The Role of Supply Responses in Public Insurance Expansion: Evidence from the New Cooperative Medical Scheme in China

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Abstract

In our study, we explore the impact of the New Cooperative Medical Scheme (NCMS) — a significant health insurance expansion in rural China — on healthcare supply, utilizing a nationwide dataset spanning from 2004 to 2011. Our findings reveal notable positive supply-side responses to the NCMS expansion, characterized primarily by a substantial increase in the number of inpatient beds at township health centers serving rural residents. The magnitude of the supply-side responses are comparable to those in high-income countries. Moreover, we observe large positive effects on the number of county hospitals; however, these effects lack statistical significance. These findings indicate that the surge in demand prompted by the NCMS leads to greater healthcare investment by existing rural providers rather than encouraging new providers to enter the market. Furthermore, when adjusting for these supply-side responses, we find that responsive healthcare supply plays a crucial role in the effectiveness of the NCMS: the growth in inpatient care utilization attributable to the NCMS is significantly mitigated once the availability of inpatient beds is controlled. These insights underscore the universal importance of responsive healthcare supply in the effectiveness of public insurance expansions.

Keywords: Health Insurance in China, NCMS, Supply Responses, Medical resources
JEL classification: H51, I12, I13, I18

1 Introduction

Aligned with the World Health Organization's advocacy, low- and middle-income countries (LMICs) have been progressively expanding health insurance coverage to their uninsured low-income populations since the 1990s,[1] aiming to achieve the goal of universal health insurance coverage. Contrary to the experience in high-income nations that public health insurance programs have been consistently effective in improving healthcare utilization and health outcomes,[2] public insurance initiatives in several LMCIs have been shown to have limited or no significant impact.[3] Therefore, it is essential to investigate the determinants that influence the success of public insurance policies in LMICs to enhance their efficacy.

As suggested by studies in high-income countries, supply-side responses have served as a significant contributor to the success of public insurance reforms in increasing healthcare use and health outcomes. Finkelstein (2007) shows that the increased medical investments by hospitals can triple the inpatient effect of public insurance expansion in the United States. In Japan, Kondo and Shigeoka (2013) show that universal health insurance introduced during 1961 significantly increased the number of hospital beds to meet the increased healthcare needs. Are there sufficient supply-side responses subsequent to the public insurance expansion in LMCIs? This research question is essential for policy makers in LMCIs aiming to enhance the efficacy of such programs, but is nevertheless understudied in these contexts due to inadequate supply-side data. Another related research question is whether the responsive healthcare supply, if any, can enhance the efficacy of insurance expansion. Similarly, rare evidence exists regarding the extent to which supply-side responses affect the effectiveness of public insurance programs in LMICs. Understanding this dynamic is crucial for governments struggling with how to expand or improve their insurance plans (Han, 2012).

The extent to which healthcare supply responds to public insurance expansion in LMICs could potentially differ from responses observed in high-income countries. In LMICs, the post-reform increase in healthcare demand might be constrained by the less generous plans provided. The demand shock is further limited by the disadvantaged economic conditions of the targeted low-

[1] Nations such as Colombia in 1993, Ghana, Vietnam, and China in 2003, Mexico in 2005, Georgia in 2006, and Nicaragua in 2007 have undertaken substantial insurance expansions. A detailed evaluation of these initiatives is available in Acharya et al. (2013).

[2] The U.S. public insurance programs, for instance, are shown to raise healthcare utilization and reduce mortality rates, as documented in studies by Currie and Gruber (1996a,b); Hanratty (1996); Currie and Gruber (2001); Finkelstein (2007); Card et al. (2008, 2009); Chay et al. (2010); Finkelstein et al. (2012); Kolstad and Kowalski (2012); Sommers et al. (2012); Chou et al. (2014); Goodman-Bacon (2018); Swaminathan et al. (2018); Khatana et al. (2019); Borgschulte and Vogler (2020); Goldin et al. (2021); Miller et al. (2021).

[3] Research in Mexico King et al. (2009), Nicaragua Thornton et al. (2010), Georgia Bauhoff et al. (2011), and India Karan et al. (2017) has highlighted this trend. A thorough review by Acharya et al. (2013) offers comprehensive insights.

income population.[4] Consequently, it is likely that the healthcare supply side in LMICs will not be as responsive in meeting the increased healthcare needs of low-income beneficiaries as it is in high-income nations following insurance expansion.

Our paper attempts to fill these gaps by utilizing China's New Cooperative Medical Scheme (NCMS) reforms as a natural experiment to explore the supply-side effects of public insurance reforms in LMICs. Initiated in 2003, the NCMS was designed to extend health insurance coverage to China's rural population, which largely comprised individuals without formal employment and, consequently, without access to urban employee health insurance before the reform. Prior to the NCMS, around 18% of rural inhabitants lacked health insurance. The scheme was rolled out on a county-by-county basis and expanded rapidly, ultimately providing coverage to 640 million previously uninsured rural residents by 2008-representing 95% of China's rural demographic.

In rural China, the majority of healthcare is delivered by public providers. Healthcare professionals are typically salaried employees of public health centers or hospitals, making medical institutions responsible for supply decisions, including the hiring of doctors and ancillary staff, as well as investments in hospital facilities, medical equipment, and beds. In particular, we first examine whether and to what extent healthcare supply responds to the NCMS. Given the large-scale health insurance expansion under the NCMS, the substantial number of newly covered rural people is expected to provide sufficient incentives for healthcare providers to expand their supply. To assess whether the supply-side responses, if any, are adequate, we compare the magnitude of our estimates to the benchmark supply-side effects as estimated in studies from high-income countries. Should our supply-side effects be outpaced, this could suggest that a restrained supply-side response may be contributing to the weaker efficacy for China's NCMS reform. Furthermore, we directly test the contribution of supply-side responses following the NCMS to the scheme's efficacy using mediation analysis.

Our study focuses on supply-side measures that have not been explored extensively in previous studies, such as the number of inpatient beds and medical institutions, using the province-level panel data in 2004-2011. The identification relies on the plausibly exogenous temporal and geographical variations in the NCMS enrollment rate in a two-way fixed effect (TWFE) model conditional on socio-economic characteristics of each province. We find that the supply-side responses to the NCMS differ across types of healthcare resources. While the NCMS does increase the number of medical providers in areas with larger demand shocks, the estimates lack statistical significance. Conversely, the number of inpatients beds increase significantly in response to the insurance expansion, particularly at township health centers. The distinct impact

[4]Despite successes in expanding coverage, the benefits are more restrictive in developing countries. In 2014, on average, 36.26% of medical spending was out of pocket in LMICs, compared to only 13.63% in OECD countries. For more details, see the WHO Global Health Expenditure Database at https://apps.who.int/nha/database

observed in the expansion of inpatient beds, as opposed to the more modest growth in healthcare facilities, could be attributed to the lower cost associated with augmenting existing infrastructure compared to the substantial fixed expenses required for establishing new healthcare centers or hospitals. To clear concerns that the supply-side responses might be resulted from increased government subsides to rural healthcare organizations in 2009-2011 (Chen et al., 2021), we present the dynamic effects of the NCMS on healthcare resources and show the increase in hospital beds is mainly driven in years before 2009.

The expansion in inpatient beds following the NCMS implementation is comparable to supply-side responses in high-income countries, suggesting that the supply side in rural China has adequately responded to the demand shocks generated by the insurance expansion. Furthermore, we investigate the extent to which the supply-side responses enhance the effectiveness of the NCMS in improving healthcare utilization. After accounting for hospital beds, we find that the magnitude of the NCMS's effect on inpatient care use is reduced by about 50 percent. This suggests that approximately half of the success of the NCMS in increasing healthcare utilization can be attributed to supply-side responses that meet increased healthcare demand. These findings suggest that a less responsive supply side may not be contributing to the limited efficacy of insurance expansion in LMICs. Rather, the efficacy of health insurance expansion in LMCIs would require demand-side supporting policies such as improved insurance benefits.

Related Literature. The first relevant branch of literature comprises studies on the effects of the NCMS. On the one hand, some of these studies find that the NCMS is not effective in terms of increasing outpatient care use (Yip et al., 2008; **?**; Babiarz et al., 2012).[5] On the other hand, more studies find evidence in support of the effectiveness of the NCMS in terms of increasing healthcare use, providing financial protection, and improving health outcomes.[6] Our study contributes to

[5] **?** find that the introduction of the NCMS leads to increases in the number of general physical examinations, but has little effects on the numbers of inpatient stays or outpatient visits, out-of-pocket expenses, or health improvements using the 2000, 2004, and 2006 CHNS data. Yip et al. (2008) conduct a longitudinal survey in 2002 and 2005, and employ a DID method to show that the NCMS does not increase outpatient visits. Babiarz et al. (2012) also estimate a DID model using two waves of survey data for five provinces (Jiangsu, Sichuan, Shaanxi, Jilin, and Hebei) in China in 2005 and 2008, and find little evidence that being enrolled in the NCMS increases the likelihood of visiting healthcare providers when sick.

[6] In particular, Wagstaff et al. (2009) use a DID design from the National Health Service Survey (NHSS) for 2003 and 2005 covering 12 provinces and show that the NCMS increases inpatient stays and outpatient visits, particularly at township health centers. Liu (2016) also uses a DID model from the CHNS for 1993 to 2011 showing that the NCMS is effective in insuring households against health shocks, and in helping them invest in their children's education. The most recent study by Huang and Wu (2020) exploits the enhancement of insurance benefits since the integration of rural-urban insurance in 2009 in a staggered DID design, and shows that the increased reimbursement rates lead to higher inpatient care utilization by middle-aged and older residents and lower chances of having high blood pressure with suggestive evidence . Of the studies that examine the NCMS's effects on medical OOP expenditures, some find that it reduces OOP expenses only slightly (**?**Wagstaff et al., 2009; You and Kobayashi, 2009; Cheng and Zhang, 2012; Cheng et al., 2015), while others show that it reduces them substantially (Babiarz et al., 2012). There are a handful of papers that investigate the health effects of the NCMS. Cheng et al. (2015) use a panel data of the Chinese Longitudinal Healthy Longevity Survey with a DID method and find that the insurance significantly improves cognitive functions

this branch of literature by exploring the supply-side mechanism behind its effectiveness, and suggesting the importance of supply-side supporting policies in the design and implementation of large-scale insurance programs in LMICs.

Our work also contributes to an emerging literature seeking to examine the impact of health insurance on medical providers' behaviors, including pharmaceutical innovation in both developed (Blume-Kohout and Sood, 2013; Clemens, 2013) and developing countries (Zhang and Nie, 2021), physician labor supply (Garthwaite, 2012; Matsushima et al., 2020), and healthcare investment such as inpatient beds and medical equipment (Finkelstein, 2007; Kondo and Shigeoka, 2013; Freedman et al., 2015; Chen et al., 2016). These studies regard supply-side responses as a downside of health insurance expansion because it could induce more healthcare expenses. In the context of developing countries constrained by both the quantity and quality of healthcare resources, supply-side responses could be an important mechanism for the success of their insurance expansion programs. We extend this literature by focusing on China's NCMS and exploring how much of the supply-side responses explains the success of the program.

This paper proceeds as follows. Section 2 describes the institutional background of the NCMS expansion and healthcare supply in rural China. Section 3 provides an overview of the data and presents summary statistics of main variables. Section 4 explains the empirical model used in the estimation. Section 5 reports the NCMS's effects on healthcare supply, investigates the role of healthcare supply in affecting the effectiveness of the program, and presents robustness checks. Section 6 discusses and concludes.

2 Institutional Background

2.1 The New Cooperative Medical Scheme (NCMS)

The New Cooperative Medical Scheme (NCMS) stands as a landmark in China's health insurance landscape, designed to extend coverage to 640 million rural residents previously uninsured. Initiated in 2003, the program rapidly approached complete coverage by 2010, as depicted in Figure 1, with enrollment surging from 18 percent in 2004 to near universal coverage in 2010.

NCMS's successful expansion can be attributed to two primary factors. Primarily, the government heavily subsidized rural residents' insurance premiums, where participants contributed merely a fraction of the total—beginning at 10 yuan in 2004, with governmental support covering the remainder. This contribution requirement incrementally rose over the years,

for rural elderly while has no effects on other health outcomes such as general health status and mortality rate. **?** use the CHNS with individual fixed effects and do not find significant health benefits from the NCMS.

as mandated by the central government, leading to a contribution of 10 yuan in 2006, 20 yuan in 2007, 30 yuan in 2008, 50 yuan in 2009, 60 yuan in 2010, and 80 yuan in 2011. Additionally, vigorous administrative efforts and promotional activities by the government played a significant role, linking local government budget transfers and officials' promotions to achieving predetermined enrollment targets (Lin and Zai, 2024). Anecdotal accounts suggest village leaders directly engaged with households to facilitate their enrollment.

However, the NCMS's implementation, staggered across counties in different years, inherently selected economically more advantageous counties for early adoption, raising potential endogeneity concerns. In related research, Lin and Zai (2024) addressed this issue, finding minimal evidence of economic disparities between provinces with different enrollment gains. Section 5 further investigates whether these minor economic differences influence healthcare demand and supply, with findings indicating no significant impact.

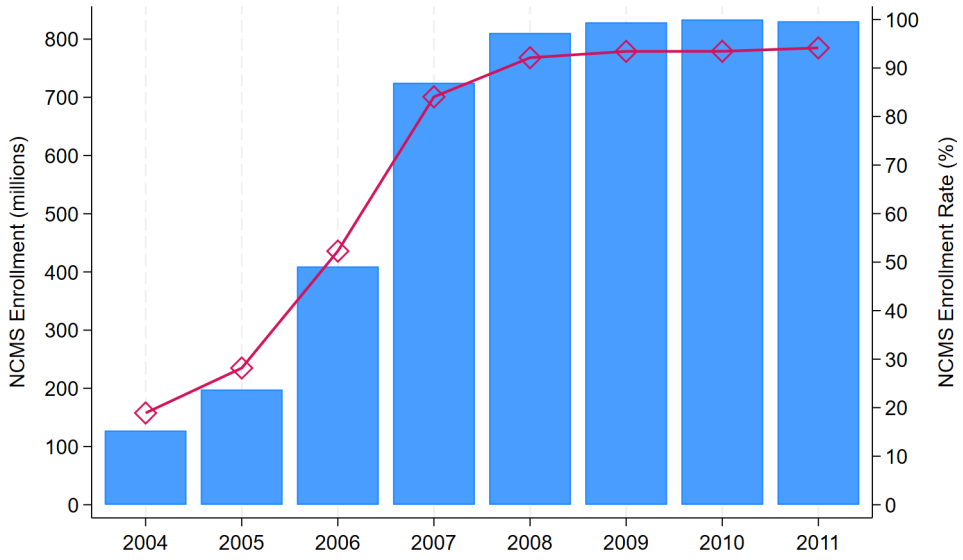


Figure 1: NCMS Enrollment over Time

Notes: The data source is the NCMS development report by Chen and Zhang (2013). The y-axis on the left is the number of enrollees. The y-axis on the right is the enrollment rate, which is calculated by dividing the rural population by the number of enrollees over the 2004-2011 period.

The NCMS tends to offer more comprehensive benefits for inpatient care compared to outpatient care, with all providers covering inpatient services, whereas only a quarter extend coverage to outpatient services on a pooled basis (Wagstaff et al., 2009). To mitigate medical costs, the NCMS employs a tiered reimbursement model favoring care from lower-tier providers with more substantial benefits and reducing reimbursements for services from higher-tier facilities. In 2011, primary care providers, including Township Health Centers (THCs) and Community Health Centers (CHCs), received the highest coverage rates (between 65 to 90

percent). County hospitals had the next level of coverage (60 to 80 percent), while city hospitals had the lowest (45 to 70 percent) (Zeng et al., 2019).

2.2 Healthcare Supply in Rural China

Rural healthcare in China is structured around a three-tier public system, pivotal for distributing healthcare supply in these regions (Wang, 2004; Babiarz et al., 2012). At the grassroots, village health clinics, staffed by "barefoot doctors," provide basic outpatient care and prescriptions. THCs form the intermediary tier, offering a broader range of inpatient and outpatient services. In more urbanized rural areas, such as in Zhejiang and Jiangsu provinces, CHCs also serve, functioning similarly to THCs but focusing on community residents. County hospitals stand at the apex, delivering the highest quality care compared to the other two tiers.

THCs are crucial in bridging village clinics with county hospitals, facilitating a continuum of care that ranges from preventive services to basic medical care, health education, and family planning (Wang, 2004). While city hospitals are not officially part of this rural framework, their higher-quality services attract rural residents, particularly those living near urban areas or those with conditions that lower-tier facilities cannot address.[7] This model underscores the relationship between the three-tier system and healthcare supply, revealing how rural residents navigate China's healthcare landscape (Lin and Zai, 2024).

The healthcare resource landscape in China is shaped by a triad: government entities, public healthcare providers, and private sector participants, with public providers playing a leading role in the healthcare market. Government interventions significantly influence healthcare supply, notably through subsidies directed at public healthcare facilities, particularly in rural regions. A prime example of this dynamic occurred in April 2009, when China initiated a comprehensive healthcare reform aimed at enhancing equitable medical service access for rural populations. This reform period, especially between 2009 and 2011, saw a significant uptick in infrastructure investments targeting primary care facilities in less served areas. Our analysis rigorously incorporates the potential confounding impact of government subsidies through robustness checks, ensuring a nuanced understanding of healthcare supply factors in China.

Since the 1980s, public healthcare providers in China have enjoyed a considerable degree of autonomy in their operations. They have the authority to generate revenue, retain surpluses, and allocate funds, with government subsidies constituting a small and diminishing portion of their income (Eggleston et al., 2008). This shift has motivated public providers to invest in infrastructure and medical equipment, aligning their services with the growing healthcare demands. Moreover, the landscape began to change further in 2000, when private for-profit hospitals were permitted,

[7]Patients with chronic or rare diseases also seek care at city hospitals outside their province, as China's referral system allows patients to self-refer to any provider post the market reforms of the 1980s.

and private investment in the healthcare sector was actively encouraged. This policy adjustment led to a rapid increase in the number of private medical facilities, which have since played an increasingly significant role in providing outpatient care (Liu et al., 2006).

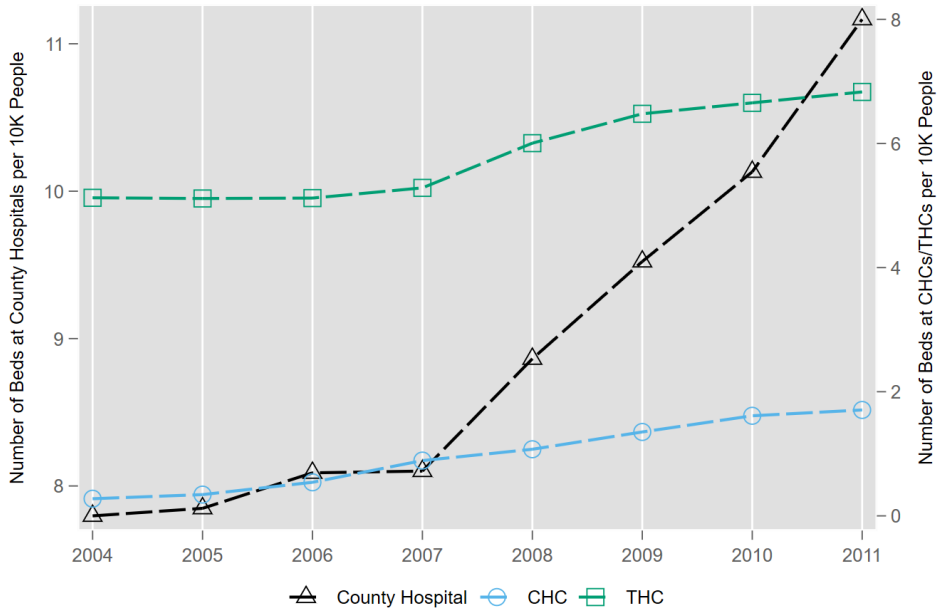


Figure 2: The Number of Hospital Beds Over Time

Notes: The data source is the 2004-2011 CHSY. The y-axis on the left is the number of beds at county hospitals per 10,000 people and the y-axis on the right is the number of beds at CHCs or THCs per 10,000 people over the 2004-2011 period.

Concurrent with the rollout of the NCMS from 2004 to 2011, rural areas saw a noticeable expansion in medical resources. Specifically, county hospitals experienced a rapid increase in the number of hospital beds, highlighting a significant boost in their capacity to provide care. Meanwhile, CHCs and THCs also observed an uptick in bed numbers, albeit to a lesser extent (as illustrated in Figure 2). Moreover, the healthcare infrastructure expanded with a considerable rise in the number of CHCs and a notable growth in county hospitals, particularly from 2010 onwards. Contrarily, the quantity of THCs saw a decline over the same period, reflecting a shift in the distribution of healthcare facilities (referenced in Figure 3). Overall, the quantity of the medical resources in rural areas have improved as a result of the NCMS expansion.

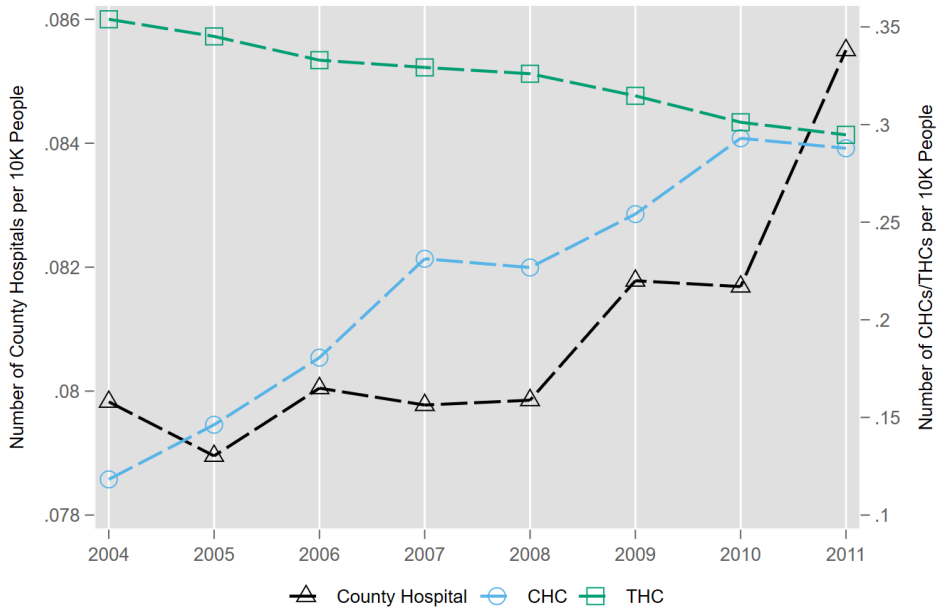


Figure 3: The Number of Medical Institutions Over Time

Notes: The data source is the 2004 to 2011 CHSY. The y-axis on the left is the number of county hospitals per 10,000 people and the y-axis on the right is the number of CHCs or THCs per 10,000 people over the 2004-2011 period.

3 Data

3.1 Key Variables

To examine the responses of supply-side resources to the NCMS in China, we utilize various data sources that provide annual information for each Chinese province. Our analysis is primarily based on data from the China Health Statistical Yearbook (CHSY) for the years 2004 to 2011. Published annually by China's Health Department, the CHSY offers comprehensive health-related data for each province, including specifics on healthcare resources. In this study, we focus on two main types of healthcare resources: the availability of hospital beds and the number of healthcare providers. We assess these resources by calculating the number of hospital beds and healthcare institutions per 10,000 people in each province. Further, to understand the NCMS's varied impacts on healthcare supply among different provider levels within the rural three-tier medical system, we classify both hospital beds and healthcare provider counts according to the facility type, including city hospitals, county hospitals, Community Health Centers (CHCs), and Township Health Centers (THCs).

Our analysis of the NCMS policy draws upon data from Lin and Zai (2024), which provides detailed information on NCMS enrollment, serving as our study's primary independent variable

of interest. Additionally, to ensure a comprehensive examination, we incorporate data on demographic and economic conditions from the annual China Statistical Yearbook (CSY). These variables are used as crucial controls in our model.

3.2 Sample Statistics

Table A1 presents the summary statistics for the key variables discussed in our study. Initially, in 2004, the NCMS enrollment rate was at 19 percent, which averaged approximately 70 percent throughout the 2004-2011 timeframe. In terms of healthcare resource distribution, city hospitals have the highest allocation, with 16 inpatient beds per 10,000 people. In comparison, county hospitals, CHCs, and THCs provide 9, 1, and 6 inpatient beds per 10,000 people, respectively. The average per capita availability of healthcare institutions reveals 0.1 urban hospitals, 0.08 county hospitals, 0.22 CHCs, and 0.32 THCs for every 10,000 individuals. Regarding healthcare utilization, the data indicates that the average number of claims filed per rural resident under the NCMS is about one, suggesting that the typical enrollee accesses NCMS services at least once within the study period. Additionally, rural residents on average visit a doctor twice annually, with roughly 8 percent utilizing inpatient services.

4 Estimation Model

In this study, we implement a Two-Way Fixed Effect (TWFE) model, integrating continuous NCMS enrollment rates to explore the responses of healthcare supply to the insurance scheme. Lin and Zai (2024) examines the exogeneity of the NCMS enrollment rate, demonstrating minimal pre-existing trends in NCMS development and finding a negligible correlation between the insured rate in 2004 and both the pre-NCMS levels and trends of healthcare provision and utilization. Leveraging the seemingly exogenous introduction of health insurance for rural populations, the model captures both the intra- and inter-provincial variations in NCMS enrollment rates over time. To this end, we estimate the supply-side impacts using the regression equation specified below:

$$ln(Y_{pt}) = \beta_0 + \delta NCMS_{pt} + \eta_p + \mu_{rt} + X_{pt}^{'}\beta + \epsilon_{pt} \tag{1}$$

where Y_{pt} denotes the healthcare resources (e.g. inpatient beds, number of healthcare institutions) available in province p in year t, normalized per 10,000 people. The outcome variable is logarithmically transformed unless stated otherwise. $NCMS_{pt}$ represents the continuous NCMS enrollment rate in province p during year t. The parameter of interest, δ, quantifies the impact of comprehensive NCMS expansion on the targeted outcomes. To account for unobservable factors

that are constant over time within each province but may influence both the NCMS rollout and the outcomes of interest, we incorporate province fixed effects η_p. These effects control for variables such as governmental enforcement capability, unique health behaviors, and health outcomes. The region-by-year fixed effect μ_{rt} enables the comparison of provinces within the same region by mitigating the effects of regional shocks or trends that could correlate with the NCMS deployment (Stephens Jr and Yang, 2014; Goodman-Bacon, 2021; Lin and Zai, 2024).[8] X_{pt} incorporates a set of demographic and economic indicators at the province level, encompassing metrics such as population size, age distribution, educational attainment, marriage rates, gender ratio, and the dependency ratio within households. Economic variables include the unemployment rate, GDP per capita (denominated in 2014 yuan), disposable income levels in rural and urban sectors (also in 2014 yuan), alongside urban consumption patterns and healthcare expenditures (in 2014 yuan). The inclusion of urban consumption and medical expenses aims to mitigate the influence of healthcare demand from urban populations on the analysis. The error term, ϵ_{pt}, signifies the standard error, which is aggregated at the provincial level to account for intra-provincial correlation. The weighting of all regression analyses is based on the size of the rural population in the year 2003, ensuring that the study accurately reflects the demographic emphasis of the NCMS program (Lin and Zai, 2024).

5 Results

In this section, we delve into two interconnected questions: firstly, we examine if the demand shocks generated by the NCMS incentivize medical institutions to enhance their supply capabilities; secondly, we assess the extent to which the supply-side responses to the NCMS contribute to the scheme's success in bolstering healthcare utilization among rural populations.

5.1 Supply-side Responses to NCMS

To quantify the impact of the NCMS enrollment shock on healthcare supply in rural areas, we use our baseline model in equation (1)., and specifically examine two key indicators of healthcare resources among rural providers: the total number of healthcare facilities and the quantity of inpatient beds per 10,000 people. Rural providers refer to county hospitals, CHCs, and THCs, which primarily serve the rural population.

The findings, as detailed in Table 1, illustrate a positive correlation between the NCMS enrollment rate and the expansion of rural healthcare infrastructure. An increase in the NCMS

[8]China's 31 provinces are grouped into five regions based on geographic location and economic conditions: eastern, northern, middle, southern, and western regions. Provinces within the same region share similarities in geographical features, government policies, and socio-economic statuses.

enrollment rate by one percentage point is associated with a 0.14 percent rise in the number of county hospitals (as presented in column 1 of Panel A), and a 0.33 percent increase in the availability of inpatient beds at THCs, equating to an additional 0.02 beds per 10,000 individuals (column 3 of Panel B). This growth indicates that the NCMS significantly contributes to the development of rural healthcare facilities and resources. Interestingly, the analysis suggests a redistribution effect, where urban primary healthcare providers, such as CHCs, witness a marginal decline of about 0.1 percent in their numbers, although these findings do not achieve statistical significance. This pattern may reflect a strategic allocation of health resources favoring rural over urban areas within the context of the NCMS.

The distinct impact observed in the expansion of inpatient beds, as opposed to the more modest growth in healthcare facilities, could be attributed to the lower costs associated with augmenting existing infrastructure (e.g., adding beds) compared to the substantial fixed expenses required for establishing new healthcare centers or hospitals. In conclusion, our findings underscore the NCMS's pivotal role in not only augmenting the count of rural healthcare providers, including county hospitals and THCs, but also in significantly enhancing critical healthcare infrastructure, through the increase in inpatient bed capacity.

The supply-side adjustments following the expansion of the NCMS in China are comparable in magnitude to those observed in more advanced healthcare systems. Our analysis indicates a significant 26 percent increase in the number of inpatient beds at THCs with the NCMS program in implementation, although the bed capacity in county hospitals remained largely unchanged.[9] Given that inpatient beds in THC accounts for about 40 percent of total inpatient beds in rural healthcare providers, we can infer an average increase of about 10 percent in inpatient bed availability across rural healthcare providers due to the NCMS rollout. This increment mirrors findings from other countries with advanced healthcare systems. Specifically, research conducted by Kondo and Shigeoka (2013) in Japan identifies a comparable 10 percent rise in inpatient bed capacity following health insurance expansions. Similarly, Finkelstein (2007) in the United States documents an increase of 20 to 30 percent in medical technology adoption post-expansion of health insurance coverage. While we lack direct data to compare the expansion of medical technology in China with that of the United States, these findings suggest a noteworthy alignment of China's supply-side responses with international experiences.

Even though the quantitative impact on medical technology in China remains unmeasured due

[9]Considering that the NCMS has elevated insurance coverage among rural residents by approximately 80 percentage points, and a one percentage point increase in NCMS enrollment correlates with a 0.33 percent rise in inpatient beds at THC computed using the formula $e^{0.28}-1$, we can infer a linear relationship between enrollment rates and the supply-side effect on inpatient bed availability. By applying the one-percentage-point effect to the increase in NCMS enrollment, we can estimate that the NCMS's overall impact (from 0 to 1) on inpatient bed provision in THC is about 26 percent, calculated from the formula $[e^{0.28}-1]\times 0.8\times 100$.

Table 1: Effects of the NCMS on Healthcare Investments by Rural Medical Providers

	(1)	(2)	(3)
	County hospital	CHC	THC
	Panel A. Number of Healthcare Providers		
NCMS rate	0.130	-0.108	0.062
	(0.095)	(0.280)	(0.074)
Mean	0.067	0.105	0.334
Observations	231	231	225
	Panel B. Number of Beds at Hospitals		
NCMS rate	0.029	1.046	0.282**
	(0.043)	(0.941)	(0.109)
Mean	7.335	0.098	5.280
Observations	231	220	225

Notes: Each cell reports estimates from the baseline specification (1), with full controls of both time-varying demographic covariates and economic covariates, province fixed effects, and region by year fixed effects on dependent variables per 10,000 people in logarithm form in each panel. CHC denotes community health centers, and THC denotes township health centers. County hospitals and THCs mainly serve rural people, while CHCs are mainly used by urban residents. The mean of each dependent variable is the average in 2004 per 10,000 people and is weighted by the rural population in 2003. All estimates are weighted by the rural population in 2003. Standard errors are clustered by province and are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

to data limitations, the increase in inpatient beds within rural healthcare facilities post-NCMS implementation closely aligns with the upper bounds of the response seen in the United States and directly parallels the outcome observed in Japan. Thus, without necessarily exceeding the supply-side enhancements seen in the U.S., China's performance in expanding healthcare resources post-NCMS implementation matches or mirrors the experiences of developed nations like Japan, serving as a significant benchmark in the global context of healthcare system responses to insurance expansion.

5.2 Supply-Side Mediation of NCMS Efficacy

To further investigate whether supply-side responses to the NCMS are significant and translate into improved healthcare utilization , we examine the extent to which medical resources mediate the NCMS's effects on health services use. Our analysis concentrates on two critical types of healthcare: inpatient care and outpatient care, which have been shown to experience significant effects from the NCMS, as documented by Lin and Zai (2024). We then assess the contribution of

supply-side responses to the NCMS's efficacy through exploring their potential roles as mediators in the NCMS's effects on outpatient and inpatient care use. Should the increased supply substantially influence the NCMS's impact on healthcare utilization, we anticipate these supply responses to account for a significant portion of the NCMS's effectiveness. Such an analysis not only clarifies the importance of supply-side responses but also highlights their mediating effects, providing insights that complement and build upon the findings in Lin and Zai (2024).

Table 2 reports the NCMS's effects on inpatient care utilization after controlling for the number of inpatient beds (Panel A) and healthcare institutions (Panel B) among rural healthcare providers. Panel A shows that controlling for hospitals beds decreases the baseline estimate of the NCMS's effect on total inpatient stays by 6 percentage points (0.30 inpatient stays per 10,000 people), by 75 percentage points (0.07 inpatient stays per 10,000 people) at CHCs, by 5 percent points (0.08 inpatient stays per 10,000 people) at county hospitals, and by 38 percentage points (0.49 inpatient stays per 10,000 people) at THCs, compared to the baseline estimates. It is noteworthy that the NCMS's effects on inpatient services utilization at THCs is close to zero after controlling for inpatient beds (Column 4), which suggests that the baseline effect at THCs is mainly driven by increased bed capacity following the NCMS. Panel B shows further evidence that the number of providers also plays a role in the NCMS's effect on inpatient care use, but smaller than the role of inpatient beds, which is reasonable given that the number of inpatient beds directly impacts the capacity for inpatient services. Appendix Table A2 reports the effect of the NCMS on inpatient use after controlling for all rural healthcare resources (both the number of healthcare providers and hospital beds). Compared to the baseline estimates, responses from medical resources account for about 65 percent of the NCMS's effect on total inpatient services utilization, 27 percent of the NCMS's effects at CHCs, 32 percent of the NCMS's effects at county hospitals, and absorb all of the NCMS's effects at THCs.

Column 1 of Table 3 reports the estimate of the NCMS's effects on outpatient visits to county hospitals, and columns 2 to 4 report the estimates after controlling for inpatient beds, the number of providers, and both, respectively. The results are in line with our expectation: outpatient services utilization at county hospitals is positively correlated with the supply of medical resources in rural areas. After controlling for these medical resources, the magnitude of the baseline effect is reduced substantially, which suggests that the increase in outpatient visits to county hospitals can be attributed to improvements in the rural healthcare supply. In total, column 4 shows that the supply-side healthcare resources account for about half of the baseline effects of the NCMS on outpatient visits at county hospitals.[10] To conclude, the NCMS not only increases the quantity but also plausibly enhances the quality of medical resources , which works with the NCMS coverage expansion to increase rural people's healthcare use.

[10]The mechanisms are similar for outpatient visits at THCs. Results are available upon request.

Table 2: The NCMS's Effects on Inpatient Care Use Controlling for Rural Healthcare Resources

	(1) Total	(2) CHC	(3) County hospital	(4) THC
		Baseline Estimates		
NCMS rate	0.114*	1.647*	0.116***	0.360*
	(0.065)	(0.850)	(0.041)	(0.184)
Mean	479.4	0.99	169.1	127.6
		Panel A. Number of Beds at Hospitals		
NCMS rate	0.052	0.892**	0.070**	-0.023
	(0.057)	(0.414)	(0.026)	(0.124)
THC beds	0.242	-0.020	0.086	1.162***
	(0.143)	(0.495)	(0.056)	(0.135)
County hospital beds	0.343**	0.120	0.759***	0.324
	(0.150)	(0.840)	(0.077)	(0.272)
CHC beds	-0.005	1.050***	-0.007	0.003
	(0.010)	(0.127)	(0.005)	(0.021)
Observations	210	210	214	214
		Panel B. Number of Healthcare Providers		
NCMS rate	0.096	1.767**	0.075*	0.278
	(0.066)	(0.716)	(0.043)	(0.178)
Number of THCs	0.137	0.720	0.125	1.283***
	(0.118)	(0.607)	(0.098)	(0.165)
Number of county hospitals	0.081	-0.116	0.326***	0.076
	(0.128)	(0.876)	(0.077)	(0.221)
Number of CHCs	0.021	0.645**	0.002	0.060
	(0.022)	(0.314)	(0.014)	(0.054)
Observations	210	210	225	225

Notes: Each cell reports estimates of the NCMS's effects on inpatient care use after controlling for each set of healthcare resources: hospital beds and number of providers in rural areas using the baseline model (1) with full controls of both time-varying demographic covariates and economic covariates for each province, province fixed effects, and region-by-year fixed effects. CHC denotes community health centers, and THC denotes township health centers. Each column corresponds to the estimates of inpatient care at specific hospitals. The mean of the dependent variable is the average of inpatient care use in 2004 per 10,000 people and is weighted by the rural population in 2003. *** p<0.01, ** p<0.05, * p<0.10.

5.3 Robustness Checks

Concerns may arise that the observed supply-side responses are influenced not solely by the NCMS but also by concurrent government initiatives aimed at bolstering rural healthcare infrastructure. Notably, one independent medical reform launched in 2009 significantly augmented subsidies for medical providers and investments in rural healthcare facilities (Chen

Table 3: The NCMS's Effects on Outpatient Visits at County Hospitals Controlling for Rural Healthcare Resources

	(1)	(2)	(3)	(4)
NCMS rate	0.077	0.060	0.022	0.039
	(0.056)	(0.043)	(0.039)	(0.035)
THC beds		-0.059		-0.028
		(0.042)		(0.069)
County hospital beds		0.666***		0.467***
		(0.073)		(0.100)
CHC beds		0.001		-0.003
		(0.007)		(0.007)
Number of THCs			0.013	0.017
			(0.051)	(0.085)
Number of county hospitals			0.419***	0.194***
			(0.062)	(0.070)
Number of CHCs			-0.009	0.005
			(0.016)	(0.015)
Mean	3,599	3,599	3,599	3,599
Observations	231	214	225	214

Notes: Each cell reports estimates of the NCMS's on outpatient visits at county hospitals after controlling for each set of healthcare resources: hospital beds and number of providers in rural areas using the baseline model (1) with full controls of both time-varying demographic covariates and economic covariates for each province, province fixed effects, and region-by-year fixed effects. CHC denotes community health centers, and THC denotes township health centers. The mean of the dependent variable is the average of outpatient visits in 2004 per 10,000 people and is weighted by the rural population in 2003. All estimates are weighted by the rural population in 2003. Standard errors are clustered by province and are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

et al., 2021). This overlap raises questions about the attributability of improvements in healthcare supply directly to the NCMS. To address these concerns and disentangle the effects of the NCMS from those of the 2009 medical reform, we employ an event study model (Lin and Zai, 2024).

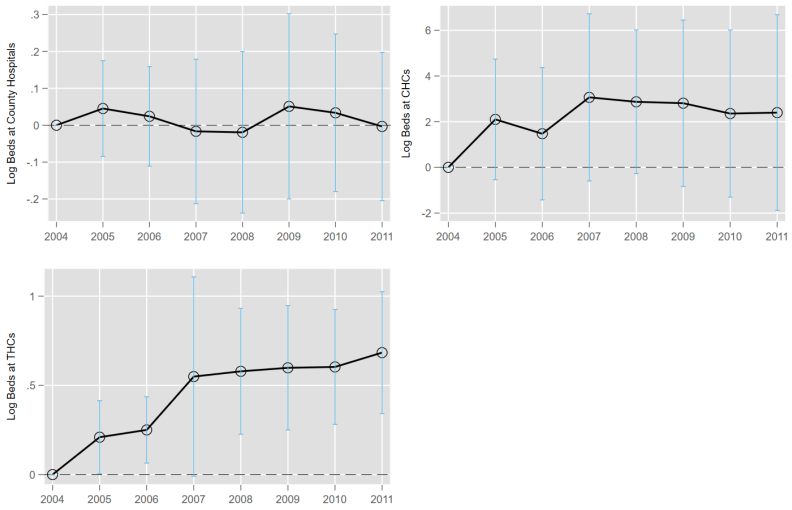
$$ln(Y_{pt}) = \alpha_0 + NCMS_p \times \left[\sum_{y=1}^{7} \theta_y \mathbf{1}\{t - 2004 = y\}\right] + \eta_p + \mu_{rt} + X_{pt}^{'}\beta + \epsilon_{pt} \quad (2)$$

where $NCMS_p$ indicates the NCMS enrollment rate in province p for the year 2004. The model utilizes event-year dummies, $\mathbf{1}\{t-2004 = y\}$, which take the value one for each observed year $t = 2005, 2006, \ldots, 2010, 2011$, respectively, comparing these years against the baseline year of 2004, which is excluded as the reference year in the analysis. The rest of the variables and specifications adhere to those presented in the baseline equation (1).

Figure 4 illustrates the impact of the NCMS on the availability of healthcare resources in rural

areas using equation (2). Should the escalation of government investments post-2009 be the primary catalyst for supply-side adaptations, a pronounced enhancement post-2009 would be anticipated. However, in contradiction to such expectations, Figure 4 reveals no sudden surge in supply-side effects subsequent to 2009. Instead, it indicates that the supply responses commenced prior to 2009, challenging the concern that these adaptations are exclusively a result of the autonomous medical reform launched in 2009.

(a) Number of Beds



(b) Number of Institutions

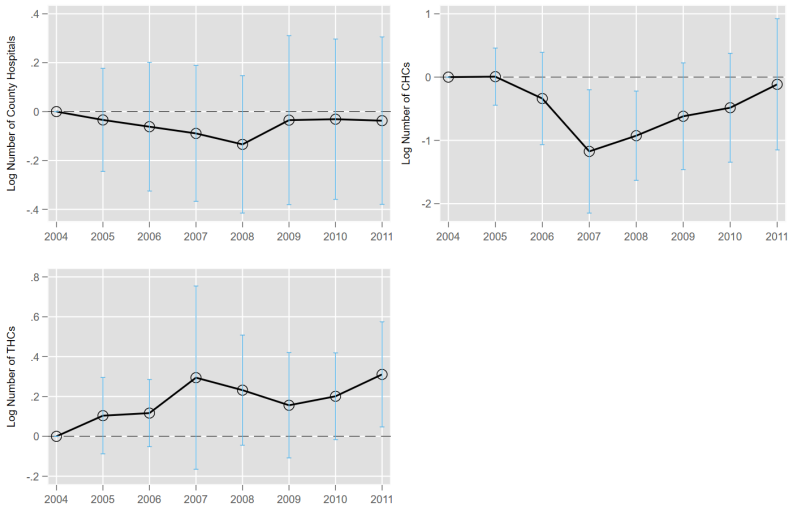


Figure 4: Event-Study Estimates by NCMS Enrollment Gain

Notes: The data source is the 2004-2011 CSY. Each figure plots the event-study estimates in specification (2). The y-axis is the dependent variable in log form. The interval is the 95 percent confidence interval of each estimate.

6 Conclusion

Our analysis evaluates the impact of the NCMS on healthcare resources in rural China, highlighting the significant role of supply-side responses in enhancing the scheme's effectiveness. The NCMS is a major initiative aimed at expanding insurance coverage for rural populations in LMICs. Using a province-year panel dataset spanning eight years after the NCMS's nationwide implementation in 2004, we investigate the dynamics of healthcare supply changes attributable to the scheme. Our findings reveal a notable increase in hospital bed availability attributed to the NCMS, with a minimal impact on the number of healthcare institutions. Compared to outcomes in high-income countries, the supply-side responses we identified are significant.

Adjusting for variations in healthcare resources, we find that the NCMS's influence on inpatient care utilization is halved, emphasizing the crucial role of rural healthcare providers adapting to increased demand for the success of insurance expansion initiatives. This mirrors results found in Kondo and Shigeoka (2013), indicating the universal importance of responsive healthcare supply in the effectiveness of public insurance expansions.

The study underlines the urgent need to address supply-side constraints and increase investment in healthcare infrastructure as essential measures to meet the growing healthcare demands of low-income populations in LMICs. Moreover, the significant effect of supply-side adjustments on the NCMS's outcomes highlights the necessity of tackling non-supply factors to improve the scheme's overall success. This dual approach—enhancing both healthcare provision and addressing broader systemic issues—emerges as a critical strategy for maximizing the benefits of insurance expansion in LMIC settings.

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Appendices

A Tables and Figures

Table A1: Summary Statistics

	Mean	S.D.	Min.	Max.	N
NCMS Variables					
NCMS enrollment rate	0.70	0.35	0.02	1.27	232
Initial NCMS rate in 2004	0.19	0.24	0.02	0.93	232
Inpatient reimbursement rate	0.37	0.10	0.16	0.57	222
Rural Health Resources (per 10,000 people)					
Beds at city hospitals	16	13	5	67	232
Beds at county hospitals	9	4	1	30	232
Beds at CHCs	1	2	0	13	232
Beds at THCs	6	2	0	11	232
Number of city hospitals	0.10	0.07	0.04	0.44	232
Number of county hospitals	0.08	0.05	0.01	0.28	232
Number of CHCs	0.22	0.26	0.02	1.36	232
Number of THCs	0.32	0.16	0.00	0.83	232
Healthcare Utilization (per 10,000 people)					
Ratio of NCMS beneficiaries to enrollment	1.04	1.55	0.02	13.21	232
Total number of outpatient visits	24150	20474	7558	133000	232
Total number of inpatient stays	807	274	310	1771	217

Table A2: The NCMS's Effects on Inpatient Care Use Controlling for All Rural Healthcare Resources

	(1) Total	(2) CHC	(3) County hospital	(4) THC
NCMS rate	0.041	1.198***	0.079**	-0.006
	(0.055)	(0.417)	(0.032)	(0.137)
THC beds	0.380***	-1.289	0.070	0.991***
	(0.102)	(0.941)	(0.080)	(0.220)
County hospital beds	0.385**	1.203	0.790***	0.198
	(0.164)	(1.343)	(0.140)	(0.416)
CHC beds	-0.011	1.081***	-0.008	0.005
	(0.009)	(0.137)	(0.005)	(0.018)
Number of THCs	-0.239	1.771*	0.019	0.331
	(0.144)	(0.895)	(0.107)	(0.261)
Number of county hospitals	-0.039	-1.014	-0.027	0.125
	(0.114)	(1.150)	(0.092)	(0.295)
Number of CHCs	0.014	0.123	0.018	0.004
	(0.019)	(0.252)	(0.011)	(0.059)
Mean	479.4	0.995	169.1	127.6

Notes: Each cell reports estimates of the NCMS's effects on inpatient care use after controlling for all of the healthcare resources: hospital beds and number of providers in rural areas using the baseline model 1. The mean of the dependent variable is the average of inpatient care use in 2004 per 10,000 people and weighted by the rural population in 2003. All estimates are weighted by the rural population in 2003. Standard errors are clustered by province and are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.10$.