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Katherine Donato, M.A.*
Harvard University
Department of Health Policy
14 Story St, 4th Floor
Cambridge, MA 02138
katherinedonato@fas.harvard.edu
301-928-7496

Slawa Rokicki, M.S.
Harvard University
Department of Health Policy
14 Story St, 4th Floor
Cambridge, MA 02138

* Corresponding author

Abstract

Background

In 2003, the Chinese government established the New Cooperative Medical Scheme (NCMS) with the goal of improving health for the country's 800 million mostly uninsured rural residents. Using new data on objective health measures, we analyzed the program's effectiveness in improving health for enrollees.

Methods

Using longitudinal data from the China Health and Nutritional Survey from 2000 to 2009 (12 080 observations across four waves), we analyzed the impact of the NCMS on objective measures of health such as blood pressure, HbA1c, and cholesterol, as well as use of preventive care. In order to overcome inherent selection bias where less healthy people are more likely to enroll in the voluntary health insurance scheme, we used intent-to-treat and instrumental variable analysis strategies, and offered evidence that these approaches can mitigate this bias.

Results

For every additional year of NCMS coverage, the probability of seeking preventive health care increased by 0.6 percentage points (95% CI 0.1-1.0). However, we did not find evidence that the NCMS resulted in consistent improvements in objective measures of health. Sub-group analysis suggested that lower-income communities benefited more from the program, implying that the program may have resulted in some lessening of the wealth-based disparity in health.

Conclusions

The NCMS does not appear to significantly improve objective measures of health. This is consistent with evaluations of health insurance programs in other countries, but in contrast to some previously reported improvements in self-reported health resulting from the NCMS.

3-10 key words

China, health insurance, biomarkers, objective health

Introduction

On September 6, 2013 the Chinese government announced that its New Cooperative Medical Scheme (NCMS), a health insurance program initiated in 2003 for rural residents, had reached coverage of 800 million people, 99% of the rural population. A decade prior, only 8 million rural residents had access to any health insurance.[1] While the health insurance initiative scaled with remarkable speed, there is little evidence of the program's effectiveness at improving health, one the main goals of this vast undertaking.[2] Considering the significant expense of implementing the program and that several other developing countries, including Colombia,[3] Vietnam,[4] and Mexico,[5] have also recently implemented large public health insurance programs, we seek to better understand how the NCMS affects health.

In this paper, we evaluated the effect of NCMS coverage on objective measures of health. Until now, evaluation of the NCMS has focused on process measures such as health care-seeking, or has measured health through self-reports. While these previous evaluations of the NCMS have tended to show improvements in utilization and self-reported health,[2, 6, 7] evidence on the impact of health insurance on objective measures of health in other contexts has been mixed.[8-12]

Background

The central government of China introduced the New Cooperative Medical Scheme (NCMS) health insurance program in October 2002, with the goal of covering the entire rural population by 2010.[2, 13] At that time, only 4% of rural households had medical insurance, more than a third of the sick did not seek medical care, and many households were so affected by medical debt that they had reduced their food consumption.[14] Within a year, over 300 rural counties

had implemented the NCMS, and by the end of 2007 that number had reached over 2400 counties (85% of all rural counties) covering over 700 million people.[2, 15]

The NCMS is administered at the county level, and jointly financed by the central and local governments, in addition to individual-level fees. In general, participation in the NCMS requires rural registration status, and administrators are not allowed to deny coverage to any person with this rural registration based on health condition or socioeconomic status.[16] To reduce adverse selection where only the unhealthiest choose to enroll, the central government stipulated that it would only pay its share of the program's funding if coverage reached at least 80% of rural residents in the county.[13] Local governments responded in various ways, including by requiring that entire households enroll together, aggressive advertising campaigns, and social pressure.[13] As a result, participation within counties implementing the NCMS increased dramatically over a fairly short period of time.[17]

Methods

Data

To study the impact of the NCMS on health, we used data from the China Health and Nutrition Survey (CHNS). This survey, conducted by the Carolina Population Center at the University of North Carolina-Chapel Hill, the National Institute of Nutrition and Food Safety, and the Chinese Center for Disease, is a nationally representative longitudinal survey in China that spans 36 counties from nine geographically and economically diverse provinces.[18] We used data from the four waves of the household- and community-level surveys collected from 2000 to 2009. We restricted our analysis to individuals in rural areas with rural registration, since this is the group that is targeted and eligible for the NCMS. We also restricted to adults age 18 and over.

Biomarkers were only collected in the 2009 wave of the CHNS, and we restricted our main analysis to the adults for whom biomarkers were collected (results for non-biomarker outcomes for adults who did not have biomarkers collected are reported in the supplementary material in Table A4, and are virtually unchanged). This resulted in 12 080 observations from 4563 adult rural registrants across the four waves. In 2009, the year that biomarkers were collected, there were 4257 adult rural registrants in the data.

Empirical Strategy

Our analysis focused on the impact of NCMS coverage on health outcomes. Blood measures were only collected in the 2009 wave of the data, limiting us to a cross-sectional analysis of these outcomes. To mitigate the impact of selection bias, where relatively less healthy individuals are more likely to opt to join the health insurance scheme, we implemented two empirical strategies: (1) intention to treat, and (2) instrumental variable analysis. In the intention to treat (ITT) analysis, we used duration of community-level NCMS availability as the explanatory variable of interest because community-level coverage is not affected by individual choice.

In the instrumental variable analysis, we exploit the heterogeneity in rollout times of the NCMS program across communities, using duration of community-level NCMS availability as an instrument for duration of individual-level coverage. In order for this instrumental variable analysis approach to be valid, the instrument (i.e., duration of community-level availability) must predict individual insurance status, but be otherwise independent of the outcomes of interest. To test the validity of the instrument, we regressed (1) the year the community adopted NCMS, and (2) a binary indicator of being a late adopter (i.e., adopting the NCMS in 2006 or later) on community characteristics. Additionally, we analyzed the impact of community wealth – a

potentially important predictor of both NCMS adoption and health – on community health and care-seeking in 2000, before the program was implemented.

For binary outcomes, we used probit models and report marginal effects. For continuous outcomes, we used linear regression models. For all analyses, we clustered the standard errors at the community level to adjust for the within-community correlation structure.

In addition, we analyzed the differential effects of NCMS coverage by gender, wealth, and age in an extension of the ITT analysis. Using linear regression models, we interacted the duration of insurance availability with an indicator for female in one set of analyses, with an indicator for the community having below median wealth in 2000 in a second set of analyses, and with an indicator for being older than 50 years (the median age in the dataset) in a third set of analyses.

As supplementary analyses, we additionally conducted panel analyses on the outcomes collected in all waves: use of preventive health services, blood pressure, and weight. For panel ITT analyses, we used an indicator of current community-level availability of coverage as the explanatory variable of interest. For the instrumental variable analyses, we instrument for an indicator of current individual coverage with an indicator of current community availability of coverage. All panel results are presented in the supplementary materials.

Outcomes and Quantities of Interest

Outcome measures include systolic and diastolic blood pressure, body mass index (BMI), overweight status, obese status, whether the individual sought preventive care in the past 4 weeks, hemoglobin, white blood cell count, C-reactive protein, triglycerides, LDL cholesterol, HDL cholesterol, HbA1c, total cholesterol, glucose, and the Framingham Risk Score. The

Framingham risk score was used to predict the 10-year cardiovascular risk. Risk scores were calculated separately for men and women on the basis of age, total cholesterol and HDL cholesterol levels, blood pressure, use of medication for high blood pressure, current smoking status, and status of Hba1c.[19]

Individual-level controls include age, sex, education, marital status, Han nationality, household size, wealth quintile, whether the individual smoked, whether the individual was overweight in 2000, and whether the individual was hypertensive in 2000.

Community-level controls include a measure of urbanicity, whether the community is in an agricultural area, whether the community has a health clinic, and whether the community has a hospital, as well as community-level averages of all of the individual-level controls. Urbanicity is defined using a multidimensional twelve component urbanization index that captures the community-level physical, social, cultural, and economic environment and which represents the heterogeneity that would be otherwise missed in a measure based only on an urban/rural indicator of population density.[20] We also include an indicator for the province.

Results

Table 1 shows baseline characteristics of respondents in the year 2000, before the NCMS was implemented. The sample of adults is predominantly married, of Han ethnicity, and of low education. About a third of the sample smoked, nearly a fifth were overweight, and 8% were hypertensive.

Table 1

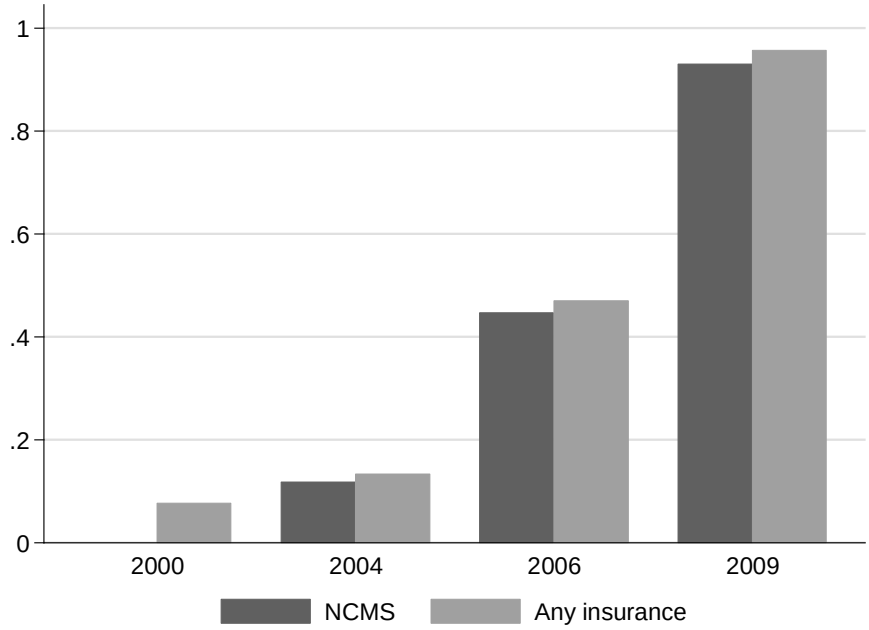
Baseline characteristics in 2000

	Mean (SD)
Age (years)	44.4 (14.97)
Female	0.53 (0.50)
Primary education or less	0.58 (0.49)
Married	0.82 (0.39)
Han	0.82 (0.39)
Household size	4.17 (1.49)
Gross household income (yuan)	13 812 (14 712)
Smoker	0.32 (0.47)
Hypertensive	0.08 (0.26)
Systolic Blood Pressure (mm/Hg)	118 (17)
Diastolic Blood Pressure (mm/Hg)	77 (11)
Body mass index	22.3 (3.0)
Overweight	0.17 (0.38)
Obese	0.02 (0.12)
Used preventive service	0.004 (0.06)
n	4257

Fractions (or relevant units, as indicated) and standard deviations of selected characteristics, measured in 2000, among all adults who were 18 years or older in the 2000 wave of the CHNS and who had measured biomarkers in 2009.

NCMS coverage increased dramatically since its inception in 2003. Figure 1 shows the percentage of adults in rural areas with any insurance and with NCMS insurance in our data, by survey wave. By 2009, nearly all eligible individuals reported having NCMS. Generally, NCMS insurance was the only available health insurance for this group during 2000 – 2009, mitigating the concern that NCMS was crowding out other insurance schemes.

FIGURE 1: Individual Insurance Coverage by Year

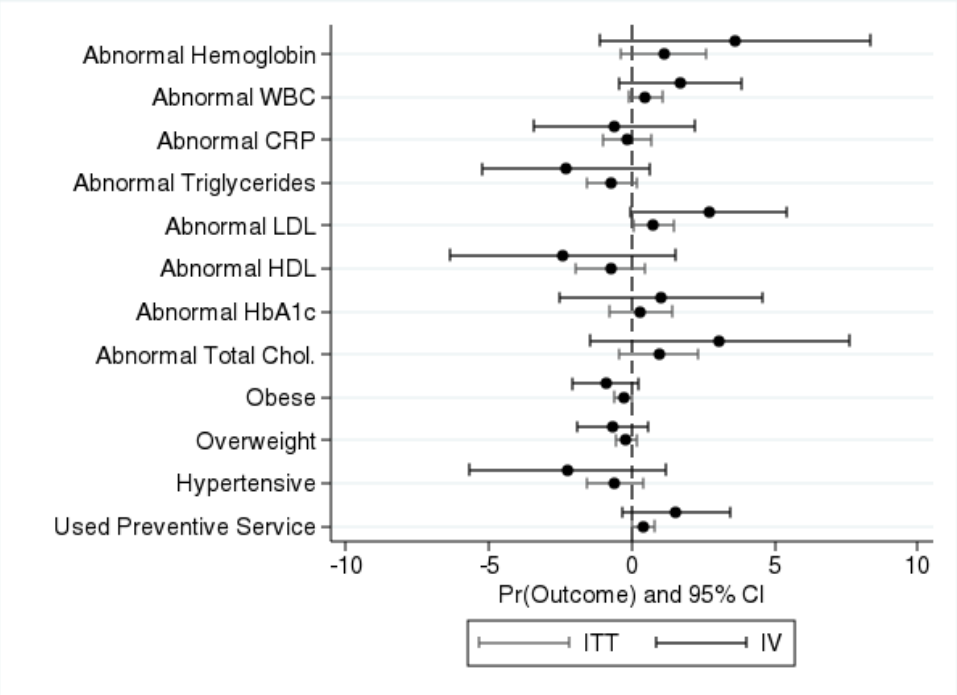


As evidence for the validity of the instrument, we found that most community characteristics did not significantly predict either the year of adoption or whether the community was a “late adopter”, apart from the average years of schooling by community members (supplementary material Table A1). Importantly, no health markers, including average rates of hypertension, overweight, or smoking status in 2000 (before NCMS was rolled out), predicted a community’s adoption year, which strengthens the case for our empirical strategy. Although we cannot rule out other unobservable factors that may violate the validity of the instrument, by controlling for community-level observable characteristics, we were able to reduce selection bias.

When analyzing the impact of community wealth on community health, we found that wealth did not predict health outcomes (hypertension, overweight, or obesity) or preventive care seeking in 2000 (supplementary material Table A2).

The results of the cross sectional analyses on discrete outcomes are presented in Figure 2. In the ITT results, each additional year of NCMS coverage was associated with an increase in the probability of use of preventive care (0.6 percentage points, 95% CI 0.1 to 1.0), and a decrease in the probability of being obese (-0.6 percentage points, 95% CI -1.0 to -0.3), but was also associated with an increase in the probability of abnormal levels of LDL cholesterol (1 percentage point, 95% CI 0.2 to 1.8). No significant relationship was found for any other outcome measure, including Hba1c, HDL cholesterol, total cholesterol, Triglycerides, CRP, WBC, or Hemoglobin. In general, the program appears to have had little consistent effect on objective measures of health.

FIGURE 2: Effect of Insurance on Health, Percentage Point Changes in Probabilities



In Table 2 we present the results on continuous measures of health as well as the Framingham Risk score. Each additional year of NCMS was associated with an increase in LDL (which is unfavorable, at the 95% level), as well as an increase in HDL (which is favorable, at the 90%

level), but in general there is no evidence of improved health as a result of NCMS coverage, in line with our findings on the discrete health outcomes shown in Figure 2.

Table 2

Effect of Insurance on Health,
Cross Sectional Analysis of Continuous Health Outcomes

	ITT	IV	n
HbA1c (mmol/L)	-0.004 (-0.032, 0.024)	-0.016 (-0.12, 0.089)	4101
Total Cholesterol (mg/dL)	0.56 (-0.80, 1.92)	2.10 (-2.69, 6.89)	4109
LDL Cholesterol (mmol/L)	0.037 (0.006, 0.068)	0.14 (0.019, 0.26)	4112
HDL Cholesterol (mm/dL)	0.41 (-0.086, 0.91)	1.56 (-0.30, 3.43)	4112
Systolic Blood Pressure (mm/Hg)	-0.27 (-0.94, 0.40)	-1.02 (-3.38, 1.34)	4085
Diastolic Blood Pressure (mm/Hg)	-0.88 (-0.53, 0.36)	-0.35 (-1.97, 1.28)	4085
Hemoglobin (g/dL)	-0.003 (-0.019, 0.013)	-0.012 (-0.070, 0.047)	4110
White Bood Cell Count (x10^9)	0.01 (-0.037, 0.057)	0.042 (-0.13, 0.22)	4112
C-reactive Protein (mg/L)	0.087 (-0.088, 0.26)	0.33 (-0.35, 1.00)	4107
Triglycerides (mg/dL)	-1.99 (-5.49, 1.52)	-7.18 (-19.29, 4.93)	4108
Glucose (mmol/L)	0.007 (-0.025, 0.039)	0.023 (-0.09, 0.14)	4110
Body Mass Index	-0.35 (-0.082, 0.012)	-0.13 (-0.31, 0.044)	4054
Framingham 10 Year Risk Score	-0.092 (-0.23, 0.043)	-0.32 (-0.77, 0.14)	3710

Coefficients from intention-to-treat (ITT) and instrumental variable (IV) linear regressions are reported, with 95% confidence intervals that account for clustering at the community level in parentheses below. All specifications control for age, sex, highest education attained, marital status, Han nationality, household size, wealth quintile; whether the individual smoked, whether the individual was overweight in 2000, and whether the individual was hypertensive in 2000. All specifications additionally control for the community's average wealth, education, age, household size, and urbanicity score; the percent Han, female, married, overweight, and hypertensive in the community; and indicators for whether the community is in an agricultural area, has a clinic, and has a hospital. Province fixed effects are also included. The Framingham risk score was used to predict the 10-year cardiovascular risk. Risk scores were calculated separately for men and women on the basis of the following variables: age, total cholesterol and HDL cholesterol levels, measured blood pressure and use or nonuse of medication for high blood pressure, current smoking status, and diabetes diagnosis. Framingham risk scores, which are calculated for persons 30 years of age or older, range from 0.5 to 30%.

The results are consistent in the panel analysis: coverage of NCMS increased the probability of using a preventive health service but objective measures of health appear unchanged. Details of this analysis are presented in the supplementary materials (Tables A3, A4).

The results of the interaction analysis are shown in Table 3. We found little differential effect of insurance coverage for women compared to men or for people older than 50 compared to those who were younger. However, we found a negative (favorable) impact of NCMS coverage on a number of adverse health conditions in below median wealth communities, including significant reductions in rates of abnormal levels of HbA1c (-2 percentage points, 95% CI -4 to 0.1) and triglycerides (-2.3 percentage points, 95% CI -3.9 to -0.6). However, the probability of using a preventive care service is also significantly lowered for poor communities (-1.2 percentage points, 95% CI -2.1 to -0.2).

Table 3

Heterogeneous Effects of Insurance on Health

	Additional Impact of Insurance for Women	Additional Impact of Insurance for People in Communities with Below Median Wealth in 2000	Additional Impact of Insurance for People Older than 50 Years	n
Used preventive service	0.001	-0.012	-0.003	4127
	(-0.005, 0.007)	(-0.021, -0.002)	(-0.009, 0.003)	
Hypertensive	0.00	-0.015	-0.013	4091
	(-0.015, 0.014)	(-0.033, 0.003)	(-0.030, 0.004)	
Overweight	0.003	-0.002	-0.006	4059
	(-0.014, 0.021)	(-0.012, 0.007)	(-0.023, 0.010)	
Obese	0.005	-0.001	0.001	4059
	(-0.002, 0.011)	(-0.007, 0.006)	(-0.004, 0.006)	
Abnormal total cholesterol	-0.006	-0.013	0.016	4118
	(-0.027, 0.015)	(-0.038, 0.012)	(-0.002, 0.034)	
Abnormal HbA1c	0.00	-0.02	-0.003	4107
	(-0.012, 0.011)	(-0.040, -0.001)	(-0.017, 0.012)	
Abnormal HDL	-0.003	0.011	-0.003	4118
	(-0.023, 0.016)	(-0.008, 0.030)	(-0.017, 0.011)	
Abnormal LDL	0.001	-0.004	0.007	4118
	(-0.009, 0.011)	(-0.020, 0.012)	(-0.006, 0.019)	
Abnormal triglycerides	0.00	-0.023	0.005	4118
	(-0.015, 0.014)	(-0.039, -0.006)	(-0.008, 0.017)	
Abnormal CRP	0.004	0.008	-0.012	4117
	(-0.013, 0.021)	(-0.006, 0.022)	(-0.030, 0.005)	
Abnormal WBC	0.006	0.002	0.005	4118
	(-0.006, 0.018)	(-0.007, 0.012)	(-0.006, 0.016)	
Abnormal Hb	0.019	-0.013	-0.012	4116
	(0.001, 0.037)	(-0.043, 0.016)	(-0.026, 0.002)	

Coefficients from intent-to-treat linear regressions are reported The first column shows coefficients on the interaction between community insurance duration and an indicator for female for each outcome. Likewise, the second column shows coefficients on the interaction between community insurance duration and an indicator for whether the community had below median wealth in 2000 (prior to the insurance scheme) and the third shows coefficients on the interaction between community insurance duration and an indicator for being older than 50 years. For example, a coefficient of 0.001 can be interpreted as an increase of .1 percentage points. 95% confidence intervals, accounting for clustering at the community level, are in parentheses below the coefficient estimates. All specifications control for age, sex, highest education attained, marital status, Han nationality, household size, wealth quintile; whether the individual smoked, whether the individual was overweight in 2000, and whether the individual was hypertensive in 2000. All specifications additionally control for the community's average wealth, education, age, household size, and urbanicity score; the percent Han, female, married, overweight, and hypertensive in the community; and indicators for whether the community is in an agricultural area, has a clinic, and has a hospital. Province fixed effects are also included.

Discussion

We used intent-to-treat and instrumental variable strategies to overcome selection bias in estimating the effect of NCMS insurance on health outcomes. We consistently found an increase in utilization of preventive health services for those with NCMS coverage, measured by use of a preventive health service in the past four weeks. However, we found no clear indication of improved health for those with NCMS coverage, measured by blood pressure, weight, HbA1c, total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, C-reactive protein, white blood cell count, hemoglobin, or the Framingham Risk Score. There was some suggestive evidence of improvements for relatively poor communities, which is encouraging since it could imply that the program has been able to reduce some wealth-related disparities in health. However, use of preventive services was also lower for poor communities, indicating that access to health services is still limited for these communities.

Our results are consistent with those of previous studies evaluating the impact of NCMS on outcomes such as utilization, spending, and self-reported health. Lei & Lin (2009) found that NCMS enrollees decreased their use of traditional Chinese folk doctors and increased their use

of preventive care.[2] However, they did not find improvements on other important measures, including out-of-pocket expenditures, use of formal medical services, or health status, as measured through self-reported health. Wagstaff et al. (2009) found that the NCMS increased inpatient and outpatient utilization and reduced the cost of mothers' deliveries, but these benefits were largely concentrated among relatively wealthy households.[6] The NCMS did not, however, reduce out-of-pocket payments per inpatient or outpatient visit or overall out-of-pocket payments.

Previous studies have also evaluated the effects of other health insurance schemes on objective biomarkers. Pan, et al. (2015) showed that relatively low income and low education citizens benefited disproportionately more from China's urban health insurance scheme, in line with the suggestive results presented here for the rural health insurance scheme.[21] Sosa-Rubi et al. (2009) evaluated Mexico's public health insurance scheme, Seguro Popular, and found that poor diabetic adults covered under the health insurance scheme were both significantly more likely to have appropriately controlled glucose levels (HbA1c $\leq$ 7%) and significantly less likely to have very poor glucose control (HbA1c > 12%) than their uninsured counterparts.[12] Baicker, et al. (2013) evaluated the impact of Medicaid health insurance coverage on recipients' biomarkers in Oregon. They found that Medicaid improves some process measures like the probability of diagnosis for some diseases, but they do not show any statistically significant improvements in objective measures of health.[11]

This analysis has some limitations. Although we reduced selection bias by using an ITT analysis and with instrumentation, there may be some unmeasured confounding due to unobservable variables. Additionally, the rollout of NCMS across communities was not randomly assigned.

Some communities likely implemented the insurance program earlier because they were administratively ready to comply with the new regulations surrounding the insurance and with the potential increase in demand for health care, though we are able to alleviate some of this concern by showing that relevant observable community factors are not particularly predictive of NCMS adoption. Finally, the analysis utilized a relatively small sample size from a small number of communities, which increased the size of the standard errors due to clustering.

There are many possible explanations for why the NCMS increased preventive health care service use but did not appear to have influenced objective measures of health. First, it may simply be that the NCMS does not go far enough to protect households in the case of large health costs. In over a third of counties surveyed by Brown, et al. (2009), households are required to pay out of pocket for over half of a 15,000 yuan bill for eligible inpatient care at a county-level hospital.[13] Perhaps households still cannot afford to seek care for serious or chronic illnesses, even with NCMS coverage. Second, it could also be the case that there is an insufficient supply of (high quality) health care providers, and having insurance coverage does not result in greater access to quality health care. (Our attempts to explore this possibility are limited by our data, but this is an important avenue for further exploration.) Another potential explanation is that because of pressure from the central government to enroll community members, local governments coerced many people to participate, and as a result they did not fully embrace the program and make full use of its benefits. One final possibility is that the program is crowding out some other means for providing access to health care such as traditional medicine, resulting in little to no net improvements the health of members of participating counties. We are unable to disentangle which of these explanations – if any – is the

most likely explanation for our results, but it is worth further exploring these questions in the future.

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