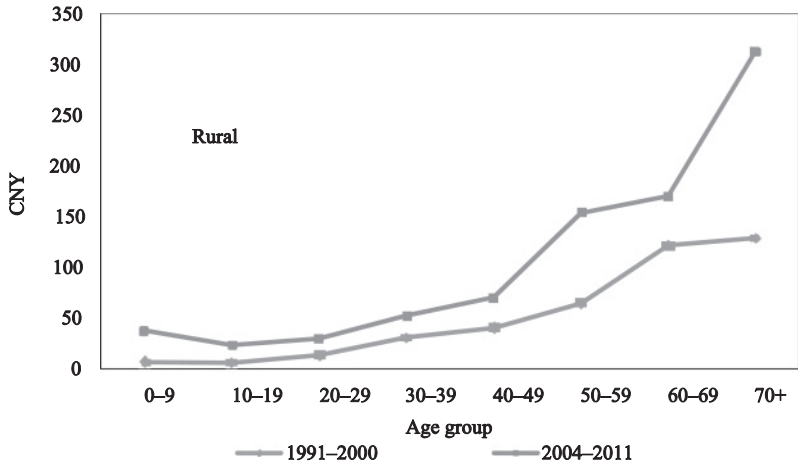


Figure 6b. **Health Expenditure by Period**
(rural residents, both sick and non-sick samples)



Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

D. Health Insurance and Health Expenditure

In our sample, the number covered by public health insurance programs has been increasing over time. Those programs include the BMI, the NCMS, the URBMI, and free medical care for government officials. In 1991, the coverage rate of the cooperative medical care system for rural samples was only 17%, but this rose to 95% in 2011. The coverage rate of health insurance for urban samples increased

Figure 7a. **Health Expenditure by Gender**
(urban residents, both sick and non-sick samples)

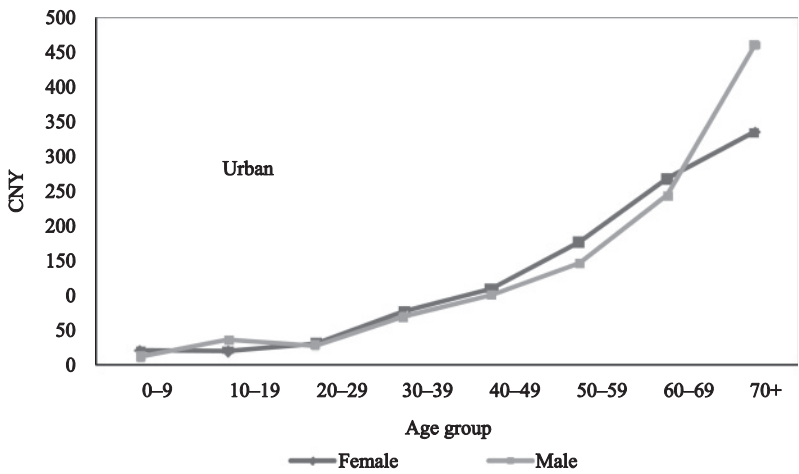
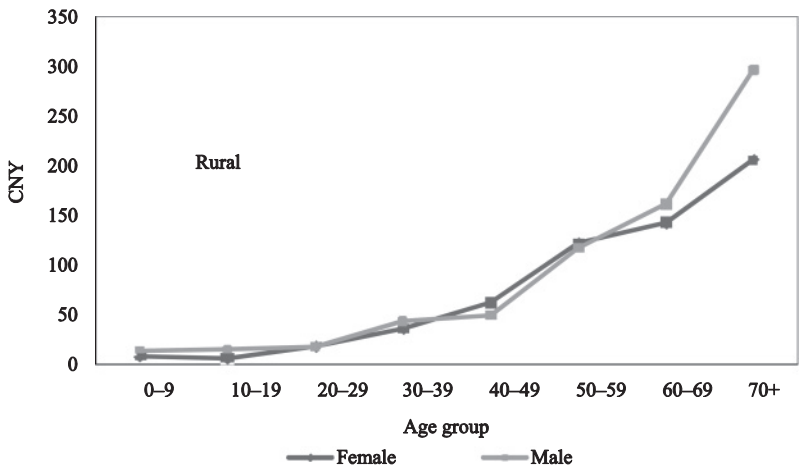


Figure 7b. **Health Expenditure by Gender**
(rural residents, both sick and non-sick samples)



Source: Authors’ calculations using data from the China and Health Nutrition Survey (CHNS).

from 51% in 1991 to 85% in 2011. In the 2011 samples, 50% were covered by NCMS, 17% were covered by URBMI, 22% were covered by BMI, and 3% were still enjoying free medical care.

We compare the spending of those who have health insurance with those who do not have health insurance. Figures 8a and 8b show that, in both urban and rural areas, health insurance increases the expenditure in each age group.

Figure 8a. **Health Expenditure by Insurance Status**
(urban residents, 1991–2011, both sick and non-sick samples)

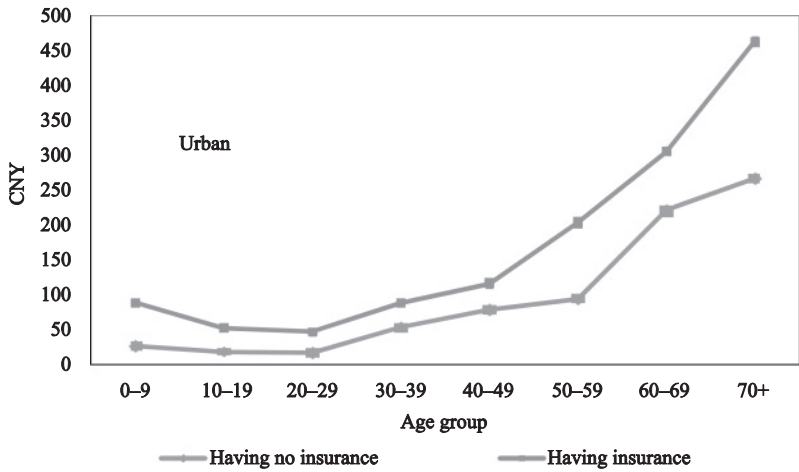
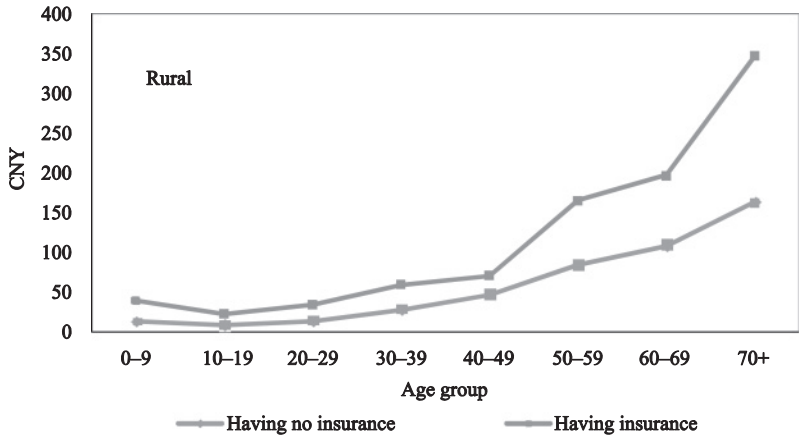


Figure 8b. **Health Expenditure by Insurance Status**
(rural residents, 1991–2011, both sick and non-sick samples)

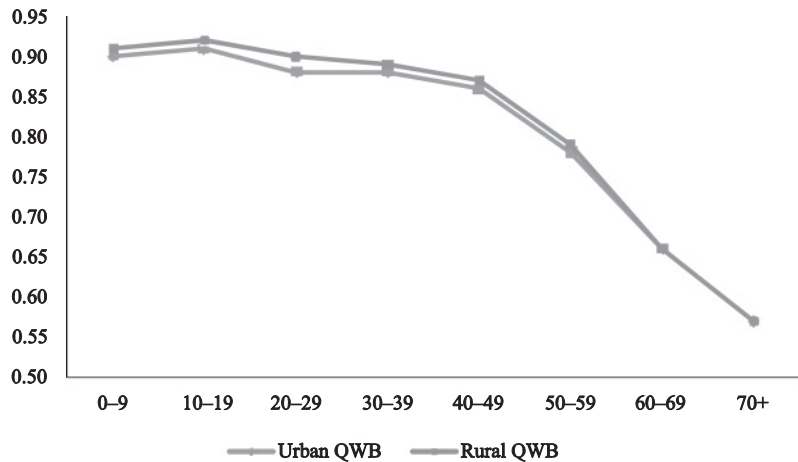


Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

E. Health Status across Age Groups

The survey provides comprehensive information for evaluating the health status of individuals. Self-reported health (SRH) refers to an individual's subjective evaluation of his or her own health. SRH is set according to the interviewee's reply to the question "How would you describe your health?" SRH is set to 1 when the answer is "very good" or "good," while it is 0 with an "ok" or "bad" reply. The

Figure 9a. **Quality of Well-being Scale**
(by rural and urban)



QWB = quality of well-being.
Source: Authors’ calculations using data from the China and Health Nutrition Survey (CHNS).

quality of well-being scale (QWB) is also constructed to more objectively evaluate an individual’s health. QWB is an index developed by Kaplan and Anderson (1988). It not only includes various objective indicators for one’s health status, but subjective evaluation of one’s own health as well. Related questions in the CHNS questionnaire are investigated. Based on those questions, we constructed QWB following the method in Zhao (2008).⁹ QWB is between 0 and 1. Smaller QWB indicates worse health status.

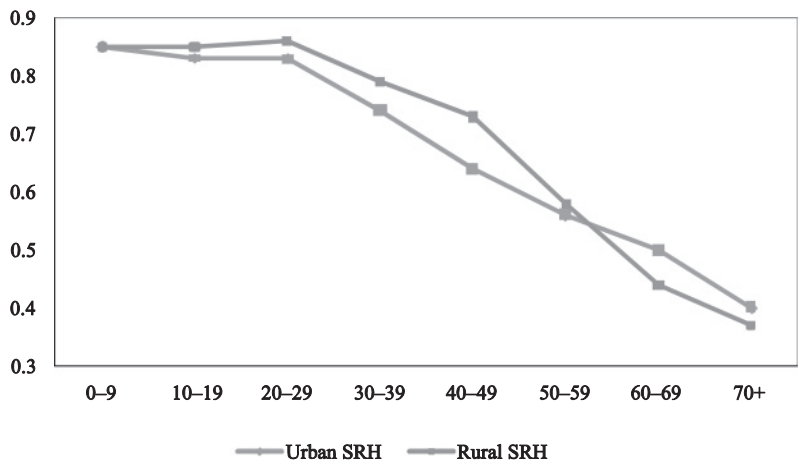
The sample is divided into two groups, those in urban and rural areas. Figures 9a and 9b present the average of SRH and QWB indicators for each age group, respectively. The figures show that in both rural and urban areas, health status deteriorates with age. QWB indicates that the health status of people age 60 and older in rural areas is worse than that of their counterparts in urban areas (Figure 9a).

V. Methodology

The relationship between age and health expenditure in summary statistics includes many forces other than the age structure of the population. To identify the age effects and test the differences of these effects between urban and rural areas, and

⁹QWB is constructed following three steps. First, daily activity is divided into three groups: mobility, physical activity, and social activity. Different illnesses and disabilities can then be catalogued into these three groups. Three sub-indexes can therefore be constructed, reflecting objective health status. Second, a subject index is constructed according to an individual’s own description of his or her health status. Finally, preference weights are used to integrate all the four sub-indexes into one index.

Figure 9b. **Self-reported Health**
(by rural and urban)



SRH = self-reported health.
Source: Authors' calculations using data from the China and Health Nutrition Survey (CHNS).

across various periods, we simultaneously control for demographic characteristics, time effects, and county fixed effects.

The main problem of health spending data at the individual level is that there are a large number of zero-expenditure observations. Such may occur for two main reasons. First, the survey records health spending in the “last 4 weeks,” and a large percent of individuals may not have made such expenditures during this period. Second, even though an individual may have been ill, he may not be able to afford health care. Neglecting these observations, the estimation will be biased. We therefore use a two-part model (2PM) proposed by Duan et al. (1983) to account for these zero-expenditure observations.¹⁰ Two-part models have been widely used in modeling health care expenditure determination in recent studies (e.g., Madden 2008, Bjorner and Arnberg 2012).

In a two-part model, individual behavior is a two-stage process. First, individuals decide whether or not they wish to spend money on health care. Second, the amount of health expenditure is determined. The model regards these two decisions as independent processes and combines them to calculate the marginal effect of variables on health care spending.¹¹

¹⁰Heckman's two-step procedure (1979) constructs the inverse Mills ratio to control for the unobserved selection factors. This correction for sample selection, however, is based on the assumption that the error term in the participating equation and the expenditure equation are subject to bivariate normal distribution. A large bias will be incurred if there is a departure from a bivariate normal distribution (Duncan 1983). Therefore, we use a two-part model to estimate medical spending, which relinquishes the strict assumption while controlling for selection.

¹¹Although the two-part model assumes that the decision processes are independent, the estimation is still unbiased even if the process is a sample selection (Duan et al. 1983).

For the first part, we use a probit model to estimate, using the full sample, whether or not an individual has health expenditures. The equation is written as:

$$I_i = X_i\delta_1 + \varepsilon_i \quad \varepsilon_i \sim N(0, 1) \quad (1)$$

where X_i is a vector of explanatory variables for the i th individual (including age, gender, years of schooling, income, insurance status, year dummies, and county dummies), and ε_i is the error term. If $I \geq 0$, then health spending is larger than zero; otherwise, if $I < 0$, then spending is equal to zero.

The second part is a linear regression of the same vector of explanatory variables on health expenditure (y) using the subsample, with $y > 0$:

$$\log(y_i | I_i > 0) = X_i\delta_2 + u_i \quad u_i \sim [0, \sigma_u^2] \quad (2)$$

These two parts can be estimated separately. Expected health spending, which we are interested in, is the combination of these two parts. For the i th individual in the full sample, the expected health expenditure is:

$$E(y_i | X_i) = \Phi(X_i\delta_1) \times \phi \times \exp(X_i\delta_2) \quad (3)$$

where the transfer factor is $\phi = \exp(\sigma_u^2/2)$, $E(\cdot)$ denotes expected values, and Φ is the cumulative standardized normal distribution.

Furthermore, we can estimate the joint marginal effect of each variable on the probability and magnitude of spending. This is jointly determined by the two-part regression results.¹²

Adopting the two-part model, we first estimate the overall effect of age group and residence using observations from both urban and rural areas. We also estimate age effects of urban and rural residents separately. We then investigate the different age effects across periods.

VI. Estimation Results

Estimated coefficients from the first part of the two-part model are interpreted as the relative magnitude of the effects of explanatory variables on the probability of having positive health expenditure, while estimated coefficients from the second part are the marginal effects of these variables on log spending, for those who do have expenditures. It should be noted that the coefficients cannot tell the overall effect of a variable directly. The overall effect depends on the results of both parts

¹²We use the Stata command "tpm" to estimate coefficients and marginal effects of the two-part model.

jointly, which need further calculations. We will present the regression results and the estimation of overall marginal effects but will focus on the latter.

A. Age Effects in Urban and Rural Areas

The relationship between age and health expenditure in urban and rural areas is presented in Table 2. Columns 1 and 2 summarize the results based on the sample that includes both rural and urban observations. The coefficient of the rural dummy is significantly negative in both parts of the two-part model. In rural areas, the likelihood of spending is 8.22 percentage points lower than in urban areas, while the amount of spending is 44.6% lower among those who do spend.

We run regressions for urban and rural observations separately (Columns 3–4 and 5–6, respectively) to investigate whether urban and rural residents have different age–expenditure profiles. It is shown that after controlling for gender, years of schooling, per capita household income, health insurance, and county dummies, the direction of the coefficients of the age group dummies in rural and urban areas turns out to be similar. However, there are some differences in the size of the coefficients. In the first part of the two-part model, the likelihood of spending generally increases with age, but the size of the increase appears smaller in urban areas than in rural areas. In the second part, health spending similarly increases with age but at a higher rate in urban areas. Year dummies are all significant in the first part and there is a turning point in 2004. The likelihood of incurring expenditure is negative in 2004 compared to 1991 but gradually becomes positive afterwards. Year dummy coefficients are all positive in the second part.

Overall effects are calculated and listed in Table 3. On average, the 4-week expenditure of rural residents is CNY59 or significantly lower by 33% than that of urban residents during 1991–2011. In urban areas, spending is significant higher after age 30 compared to age 0–10. In rural areas, the increase in expenditure occurs beginning age 20.

The most important finding is the much steeper age–expenditure profile in urban areas compared to rural areas even after controlling for time effects and other personal characteristics (Figure 10). However, there is no evidence of better health status among rural residents. Figures 9a and 9b show that health–age profiles are very similar in urban and rural areas. In terms of self-reported health, the rural elderly are worse off than the urban elderly, and health status decreases with age at a more rapid rate. The findings imply that the health spending of the rural elderly may increase more during the process of rural–urban integration.

Although the effect of rising income and expanding health-insurance coverage has been controlled, year dummies capture the net effects of many drivers of health expenditure, such as technology progress and the comprehensive institutional impacts we described in Section II. Table 3 shows that the overall effects of the

Table 2. Results of the Two-part Model in Urban and Rural Areas

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Total		Urban		Rural	
	1st-part probit	2nd-part regress log	1st-part probit	2nd-part regress log	1st-part probit	2nd-part regress log
Rural	−0.0822*** (0.0135)	−0.446*** (0.0401)				
10–19	−0.133*** (0.0377)	0.106 (0.127)	−0.223*** (0.0647)	0.193 (0.196)	−0.0881* (0.0470)	0.0551 (0.165)
20–29	−0.0986** (0.0396)	0.556*** (0.132)	−0.216*** (0.0674)	0.575*** (0.204)	−0.0436 (0.0496)	0.529*** (0.173)
30–39	0.0680* (0.0363)	0.718*** (0.118)	−0.121* (0.0627)	0.824*** (0.186)	0.161*** (0.0450)	0.632*** (0.153)
40–49	0.182*** (0.0347)	0.860*** (0.112)	0.00718 (0.0601)	1.013*** (0.177)	0.266*** (0.0430)	0.766*** (0.145)
50–59	0.375*** (0.0338)	1.166*** (0.108)	0.193*** (0.0584)	1.241*** (0.169)	0.463*** (0.0418)	1.114*** (0.140)
60–69	0.559*** (0.0340)	1.320*** (0.108)	0.389*** (0.0586)	1.397*** (0.168)	0.638*** (0.0423)	1.254*** (0.139)
70+	0.729*** (0.0350)	1.547*** (0.108)	0.594*** (0.0594)	1.664*** (0.167)	0.788*** (0.0439)	1.442*** (0.141)
1993	−0.295*** (0.0285)	0.204** (0.0959)	−0.294*** (0.0490)	−0.00167 (0.154)	−0.295*** (0.0351)	0.335*** (0.122)
1997	−0.237*** (0.0278)	0.176* (0.0917)	−0.145*** (0.0462)	0.201 (0.141)	−0.286*** (0.0352)	0.194 (0.121)
2000	−0.192*** (0.0277)	0.222** (0.0900)	−0.138*** (0.0469)	0.319** (0.142)	−0.219*** (0.0346)	0.202* (0.116)
2004	0.240*** (0.0248)	0.177** (0.0752)	0.214*** (0.0423)	0.282** (0.121)	0.262*** (0.0308)	0.112 (0.0961)
2006	0.157*** (0.0253)	0.0665 (0.0764)	0.105** (0.0433)	0.324*** (0.124)	0.200*** (0.0318)	−0.0899 (0.0989)
2009	0.128*** (0.0265)	0.460*** (0.0787)	0.0709* (0.0431)	0.655*** (0.122)	0.193*** (0.0351)	0.305*** (0.107)
2011	0.0564** (0.0275)	0.452*** (0.0818)	0.0580 (0.0441)	0.561*** (0.125)	0.0878** (0.0364)	0.323*** (0.112)
Male	−0.0729*** (0.0128)	0.0966** (0.0386)	−0.103*** (0.0210)	0.119** (0.0590)	−0.0504*** (0.0163)	0.0803 (0.0508)
ln(income per capita)	−0.00528 (0.00570)	0.0270 (0.0174)	−0.0107 (0.00939)	0.0186 (0.0273)	−0.00521 (0.00723)	0.0251 (0.0227)
Years of schooling	−0.0152*** (0.00185)	0.0167*** (0.00532)	−0.00809*** (0.00286)	0.0136* (0.00771)	−0.0207*** (0.00247)	0.0201*** (0.00747)
Having insurance	0.143*** (0.0165)	0.0402 (0.0495)	0.181*** (0.0257)	0.0506 (0.0730)	0.0955*** (0.0229)	0.100 (0.0705)
Observations	89,235	8322	28,924	3,187	60,311	5,135

*** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.

Note: County dummies are included in regressions as controls. Reference age group is 0–9 years, while reference year is 1991. Standard errors in parentheses.

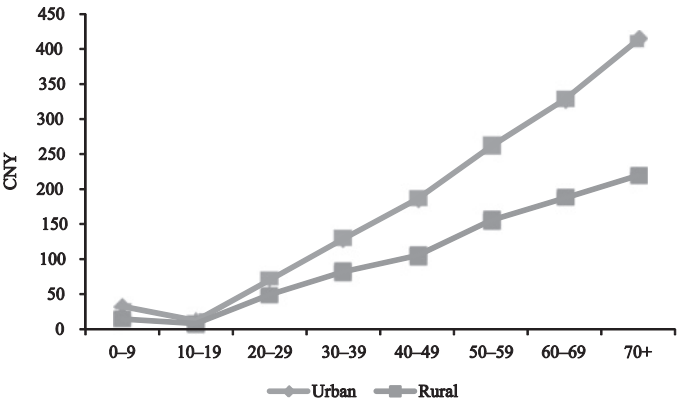
Source: Authors' computations.

Table 3. Overall Effects in Urban and Rural Areas

	Total dy/dx	Urban dy/dx	Rural dy/dx
Rural	−58.811***	—	—
10–19	−10.156	−20.490	−6.509
20–29	41.556***	37.928	34.875**
30–39	84.434***	96.516***	67.607***
40–49	117.035***	153.119***	90.521***
50–59	178.937***	228.547***	140.762***
60–69	223.778***	295.333***	172.610***
70+	273.880***	380.852***	205.139***
1993	−25.593*	−65.607	−10.384
1997	−19.307*	−2.171	−19.921*
2000	−7.474	17.046	−11.276
2004	56.092***	89.697***	40.285***
2006	31.665***	71.811***	17.504**
2009	67.380***	113.715***	46.543***
2011	55.272***	96.866***	35.213***
Male	−1.569	−5.147	−0.011
ln(income per capita)	1.940	0.413	1.271
Years of schooling	−0.672	0.244	−0.981
Having insurance	26.748***	47.762***	19.227***

*** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: Overall marginal effects are calculated from the estimates in Table 2. For dummy variables, dy/dx is the change in health expenditure when there is a discrete change from the base level. For continuous variables, dy/dx is the change in health expenditure when x increases by 1 unit.
Source: Authors' computations.

Figure 10. Estimated Age Profile of Health Expenditure in Urban and Rural Areas



Source: Authors' computations (data obtained from the overall effects in Table 3).

year dummies for 1993, 1997, and 2000 are negative, and some of them are not significant. However, year dummies are significantly positive since year 2004. The results are largely driven by the rising government involvement in the health care sector, which increased the accessibility of health care.

Health insurance is very significant both in urban and rural areas, though the effect is larger in urban areas. The finding is consistent with the higher reimbursement ratio of BMI compared to that of NCMS.

The effect of gender is not significant but is negative. The expenditure of males is lower than that of females, a common finding in the literature (e.g., Strauss et al. 1993). The magnitude of this gender effect is smaller in rural areas, consistent with the observation that household resource allocation is male-biased in rural areas. Household per capita income and years of schooling have no significant overall effect on health spending. The more highly educated are less likely to incur expenditures because of better health but spend more if needed, so that the combined overall effect is not significant.

B. Age Effects across Different Periods

We further investigate whether age effects change across time. As explained in Section II, there have been some fundamental changes in health care reform after 2003. We also observe from the results in Tables 2 and 3 that the direction of year effects changes since 2004. Hence, we divide the samples into two periods: 1991–2000 and 2004–2011.

Table 4 presents the results of the two-part model for the two periods, for both urban and rural residents, where we focus on age effects. Based on the results, we then obtain the overall effects of the different age groups in Table 5. The results indicate that in urban areas, health expenditure is increasing with age after age 40 in both periods. The effects are larger during 2004–2011 for ages 50 and older.

It is worth noting that in rural areas, the marginal effect of the age group 70 and over is smaller than the age group 60–69 during 1991–2000. There is similar evidence in the literature that the rural elderly spend less than the primary-age household members (e.g., Yan and Chen 2010). The age–expenditure profile in rural areas changed to a more typical pattern during 2004–2011, where expenditure tends to increase with age in adulthood. The magnitude of age effects is also much bigger during the period 2004–2011 than during 1991–2000.

The estimated age–expenditure profile becomes steeper over time in both urban and rural areas (Figure 11). Other factors being equal, comparing age–expenditure profiles in the two periods may reveal a cohort effect that is mixed with age effects. The cohort effect captures a number of influences, including the various impacts across age groups of a changing health care system, economic

Table 4. Results of the Two-part Model in Different Periods

Variables	(1) Urban 1991–2000		(3) Urban 2004–2011		(5) Rural 1991–2000		(7) Rural 2004–2011	
	1st part probit	2nd part regress log	1st part probit	2nd part regress log	1st part probit	2nd part regress log	1st part probit	2nd part regress log
10–19	–0.321*** (0.0972)	0.385 (0.350)	–0.162* (0.0892)	0.00786 (0.237)	–0.173*** (0.0661)	0.352 (0.251)	–0.00303 (0.0676)	–0.157 (0.221)
20–29	–0.300*** (0.0999)	0.882*** (0.356)	–0.176* (0.0938)	0.278 (0.251)	–0.128* (0.0692)	0.743*** (0.262)	0.0422 (0.0720)	0.382 (0.233)
30–39	–0.0513 (0.0921)	1.205*** (0.319)	–0.206** (0.0875)	0.517** (0.231)	0.205*** (0.0638)	0.750*** (0.236)	0.130** (0.0642)	0.517*** (0.204)
40–49	0.139 (0.0890)	1.321*** (0.307)	–0.0859 (0.0836)	0.720*** (0.218)	0.254*** (0.0609)	0.938*** (0.224)	0.292*** (0.0614)	0.642*** (0.194)
50–59	0.340*** (0.0892)	1.598*** (0.302)	0.113 (0.0802)	0.945*** (0.205)	0.442*** (0.0609)	1.264*** (0.222)	0.490*** (0.0590)	0.992*** (0.185)
60–69	0.455*** (0.0892)	1.769*** (0.301)	0.348*** (0.0804)	1.090*** (0.204)	0.616*** (0.0622)	1.413*** (0.221)	0.666*** (0.0593)	1.119*** (0.184)
70+	0.673*** (0.0939)	1.841*** (0.310)	0.532 (0.0801)	1.424*** (0.201)	0.614*** (0.0691)	1.328*** (0.241)	0.870*** (0.0602)	1.371*** (0.184)
1993	–0.312*** (0.0496)	0.128 (0.170)			–0.297*** (0.0353)	0.350*** (0.125)		
1997	–0.174*** (0.0482)	0.250 (0.160)			–0.283*** (0.0361)	0.244* (0.127)		
2000	–0.187*** (0.0496)	0.447*** (0.166)			–0.214*** (0.0358)	0.261** (0.124)		
2006			–0.103*** (0.0398)	0.0188 (0.105)			–0.0512* (0.0300)	–0.144* (0.0872)
2009			–0.121*** (0.0420)	0.392*** (0.109)			–0.0434 (0.0355)	0.309*** (0.101)
2011			–0.133*** (0.0431)	0.300*** (0.111)			–0.149*** (0.0370)	0.331*** (0.106)

Continued.

Table 4. *Continued.*

Variables	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	Urban 1991–2000		Urban 2004–2011		Urban 1991–2000		Urban 2004–2011		Rural 1991–2000		Rural 2004–2011		Rural 1991–2000		Rural 2004–2011	
	1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part
	probit	regress log	probit	regress log	probit	regress log	probit	regress log	probit	regress log	probit	regress log	probit	regress log	probit	regress log
Male	–0.0593*	0.181	–0.131***	0.0724	–0.0233	0.0132	–0.0697***	0.102*								
	(0.0351)	(0.115)	(0.0264)	(0.0683)	(0.0267)	(0.0949)	(0.0207)	(0.0602)								
ln(income per capita)	–0.000752	–0.0846	–0.00669	0.0380	–0.00317	–0.0587	–0.00606	0.0391								
	(0.0226)	(0.0767)	(0.0105)	(0.0289)	(0.0164)	(0.0611)	(0.00811)	(0.0244)								
Years of schooling	0.00447	0.00155	–0.0146***	0.0232***	–0.0166***	0.0104	–0.0228***	0.0234***								
	(0.00485)	(0.0151)	(0.00360)	(0.00899)	(0.00431)	(0.0150)	(0.00307)	(0.00871)								
Having insurance	0.207***	0.102	0.135***	0.000760	0.138***	0.474***	0.0598**	–0.0841								
	(0.0395)	(0.129)	(0.0351)	(0.0912)	(0.0364)	(0.127)	(0.0297)	(0.0860)								
Observations	13,202	951	15,722	2,236	31,609	1,513	28,702	3,622								

*** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.

Note: County dummies are included in regressions as controls. Reference age group is 0–9 years. Reference year in period 1991–2000 is 1991. Reference year in period 2004–2011 is 2004. Standard errors in parentheses.

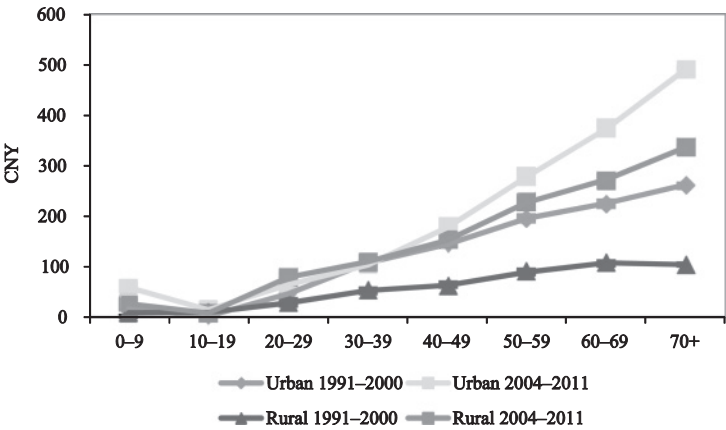
Source: Authors' computations.

Table 5. Overall Age Effects in Different Periods

Age group	Urban 1991–2000 dy/dx	Urban 2004–2011 dy/dx	Rural 1991–2000 dy/dx	Rural 2004–2011 dy/dx
10–19	–13.830	–44.130	0.860	–18.796
20–29	29.946	5.356	19.128	51.696
30–39	91.615	44.451	43.599***	82.645***
40–49	128.138***	118.706**	54.321***	125.224***
50–59	179.280***	219.151***	80.538***	200.303***
60–69	209.595***	314.352***	98.886***	245.691***
70+	246.440***	432.767***	95.500***	310.306***

*** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
Note: Overall marginal effects of age are calculated from the estimates in Table 4. For each age group, dy/dx is the change in expenditure compared with the reference group (0–9 years) when the group dummy changes from 0 to 1.
Source: Authors’ computations.

Figure 11. Estimated Age Profile of Health Expenditure across Periods



Source: Authors’ computations (data obtained from the overall effects in Table 5).

development, initial conditions of people born in different times, etc. The steeper profiles imply that the cohort effect is in the same direction as age effects in adulthood, which leads older groups to have greater increases in health spending than younger groups under the same circumstances.

VII. Population Aging and Growth of Aggregate Health Spending

The aggregate national health expenditure of the PRC has been growing as a share of GDP and in terms of per capita level. The figures were 4% and CNY65,

respectively, in 1990, and 4.6% and CNY362 in 2000, increasing to 5% and CNY1,400 in 2010. During 1990–2010, the real annual growth rate of health spending (including government spending, health insurance, and household expenditure) of the PRC was 13.3%. The growth rate is much higher than in OECD countries, where it stood around 5%. The higher growth rate of health spending in the PRC is related to a series of factors, including lower initial levels, rising per capita income, rising government spending, more comprehensive public health insurance programs, and rapid population aging. The difference implies that spending growth in the PRC during urbanization is a welcome development, as people receive much-needed health care.

We estimate the contribution of population aging and urbanization to the growth of spending in the PRC during this period based on the results of Section VI. We employ demographic data of the PRC from *World Population Prospects* of the United Nations.¹³ We predict per capita health expenditure for each age group. Using per capita spending multiplied by the population of the age group, we sum the expenditures for each age group and obtain the total health expenditure for each year. Comparing the predicted health expenditure of a year with the amount spent in year 2010, we obtain the ratio from which we may calculate the annual growth rate of health expenditure. The growth rate we are estimating is purely due to the change of demographic structure and urbanization, and not due to other factors.

During 1990–2010, urbanization increased from about 26% to 45%. According to the estimation, annual growth of health expenditure caused by population aging during urbanization in this period was about 2.8%, accounting for about a fifth of the total 13.3% real annual growth.

Rapid population aging and urbanization will likely continue in the PRC. Using the method of estimation as in the previous paragraph (employing demographic projections by the United Nations shown in Table 6 and assuming an urbanization rate of 70% in 2030), we compute the annual growth in health expenditure caused by population aging during urbanization to be about 2.2%. However, we are cautious with such a projection, as there are many uncertainties in the future. As we have shown, the age–expenditure profile may change over time. This could be because different cohorts have different age profiles of health expenditure, or because people of different ages respond to the changing health care system differently. Insurance, for example, has exerted a significant influence on health care. However, the expansion of health insurance coverage will someday end, which will have different effects on people of various ages.

¹³United Nations, Department of Economic and Social Affairs. *World Population Prospects: The 2012 Revision*. Available online: <http://esa.un.org/unpd/wpp/index.htm>.

Table 6. Demographic Change of the People's Republic of China

	1990	1995	2000	2005	2010	2015	2020	2025	2030
Population									
(millions)									
0–9	245	245	192	162	164	177	176	160	146
10–19	219	204	242	244	191	161	163	176	175
20–29	232	245	216	201	239	241	189	159	161
30–39	172	190	228	241	212	198	237	239	188
40–49	111	148	168	186	223	237	209	196	234
50–59	86	90	105	141	161	179	216	230	203
60–69	59	68	75	80	95	127	145	163	198
70+	42	47	54	64	74	82	97	126	148
Total	1,165	1,238	1,280	1,318	1,360	1,402	1,433	1,449	1,453
Structure									
(%)									
0–9	20.98	21.06	16.51	13.86	14.06	15.15	15.11	13.76	12.52
10–19	18.78	17.49	20.79	20.90	16.41	13.79	13.98	15.08	15.05
20–29	19.88	21.06	18.56	17.24	20.51	20.68	16.25	13.65	13.85
30–39	14.78	16.30	19.56	20.71	18.23	17.01	20.31	20.50	16.11
40–49	9.54	12.67	14.41	15.93	19.16	20.36	17.97	16.79	20.09
50–59	7.39	7.73	9.03	12.11	13.82	15.34	18.52	19.72	17.44
60–69	5.07	5.84	6.40	6.82	8.12	10.93	12.47	13.98	16.97
70+	3.57	4.03	4.61	5.53	6.37	7.01	8.33	10.84	12.68

Note: We use the results of medium variant.
Source: United Nations, Department of Economic and Social Affairs. *World Population Prospects: The 2012 Revision*. Available online: <http://esa.un.org/unpd/wpp/index.htm>.

VIII. Conclusions

Estimating health expenditure over the life cycle is primary work needed to understand the influence of population aging on the growth of health spending in the PRC. We use eight waves of CHNS data during 1991–2011 to investigate the age–expenditure relationship for rural and urban residents in different periods. The estimations show that health care reform and urbanization increase the demand for health care generally, but expenditure by the elderly increases more than other age groups.

Specifically, while health care spending of rural residents is lower than that of urban residents in all age groups, the age–expenditure profile is much steeper in urban areas than in rural areas. Therefore, health expenditure of the elderly increases more during the process of rural–urban integration. There is also a significant difference in age–expenditure profiles across time in both urban and rural areas, with steeper profiles verified in the later period. The result suggests that there is a cohort effect mixed with age effects, which is in the same direction as age effects in adulthood. The cohort effect causes the elderly to increase health expenditure by more than the younger group even if they experience common social or economic changes.

Population aging during urbanization has contributed to the growth of aggregate health expenditure in the PRC by about 2.8%, accounting for about a fifth of total annual growth between 1990 and 2010. In the future, population aging and urbanization will continue to drive health spending.

Nevertheless, the growth of health expenditure has a different meaning for the PRC than for OECD countries. Our results suggest that there is an unmet health care demand among rural residents, particularly among the elderly. It has been reported by the National Health Services Survey that a non-negligible proportion of rural people refuse outpatient services and inpatient care when sick, even when they are referred to hospitals, as they cannot afford the services. Owing to the current low ratio of health care spending to GDP, the PRC has the potential to greatly improve health insurance and increase government investment in health care.

It is important to mention that our estimation of age-expenditure profiles is based on health spending from the demand side, without considering government spending directly. Referring to the findings of Shen and Lee (2014), who find a similar age profile of per capita public health care spending as in our estimations, the results we obtained can also apply to the scenario where government spending is included.

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*ADB recognizes "China" as the People's Republic of China.

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