The Welfare Effect of Health Insurance in Rural China: Evidence from New Cooperative Medical Scheme[*]

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Abstract

The New Cooperative Medical Scheme (NCMS) provides primary health insurance for the rural residents in China. We evaluate the welfare benefits of access to health insurance via the introduction of NCMS and compare them against the costs. We find that the value of participating in the NCMS is well below the government's costs in implementation. A benefit-cost ratio of 0.41RMB shows that the enrollees would rather give up the insurance than paying the government's costs.

Key Words: Health insurance, New Cooperative Medical Scheme, China, welfare analysis
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1. Introduction

Providing adequate healthcare is a critical element of economic development. As one of the fastest developing countries in the world, China is no exception. Since the inception of the New Cooperative Medical Scheme (NCMS) in 2003, access to health insurance for rural residents expanded dramatically given the fact that almost none were enrolled in health insurance in rural China (see Figure 1) in 1990s. NCMS is a heavily subsidized government-run insurance program. Its aim is to provide health insurance for all citizens with rural hukou and thus to eliminate rural poverty caused by catastrophic medical expenditures.[4] The enrollment is voluntary, but 97.5% of rural residents (or 832 million individuals) enrolled by 2011 (Hou et al., 2014, Ministry of Health, 2012) which essentially achieves the goal of universal health insurance in China (see Figure 2).

Previous studies evaluating the impacts of NCMS mostly focus on healthcare utilization and health (Lei and Lin, 2009; Hou et al, 2014; Wagstaff et al, 2009; Liu and Tsegai, 2011; Cheung and Padieu, 2015). These studies document that NCMS increases healthcare utilization but fail to find evidence of significant health improvements. In addition, access to NCMS does not lead to a significant reduction in out-of-pocket medical expenditures (Wagstaff et al., 2009; Liu and Tsegai, 2011; Hou et al., 2014; Lei and Lin, 2009).

It is important to establish behavioral impacts of NCMS, but it is also important to estimate the welfare impacts of NCMS, the largest health insurance reform in rural China for the past decades.[5] Yet, no study has estimated whether NCMS as a major healthcare policy reform is cost effective in terms of the welfare of the society as a whole. There exists strong demand for other social insurance programs such as old-age pension in rural China, thus it is critical to conduct rigorous welfare analysis of NCMS to make sure that policy makers are optimizing the use of scarce resources.

However, the welfare evaluation of a social insurance program like NCMS is empirically difficult because it is not a traded good in the free market (Finkelstein et al., 2016; Samuelson, 1954). To overcome this challenge, most empirical studies in the literature structurally estimated key parameters of a life-cycle model to calculate the welfare value of

[4] *Hukou* is a household registration system in China that identifies a person as a resident of a specific urban or rural area. In most cases, urban hukou comes with various social benefits such as health insurance, pension, unemployment insurance, housing benefit, etc.

[5] The government expenditure for NCMS reached 240.8 billion RMB in 2012 (China Health Statistical Yearbook, 2013). 1 RMB is equivalent to 0.15 USD as of September, 2016.

public health insurance such as Medicare and Medicaid in the U.S. (French and Jones, 2011; De Nardi, French and Jones, 2016; Blau and Gilleskie, 2006; Blau and Gilleskie, 2008; Kim, 2016). A structural approach is useful in identifying specific mechanisms and performing counterfactual policy simulations but it requires significant computational burden as well as strong assumptions about the model structure.

We evaluate the welfare benefits of the NCMS through a "sufficient statistic" approach, an increasingly popular and growing middle ground between structural estimation and reduced-form estimation.[6] Specifically, our analysis closely follows the framework proposed by Finkelstein, Hendren and Luttmer (2016), modeling individual's willingness-to-pay for the NCMS as the amount of consumption that would leave the individual indifferent between enrollment and non-enrollment.

[brief description of the methodology]

[brief description of the main analysis]

[brief discussion of the main findings]

The rest of the paper proceeds as follows. Section 2 provides a brief background of the NCMS and reviews the related literature. Section 3 describes the data. Section 4 discusses the identification strategy for the welfare evaluation of NCMS and we report the results in Section 5. Section 6 concludes.

2. Institutional Background and Related Literature

Institutional Background

Since its establishment in 1949, the People's Republic of China has undertaken a series of policy measures in providing health care to the public. From 1950 to 1984, under the central-planned economy, the Chinese government created state-run health care system similar to other communist countries and provided universal health care. Agricultural workers were covered by the Commune-based Cooperative Medical Scheme (CMS). Workers from state-owned enterprises (SOE) were covered under Labor Insurance Scheme (LIS) and civil servants were reimbursed through the Government Insurance Scheme (GIS). The CMS covered almost 90% of the rural residents in its peak in 1978 (Lei and Lin, 2009).

However, the Chinese government greatly reduced its role in providing health care services with free-market reforms starting from 1984. This radical policy change not only led

[6] The sufficient statistics approach combines the advantage of both structural and reduced-form approaches in that it translates the reduced-form estimates on behaviours into welfare estimates (Chetty, 2008; Chetty and Finkelstein, 2010; Kowalski and Kolstad, 2016).

to the dismissal of people's communes but also the collapse of the CMS. As a result, the majority of the rural residents remain uninsured through 1985 to 2003 (Hou et al., 2014; Lei and Lin, 2009). Figure 1 shows the health insurance coverage for rural and urban population by income in 1993, 1998 and 2003, respectively. Compared to the urban counterparts, even the highest income quantile of the rural residents has much lower insurance coverage, indicating wide inequalities in health insurance accessibility.

To establish universal coverage and improve the affordability of medical services, the Chinese government announced the New Cooperative Medical Scheme (NCMS) in 2003, a highly subsidized public health insurance program for rural residents. NCMS covered 310 counties in 2004, but it included 2,489 counties by the end of the 2013 [7], accounting for 87% of all rural counties in China (Lei and Lin, 2009; China Statistical Yearbook, 2013). Figure 2 presents the percentage of insurance coverage for rural residences from 1993 to 2011 using the CHNS data. In 1993, only 0.8% of the rural sample had insurance. Starting from 2004, the proportion of rural sample having insurance increased steadily from 11.7% to 95.9% in 2011, reflecting the rapid expansion of the NCMS enrollment.

An interesting feature of the NCMS is that it exhibits variations in deductibles, copayments, premiums and coverage across counties. It is because a local government has considerable discretion over specific program parameters following the guideline issued by the central government.[8] Another interesting feature of NCMS is that its enrollment is voluntary but it requires enrollment of all household members to avoid the adverse selection problem.

NCMS is financed by both individual contributions and government subsidies. The individual contribution for NCMS was on average 150 RMB per enrollee across provinces in 2016 (Ministry of Finance, 2016). The total subsidies from central and local government steadily increased over time and reached 420 RMB per person in 2016.

Literature Review

Our study is related to several strands of the literature. First, our study is related to the existing literature on the welfare effect of public health insurance. We contribute to the literature by estimating a welfare impact of a rural health insurance reform in China using a "sufficient statistic" approach. As stated in the introduction, it is difficult to directly estimate

[7] There are in total 2,862 counties in China.
[8] The 2002 State Council Policy Document No.13, Decisions of the State Council on Strengthening Rural Healthcare (State Council, 2002).

the welfare effect from a reduced-form approach which mainly focuses on behavioral impacts. Most of the studies in this literature that conduct welfare analysis use a structural estimation approach (French and Jones, 2011; De Nardi, French and Jones, 2016; Blau and Gilleskie, 2006; Blau and Gilleskie, 2008; Kim, 2016).[9] A disadvantage of a reduced-form approach is its inability to address welfare impacts and a disadvantage of a structural estimation approach is that it requires significant computational burden as well as strong assumptions about the model structure. The sufficient statistic approach combines the advantage of both structural and reduced-form approaches by estimating key model parameters via reduced-form regression that can be used to conduct welfare evaluations (Chetty, 2008; Chetty and Finkelstein, 2010). For example, Finkelstein, Hendren and Luttmer (2016) use this approach to translate the reduced-form behavioral impacts of Medicaid to welfare estimates. In a similar spirit, Kolstad and Kowalski (2016) estimate the welfare impacts of Massachusetts health insurance reform based on a set of reduced-form estimates on wages and employment.

Our study is also related to the growing literature on the impact evaluations of NCMS (Lei and Lin, 2009; Wagstaff et al., 2009; Liu and Tsegai, 20011; Chen and Jin, 2012; Hou et al., 2014; Cheung and Padieu, 2015; Donato and Rokicki, 2016). To our best knowledge, all of the earlier studies focus on the impacts of NCMS on health and healthcare utilization. They find that NCMS enrollees are more likely to seek proper medical advices for minor symptoms at early stage before turning into serious diseases (Liu and Tsegai, 2011). In particular, NCMS enrollment decreases folk doctor visits and increases the utilization of preventive care, particularly general physical examination (Lei and Lin, 2009). However, there is no evidence that NCMS significantly improved health outcomes (Lei and Lin, 2009; Chen and Jin, 2012; Donato and Rokicki, 2016). We contribute to the literature on NCMS by providing evidence on its welfare effect through the sufficient statistics approach following the framework of Finkelstein et al. (2016). To our best knowledge, this is the first study to evaluate the welfare impact of NCMS.

3. Data

[9] For example, French and Jones (2011) develop a life-cycle model of saving and labor supply that incorporates uncertain medical expenses and health insurance to evaluate the effect of health insurance on retirement behaviors and welfare. Similarly, Kim (2016) estimate a life-cycle model of consumption, labor supply, and disability insurance application decisions to find the welfare effect of Medicare, public health insurance for the elderly and the disabled in the U.S.

We use the China Health and Nutritional Survey (CHNS) to estimate the value of NCMS. CHNS begins in 1989 and has eight subsequent waves in 1991, 1993, 1997, 2000, 2004, 2006 and 2011. It covers nine provinces (Guangxi, Heilongjiang, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong) that vary considerably in terms of geography, economic development and public resources.[10] In this study, we use waves from 1997, 2000, 2004, 2006, 2009 and 2011.

The advantages of using CHNS for this study are that (i) it offers a wide range of measures of health, medical spending, nutritional intakes and other individual and household characteristics; (ii) it covers the time range before and after the implementation of the NCMS and thus allows us to employ a difference-in-differences approach; (iii) it contains county-level information such as local food prices, which enables the construction of individual and household consumption; (iv) it records both individual NCMS enrolment status and county-level offer status so that we can use the county-level offer status as an instrument for an endogenous individual-level NCMS enrolment decision. By comparison, the China Health and Retirement Longitudinal Study provides comparable information in terms of demographics and medical expenditures, but it starts from 2011 and does not offer any county level identification. The China Family Panel Studies provides both individual and county level information but was launched only from 2010, thus we cannot observe changes in key outcome variables before the inception of NCMS.

We use the following sample selection criteria. First, we restrict the sample to be rural residents with rural hukou following Lei and Lin (2009) because NCMS only enrolls individuals with rural hukou. Second, we exclude observations with missing information on key variables such as insurance enrollment status, county-level NCMS offer status, education, and ethnicity. After imposing the above selection criteria, the final sample consists of 15,453 individuals (3,039 households).

The key variables for analysis are defined as follows. All monetary values are measured in 2011 RMB, adjusting for inflation using the Consumer Price Index of China for the rural population.

Consumption

Consumption expenditure is a critical variable to measure for welfare analysis. CHNS has very detailed information about household consumption items to construct household

[10] Liaoning was dropped out from the survey in 1997 but returned from 2000 and onwards.

consumption expenditure per adult equivalent.[11] Closely following the approach used by Santaeulalia-Llopis and Zheng (2016), we define household consumption as total expenditures of food, utilities, housing services, childcare services and education, and semi-durable supplies. Compared to the consumption composition of a Chinese household from the China Statistical Year Books, our definition captures approximately 50% to 60% of rural household's consumption basket. We do not have information regarding transportation and clothing expenditures. The specific details of the variable construction procedures are described in Appendix B.

Health

CHNS asks a variety of health-related information to its respondents. To summarize the overall condition of a respondent's health status using rich information in CHNS, we construct a health index, an average over standardized z-score measures of five major health outcome variables (hypertension, diabetes, heart attack, bone fracture and stroke).[12] We choose these five health conditions because they are available through all waves. A larger value in the index represents better health status. Compared to using each health outcome variable alone, aggregating multiple measures into a single index is parsimonious and straightforward to apply in the welfare calculation. Alternatively, one can use self-reported general health status as in Finkelstein et al. (2016). However, CHNS has asked the self-reported health only until 2006, and they are missing in 2009 and 2011.[13]

Medical Expenditure

CHNS has rich information regarding respondents' healthcare utilization and medical expenditures. In CHNS, medical costs are separately divided into treatment services and preventative service. Respondents were asked to recall the total treatment costs (not out-of-pocket cost) of most recent illness that occurred in the past four weeks. All medical services usages (inpatient, outpatient and preventive care) record the percentage covered by insurance

[11] To adjust for family size, we use the OECD equivalent scale. We assume that each household has two adults if the family size is greater than two. In the robustness analysis, we use unadjusted consumption expenditure.
[12] We follow the approach of Kling et al., (2007) who use the control group mean and standard deviation when computing an economic index based on z-scores. To mimic their approach, we use the mean and standard deviation of the sample from the counties that do not offer NCMS.
[13] We later report the results using the self-reported health based on the data until the 2006 wave as a robustness check.

(i.e., coinsurance rate). We infer individual-level out-of-pocket expenditure based on the coinsurance rate and total medical expenditure.

NCMS Status

CHNS provides the information on health insurance types an individual is enrolled. However, it does not distinguish between the old CMS (in which only few were enrolled) and the current NCMS until the 2009 wave and onwards. Fortunately, the community survey contains the information on whether the surveyed community had implemented the CMS and the starting date. Exploiting the fact that NCMS was implemented from 2003, we define the CMS plans that operate in or after 2003 as NCMS. For example, we define individuals who reported participating in CMS and living in a community that had adopted NCMS as having enrolled in NCMS.[14] Since NCMS implementation operates at the county level, we define a county offered NCMS if any of the community within a county adopted NCMS. Following Lei and Lin (2009), the rollout of county NCMS is used as an instrument for endogenous NCMS participation in the regression analysis.

Mortality

Using the death information available from 1997 through 2011, we construct the post 14-year survival probability and use it to estimate the effect of health using the aggregate health index (as of year 1997) on mortality (as of year 2011). We cannot use the data before 1997 because components of the health index are only available from 1997 onwards.

Sample statistics

Sample statistics are reported in Table 1. The first column reports results for the whole rural sample. Second and third column presents descriptive statistics for the insurance enrollees and individuals without any health insurance. Fourth column reports the difference between individuals with insurance and the ones without. Compared to the non-enrollees, the insurance participants are in general less healthy. For disease history measures, the insurance enrollees are more likely to have hypertension, diabetes, heart attack, bone fracture and stroke. Panel 2 of Table 1 presents the descriptive statistics for utilization. Compared to the

[14] Similarly, individuals who reported participating in CMS but was living in a community that had not adopted NCMS are defined as not enrolled in the NCMS.

uninsured, the insured have larger total medical expenditure and out-of-pocket expenditure. However, the difference between out-of-pocket spending between the insured and the uninsured is much smaller than the difference between total medical expenditure. In addition, the insured have higher household consumption compared to the non-insurance holders even after adjusting for family size.

4. Identification Strategy

As stated in the introduction, NCMS is not traded in the market and individuals do not have a menu of schemes to choose from, thus, it is difficult to estimate its welfare benefits. We use the newly proposed sufficient statistics approach by Finkelstein et al. (2016) to estimate the welfare value of NCMS. In this section, we briefly introduce the methodology proposed by Finkelstein et al. (2016) but modified to the context of our study.[15]

Complete Information Approach

Assume that an individual's utility is derived from non-medical consumption, *c* and from health status, *h*:

$$u = u(c, h) \tag{1}$$

The health production function $\tilde{h}$ has the following form:

$$h = \tilde{h}(m; \theta) \tag{2}$$

where *m* is a medical expenditure and θ denotes the state of the world. We assume that everyone faces the same distribution of θ. q is a coinsurance rate which indicates the generosity of NCMS coverage. q = 0 indicating no health insurance and q =1 denoting full coverage (i.e., no out-of-pocket payment). CHNS asks each individual about the size of q if the individual is insured. Hence we use the self-reported coinsurance rate. Consumption, medical expenditure, and health depend both on the health insurance status, q and the state of the world, θ.

We can define the value of NCMS to the individual, $\gamma(q)$, is defined as the implicit solution to

$$E_\theta[u(c(0;\theta), h(0;\theta)] = E_\theta[u(c(q;\theta) - \gamma(q), h(q;\theta))] \tag{3}$$

$\gamma(q)$ is the consumption that the individual would give up in the world of NCMS that would leave her at the same level of expected utility as without. To estimate $\gamma(q)$ from equation (3),

[15] For the full details of the sufficient statistics approach to estimate the welfare analysis of health insurance, see Finkeltstein et al. (2016). See Chetty (2009) and Chetty and Finkelstein (2010) for the discussion of the sufficient statistics approach to estimate the welfare value of social insurance in general.

we need (i) a full specification of the utility function over consumption and health; (ii) estimation of the distribution of consumption and health for all values of q ($q \in [0,1]$). As in Finkelstein et al. (2016), we assume that the utility function takes the following form:

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + \tilde{\phi}h,$$

where σ is the coefficient of relative risk aversion and $\tilde{\phi}$ is the impact of health on utility. With this assumption, equation (3) could be rewritten as

$$E\left[\frac{c(0;\theta)^{1-\sigma}}{1-\sigma} + \tilde{\phi}h(0;\theta)\right] = E\left[\frac{\left(c(q;\theta)-\gamma(q)\right)^{1-\sigma}}{1-\sigma} + \tilde{\phi}h(q;\theta)\right] \quad (4).$$

To evaluate $\gamma(q)$, we need to estimate the average health outcomes and the distribution of consumption under each insurance status. Since only one status could be observed for an individual, $c(0;\theta)$, $h(0;\theta)$ and $c(q;\theta)$, $h(q;\theta)$ are naturally counterfactuals to each other. Therefore, it would require estimation strategy to evaluate the causal impacts of the NCMS on potential outcome variables.

We decompose $\gamma(q)$ into two components: a transfer term T, and a pure-insurance term I. The transfer term measures the average increase of resources for the individuals, or in other words the value of the NCMS as a transfer program. The pure-insurance term represents the value of the insurance in reallocating resources across different states of the world. It is positive if NCMS moves resources into the state of the world with higher marginal returns to consumption or health.

The transfer term is calculated as the solution to the following equation:

$$\frac{E[c(0;\theta)]^{1-\sigma}}{1-\sigma} + \tilde{\phi}E\left[\tilde{h}(E[m(0;\theta)];\theta)\right] = \frac{(E[c(q;\theta)]-T)^{1-\sigma}}{1-\sigma} + \tilde{\phi}E\left[\tilde{h}(E[m(q;\theta)];\theta)\right]. \quad (5)$$

Since health is produced according to a health production function $h = \tilde{h}(m;\theta)$, we approximate the health improvement $E\left[\tilde{h}(E[m(q;\theta)];\theta) - \tilde{h}(E[m(0;\theta)];\theta)\right]$ as $E\left[\frac{d\tilde{h}}{dm}\right]E[m(q;\theta) - m(0;\theta)]$. Rewrite equation (5), we have

$$\frac{E[c(0;\theta)]^{1-\sigma}}{1-\sigma} - \frac{(E[c(q;\theta)]-T)^{1-\sigma}}{1-\sigma} = \tilde{\phi}E\left[\frac{d\tilde{h}}{dm}\right]E[m(q;\theta) - m(0;\theta)]. \quad (6)$$

After obtaining the value of transfer term T, the pure-insurance term is $I = \gamma(q) - T$. The evaluation of equation (6) requires us to estimate the slope of the health production function $E\left[\frac{d\tilde{h}}{dm}\right]$ between $m(q;\theta)$ and $m(0;\theta)$. The details of estimating $E\left[\frac{d\tilde{h}}{dm}\right]$ are described in Appendix E.

The utility function is chosen to reduce the potential set of outcomes required for estimation. It is composed of two parts: a standard CRRA function for consumption and a

linear term for health. The curvature of the consumption function models the risk averse attitudes of the individuals while the linear component of health focuses the impacts of the NCMS on average health outcomes under each insurance status. The additive relationship between consumption and health would spare me from estimating the causal effects of the NCMS on joint distributions. However, the functional form of the consumption component requires to estimate the whole consumption distribution under each insurance status, as opposed to estimating only mean effects.

The estimation method imposes little assumption regarding individuals' behaviours (i.e. no requirement for individual optimization). However, it demands the summation of the NCMS's impacts on all utility relevant components. In this paper, we include only consumption and health in the utility function. If we were to include other potential utility-relevant components such as children's education, spouse's labour market decision, the estimation framework would need to incorporate the impacts of the NCMS on these factors. Therefore, the evaluation of the welfare gains might be biased since one could add components to the utility function until the result is satisfactory.

Consumption-based optimization approach

The implementation requirements of the complete information approach are reduced through two additional assumptions: (i) the NCMS only affects the individuals through its influences on the out-of-pocket price for medical care p(q); (ii) individuals choose m and c optimally subject to their budget constraint ($c = y(\theta) - x(q,m)$).

Under individual optimization assumption, the marginal welfare impact of the NCMS on recipients $\frac{d\gamma}{dq}$ follows from applying envelope theorem to equation (3):

$$\frac{d\gamma}{dq} = E\left[\frac{u_c}{E[u_c]}\left(-\frac{\partial x(q,m)}{\partial q}\right)\right] \tag{7}$$

where u_c denotes the partial derivative of utility w.r.t consumption. Define a linear price structure of out-of-pocket price p(q): p(q) = qp(1) + (1- q)p(0). Out-of-pocket spending can be expressed as x(q,m) = p(q)m = qp(1)m + (1-q)p(0)m. Therefore, we could write the marginal expansion of the NCMS as:

$$-\frac{\partial x(q,m)}{\partial q} = \frac{1}{q}\big(p(0) - p(q)\big)m(q;\theta). \tag{8}$$

Substitute it into equation (7), we get

$$\frac{d\gamma}{dq} = E\left[\frac{u_c}{E[u_c]}\left(\frac{1}{q}\big(p(0) - p(q)\big)m(q;\theta)\right)\right] \tag{9}.$$

We decompose the marginal value of the NCMS to recipients in equation (9) into two parts: a transfer term and a pure-insurance term. Empirical estimation is conducted by evaluation each component separately. The decomposition follows:

$$\frac{d\gamma}{dq} = \frac{1}{q}\big(p(0) - p(q)\big)E[m(q;\theta)] + Cov\left[\frac{u_c}{E[u_c]}, \frac{1}{q}\big(p(0) - p(q)\big)m(q;\theta)\right] \quad (10).$$

The estimation of the transfer term is straightforward but the evaluation of the pure-insurance term requires us to specify the utility function over the consumption argument. We assume the utility function take the following form:

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + v(.)$$

where σ denotes the coefficient of relative risk aversion and $v(.)$ is the subutility function for health which can be left unspecified. With this assumption, the pure-insurance term can be written as:

$$Cov\left(\frac{c(q;\theta)^{-\sigma}}{E[c(q;\theta)^{-\sigma}]}, \frac{1}{q}\big(p(0) - p(q)\big)m(q;\theta)\right) \quad (11).$$

To obtain the non-marginal estimate of the total welfare impact of the NCMS, we approximate the integral of equation (9) linearly, following

$$\gamma(q) = \int_0^q \frac{d\gamma(q)}{dq}dq = \frac{q}{2}\left[\frac{d\gamma(0)}{dq} + \frac{d\gamma(q)}{dq}\right].$$

Health-based optimization approach

Consumption-based optimization approach evaluates the welfare through the marginal utilities of consumption at different states of the world. Alternatively, we could estimate the value of the NCMS through its impact on the budget constraint using different marginal utility of health. To do so, we require individuals' choices satisfy a first-order condition:

$$u_c(c,h)p(q) = u_h(c,h)\frac{d\tilde{h}(m,\theta)}{dm} \quad \forall m, q, \theta \quad (12).$$

The left-hand side of the equation evaluates the marginal cost of additional medical spending in terms of forgone consumption. The right-hand side of the equation represents the marginal benefit of additional medical spending through its impact on improvement of health. Using equation (12) to replace the marginal utility of consumption in (9), we get:

$$\frac{d\gamma}{dq} = E\left[\left(\frac{u_h}{E[u_c]}\frac{d\tilde{h}(m;\theta)}{dm}\frac{1}{p(q)}\right)\left(\frac{1}{q}(p(0) - p(q)m(q;\theta))\right)\right] \quad (13).$$

Similar in consumption-based optimization approach, we decompose equation (13) into a transfer term and a pure-insurance term:

$$\frac{d\gamma(q)}{dq} = \frac{1}{q}(p(0) - p(q))E[m(q;\theta)] + Cov\left(\frac{u_h}{E[u_c]}\frac{d\tilde{h}(m;\theta)}{dm}\frac{1}{p(q)}, \frac{1}{q}(p(0) - p(q)m(q;\theta))\right) \quad (14).$$

Estimation of the transfer term is same as the consumption-based optimization approach. However, the pure-insurance term requires specification of utility function over the health argument. We assume the utility function takes the following form:

$$u(c,h) = \tilde{\phi}h + \tilde{v}(c)$$

where $\tilde{v}(.)$ is the subutility function for consumption which is left unspecified. With this assumption, the pure-insurance term can be written as:

$$Cov(\frac{d\tilde{h}(m;\theta)}{dm}\frac{\phi}{p(q)}, \frac{1}{q}(p(0) - p(q)m(q;\theta)) \quad (15).$$

where $\phi = \frac{\tilde{\phi}}{E[\tilde{v}'(c)]}$. The extrapolation of $\gamma(q)$ is same with the consumption-based optimization approach.

4.1 Behavioral Impacts

We estimate the effect of increasing access to health insurance using the two-staged least square (2SLS) approach where county-level NCMS offer status is used as instrument. It is modeled as follows:

$$y_{itc} = \beta_0 + \beta_1 INSURANCE_{itc} + \beta_2 X_{itc} + \lambda_t + \gamma_c + \varepsilon_{itc} \quad (16)$$

where *i* represents the individual, *t* the survey year and *c* the county of residence. $INSURANCE_{itc}$ is a binary variable indicating whether individual *i* is enrolled in any insurance in year *t*, county *c*. X_{itc} provides a series of controls for individual characteristics including years of education, ethnicity, gender, marital status, family size, age and age square. λ_t controls for year-specific unobserved heterogeneity invariant across counties and γ_c controls for permanent unobserved county-specific heterogeneity. Since the NCMS is designed and implemented by county governments, standard errors are clustered by county of residence to account for potential error correlation. We estimate equation (16) using the following first stage equation:

$$INSURANCE_{itc} = \alpha_0 + \alpha_1 OFFER_{tc} + \alpha_2 X_{itc} + \lambda_t + \gamma_c + \epsilon_{itc} \quad (17)$$

where $Offer_{tc}$ is a binary variable indicating whether NCMS was offered in county c at time *t*.

The coefficient of *INSURANCE*, $\widehat{\beta_1}$, is the parameter of interest and we interpret it as a local average treatment effect (LATE). It identifies the causal impact of increasing access to insurance among individuals who would obtain insurance on being offered through the county NCMS implementation and would not obtain insurance without county offer

status. The causal effects of our 2SLS estimation are based on the assumption that there is no effect on the outcomes, on average, of increasing access to health insurance does not operate via the impacts of the county's NCMS offer status on personal insurance enrollment. We believe that, given the setting of public health insurance of rural population in China, this is a reasonable conjecture.

The validity of the instrument depends on two assumptions: i) the county NCMS offer status (*OFFER)* is not correlated with the unobserved individual characteristics and impacts the outcome variables only through individual program participation; ii) the county NCMS offer status (*OFFER)* is related to the individual insurance enrollment decision, *INSURANCE*.

Though not a random assignment, the decision on whether a county would implement NCMS is made by the provincial government following the guidelines from the central government thus unlikely to be correlated with any individual level characteristics. Therefore, it is reasonable to assume the exogeneity of *OFFER* after controlling for county fixed effect. Since individuals could only enroll in the NCMS at the hukou registered county, the county NCMS offer status, OFFER, is highly correlated with the increase of individual insurance access. Table 2 reports the first stage estimate using equation (17) for health index. The result indicates that launching the NCMS leads to approximately 44.9 percent increase of probability in acquiring personal health insurance. The F-statistics is above 50.

Whether the county NCMS offer status directly influences the individual outcomes is a concern for the validity of the instrument. For example, if the introduction of the NCMS causes the county government to improve on health care facilities, individuals may receive better treatment and thus improve on health conditions without participating in the NCMS. Differences across counties in policies after the NCMS introduction could potentially bias the estimation. The direction of the bias depends on the nature of the policies. However, we are not aware of any systematically different policy responses towards the NCMS introduction across counties.

Table 3 shows estimation results for "health index" and its components. The effect of increase access to health insurance through NCMS on health index, as shown in column 1, is -0.020. The magnitude of the coefficient implies that joining the insurance (*INSURANCE* status from 0 to 1) decreases health index by 0.020 standard deviations, indicating that NCMS does not improve the participants' health conditions. Column two to column seven of Table 3 report the regression results for components of the health index. Participating in the NCMS decreases individuals' probability of having hypertension and stroke. However, there

is no significant impact of the joining the NCMS on reducing the probability of diabetes, heart attack, and bone fracture, indicating that the NCMS provides limited health improvements.

Table 4 presents the mean effect estimation of NCMS's impacts on health care utilization. Column one reports the impact of the NCMS on log of annual out-of-pocket expenditure. Participating in the NCMS lowered the out-of-pocket expenditure of recipients by 40%. Column two demonstrates the effects of the NCMS on log of individuals' annual total medical spending. Enrollment in the NCMS leads to a decrease of 7% of individuals' total medical spending. The results of column one and two are in general consistent with the findings of the previous studies: joining the NCMS has modest impact on reducing the total medical service usage but leads to lower out-of-pocket expenditure (Lei and Lin, 2009; Wagstaff et al., 2009; Hou et al., 2014). Column three and four shows the impacts of the NCMS on the probability of individuals taking preventive care in the last 4 weeks and visiting folk doctor over the last year. Participating in the NCMS increases the individuals' probability of using preventive care and decreases the probability of of folk doctor visits.

Table 5 shows the impacts of the NCMS on individuals' non-medical consumption. Column 1 shows the average impact of the NCMS on non-adjusted individual consumption. Though statistically insignificant, the estimation indicates a positive effect of enrolment in the NCMS: joining the NCMS leads to an increase of 438 RMB per year in consumption to the enrollees. Column 2 and column 3 report the estimation results of the NCMS's influences on non-medical consumption adjusted by OECD standard and household size. Consistent with result of column 1, participating in the NCMS leads to increase of non-medical consumption, though smaller in magnitude.

5. Results

5.1 Welfare Estimation and Results

Empirical estimation of the welfare benefits requires an assumption of two parameter values: the coefficient of relative risk aversion σ, and the value of health ϕ. The coefficient of relative risk aversion σ models individual's risk-taking behaviors. The higher the value of σ, the less tolerant to risk. The value of the σ varies under different contexts and typically takes a range of 1 to 5. For the baseline analysis, we assume $\sigma = 2$ following the simulation literature evaluating social insurance (McClellan and Skinner 1997; Finkelstein et al. 2016). The estimation of value of health ϕ is described in Appendix C.

5.1.1 Complete-information approach

The welfare gains of the NCMS is evaluated using equation (4). Since the welfare benefits of the NCMS $\gamma(q)$ is defined as the amount of consumption that would leave an individual indifferent between enrolment and non-enrolment, the estimation requires the knowledge of health and consumption under the counterfactual states. The linear assumption of the health component in the utility function lessens the estimation procedures and requires only the mean effects of the NCMS on health index.

Table 6 Panel A presents the estimation results for welfare benefits. To avoid complications, we use only wave 2006 for welfare estimation in complete-information approach. On average, participating in the NCMS leads to a welfare estimate of 1718 RMB per recipient per year. An individual would be indifferent between giving up 1718 RMB in consumption and giving up the NCMS. To further explore the underlying factors that driven the value of the welfare, we define the welfare value of the NCMS operating through consumption as:

$$E\left[\frac{c(0;\theta)^{1-\sigma}}{1-\sigma}\right] = E\left[\frac{(c(q;\theta)-\gamma_c)^{1-\sigma}}{1-\sigma}\right].$$

The estimated value of welfare gains through consumption γ_c is 1602 RMB. Therefore, we infer the welfare benefits operating through health is $\gamma_M = \gamma(q) - \gamma_c$, 116 RMB per recipient per year. The details of implementation are described in Appendix D.

Similar in spirit with the optimization approach, we decompose $\gamma(q)$ into transfer and "pure-insurance" terms. Following equation (6), we estimate the value of the transfer term as 1125 RMB and the value of pure-insurance term as 593 RMB. This suggests that more than 50% of the benefits come from the NCMS's ability in transferring resources to the individuals.

5.1.2 Optimization approaches

The transfer components of both consumption-based and health-based optimization approach do not require any assumption of utility function. The change in the out-of-pocket price for healthcare due to insurance (p(0) – p(q)) is 0.26. Under the linear approximation assumption, the transfer term is estimated to be 959 RMB. We report the estimate in columns II and III in Table 6. Without the assumption, the lower and upper bound of the transfer term is 525 RMB and 1302 RMB.

The pure-insurance term of consumption-based optimization approach is estimated following equation (11). For both NCMS enrollees and non-enrollees, we directly estimate the covariance between $c^{-\sigma}$ and x, respectively. The raw data show negative covariance between the marginal utility of consumption and out-of-pocket spending for both the insured and the uninsured. This means higher non-medical consumption is associated with higher out-of-pocket spending. This is not an idiosyncratic feature of the CHNS. Finkelstein et al. (2016) find same negative correlation between the marginal consumption and out-of-pocket expenditure in both Consumer Expenditure Survey (CEX) and Panel Study of Income Dynamics (PSID). One of the explanations is that there is implicit income which leads to higher consumption with higher medical spending. Another explanation is that the covariance term suffers from measurement error. Therefore, we implement a measurement-error correction by instrumenting out-of-pocket expenditure with hospital admissions. The details of the implementation are described in Appendix F. Table 6 column II presents the estimation result. After measurement-error correction, the value of pure-insurance term is estimated to be 624 RMB.

The pure-insurance term of health-based optimization approach is evaluated according to equation (15), which requires the estimation of marginal return to medical spending, $\frac{d\tilde{h}}{dm}$. We estimate the health returns to medical spending using the county NCMS offer status as instrument for medical spending, implicitly assuming that the insurance impacts health only through medical expenditure. We capture the heterogeneity of returns to medical spending through a proxy constructed using a set of observable variables. Health production function is assumed to be constant for all m conditional on the proxy. Details of implementation are described in Appendix E. The estimation result is reported in Table 6 column III. The value of the pure-insurance term is estimated to be 6 RMB.

The first row of Table 6 reports the total welfare estimates of the NCMS for both consumption-based and health-based optimization approach. Combining with the transfer component, the overall welfare estimate $\gamma(q)$ range from 965 RMB to 1386 RMB. Under both implementations, the transfer component represents of a big share of the total welfare. Under the health-based optimization approach, the welfare value is virtually all from the transfer term. For consumption-based optimization approach, the transfer term delivers almost 69% of the total welfare.

5.2. Cost-benefit analysis

In this section, we compare the costs and benefits of enrolling in the NCMS and discuss the policy implications of the results. To start, the average costs to the government in implementing the NCMS per recipient is defined as $\mathrm{G} = \mathrm{E}\left[\mathrm{m}(\mathrm{q};\theta) - \mathrm{x}\left(\mathrm{q};\mathrm{m}(\mathrm{q};\theta)\right)\right]$, the difference between total medical spending and out-of-pocket expenditure. Though the welfare model assumes that the medical spending is equal to out-of-pocket expenditure for the uninsured (i.e $m(0;\theta) = x(0;\theta)$), the actual data show that a substantial amount of the uninsured incur less out-of-pocket expenditure than their total medical bills. Therefore, we define the discrepancy as $N = E[m(0;\theta) - x(0;\theta)]$. we further define the net cost of the NCMS to the society as $\mathrm{C} = \mathrm{G} - \mathrm{N}$. Rearranging the terms, C represents the difference between the increase in medical spending caused by the NCMS ($m(q;\theta) - m(0;\theta)$), and the decrease of out-of-pocket spending ($x\left(q;m(q;\theta)\right) - x\left(0;m(0;\theta)\right)$).

On average, the medical spending for NCMS participants is 5003 RMB and out-of-pocket expenditure is 2863 RMB, yielding the government's costs as 2140 RMB per recipient per year. The total medical expenditure for the uninsured is 2017 RMB with 1679 RMB for out-of-pocket spending. This gives N the value of 338 RMB per recipient per year. Since N measures the difference between the total medical bills and the amount the uninsured paid, a positive value of N indicates the existence of implicit insurance for the uninsured. Combining the the estimation of G and N gives the value of the net cost of NCMS as 1802 RMB. For every RMB the government spent on the NCMS, 16 cents were used to cover the previous implicit insurance individuals received, indicating evidence on crowding out effects.

To better understand the meanings of these estimates, we conduct several comparisons between the costs and the welfare evaluations. The results are summarized in panel B of Table 6. We first compare our baseline estimation value $\gamma(q)$ with the government's total cost of providing NCMS, G. Depending on the approaches, we estimate a ratio of $\gamma(q)/G$ between 0.45 RMB to 0.803 RMB. A value below 1 indicates that individuals would rather give up the NCMS than paying the government's costs. Under both approaches, an uninsured individual would not enrol in the program if asked to pay the government's costs.

Another useful benchmark is to compare the welfare evaluation with the net cost of the NCMS, C, excluding the costs associated with transfers to the external party. If $\gamma(q)$ is above C, it indicates that the insurance value of the NCMS is above the moral hazard costs. Depending on different approach, the value of the NCMS relative to the net costs C varies from 0.54 to 0.954. Comparatively, the moral hazard cost is the lowest under complete-

information approach, 677 RMB, compared to 843 RMB under both optimization approaches.

Other than the net cost of providing NCMS, there are still moderate proportion of costs (16%) associated with transfers to external parties. The sources of the implicit insurances are difficult to identify. A starting point would be the individuals' relatives and family members. The amount of implicit insurance individuals received from family members when uninsured is beard by the NCMS. In other words, the implicit insurance providers receive benefits from the NCMS as well. The welfare estimation model does not take into account of the welfare of external parties, thus undervaluing the total welfare benefits of the NCMS. Including the welfare impacts of the NCMS on other parties requires additional causal estimates.

5.3 Sensitivity Analysis

The welfare estimation relies on the value of two parameters: the degree of risk aversion σ, and the value of health ϕ. To test the sensitivity of the welfare analysis findings, we first report results using alternative value of statistical life (VSLY). In the baseline estimation, we estimate the parameter ϕ assuming a VSLY of 418,000 RMB. In Table 11 Column one, we report estimation results using a VSLY of 814,000 RMB, the upper bound of the VSLY interval. The welfare benefits of the NCMS increase to 414 RMB due to a higher value of the health benefits from participating in the NCMS.

We also test results using different risk aversion measures. The coefficient of relative risk aversion σ models individuals' attitude towards risk. The higher the σ, the more risk averse of the individuals and thus have a higher preference for consumption smoothing. Table 11 Column two, three and four report the welfare gains of the NCMS under $\sigma = 2,4$ and 5. Compare to results using the baseline value of 3, higher risk aversion value decreases the welfare benefits of the NCMS. One of the possible reasons is that individuals who are more risk averse might have taken measures to smooth consumption even without the insurance. Therefore, compared to individuals with lower value of σ, more risk averse individuals would experience less welfare benefits from the NCMS especially from its ability in providing financial protection. Chetty and Looney (2005) shows that when experiencing consumption fluctuation associated with shocks, agents from developing regions may seek costly measures to smooth consumption, such as withdrawing children from school, avoiding medical treatment and etc. Since the models in this paper only measures the welfare through

consumption, the estimation results may underestimate the benefits of the NCMS in terms of reducing the efficiency costs of the households in hedging risks. Decomposing the welfare values under $\sigma = 2, 4$ and 5, the welfare benefits from improvement of health remains almost unchanged. However, the proportion of benefits operating from consumption vary considerably with the risk aversion value, confirming that the more risk averse individual may benefit less from the NCMS's ability in providing consumption smoothing.

6. Conclusion

This paper has evaluated the welfare benefits of the New Cooperative Medical Scheme and compared them against the government costs. We find robust evidence that the welfare gains individuals enjoy from the NCMS program are strictly below the costs. A benefit-cost ratio of 0.41 RMB per 1 RMB of government's implementation costs confirms that enrolled individuals would rather give up the insurance than to pay the government's costs. Or equally, the uninsured individuals would prefer not to enroll in the program given the government's spending. A substantial amount of government's costs goes to cover the implicit insurance individuals received when uninsured, indicating the existence of crowding out effects of the insurance.

The paper provides new evidence for the heterogeneous effects of the NCMS across the distribution of consumption and healthcare utilization. Participating in the program in general has positive effects on individuals' non-medical consumption. But the magnitude of the effects is bigger for individuals with higher consumption levels. Different from the previous studies, the NCMS not only increases impacts on individuals' total medical service utilization but also has larger influences on individuals with higher medical expenses. The effects are more obvious for individual's out-of-pocket spending. The NCMS significantly leads to higher out-of-pocket expenditure for individuals with high medical expenses, indicating its limited financial protection for costs related to catastrophic illness.

The paper confirms the previous literature's results regarding the heterogeneous effects of the NCMS by income group. The welfare estimation results by income groups show that the middle and high income individuals benefit more from participating in the NCMS both from improvement of consumption and health conditions. The estimated results suggest that to increase the average welfare benefits to the recipients, government should provide more support for low-income individuals.

The estimation results of the paper are open to interpretation. The estimated welfare gains under the estimation framework are sensitive to its own assumptions. An alternative utility specification and change of structural parameter values would produce different results. Lacking detailed county identification, we do not incorporate the county level heterogeneity inside the models. Therefore, for future work, it would be both interesting and important to incorporate the regional differences and test the most efficient way in implementing the NCMS.

The paper provides evidences and implications for future policies targeting universal health care in developing regions. In line with the Sustainable Development Goals (SDGs), which will guide the post-2015 agenda, achieving universal health coverage aims to achieve better health outcomes and prevent poverty trap due to illness. It has received increasing attention from governments in low- and middle-income countries. My study highlights the importance of the mechanism which would decide on the immediate and ultimate beneficiaries.

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Table 1. Summary Statistics

Variable	All	With insurance	Without insurance	Difference (p-value)
Panel I: Health Related Variables				
Self-reported health	.653	.650	.653	-.003
	(.476)	(.477)	(.476)	(.714)
Health Index	.011	-.033	.047	-.08
	(.480)	(.552)	(.409)	(.000)
Hypertension	.064	.090	.043	.047
	(.244)	(.286)	(.202)	(.000)
Diabetes	.010	.013	.008	.005
	(.102)	(.113)	(.091)	(.000)
Heart attack	.004	.006	.003	.003
	(.063)	(.076)	(.050)	(.000)
Stroke	.008	.011	.005	.006
	(.087)	(.106)	(.068)	(.000)
Bone Fracture	.033	.039	.028	.011
	(.178)	(.194)	(.164)	(.000)
Panel 2: Healthcare Utilization				
Any formal medical care in the last 4 weeks	.011	.009	.013	-.004
	(.104)	(.097)	(.114)	(.000)
Total medical expenditure last year	3336	4751	2298	2453
	(28531)	(35521)	(22098)	(.0001)
Out-of-pocket medical expenditure last year	2274	2770	1908	862
	(22482)	(24924)	(20606)	(.000)
Any preventive care during the last 4 weeks	.027	.040	.016	.024
	(.161)	(.196)	(.127)	(.000)
Household Consumption	10,508	13713	8155	5558
	(10,818)	(12512)	(8617)	(.000)
Adult-equivalent Consumption	3,902	5203	2954	2249
	(3,707)	(4279)	(2876)	(.000)
Per capital Consumption	2,766	3728	2066	1662
	(2,806)	(3270)	(2158)	(.000)
Panel 3: Other Variables				
Gender	.507	.514	.503	.011
	(.500)	(.500)	(.500)	(.026)
Married	.625	.682	.588	.094
	(.484)	(.466)	(.492)	(.000)
Ethnicity Han	.839	.854	.827	.027
	(.368)	(.353)	(.379)	(.000)
Household Size	4.26	4.13	4.35	-.221
	(1.60)	(1.69)	(1.53)	(.000)
Age	38.0	41.3	35.8	5.46
	(20.6)	(20.9)	(20.2)	(.000)

Note: all monetary values are in 2011 CNY.
Probability of seeking formal medical care only includes data from wave 2004 and onwards

Table 2. First Stage Result for *INSURANCE*

	INSURANCE
OFFER	.449***
	(.007)
F-statistics	61.4
R-square	.687
Observations	36,177

Note: Standard errors clustered at county level are reported in parentheses. All regression results include marital status, years of education, family size, ethnicity, age and age square as controls and fixed effects for county and survey year. *** p <0.01, **p<0.05, * p<0.1

Table 3. The Effects of NCMS on Health Outcomes (IV estimation)

		Components of aggregate health index				
	Aggregate Health Index	Hypertension	Diabetes	Heart Attack	Stroke	Bone Fracture
INSURANCE	-.020	-.015	.007	.001	-.0002	.015
	(.029)	(.012)	(.008)	(.003)	(.003)	(.011)
R-square	.077	.085	.019	.010	.021	.025
Observations	36,177	36,022	35,767	34,347	34,196	36,030

Notes: Standard errors clustered at county level are reported in parentheses. All regression results control for marital status, years of education, family size, ethnicity, age and age square and fixed effects for county and survey year. *** p <0.01, **p<0.05, * p<0.1

Table 4. The Effects of NCMS on Health Care Utilization (IV estimation)

	log(Out-of-pocket expenditure)	log(Total Medical Expenditure)	Any preventive care utilization	Any formal medical care
INSURANCE	-.505	-.077	.011	-.017
	(.459)	(.427)	(.018)	(.009)
R-square	.100	.099	.035	.012
Observations	44,644	44,633	44,033	24,389

Notes: Standard errors clustered at county level are reported in parentheses. All regression results control for marital status, years of education, family size, ethnicity, age and age square and fixed effects for county and survey year. *** p <0.01, **p<0.05, * p<0.1

Table 5. The Effect of NCMS on Household Consumption (IV estimation)

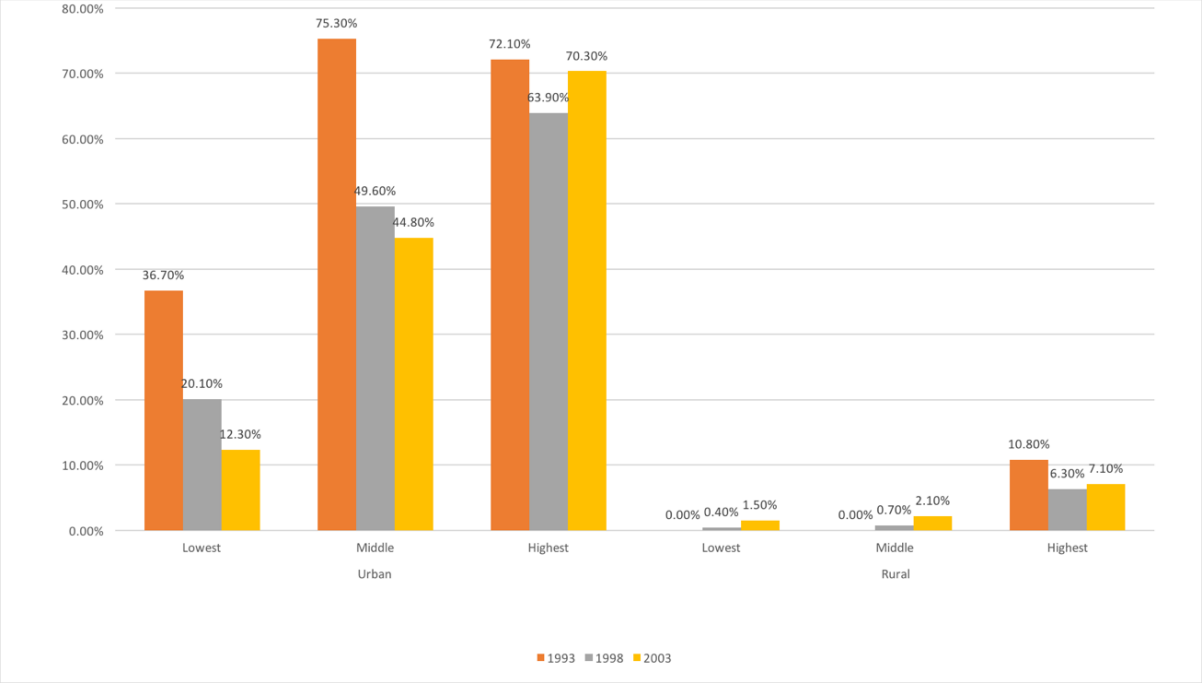
	Household Consumption	Adult-equivalent Consumption	Adult-equivalent Consumption
INSURANCE	438	301	246
	(1520)	(579)	(413)
R-square	.350	.372	.401
Observations	44,633	44,633	44,633

Notes: Household consumption used in this regression excludes medical expenditure. Standard errors clustered at county level are reported in parentheses. All regression results control for marital status, years of education, family size, ethnicity, age, and age square and fixed effects for county and survey year. *** p <0.01, **p<0.05, * p<0.1

Table 6. Welfare Benefits and Costs of the NCMS

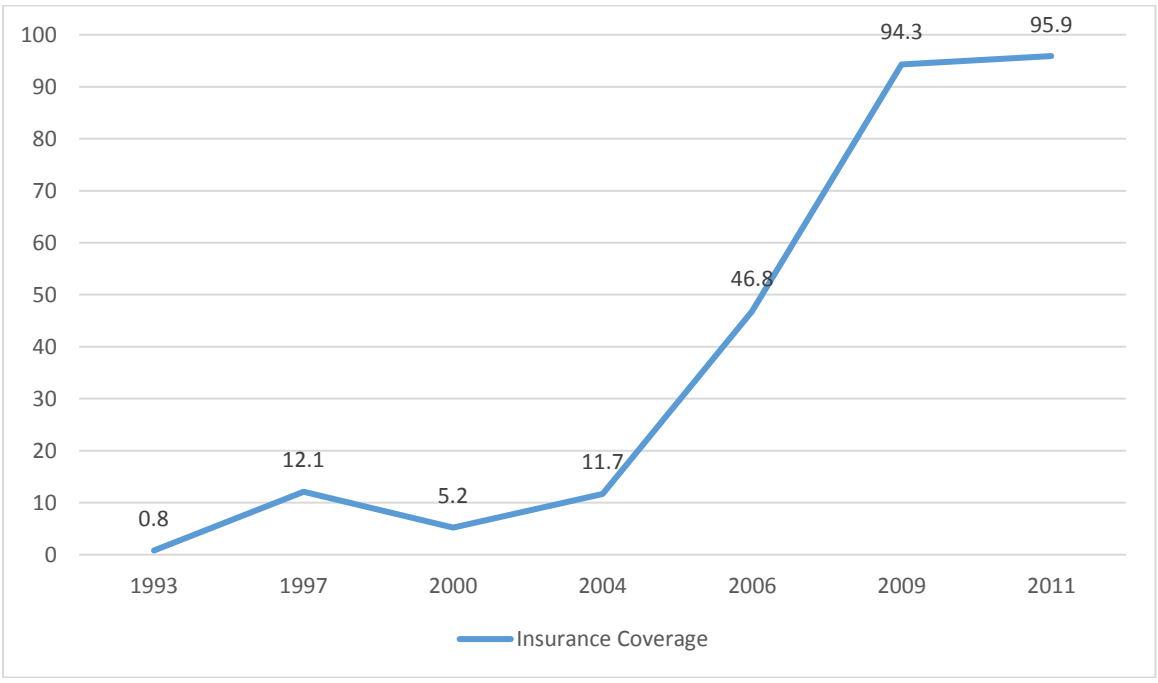
	I Complete-information approach	II Consumption-based optimization approach	III Health-based optimization approach
Panel A. Welfare Estimates			
$\gamma(q)$ (standard error)	1718	1386	965
Transfer component, T	1125	959	959
Pure-insurance component, I	593	427	6
B. Benchmarks			
Welfare effects on recipients relative to:			
Gross costs, $\gamma(q)/G$	.803	.648	0.45
Net costs, , $\gamma(q)/C$	.954	.770	0.54
Moral hazard cost, G-T-N	677	843	843
Monetary transfers to external parties, $\gamma(q)/N$	5.08	4.10	2.86

Figure 1. Health Insurance Coverage for Urban and Rural Residences by Income



Source: Yip and Hsiao (2008)

Figure 2: Percentage of Rural Sample Covered by Any Type of Health Insurance



Source: Authors' calculation based on the CHNS data