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Welfare consequences of access to health insurance for rural households: Evidence from the New Cooperative Medical Scheme in China

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Welfare Consequences of Access to Health Insurance for Low- and Middle-income Households: Evidence from New Cooperative Medical Scheme in Rural China

Jessica Ya Sun[1]

Abstract

This paper evaluates the welfare benefits of the New Cooperative Medical Scheme (NCMS), the main public health insurance plan for the rural population in China. I find that the value of the NCMS to recipients is slightly higher than the government's costs of implementation. The estimated moral hazard costs are small compared to the total benefits. The findings suggest that behavioral changes due to health insurance (i.e. increased utilization of medical services) are largely welfare-improving for low- and middle-income households.

Keywords: Health insurance, New Cooperative Medical Scheme, China, Welfare analysis

JEL Classification: I13, I18, I38

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1. Introduction

Improving access to healthcare and financial protection among low- and middle-income households through a health insurance program is a key concern for policymakers all over the world. One of the classic empirical results in public health insurance is that demand for healthcare increases due to the lowering of the out-of-pocket price. This finding has traditionally been interpreted as evidence of moral hazard caused by the substitution effect: public health insurance distorts the relative price of consumption and healthcare, increasing the cost of providing insurance. At the same time, health insurance coverage enables individuals to seek medical treatments that would otherwise be unaffordable, particularly among low-income households where the cost of treatment is high relative to income.

The goals of this paper are to understand the welfare consequences of access to health insurance, and to question whether the correlation between the provision of health insurance and higher medical spending is purely due to moral hazard among low- and middle-income households. The analysis is motivated by evidence that many uninsured households in developing countries have limited liquidity and adopt costly measures in consumption smoothing (Chetty and Looney, 2006a; Chetty, 2006b; Liu, 2016). Indeed, nearly 40% of individuals residing in rural areas who were canvassed for the China Health and Nutritional Survey (CHNS) from 1993 to 2011 reported that they did not seek formal medical treatment when they fell sick, suggesting that many individuals may avoid treatment due to expense.

In this paper, I evaluate the welfare benefits of access to health insurance by examining the effects of a Chinese policy reform that introduced a large-scale health insurance program in rural parts of the country. The New Cooperative Medical Scheme (NCMS) is the main public health insurance plan for the rural population in China. Since its inception in 2003, access to health insurance for rural residents expanded dramatically: In the 1990s, almost none were enrolled in health insurance in rural China (see Figure 1). But by the end of 2011, more than 97% of the rural population (800 million people) had been enrolled in the scheme (Hou et al., 2013).

My analytical approach differs from the traditional one, in which a model's primitives are structurally estimated and then the effects of policy changes are numerically simulated. Instead, I

adopt two approaches from Finkelstein et al. (2016): the "complete-information" approach and the "optimization" approach, which are in the spirit of the "sufficient statistics" to analyze the welfare value of the policy change. In particular, I decompose the welfare effect in terms of transfer and insurance value, which would provide implications on the sources of welfare as well as the size of associated moral hazard costs. Compared to the structural method and reduced-form method, the advantages of using the two approaches derived from Finkelstein et al. (2016) are that (i) they are easier to implement; and (ii) they are more empirically credible, since program effects are estimated using quasi-experimental variations.

The NCMS was implemented over a six-year period, from 2003 to 2009, in different counties at different times in rural China. As a result, some areas received coverage earlier than others did, and the households in those areas were then subject to exogenous changes in health insurance status at different points in time. In my empirical implementation of the methods derived from Finkelstein et al., I exploit these variations in the timing of the introduction of the NCMS across counties to identify the impacts of the program. Since participation in the NCMS is voluntary, I use the proportion of households enrolled in NCMS at the residential community as an instrumental variable (IV) to account for potential adverse selection. Two additional features of the NCMS make the identification strategy more appealing. First, because of the strict household registration system (*hukou*),[2] household mobility in China is restricted. Therefore, it is unlikely for households to select into the insurance through mobility. Second, the NCMS program was introduced at county level. Combining with the restricted mobility, the potential spillover effects to other countries are likely to be small.

The analysis is conducted using panel data from the China Health and Nutritional Survey (CHNS). The key findings are as follows: The baseline estimates indicate that the value of the NCMS to recipients is higher than the government's costs of provision. I estimate that the welfare benefit to recipients per (gross) RMB of government spending is approximately 1.4. If (counterfactually) the NCMS recipients had to pay the government's average cost of the NCMS,

[2] Hukou is a residential registration system in China. Only individuals with rural hukou can participate in the NCMS.

they would prefer to accept the offer than being uninsured. I do not find a large proportion of transfers from the NCMS to external parties (i.e., individuals who are not enrolled in the program). These results are the opposite of findings from developed countries. For example, in the US, due to the high usage of emergency care for the uninsured, a large proportion of the welfare benefits generated from accessing health insurance are transferred to third parties such as hospitals. However, in the context of rural China, the uninsured typically pay all their medical expenses, with little covered by hospitals or any other third parties.

An important question is whether the value of the NCMS to recipients exceeds the associated moral hazard costs. By decomposing the welfare estimates, I find that the welfare value from the NCMS's transfer function constitutes 50% to 70% of the total benefits. Compared with the net costs to the government of providing the NCMS, I estimate the welfare benefit to recipients per *net* RMB of spending ranges from 1.39 to 1.44. A consistent estimate above 1 suggests that the moral hazard costs do not exceed the insurance value NCMS provides by moving resources across states of the world.

In addition to evaluating the welfare value of the NCMS, this paper contributes to the literature by providing a welfare interpretation of the previously evaluated behavioral impacts of the NCMS. Some studies have found that participating in the NCMS has no significant effects on reducing out-of-pocket spending (Lei and Lin, 2009; Liu and Tsegai, 2011; Hou et al., 2013) or improving health status (Lei and Lin, 2009; Chen and Jin, 2012; Donato and Rokicki, 2016). At the same time, compared to the uninsured, the NCMS enrollees are more likely to seek proper medical advice for minor symptoms at an early stage (Liu and Tsegai, 2011), decrease usage of folk doctors, and increase their utilization of preventive care (Lei and Lin, 2009). While these results provide useful insights, few studies have attempted to offer interpretations in terms of welfare. Among those that do, few papers have provided quantitative measurements.

This paper also contributes to the understanding of the welfare effects of access to health insurance in developing countries more generally, where formal insurance and credit markets are less developed. Closely related to the current paper is a set of papers analyzing the role of public insurance in mitigating the adverse outcomes associated with shocks in developing countries (e.g.

Chetty and Looney, 2006a; Wagstaff and Lindelow, 2008; Wagstaff et al., 2009; Liu, 2016). This paper adds to the previous studies by quantifying the welfare value of access to public insurance and analyzing the sources of welfare benefits. The findings of this paper are consistent with previous literature: low- and middle-income households benefit from public insurance because it limits the use of inefficient consumption-smoothing methods, such as reducing human capital investment. This paper provides important implications for policymakers. Some studies have found that the NCMS has limited or adverse effects in financial protection (i.e. no effect in reducing out-of-pocket spending; see Lei and Lin, 2009; Wagstaff et al., 2009; and Liu and Tsegai, 2011). The results of this study strengthen those of previous studies illustrating the salutary effects of the NCMS, by showing the magnitude of the welfare gains generated from the NCMS's insurance function. Though the total welfare benefits are higher than the implementation costs, the NCMS's ability to protect from risk is limited. A high percentage of the program's value to recipients comes from its insurance function, reflecting rural Chinese households' high demand for actuarially fair insurance, as well as their lack of access to complete credit markets. The results suggest that, to achieve higher welfare benefits, especially for the low-income households, there is a need for a more generous NCMS program.

Naturally, the estimated results are sensitive to the modeling choices. I explored the sensitivity of the results to a variety of alternative assumptions. The evaluation of the welfare value associated with the NCMS insurance function is more sensitive to modeling assumptions, while the transfer values are relatively robust. The welfare value estimates are particularly sensitive to the imposed consumption floor, the minimum value of household consumption. Households with better consumption-smoothing abilities would place lower values on the insurance program. A 300 RMB increase of the imposed consumption floor lowers the benefit-cost ratio by 40%.

The rest of the paper proceeds as follows: Section 2 discusses the institutional background of the health insurance reform. Section 3 presents the welfare analysis framework. Section 4 discusses the empirical strategy. Section 5 describes the data, sample construction, and variables used in the estimation. Section 6 discusses the welfare estimate results, interpretation, and the sensitivity analysis. Section 7 concludes.

2. Institutional background

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

However, with free-market reforms starting from 1984, the Chinese government greatly reduced its role in providing healthcare services. This radical policy change not only led to the dismissal of people's communes but also the collapse of the CMS. As a result, a majority of the rural residents were uninsured from 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 their urban counterparts, even the highest income quantile of the rural residents during this period had much lower insurance coverage, indicating wide inequalities in health insurance accessibility.

To establish universal coverage and improve the affordability of medical services, in 2003 the Chinese government launched the NCMS, a highly subsidized public health insurance program for rural residents. The NCMS was rolled out gradually at the county level. Provincial governments have the autonomy in program adoption time and design,[3] following the guidelines from the central government. In 2003, pilot counties were selected at each province based on three criteria: rural residents' willingness to participate, fiscal soundness, and a solid foundation for management (Liu, 2016). The central government required provincial governments to expand the program to include at least 40% of all counties by 2006 and 60% by 2007 (Department of Health, 2006). By the end of 2013, 2,489 out of 2,862 counties had adopted the NCMS, accounting for 87% of all rural

[3] The 2002 State Council Policy Document No.13, Decisions of the State Council on Strengthening Rural Healthcare (State Council, 2002).

counties in China (Lei and Lin, 2009; China Statistical Yearbook, 2013). Thus, over almost a decade, rural households across counties in China experienced different access to public health insurance. The access to coverage was determined by the county in which a household was registered. And as noted above, China's hokou system limits the mobility of households across counties.

Enrolment in the NCMS is voluntary, but opting into it requires the participation of all household members. The NCMS is financed by both individual contributions and government subsidies: about 20% is covered by the central government, 50% by local government, and the remaining 30% by a household's premium payments (Liu, 2016). Though the annual premium is kept low by the government's heavy subsidization, it has increased over the years: the typical annual premium was 20 RMB per person in 2008 but rose to 150 RMB per person in 2016 (Department of Health, 2008; Ministry of Finance, 2016). The total subsidies from central and local government also steadily increased over time: from 80 RMB per person in 2008 to 420 RMB per person in 2016.

Table 1 reports the expansion of the NCMS program in the sample used in the analysis.[4] Columns II and III describe the percentage of households that had access to the NCMS program and enrolled from 1993 to 2011. Column IV shows the percentage of counties that have introduced the NCMS in each survey year. Before the first year of the implementation of the NCMS, the insurance coverage was lower than 15%. After implementation, the proportion of the rural sample having insurance steadily increased from 15.2% in 2004 to 98.1% in 2011, reflecting the rapid expansion of the NCMS.

3. Welfare analysis framework

Following Finkelstein et al. (2016), individual utility is derived from two components: non-medical goods consumption, c, and from health, h, following the utility function:

$$u = u(c, h)\ . \quad (1)$$

[4] Details of sample construction are discussed in Section 5.

Health is produced according to

$$h = \tilde{h}(m;\pi)\ ,\ (2)$$

where m is the medical spending and π represents the existence of health shocks. In general, I assume that an individual's health is affected by a health shock and medical expenditures.

The presence of the NCMS is represented by the variable q, with q = 1 indicating that the individual is fully covered by the NCMS and q = 0 denoting no coverage. Consumption, medical expenditure and health are determined by NCMS status and the underlying state of the world.

The value of the NCMS, $\gamma(q)$, is defined as the implicit solution to:

$$E[u(c(0;\pi),h(0,\pi)] = E[u\big(c(q;\pi)-\gamma(q)\big),h(q,\pi)]\ ,\ (3)$$

where expectations are taken over by the probability distribution of the underlying states of the world. The value of $\gamma(q)$ could be interpreted as the amount of consumption that would leave individuals indifferent in terms of expected utility between the world with the NCMS and the world without. The focus of the paper is to empirically estimate the value of $\gamma(q)$.

3.1 Complete-information approach

The complete-information approach follows the spirit of structural estimation, specifying the normative utility function over all its arguments. I assume that the utility function follows:

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + \tilde{\phi}h\ ,\quad (4)$$

where σ is the coefficient of relative risk aversion, $\phi = \tilde{\phi}/E[c^{-\sigma}]$ is the marginal value of health in units of consumption.

The utility function has two additive components: a standard constant relative risk aversion (CRRA) function in consumption c with a coefficient of relative risk aversion of σ, and a linear term in h. Under this assumption, equation (3) could be written as:

$$E\left[\frac{c(0,\pi)^{1-\sigma}}{1-\sigma} + \tilde{\phi}h(0,\pi)\right] = E\left[\frac{(c(q,\pi)-\gamma(q))^{1-\sigma}}{1-\sigma} + \tilde{\phi}h(q,\pi)\right].\quad (5)$$

I use equation (5) to solve for the value of the NCMS $\gamma(q)$. The estimate requires observing the distributions of consumption and expected health status that would occur if the individual were on the NCMS, and if he were not. One of the distributions is a counterfactual of the other and therefore requires estimating the distributions of "potential outcomes" under treatment and control statuses.

The choice of the utility function naturally influences the estimation procedures and results. The additivity of the utility function from consumption and health makes it easier to estimate the marginal consumption and marginal health distributions under each insurance status. Imposing complementarity between consumption and health is empirically feasible but more cumbersome to implement since it requires estimating the program influences on joint distributions. The linearity assumption in health, *h*, restricts the estimate to average treatment effects. To capture the risk-adverse nature of the individuals, I allow curvature in utility over consumption, which requires estimating the distribution of consumption under each insurance status.

To reflect the sources of benefits from the NCMS program, I decompose $\gamma(q)$ into two components: (i) the transfer component, which reflects the average increases in available resources to the recipients; and (ii) the pure-insurance component, which captures the value from better allocation of resources across states of the world.

The transfer term, denoted by T, is given as the solution to the following equation:

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

The health improvement is approximated as $E\left[\frac{d\tilde{h}}{dm}\right]E[m(q,\pi) - m(0,\pi)]$, where $E\left[\frac{d\tilde{h}}{dm}\right]$ is the slope of the health production function between $m(q,\pi)$ and $m(0,\pi)$, averaged over all states of the world. Details in estimation of $\frac{d\tilde{h}}{dm}$ are described in Appendix A.2. The transfer component represents the changes in utility from consumption and health if everyone has received the average increase in medical spending.

The pure-insurance term, denoted by *I*, is given by:

$$I = \gamma(q) - T. \quad (7)$$

The pure-insurance term measures the value of the NCMS that results from the reallocation of resources (i.e, relaxing the individual budget constraint) from lower marginal utility states to higher ones.

3.2 Optimization approach

To reduce the implementation requirements, I assume two additional economic assumptions under the optimization approach, which allows me to estimate the value of the program without full specification of the utility function.

Assumption 1. *(Program structure.) I model the NCMS program* q *as affecting the participants solely through its impact on the out-of-pocket expenditure* p(q).

Assumption 2. *Individuals choose* m *and* c *optimally, subject to their budget constraint. Individuals solve:*

$$max_{c.m} u(c,h) \text{ subjective to } c = y - x(q,m) \quad \forall m,q$$

where y *denotes the household income.*

Both assumptions are nontrivial under the context of health insurance, especially since decisions are often made jointly by both enrollees and health providers (e.g., doctors). Providing health insurance may influence the provider behavior (e.g., providers are more likely to prescribe expensive treatments to patients with insurance).

For implementation purposes, I assume that the out-of-pocket spending on medical care follows:

$$x(q,m) = p(q)m\,. \quad (8)$$

Defining the out-of-pocket price $p(q)$ as $p(q) = qp(1) + (1-q)p(q)$, the out-of-pocket spending could be represented as:

$$x(q,m) = qp(1)m + (1-q)p(q)m\,. \quad (9)$$

Under Assumption 2 and 3, the marginal welfare impact of insurance on recipients, $\frac{d\gamma}{dq}$, follows after applying an envelope theorem to equation (3):

$$\frac{d\gamma}{dq} = E\left[\frac{u_c}{E[u_c]}\left(-\frac{\partial x}{\partial q}\right)\right], \quad (10)$$

where u_c represents the partial derivative of utility with respect to consumption. Details of derivation are provided in Online Appendix A.1. Equation (10) uses the marginal utility of consumption to place a value on the relaxation of the budget constraint for each state of the world. A marginal increase in the NCMS's benefit has more value if it moves resources into the state of the world with higher marginal utility of consumption. Compared to the complete-information approach, the optimization approach only requires a partial specification of the utility function with regard to consumption, since under assumption 2, individuals are indifferent between allocating the marginal increase of the NCMS benefits for consumption or for health. The non-marginal estimate of the total welfare value of the NCMS, $\gamma(q)$, is obtained by integrating with respect to q: $\gamma(q) = \int_0^1 \frac{d\gamma(q)}{dq} dq$.

To implement the optimization approach, I assume the utility function takes the following form:

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + v(h), \quad (11)$$

where σ represents the coefficient of relative risk aversion and $v(.)$ is the sub-utility function for health, which is left unspecified. Combining with equation (9), equation (7) could be rewritten as:

$$\frac{d\gamma}{dq} = E\left[\frac{c(q)^{1-\sigma}}{E[c(q)^{1-\sigma}]}\left(\frac{1}{q}\big(p(0)-p(q)\big)m(q)\right)\right] \quad (12).$$

I decompose the marginal value of the NCMS to the recipients into a transfer term (T) and a pure-insurance term (*I*). The decomposition is:

$$\frac{d\gamma}{dq} = E\left[\left(\frac{1}{q}\big(p(0)-p(q)\big)m(q)\right)\right] + Cov\left[\frac{c(q)^{1-\sigma}}{E[c(q)^{1-\sigma}]}, \left(\frac{1}{q}\big(p(0)-p(q)\big)m(q)\right)\right].$$

Since I do not observe all $q \in [0,1]$ and the intermediate values, the calculation of the non-marginal estimate of the total welfare value of the NCMS requires an additional assumption. For the baseline estimation of the optimization approach, I make the following statistical assumption.

Assumption 3. (*Linear Approximation) The integral expression for* $\gamma(q)$ *is approximated by:*

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

3.3 The costs of the NCMS

I benchmark the welfare estimates, $\gamma(q)$, against the government's costs of implementation. For this paper, I consider only the medical expenditures when estimating the program costs. This abstracts from any potential administrative costs associated with the NCMS. Under this assumption, the average cost to the government per recipient, which I denote as *G*, is

$$G = E[m(q) - x(q)]\ . (15)$$

This gross cost per enrolled family, *G*, is higher than the net cost to society. The net cost of the NCMS, which is denoted by *C*, is:

$$C = E[m(q) - m(0)] + E[x(0) - x(q)]\ . \ (16)$$

Net cost per recipient consists of the average increase in medical spending induced by the NCMS, plus the average decrease in out-of-pocket expenditure due to the NCMS.

4. Empirical strategy

To identify the effects of enrolling in the NCMS on the outcome variables, I adopt the instrumental variable (IV) estimate strategy. It is modeled as follows:

$$y_{ijt} = \alpha_0 + \alpha_1 NCMS_{ijt} + \lambda_t + \lambda_j + \beta X_{ijt} + \epsilon_{ijt}\ , \ (17)$$

where y_{ijt} is the outcome of interest for household *i* residing in county *j* at year *t*. X_{ijt} includes a set of demographic variables, including log household size, share of children in the household, share of working-age adults in the household, age and age-squared of the household head, indicators for the education level of the household head, and whether the household head is single.

X_{ijt} controls for the effects of household demographics on the outcome of interest. λ_j and λ_t are county- and year-fixed effects, respectively. The county-fixed effects λ_j allow the fact that variation in the timing of the reform across counties may not have been exogeneous. The year-fixed effects λ_t control the unobserved household characters over time that may be completely unrelated to the reform. λ_j represents county-fixed effects, which control for the average change in outcomes across all households or the change in aggregate resources within a county. $NCMS_{ijt}$ is a dummy variable indicating whether the household *i* enrolled in the NCMS in year *t* in county *j*. To capture any common influences on the outcome variable across households within the county and over time, standard errors are clustered at county level.

The coefficient of interest is α_1, the impacts of participating in the NCMS on the outcome variable. One major concern with equation (17) is that enrolment in the insurance could be endogenous since participating in the NCMS is voluntary. Households with existing health concerns may be more likely to participate than the ones without. To account for endogeneity of participation in the scheme, I adopt an instrumental variable strategy using the same set of control variables in equation (17). Recent studies suggest that an individual's peers and social interactions play a key role in adopting health products and taking up of social programs (Kremer and Miguel, 2007; Oster and Thornton, 2011; Dahl et al., 2014. The information transmission about costs and benefits among peers increases the likelihood of program participation. Following Cheung and Padieu (2015), I use the percentage of recipients in the community, excluding the observed household, as the instrument variable. The underlying assumption is that the higher the coverage in the community, the more credible and attractive the insurance is to households. The participation rate in the community influences the household's decision to enroll in the NCMS, but has no direct effect on the outcome variables.

As we have already discussed, the rollout structure of the NCMS makes the identification strategy more appealing. As noted above, the program had a six-year implementation period (2003-9) in different counties at different times in rural China, and the lack of mobility and county-specific nature of implementation made spillover effects to other counties unlikely.

Previous studies identifying the local average treatment effect of the NCMS have adopted two other instrumental variables: county offer status (Lei and Lin, 2009), duration of community-level NCMS availability (Donato and Rokicki, 2016). All three IVs capture the relationship between the availability of the insurance and household participation. Using county NCMS offer status suffers from the critique that the IV may influence the outcome variable directly if the county implementation decision is correlated with the local economy level. Duration of the community-level NCMS fails to capture the unobserved program intensity and credibility along time, leading to a potentially weak correlation with the household participation decision. Results using the other two IVs are available in Appendix A.3.

5. Data

As noted above, I use data from the China Health and Nutritional Survey (CHNS). The CHNS began in 1989 and had eight subsequent waves in 1991, 1993, 1997, 2000, 2004, 2006,2009 and 2011. It is based on a multistage, random cluster process that results in a sample of approximately 4,400 households with 19,000 individuals over the survey periods. 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.

In this study, I use data from 1993 to 2011, covering the entire duration of the health insurance reform. Since enrolment in the NCMS is at the household level, the unit of observation under analysis is the household. I use the following criteria for sample selection. First, I restrict the sample to be rural households, whose household head lives in a rural county and has a rural hukou. Second, I exclude observations with missing information on key variables such as insurance enrolment status, county-level NCMS offer status, and education status of the household head.

Following Lei and Lin (2009), the year of the county-level implementation is determined by community survey data from the CHNS. Government officials from each community were surveyed on whether the Cooperative Medical Scheme (CMS)—which, as noted above, preceded the NCMS—had been implemented in their community, and if so, the starting date. Medical

scheme plans implemented after 2003 are defined as the NCMS. Since the NCMS operates at the county level, if any community within a county was known to have adopted the NCMS, the county as a whole was defined as having implemented the NCMS.

Table 2, Panel A presents descriptive statistics for the households used in the empirical analysis. The first column reports results for the whole population. Column 2 and 3 describe results for households without and with enrolment in the NCMS. Compared to households enrolled in the NCMS, the heads of households without NCMS enrolment tend to be younger, more likely to be single, and less likely to have achieved at least nine years of education. Households with the NCMS are smaller in size, have a lower average number of children, and have a much higher total annual household income compared to those without.

In the rest of this section, I first focus on outcome variables that are relatively easy to measure: medical spending (m), out-of-pocket spending (x), and out-of-pocket price (p). Then I describe the estimation of monetized value of health (h) and consumption (c). The measure of consumption available from the CHNS is food consumption. However, the monetary value of the food consumption is not directly available from the data. Therefore, estimation of health and consumption requires additional assumptions. Table 2, Panel B presents summary statistics on key outcome variables in this study.

Medical spending m. The CHNS queries respondents about their utilization of medical services. The medical spending includes the costs of treating the same illness used to define the health shock at up to two clinics or hospitals, as well as the cost of informal treatment if the individual chooses to use informal care (i.e., did not go to a clinic).[5]

[5] The first question asks what a respondent did if he reported being sick in the past four weeks. If the respondent reports self-care or visits a local health worker, the second question asks the amount of total costs incurred. If the respondent reports seeing a doctor, the third question records the amount of total spending in hospital, which includes registration fees, medicines, treatment fees etc. If the respondent reports seeking a second health facility regarding the same illness, the total amount of medical spending is also recorded. The fourth question asks the amount of additional costs incurred in treating the same diseases. The four questions are available in all waves of the survey for every respondent aged 18 years or older.

The household-level medical spending is measured as the sum of all medical spending incurred by the household members. On average, monthly medical spending is about 308 RMB for households enrolled in the NCMS and 112.9 RMB for households that are not.

Out-of-pocket spending x. The household out-of-pocket spending is derived from the same set of questions as the medical spending. The CHNS surveys respondents about the proportion of the cost paid by the insurance. The household out-of-pocket spending is measured as the sum of all out-of-pocket spending incurred by the household members. The average monthly out-of-pocket medical expenditure for households enrolled in the NCMS is 293.6 RMB and 484.6 RMB for those who are not.

Out-of-pocket prices p. The optimization approach requires the definition of the out-of-pocket price of medical care with the NCMS, p(q), and without, p(0). I measure the price of medical care p(q) as the ratio of mean out-of-pocket spending to mean total spending: $p(q) = \frac{E[x(q,m)]}{E[m(q)]}$. I estimate p(0) = 0.99 and p(q) = 0.75. In other words, the uninsured pay almost the whole amount of their medical spending, while the insured only pay 0.75 on 1 RMB for their medical spending.

5.1. Measuring requisite health (*h*) inputs

The complete-information approach requires estimating the impact of the NCMS on health. There are several measures of health in the CHNS data. For the baseline analysis, I adopt the specification in Liu (2016). The household health status is derived from two questions in the survey. The first question asks whether the individual, during the past four weeks, has suffered from any illness; if yes, the second question records the number of days in the same period that the person has been unable to carry out daily activities due to the illness.[6] Both questions are available in all waves of the survey for every respondent aged 18 years or older.[7]

[6] The survey questions are: "During the past four weeks, have you been sick or injured? Have you suffered from a chronic or acute disease?" and "For how many days during the past four weeks were you unable to carry out normal activities due to this illness?"

[7] The self-assessed health status question is available in the CHNS but only from wave 1997 to wave 2006. Another potential measure is the self-reported ability to perform daily activities. However, the CHNS only collects data on physical limitations for individuals aged 55 and above, and the collection of these data ends with the 2006 wave.

The household-level health status is measured as the proportion of time in the past four weeks (in percentage points) that the household suffers from a severe illness:

$$h_{ijt} = \frac{\sum_{m=1}^{M} d_{ijt}^{m}}{28} \times 100 \,, \quad (18)$$

where d_{ijt}^{m} measures the number of days in the past four weeks that household members reported severe illness. The household health status is defined as a normalization over the length of the recall period (28 days). On average, households enrolled in the NCMS experience 0.884 days of sickness in the past four weeks while households without the NCMS experience 0.721 days.

Measuring health as the capacity to perform daily activities among all household members for rural households in China captures not only the benefits from improved health conditions but also, partially, the benefits of avoiding inefficient insurance mechanisms. Recent literature has shown that household labor supply is an important insurance mechanism against health shocks among low-income households (Chetty and Looney, 2006; Chetty, 2006). Absent health insurance, during a negative health shock, households tend to reduce investment in children's education and increase the use of child employment (Liu, 2016). Evaluating health as the number of days that adult household members are unable to work indirectly captures the insurance's effects on labor supply.

A key challenge for welfare analysis is how to value changes in a given measure of health. With the health measure as the number of days unable to work, the standard approach is to evaluate using the hourly wage rate. A majority of the rural households in China do not engage in formal employment and many work in family businesses (e.g. agricultural work or raising livestock). The CHNS provides annual household income and thus I measure the value of a labor day as $\phi = \frac{y_{ijt}}{260}$, where y_{ijt} is the annual household income of household *i* residing in county *j* at wave *t*.

5.2. Measuring requisite consumption (*c*) inputs

Both the complete-information approach and the optimization approach require measurement of consumption. The complete-information approach requires the estimate of the

impact of the NCMS on the distribution of consumption. The optimization approach requires estimation of the joint distribution of consumption and out-of-pocket spending.

As a survey designed to track the nutritional intake of the respondents, the CHNS records food consumption as the amount of caloric intake. The monetary value of food consumption is, however, not directly available from the data. In this study, I proxy for non-medical household consumption c as the difference between total household income and out-of-pocket medical expenditure:

$$c = y - x\,. \quad (19)$$

The consumption proxy assumes that each household member is entitled to the same amount of consumption, i.e., the impact of a given amount of out-of-pocket expenditure on non-medical consumption is shared equally within household. This assumption is reasonable in the context of rural China, given the joint nature of household consumption and labor supply. In the sensitivity analysis, I also report results in which I assume the other extreme: the out-of-pocket spending shock is borne entirely by each individual.

Since there are unavoidable measurement errors in this approach to estimating c, and because welfare estimates are naturally sensitive to c at low values, I follow the standard procedure for ruling out implausibly low values of c (e.g. Brown and Finkelstein, 2008; Hoynes and Luttmer, 2011) by imposing an annual consumption floor. The baseline analysis imposes a consumption floor of 2,400 RMB per year, which corresponds to the 5th percentile of non-medical consumption for the whole sample. The value of the consumption floor is selected according to the 2010 China Statistical Yearbook, where the total living expenditure for the low-income households is 2535.35 RMB. In the sensitivity analysis below, I explore sensitivity to the assumed value of the consumption floor.

6. Welfare results

6.1. Empirical estimation results

This section examines the impacts of the NCMS on the following outcomes, in sequence, using the empirical strategy specified in Section 4: health, household consumption, and health

expenditure. Table 5 reports the first-stage estimate, regressing the household NCMS enrolment status against the proportion of households enrolled in the community excluding the observed household. The result indicates that the household's decision in participating in the NCMS is highly correlated with the proportion of enrolled households in the community, suggesting strong peer effects.

Table 3, Column 1 presents the coefficient estimate on the health measurement, the fraction of the past 28 days in which members of the household suffered from severe illness limiting daily activities. On average, enrolment in the NCMS increases by 7.03 the number of days household members are unable to perform daily activities. However, this increase is not statistically significant.

I construct alternative health measurements to identify the effect of the NCMS on working-age adult household members. The health measurement is defined as the following:

$$h_{ijt} = \frac{\sum_{m=1}^{M} d_{ijt}^{m} 1(18 \leq age_m \leq 65)}{28} \times 100,$$

where $\sum_{m=1}^{M} d_{ijt}^{m} 1(18 \leq age_m \leq 65)$ is the total number of days in the past four weeks that household members 18 to 65 years old were unable to perform daily activities. Table 3, Column 2 reports the estimated result. On average, participating in the NCMS leads to an increase of 2.04 days that working-age household members are unable to perform daily activities. Though statistically not significant, the estimated results show that the NCMS influences household labor supply decisions mainly through the activity of non-working-age members.

Table 3, Columns 3 and 4 present the coefficient estimates on household monthly non-medical consumption. On average, enrolment in the NCMS increases the household monthly consumption by 7.45 RMB, or equivalently, 2% of the total household non-medical consumption.

Table 4 presents the mean effect, estimating the NCMS's impacts on health expenditures. Columns 1 and 2 report the impacts of the NCMS on monthly medical expenditure. Participating in the NCMS increases the monthly medical expenditure of the enrolled households: on average, joining the NCMS leads to an increase of medical spending of 19.04 RMB, or 2% more compared

to the households without the NCMS. Columns 3 and 4 report the impacts of the NCMS on monthly out-of-pocket spending. Enrolment in the NCMS leads to an average 1.516 RMB increase or, equivalently, 0.03% more in monthly out-of-pocket expenditure compared to unenrolled households. None of the regression results are statistically significant.

The estimated effects of the NCMS on health, consumption and health expenditures are consistent with the findings of the previous studies. Joining the NCMS has a modest impact on improving health status, reducing the total medical service usage and out-of-pocket spending (Lei and Lin, 2009; Wagstaff et al., 2009; Hou et al, 2014; Liu, 2016). Bai, et al. (2013) also find that enrolment in the program increases non-medical consumption by approximately 5%, similar in scale with findings in this paper.

6.2. Welfare estimation results

Panel A of Table 5 reports the welfare results from the baseline analysis.

6.2.1. Complete-information approach

I estimate equation (5) for $\gamma(q)$. This requires me to estimate the mean health outcomes and the distribution of consumption for control compliers and treatment compliers. Table 3, Column 1 shows the estimate of the average health differences of control compliers and treatment compliers. To estimate the distribution of consumption for the treatment and control compliers, I follow a parametric IV technique specified in Imbens and Rubin (1997). Details of implementation are described in Appendix A.1. The complete-information approach requires an estimate of values in changed health, ϕ. As discussed above, the baseline analysis assumes ϕ = 73 RMB, the value of a labor day. I also assume in the baseline analysis that $\sigma = 1.5$.

The first column of Table 5 shows the resultant estimate: $\gamma(q) = 109.7$ RMB. In other words, the estimated result shows that an NCMS recipient would be indifferent between giving up the NCMS and giving up 109.7 RMB in monthly consumption. If we assume the same effects across the months, the annual welfare benefit of the NCMS per household is 1316.4 RMB. I decompose the welfare value of the NCMS to the recipients $\gamma(q)$ into a transfer term of 71.4 RMB (see equation 6) and a "pure-insurance" term of 38.3 RMB (see equation 7). The result suggests

that approximately 65% of the value of the NCMS comes from the transfer component, and about 35% comes from the NCMS's ability to move resources across different states of the world.

Since the complete-information approach involves summing up over all the impacts of the NCMS on each argument of the utility function, it is natural to decompose the welfare value into components operating through health, and components operating through consumption. I define the welfare value of the NCMS to recipients operating through consumption, γ_C as:

$$E\left[\frac{c(0,\pi)^{1-\sigma}}{1-\sigma}\right] = E\left[\frac{(c(q,\pi)-\gamma_C)^{1-\sigma}}{1-\sigma}\right],$$

and estimate $\gamma_C = 68.7$ RMB. Therefore, the value of the NCMS as it operates through health is $\gamma_M = 41$ RMB. Appendix A.2 provides implementation details. The estimated result suggests that recipients value the NCMS both for its impact on consumption and for its impact on health.

6.2.2. Optimization approach

I estimate the transfer component and pure-insurance component separately, and then combine them for the overall welfare estimate under the optimization approach. The estimate of the transfer component is relatively straightforward. The estimate of the pure-insurance component requires an assumption about the coefficient of risk aversion. I use the same assumption as in the complete-information approach: $\sigma = 1.5$.

Without any assumption on the utility function, the optimization approach estimates the value of the transfer component using only the estimates of the medical costs, *m*, and price, *p*. Using linear approximation, the transfer term is 50.6 RMB. The estimate of the pure-insurance term in turn requires an estimate of the covariance between consumption distribution and medical spending, which can be obtained directly from data. Following the linear approximation assumption, the total pure-insurance component is 55.7 RMB.

The overall welfare benefit of the NCMS measured using the optimization approach is 106.3 RMB per recipient per month. The proportion of welfare benefits that come from the transfer component is slightly smaller compared to the results under the complete-information approach. The transfer component represents 48% of the total welfare value while the pure-insurance term

represents approximately 52%. The welfare value measured by the optimization approach is slightly lower than under the complete-information approach. I interpret the values from the two approaches as the upper and lower bounds of the potential range of the two welfare components.

6.3 Interpretation

I benchmark the welfare estimates against the costs of the NCMS. Government costs, *G*, are the difference between total medical spending and out-of-pocket spending for treatment compliers. The estimated government cost for the NCMS is approximately 77.5 RMB per recipient per month. The net cost of the NCMS, *C*, is 76.4 RMB per recipient per month. The estimates of the costs are generally consistent with external estimates of annual per-household spending in the NCMS program.

I define the monetary transfer from the NCMS to external party as the difference between the gross costs and net costs: $N = G - C$. The estimates of the gross costs and net costs of the NCMS leave a small margin for transfer to external parties: only 1.1 RMB per recipient per month. Since *N* measures the difference between the total medical bills and the amount the uninsured paid, it gives a value of implicit insurance for the uninsured. The result is not surprising in the context of rural China, since the uninsured typically pay all their medical expenses out-of-pocket with little covered by a hospital or any other third parties. Uninsured individuals may receive support from family members or relatives, but since the measurement unit in the analysis is household, the magnitude of those transfers is small.

To better understand the meanings of these estimates, I conduct several comparisons of the costs and the welfare evaluation. The results are summarized in Panel B of Table 6. Comparing the value of the welfare benefits and the government's gross costs of providing the insurance provides insights into the existing rural insurance market in China. If rural residents have access to a well-functioning private insurance market or other actuarially fair risk protection products, the welfare value of the NCMS, $\gamma(q)$, may be less than the government's costs of provision, *G*. However, if self-insurance is the major means of risk hedging among rural residents in China, the welfare benefits may be well above the government's costs.

For both methods, I consistently estimate that the welfare benefit of the NCMS, $\gamma(q)$, is more than *G*. A benefit-cost ratio of 1.4 indicates that, given a choice between obtaining the NCMS at the cost of *G* in consumption and the status quo—in which he does not enroll in any health insurance—an individual would choose the NCMS. Comparing the welfare value and the government's net costs of providing the insurance paints a similar picture. Excluding the potential transfer to external parties from the NCMS (*N*), the net costs reflect the "true cost" of the NCMS to the public sector.

My consistent baseline estimate is that $\gamma(q)$ is more than *G*. Depending on the approach used, I estimate that the ratio of welfare benefits to government gross costs is approximately 1.4. This implies that the recipients value the NCMS approximately equal to or higher than the government's costs of providing the insurance. That is to say, as explained above, that an uninsured household would prefer to obtain the NCMS at the cost of *G* in consumption rather than maintaining the status quo. However, $\gamma(q)$ > G does not answer the question of whether an uninsured household would prefer receiving the NCMS to receiving *G* in additional consumption or, equivalently, whether an insured household would be willing to give up the NCMS in exchange for a consumption increase of *G*.

Comparing the value of the welfare benefits and the government's net costs of providing the insurance gives consistent interpretation. Excluding the potential transfer to external parties from the NCMS (*N*), the net costs reflect the "true cost" of the NCMS to the public sector. Depending on the approach, the ratio between the welfare value and the net costs varies from 1.39 RMB to 1.44 RMB. The fact that $\gamma(q)$ is consistently above *C* implies that the insurance value of the NCMS to the recipients, *I*, exceeds the associated moral hazard costs. The results imply that formal medical care is a "luxury" good for rural households in China. Even with access to health insurance, rural households would prefer to seek formal medical services only when necessary.

The findings suggest that the NCMS is highly valuable to the rural households in China and government could increase the generosity of the insurance for higher welfare benefits. Another reason for the high value of the welfare estimation of the NCMS is that the uninsured in rural China pay all their medical spending with few incidences of receiving unpaid care. Therefore, the

monetary transfer from the NCMS to external parties is almost nonexistent, leaving the majority of the cost of the NCMS as net costs.

6.4. Sensitivity analysis

6.4.1. Risk aversion and consumption floor

Table 7, Columns II–V explore alternative choices for risk aversion (a coefficient of relative risk aversion of 1.2 and 3, compared to our baseline of 1.5) and the consumption floor (of 100 RMB or 500 RMB per month, compared to the baseline assumption of 200 RMB). Since the coefficient of relative risk aversion models individuals' attitude towards risk, the higher the σ, the more risk-averse the individuals, and thus the higher preference they have for consumption smoothing. The estimated results confirmed the hypothesis. Compared to the baseline results, the welfare benefits of the recipient exceed the government costs under a higher risk-aversion value ($\sigma = 3$) for both approaches. That is, if rural Chinese households were more risk-averse compared to the baseline, they would value the NCMS much more highly than the government's costs of providing it. Lowering the risk aversion value ($\sigma = 1.2$) results in a lower evaluation of the welfare value of the NCMS, which is as expected. Table 7, Columns IV–V report the results using a different consumption floor. A higher consumption floor leads to lower welfare benefits, suggesting that if households have access to other consumption-smoothing channels (i.e. higher household income), they would value the NCMS less.

6.4.2. Alternative assumption about within-family smoothing

The baseline consumption proxy assumed that out-of-pocket medical spending reduced consumption of each family member by the same amount. Health is measured at the unit of a household, assuming that the influence of the health shock will impact all household members equally. In the context of rural China, within-family risk smoothing is common, because the majority of the consumption is joint (e.g. food and housing) and much work is done as a family unit (e.g. farming). However, extreme full smoothing within the family may not be guaranteed—the effect on an individual's consumption is the same regardless of whether the individual incurs the out-of-pocket spending. In Table 8, Column II, I examine the sensitivity of the results to

individual health measurement. Using individual health measurement, the welfare value is slightly lower than the baseline evaluation for the complete-information approach. The change has no impact on the results of the optimization approach. In Table 8 Column III, I examine the sensitivity of the results to an alternative assumption: that the out-of-pocket spending affects consumption only for the individual who incurred expenses. This slightly raises the estimates of the value of the NCMS relative to the gross costs under the complete-information approach. The results using the optimization approach have few changes.

7. Conclusion

This paper studies the welfare benefits of offering universal health insurance to low-income households. One of the major concerns for providing public health insurance is the associated moral hazard cost: Individuals consume more medical care because of lower out-of-pocket prices. Traditionally, the moral hazard effect has been interpreted as welfare-decreasing. In recent studies, access to health insurance is shown to also contain a welfare-enhancing income effect, allowing individuals to seek medical treatments that are otherwise unaffordable. Whether this tradeoff results in a positive welfare gain remains unclear, especially among low-income households.

Evaluating the welfare value of the NCMS in rural China based on its resource-transferring function and its role of consumption smoothing provides robust evidence that the welfare gains individuals enjoy from the NCMS program exceed its costs. A benefit-cost ratio of 1.4 confirms that uninsured individuals prefer to take up the insurance given the government's cost; government investments in the NCMS are therefore quite efficient. This finding contrasts sharply with the situation in some other countries. The US, for example, shows a benefit-cost ratio of 0.2 to 0.5, indicating that, given a chance to buy health insurance at the government's costs, Americans would not buy it at all. Further, a positive welfare gain suggests that income effect plays a major role in individuals' increased medical care consumption. Moral hazard costs, though they exist, are smaller than the welfare benefits generated. Contrary to findings in the US, less than 1% of the gross costs are due to transfers to third parties, suggesting that the NCMS enrollees are the main beneficiaries of the program.

The welfare benefits come from both the NCMS's ability to transfer resources to the recipients, as well as from its insurance function; the latter accounts for a third to a half of the NCMS's welfare benefits. The estimated results suggest that benefits of the public insurance program could come from offering efficient consumption-smoothing mechanisms among low- and middle-income households. The existing literature has shown that public insurance programs in developing countries could lead to net welfare gains by reducing the use of costly self-insurance mechanisms. The findings in this paper support the same argument.

While this study focuses on China, the results have broader implications for many developing countries whose population has little access to formal insurance. The average annual consumption among rural Chinese households in 2010 was 4,381 RMB, similar to the consumption level at several low- and middle-income countries. Further, the insurance enrolment rate and average medical spending per person among rural Chinese households prior to the offering of the NCMS are also comparable to many developing nations.

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Tables

Table 1 Implementation of the Reform

	Household		County
Year	% access to NCMS	% Insured	% Treated
1993	0	4.53	0
1997	0	14.3	0
2000	0	8.07	0
2004	29.89	15.2	8.3
2006	68.16	52.2	61.1
2009	100	96.4	100
2011	100	98.1	100

Note: Each round of the survey contains households sampled from 36 counties (four counties per province). Four counties from Liaoning province dropped out in 1997 wave but were added back from wave 2000 onwards.

Table 2 Summary Statistics

Variable	All	Without NCMS	With NCMS
Panel A. Household Demographics			
Age of the head	46.900	45.445	48.951
	(10.260)	(10.386)	(9.718)
Head being single	0.091	0.094	0.086
	(0.288)	(0.292)	(0.281)
Head with at least nine years of education	0.441	0.388	0.516
	(0.497)	(0.487)	(0.500)
Household size	3.089	3.465	2.558
	(1.471)	(1.507)	(1.238)
Share of children (aged 7 – 18)	0.183	0.223	0.125
in the household	(0.209)	(0.215)	(0.186)
Total annual household income	20,139	14,377	28,425
	(19,423)	(13,659)	(23,132)
Panel B. Outcome Variables			
Share of days with severe illness (all working members)	2.378	2.084	2.793
	(12.160)	(11.289)	(13.282)
Share of days with severe illness (all family members)	2.817	2.575	3.158
	(13.334)	(12.796)	(14.053)
Monthly out-of-pocket spending	160.9	111.4	230.7
	(1510)	(912)	(2077)
Monthly medical spending	194.0	112.9	308
	(1869)	(913.8)	(2689)
Monthly household consumption	1673	1233	2,307
	(1564)	(1082)	(1899)

Table 3 Effect of the NCMS on Health and Consumption

	Health (all family members)	Health (all working members)	Consumption	Log Consumption
	(1)	(2)	(3)	(4)
NCMS	0.251	0.0727	7.447	0.0224
	(0.707)	(0.752)	(108.7)	(0.0649)
Number of observations	12555	12555	12243	12243
Adjusted R-square	0.022	0.024	0.225	0.269

Note: Standard errors (in parentheses) are clustered at the county level. Health is the share of days in the past 28 days (in percentage points) in which all the working family members or all family members suffered from severe illness limiting daily activities. Each regression controls household size, percentage of children, household head's age and age square, household head's education, whether household head is single, wave and county fixed effects.
* p<0.1, ** p<0.05, *** p<0.01

Table 4 Effect of the NCMS on Health Expenditure

	Medical Spending	Log medical spending	Out-of-pocket Spending	Log out-of-pocket Spending
	(1)	(2)	(3)	(4)
NCMS	19.04	0.0158	1.516	0.0003
	(89.45)	(0.172)	(87.40)	(0.172)
Number of observations	12555	12555	12555	12555
Adjusted R-square	0.006	0.093	0.005	0.092

Note: Standard errors (in parentheses) are clustered at the county level. Each regression controls household size, percentage of children, household head's age and age square, household head's education, whether household head is single, wave and county fixed effects.
* p<0.1, ** p<0.05, *** p<0.01

Table 5 First Stage Result for the Instrument Variable

	Household NCMS status
Proportion of households enrolled in NCMS in the community	0.995***
	(0.0130)
Number of observations	12,555
R-square	0.916

Note: Standard errors (in parentheses) are clustered at the county level. Regression controls household size, percentage of children, household's age and age square, household education, whether household is single, wave and county fixed effects.
* p<0.1, ** p<0.05, *** p<0.01

Table 6 Welfare Benefit of the NCMS (per Month per Recipient)

	Complete-information Approach	Optimization Approach
Welfare benefits		
Welfare effect on enrolled households, $\boldsymbol{\gamma(q)}$	109.7 (49.203)	106.3
Transfer-term	71.4	50.6
Pure-insurance Term	38.3	55.7
Benchmarks **Welfare effects relative to:**		
gross costs, $\boldsymbol{\gamma(q)/G}$	1.42	1.37
net costs, $\boldsymbol{\gamma(q)/C}$	1.44	1.39
moral hazard cost, ***G-T-N***	5	25.8

Notes: Estimates of welfare effects and moral hazard costs are expressed in RMB per month per enrolled household. Standard errors are bootstrapped with 500 repetitions.

Table 7 Sensitivity of Welfare Estimates on Degree of Risk Aversion and Consumption Floor

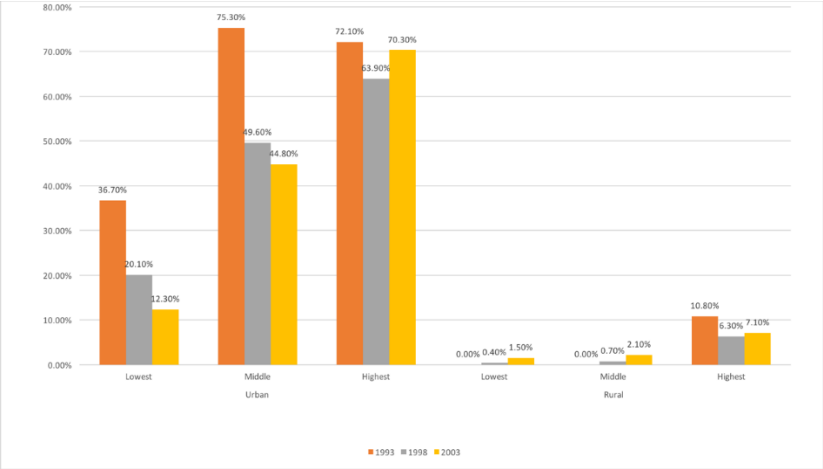
	I	II	III	IV	V
		Coefficient of relative risk aversion		Consumption floor	
	Baseline	1.2	3	100 RMB	500 RMB
Panel A : Welfare Relative to Gross Costs , $\boldsymbol{\gamma(q)/G}$					
Complete-information	1.42	1.40	2.57	1.55	1.20
Optimization	1.37	0.93	1.41	1.37	0.72
Panel B: Welfare Relative to Net Costs, $\boldsymbol{\gamma(q)/C}$					
Complete-information	1.44	1.42	2.61	1.57	1.22
Optimization	1.39	0.94	1.43	1.39	0.73

Table 8 Sensitivity of Welfare Estimates on Health Measurement

	I	II	III
	Baseline	Individual Measure	Health Shock born entirely by individual
Panel A: Welfare Relative to Gross Costs, $\boldsymbol{\gamma(q)/G}$			
Complete-information	1.42	1.174	1.55
Optimization	1.37	-	1.59
Panel B: Welfare Relative to Net Costs, $\boldsymbol{\gamma(q)/C}$			
Complete-information	1.44	1.220	1.57
Optimization	1.39	-	1.61

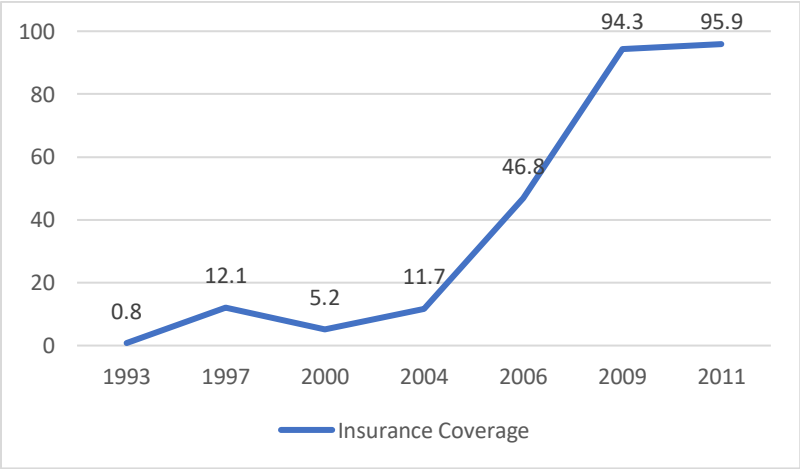
Figures

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



Source: Yip and Hisao (2008)

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



Source: Authors' calculation based on the CHNS data

Appendices

Appendix A.1 Estimating Outcome Distributions for NCMS Compliers

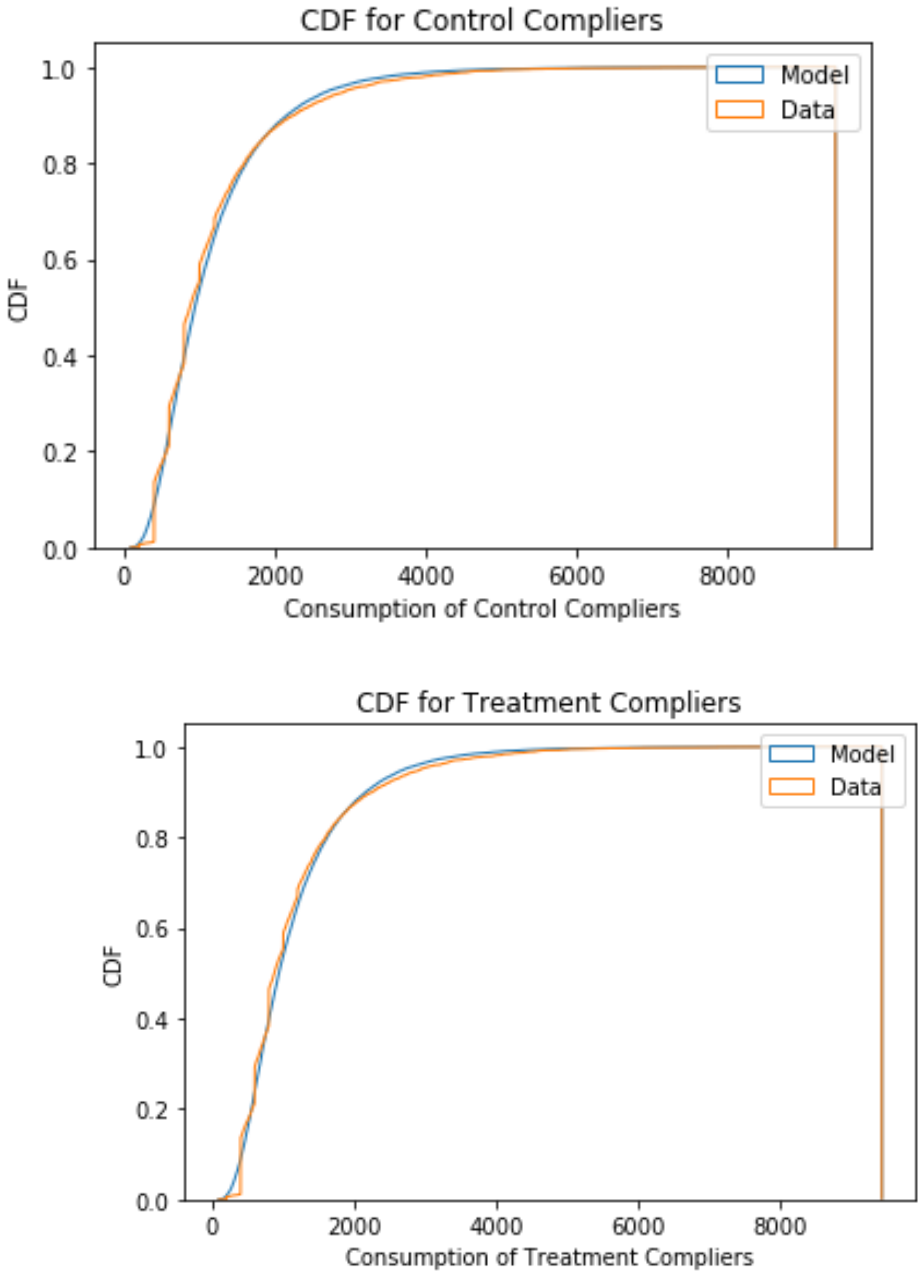
Let $f_g(x)$ denote the observed probability density function (pdf) x for group $g \in \{TC, CC, AT, NT\}$ where *TC* are the treatment compliers, *CC* are the control compliers, *AT* are the always-takers, and *NT* are the never-takers. In the sample, always-takers are defined as households who were enrolled in health insurance before the introduction of the NCMS to their residing county and never-takers are households who were not enrolled in the NCMS after the reform. I observe $f_{NT}(x)$, the distribution of x for never-takers, as well as $f_{AT}(x)$ directly. The population fraction of never-takers, φ_{NT}, is given by the fraction of the treatment group that did not take up the program. Similarly, the population fraction of always-takers, φ_{AT} is given by the fraction of the control group that took up the program.

The population fraction of compliers is given by: $\varphi_C = 1 - \varphi_{AT} - \varphi_{NT}$. The distribution of x for compliers cannot be observed directly from the data. In the control group, those who were not enrolled in any health insurance are a mixture of never-takers and compliers. Similarly, in the treatment group, those who choose to enroll in the NCMS are a mixture of always-takers and compliers. Following Imbens and Rubin (1997), I could back out the distribution of compliers as: $g_{CC}(x) = \frac{\varphi_{NT}+\varphi_c}{\varphi_c} f_{NT}(x) - \frac{\varphi_{NT}}{\varphi_c} f_{CC}(x)$, and $g_{TC}(x) = \frac{\varphi_{AT}+\varphi_c}{\varphi_c} f_{AT}(x) - \frac{\varphi_{AT}}{\varphi_c} f_{TC}(x)$, where $g_{CC}(x)$ and $g_{TC}(x)$ are the potential outcome distribution of consumption for control compliers and treatment compliers respectively.

Assume the household consumption follows a log-normal distribution (Battistin, Blundell and Lewbel, 2009), I allow the parameters of the distribution to differ across the four groups: $LOGN(x|\mu^g, v^g)$ for $g \in \{TC, CC, AT, NT\}$, where $LOGN(x|\mu, v)$ is the CDF of a log-normal with mean and variance parameters μ and v. I estimate the eight parameters using maximum likelihood estimation. Calculation of the maximum likelihood estimates is based on the EM algorithm (Dempster, Laird and Rubin (1977)).

To assess the goodness of fit, Figure A1 plots the estimated and actual CDF separately based on NCMS county level offer status. As can be seen from these figures, the parametric model fits quite well.

Figure A.1 Fitted and actual CDFs of consumption spending



Appendix A.2 Decomposition of welfare effects in the complete-information approach

To explore the underlying factors that drive the value of the welfare estimates, I decompose $\gamma(q)$ into two components: γ_c, welfare comes from consumption, and γ_m, welfare comes from health. γ_c is estimated based on the following equation given the additive nature of the utility function

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

Naturally, γ_m is calculated as the difference between $\gamma(q)$ and γ_c. I further decompose the welfare effects operate from consumption and health into a transfer term and a pure-insurance term, similar as the optimization approach. The transfer component of γ_c is defined as

$$\gamma_{c,transfer} = E[c(q;\pi) - c(0;\pi)].$$

The pure-insurance component of γ_c is then: $\gamma_{c,ins} = \gamma_c - \gamma_{c,transfer}$.

Recall from section 3, health is produced according to a health production function $h = \tilde{h}(m;\theta)$. Substituting this into equation (4), we define the transfer component of γ_m as:

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

$\gamma_{m,transfer}$ is interpreted as welfare associated with the change in health condition from the average change in medical spending due to the NCMS. The change in health condition is approximated as following:

$$\mathrm{E}[\tilde{\phi}\tilde{h}(E[m(0;\theta)];\theta) - \tilde{\phi}\tilde{h}(E[m(q;\theta)];\theta)] = \tilde{\phi}E\left[\frac{d\tilde{h}}{dm}\right]E[m(q;\theta) - m(0;\theta)].$$

The pure-insurance component of is $\gamma_{m,ins} = \gamma_m - \gamma_{m,transfer}$.

Evaluating the equation requires estimating the slope of the health production function $E\left[\frac{d\tilde{h}}{dm}\right]$ between $m(q;\theta)$ and $m(0;\theta)$. In the analysis, I use a simple OLS regression of the household medical spending on health measures, controlling log household size, share of children

in the household, share of working-age adults in the household, age and age-squared of the household head, indicators for the education level of the household head, whether the household head is single, wave and county fixed effects. The slope of the health production function is estimated as the average effect of medical spending on changes in health measures. The regression result is presented in Table A.1.

Table A.1 Effect of Medical Spending on Health Measure

	Household Health Measure
Household Medical Spending (in 100RMB)	0.0130**
	(0.00475)
Number of observations	12555
R-square	0.028

Note: Standard errors (in parentheses) are clustered at the county level. Regression controls household size, percentage of children, household's age and age square, household education, whether household is single, wave and county fixed effects.

* p<0.1, ** p<0.05, *** p<0.01

Appendix A.3 First-Stage Regression Results using Different Instrument Variables

To compare the effects of different instrumental variables, I run the first-stage of the 2SLS regression using county offer status and the duration of community-level NCMS availability. Table A.2 reports the results, regressing the household NCMS enrolment status against the county offer status and the duration of community-level NCMS availability. The result indicates that county offer status is highly correlated with the household's decision in participating in the NCMS while the duration is community-level NCMS availability is only weakly relevant. However, the R-square using proportion of households enrolled in the community excluding the observed household is higher than the county offer status, suggesting a stronger relationship.

Table A.2 First Stage Results Using Alternative Instrumental Variables

	Household NCMS status	Household NCMS status
County-offer Status	0.622***	
	(0.071)	
Duration of community-level NCMS availability		0.004
		(0.012)
Number of observations	12,555	12,555
R-square	0.837	0.756

Note: Standard errors (in parentheses) are clustered at the county level. Regression controls household size, percentage of children, household's age and age square, household education, whether household is single, wave and county fixed effects.

* p<0.1, ** p<0.05, *** p<0.01