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Research Paper

The Impact of Catastrophic Medical Insurance in China: A five-year patient-level panel study

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ABSTRACT

Background: In an effort to provide greater financial protection from the risk of large medical expenditures, China has gradually added catastrophic medical insurance (CMI) to the various basic insurance schemes. Tongxiang, a rural county in Zhejiang province, China, has had CMI since 2000 for their employee insurance scheme, and since 2014 for their resident insurance scheme.

Methods: Compiling and analysing patient-level panel data over five years, we use a difference-in-difference approach to study the effect of the 2014 introduction of CMI for resident insurance beneficiaries in Tongxiang. In our study design, resident insurance beneficiaries are the treatment group, while employee insurance beneficiaries are the control group.

Findings: We find that availability of CMI significantly increases medical expenditures among resident insurance beneficiaries, including for both inpatient and outpatient spending. Despite the greater financial protection, out-of-pocket expenditures increased, in part because patients accessed treatment more often at higher-level hospitals.

Interpretation: Better financial coverage for catastrophic medical expenditures led to greater access and expenditures, not only for inpatient admissions—the category that most often leads to catastrophic expenditures—but for outpatient visits as well. These patterns of expenditure change with CMI may reflect both enhanced access to a patient's preferred site of care as well as the influence of incentives encouraging more care under fee-for-service payment.

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Chinese translation of the abstract (Appendix 1)

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Research in context

Evidence before this study

Substantial evidence emerged in the last two decades regarding the health and financial effects of China's basic medical insurance schemes such as the New Cooperative Medical Scheme (NCMS) and Urban Employees' Basic Medical Insurance (UEBMI). But, based on Google Scholar searches conducted from June 2020 to August 2020 on published literature up to that date, limited research examined the effect of adopting CMI on spending of rural residents. Several studies broadly studied whether more robust coverage through CMI would increase spending and utilization or reduce illness-induced poverty, but few use patient-level data over a five-year period. Most of the available research provides an overview of the national implementation of CMI or compares policies across provinces by exploring the to-

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tal costs paid by individuals benefitting from the scheme before and after implementation in different provinces, without a control group.

Added value of this study

We use medical claims data specifically for individuals with hypertension and diabetes (who are therefore frequent medical care users) to explore the change in a variety of expenditure categories—such as total and out-of-pocket spending for inpatient and outpatient care—after the 2014 inclusion of CMI in the resident insurance scheme. We compare the expenditure changes for resident insurance beneficiaries to otherwise similar hypertension and diabetes patients covered by employee insurance in the same locality to derive the causal effect of CMI using a difference-in-difference regression, i.e., empirically estimating the pre-post change with a comparison group. In addition, we estimate the effect of distance on willingness-to-pay for care at higher-level hospitals. A better understanding of the effects of catastrophic coverage is crucial for countries as they design universal health coverage policies, especially if deepening coverage might lead to the paradoxical effect of higher out-of-pocket spending.

Implications of all the available evidence

Our empirical results suggest that China's insurance reforms have increased access and expenditures of rural residents, contributing to narrowing the urban-rural divide in access to health care, but also reinforcing the urgency of designing supply-side incentives to reward "value" rather than volume. This research may also have policy relevance for other low- and middle-income countries as they continue to aim for greater financial protection and reduced catastrophic spending.

Introduction

Under a series of health care policy initiatives begun in the early years of the 21st century and spurred by national health reforms in 2009, China swiftly achieved universal health coverage (UHC) for its population by 2011.[1] However, insurance coverage at a basic level left many households exposed to catastrophic medical expenditures if treatment spending exceeded the ceiling of the basic insurance schemes, which were relatively low for the voluntary schemes for the rural population and the urban non-employed. A health expense is often considered "catastrophic" when a household's out-of-pocket expenditure absorbs 40% or more of its net income after essential spending. Using this definition, one study found that 12•9% of the total population experienced catastrophic health expenses in China in 2011.[2] Rural individuals and those not employed in the urban formal sector, two particularly vulnerable subpopulations in China, respectively spent 33% and 30% of their annual disposable income on out-of-pocket expenditures for inpatient admissions in 2013.[2]

As part of China's efforts to eradicate poverty, including illness-induced poverty, and to protect families from catastrophic medical spending, the government has taken steps towards increasing the financial coverage provided by its basic health insurance schemes. In 2000, catastrophic medical insurance (CMI) was first introduced for beneficiaries of urban employee basic medical insurance (UEBMI), and only in 2013 was CMI also offered to urban individuals not covered by UEBMI and rural residents, with some variation by locality. By design, CMI supplemented insurance by relaxing the insurance reimbursement ceiling. This higher ceiling was intended to lower patients' out-of-pocket payments by providing additional reimbursement for catastrophic medical expenditures. Thus, the introduction of CMI has the potential to protect groups from the financial risk of incurring catastrophic spending from unusual and expensive medical care. In this way CMI can play an important role in preventing illness-induced poverty. Indeed, China continues to introduce policies to enhance financial protection for low-income residents, such as a recently announced 10-percentage-point increase in the reimbursement rate for inpatient expenditures for residents in poverty (i.e. an increase to 80% reimbursement for hospital admissions).[3]

Despite such policy changes, prior research has been inconclusive about the impact of CMI on out-of-pocket spending.[4-9] Such mixed impacts may be expected when patients with improved insurance choose to seek care at higher-level providers, with an ambiguous impact of higher utilization on their out-of-pocket share of expenditures.

Therefore, our study objective was to investigate the quantitative effect of China's CMI on patients' out-of-pocket spending and overall health expenditures. We examine three related but distinct hypotheses. First, CMI will increase medical care utilization, especially for the most expensive kinds of care (such as inpatient treatment in urban tertiary hospitals), perhaps with spillovers for associated follow-up care (such as outpatient visits). Second, out-of-pocket spending may decrease or increase, depending on whether the improved financial protection outweighs the increased overall spending and patient preference for care settings of higher perceived quality. Third, CMI will encourage more rural patients to self-refer or be transferred to the care settings used more often by their better-insured urban counterparts, such as urban tertiary hospitals. We used 2011 - 2015 patient-level cohort data from Tongxiang, a county reasonably representative of eastern coastal China, to estimate the effect of CMI on health care expenditures for the majority rural population, compared to the urban population who had CMI during the entire study period (a difference-in-difference approach).

The Medical Insurance System in China

Although by 2014 both employed and non-employed urban and rural residents had access to CMI, employed urban residents had access to CMI almost 15 years earlier, and overall enjoyed more generous insurance benefits. This difference arose because basic medical insurance options depend on one's place of residence, employment, and household registration (*hukou*) status: the mandatory UEBMI scheme covers urban formal sector employees; the voluntary New Cooperative Medical Scheme (NCMS, first introduced in 2003) serves rural individuals, and the voluntary Urban Residents Basic Medical Insurance (URBMI, first introduced in 2007) covers urban individuals not covered by UEBMI.[10] Over the past decade, many localities—including the county we study—began to merge the latter two risk pools to form "resident insurance." Hereafter, we will focus on resident insurance and employee insurance (UEBMI) as the two insurance schemes we are studying; the introduction of CMI improved the financial coverage of the former to more closely approximate—but still fall short of—the latter.

The benefit package for employee insurance has traditionally been far more generous than that of resident insurance because of differing legacies of organizational structure and financing. Originating from labour insurance for employees of state-owned enterprises and the relatively generous government employee insurance system, UEBMI financing flows from employers and employees based on risk pools from formal sector employment. To reach universal coverage, China later introduced voluntary schemes to cover the remaining population, financed through central, provincial and local governments as well as household premium contributions.[11] By design, UEBMI covered urban formal sector employees while NCMS and URBMI covered rural residents and lower-income urban residents like the unemployed, disabled, and elderly,

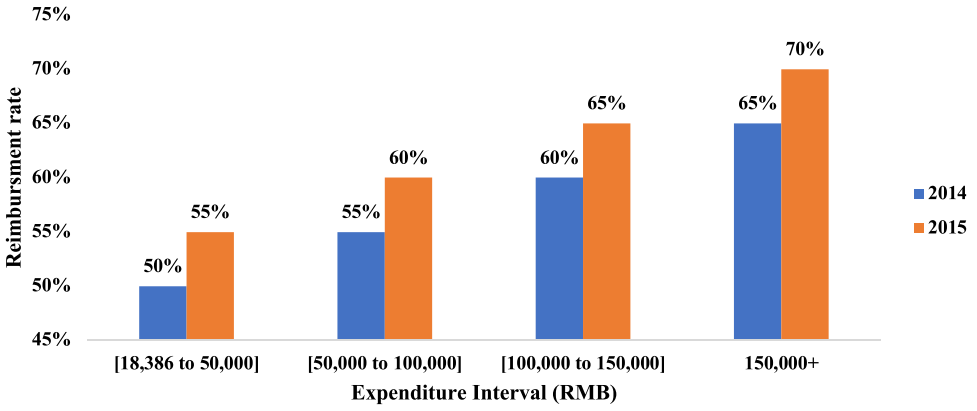

Figure 1. CMI Reimbursement Rate in Tongxiang (2014-15)

in addition to students and children. Employee insurance is available to workers at highly subsidized premiums as part of the social security system. For residents who are not employed, self-employed (e.g. in agriculture), or have not paid enough social security contributions to qualify for employee insurance, resident insurance is available for purchase at a modest premium, albeit with a limited benefit package compared to employee insurance.[11]

Over time, investments in better healthcare coverage increased, deepening the benefit packages of insurance and strengthening other parts of China's health system, including reform focused on four other areas: public health, primary health care, essential medicines, and government hospital reforms.[12] Additional elements were added to enhance the financial protection provided by insurance, including reimbursements for outpatient care within NCMS and URBMI, and reduction of individual copayments for inpatient and outpatient care.[12,13] The staggered introduction of CMI to different localities' resident insurance schemes was a part of these efforts. Resident insurance plus CMI started in a few pilot cities in 2013, with many more cities adopting this new policy since 2014. The 2014 addition of CMI to the resident insurance benefit package in Tongxiang, the county we study, followed this trend, aiming to bolster financial protection and reduce high out-of-pocket spending for rural residents and the urban population not covered by employee insurance.

In Tongxiang, within each calendar year, after the resident basic insurance reimburses one's inpatient and/or special outpatient expenditures, CMI reimburses part of an individual's total annual accumulated out-of-pocket expenditure if it exceeds a certain threshold. In 2014 and 2015, that threshold was 18,386 RMB ($2,962)—equivalent to the average income of a rural resident in Tongxiang in 2012. In 2014, CMI's reimbursement rates were 50%, 55%, 60%, 65% for expenditure intervals from 18,386 to 50,000 RMB, from 50,000 to 100,000 RMB, from 100,000 to 150,000 RMB, and above 150,000 RMB, respectively. In 2015, the reimbursement rate increased 5% for each interval (see Figure 1). With higher reimbursement rates and no upper bound at the highest expenditure interval, CMI is expected to enhance healthcare affordability and accessibility.

Methods

Our research on the introduction of CMI specifically focused on the spending outcomes of resident insurance beneficiaries in Tongxiang, a rural county in China. Our study period is 2011 to 2015. As noted, CMI was introduced to the resident insurance scheme in Tongxiang at the beginning of 2014. We use a difference-in-difference approach to explore spending changes before and after 2014 for the resident insurance group, compared to beneficiaries of employee insurance. Between 2011 and 2015, resident insurance coverage changed significantly, while employee insurance experienced only minor changes. Specifically, resident insurance switched from not having catastrophic health coverage (i.e., paying 100% out-of-pocket for any spending beyond the insurance ceiling of 18,386 RMB) to having a CMI contingency that covered 55-70% of costs after spending 18,386 RMB on medical care. In addition, there were slight decreases made to inpatient coinsurance rates below the ceiling as well. Employee insurance beneficiaries, on the other hand, had more generous coverage (since before the beginning of our study period in 2011) with only small changes in deductibles and coinsurance rates during our five-year study period. Since resident insurance experienced a significant structural change with the addition of CMI, while employee insurance only changed on the margins, we can examine the policy impact on the resident insurance beneficiaries as the treatment group while regarding the employee insurance beneficiaries as a control group.

Data sources and participants

The datasets we use for our analysis include administrative, surveillance, and medical claims records. First, as part of the government's population health initiatives, Tongxiang authorities have compiled a master administrative health database that records residents' demographic information including household registration (*hukou*), insurance status, self-reported income category, educational attainment of household members, and several other variables. As of the beginning of 2015, the database had information on about 667,000 individuals residing in Tongxiang, or 97% of the total 2014 population. For this study, we linked this first dataset with two other ones. Second, the provincial surveillance database monitors all patients diagnosed with hypertension or diabetes within Zhejiang province, reported by public hospitals, clinics, and other providers. Third, we linked to the Tongxiang county health insurance medical claims for both employee and resident insurance beneficiaries with hypertension or diabetes mellitus, overwhelmingly type 2 (hereafter diabetes), based on individuals diagnosed with those two chronic diseases.

We link the administrative database, the surveillance hypertension and diabetes database and the medical claims using unique national ID numbers for the same individuals. The matched patients' insurance claims data cover healthcare utilization between 2011 and the end of 2015. There is an 100% match between the claims data and the surveillance data in 2015. However, this data is not fully representative of those originally enrolled in 2011, only of those who were diagnosed and alive by 2015. There is attrition both from moving away, death, and those missed because they were not yet diagnosed or remain unaware of their condition.

We chose to examine this subpopulation of individuals with chronic disease because of their increased likelihood of health care utilization and risk of catastrophic medical expenditures. Since hypertension is the most common non-communicable disease (NCD), the sample includes a large subset of the population and, as individuals with pre-existing conditions, a subset likely to be affected by this policy and observed in the data with positive healthcare utilization.

Hypotheses and variables

We explore a variety of outcomes related to healthcare utilization, including total spending, inpatient spending, inpatient spending conditional on having an inpatient admission (i.e., conditional on inpatient spending greater than zero), outpatient spending, out-of-pocket spending, and care setting (i.e., change in hospital tier). As noted, we anticipate that CMI will increase medical care utilization, especially for inpatient care, perhaps with spillovers for associated follow-up outpatient care. Out-of-pocket spending may decrease or increase. Both theory and previous empirical evidence suggest that better insurance coverage leads patients to seek higher quality care. According to data from the 4th National Health Service Survey in 2008, among rural residents the majority of first-contact care was at village clinics (57%) or township health centres (24%), with only 2% of rural residents seeking first-contract care at municipal or provincial hospitals. By contrast, more than one-quarter of urban patients, who enjoy higher incomes and greater insurance coverage, self-referred to municipal or provincial hospitals for first-contact care.[14] Moreover, bed occupancy rates of community and township health centres were relatively low at 55•5 and 62•1%, respectively, suggesting that many patients able to pay for hospital-based care often self-refer to higher-level hospitals.[14] In the present context, we predict that catastrophic insurance will encourage more rural patients to self-refer or be transferred to the care settings used more often by their better-insured urban counterparts, such as urban tertiary hospitals, which may increase their out-of-pocket spending.

Statistical analysis

We undertook analyses in two steps. First, we summarize expenditure trends for both insurance groups over the time period of the study. To explore the validity of the difference-in-difference analysis of CMI introduction for resident insurance beneficiaries, we confirmed that resident and employee insurance beneficiaries have comparable trends in pre-reform spending, an important preliminary condition for employee insurance beneficiaries to constitute a viable comparison group.

Second, we estimate regression analyses to investigate the impact of CMI. The general equation for the difference-in-difference ordinary least squares (OLS) analyses to test our hypothesis is as follows:

$$\boldsymbol{s_{it}} = \boldsymbol{Y_{\geq 2014}} + \boldsymbol{\alpha}*(\boldsymbol{I_i} = \boldsymbol{Resident}) + \boldsymbol{\beta}*1(\boldsymbol{t} \geq 2014) + \boldsymbol{age_{it}} + \boldsymbol{gender_i} + \boldsymbol{education_i} + \boldsymbol{age_{it}}*\boldsymbol{gender_i} + \boldsymbol{\varepsilon_{it}}$$

The specific regression equation we ran is as follows:

$$\begin{aligned}\boldsymbol{s_{it}} = {} & \boldsymbol{\beta_0} + \boldsymbol{\beta_1 PostYear_{it}} + \boldsymbol{\beta_2 ResidentInsurance_{it}} \\ & + \boldsymbol{\beta_3}(\boldsymbol{PostYear_{it}} \times \boldsymbol{ResidentInsurance_{it}}) + \boldsymbol{\beta_4 AgeCat2_{it}} \\ & + \boldsymbol{\beta_5 AgeCat3_{it}} + \boldsymbol{\beta_6 AgeCat4_{it}} + \boldsymbol{\beta_7 AgeCat5_{it}} + \boldsymbol{\beta_8 Gender_{it}} \\ & + \boldsymbol{\beta_9 EducationCat2_{it}} + \boldsymbol{\beta_{10} EducationCat3_{it}} \\ & + \boldsymbol{\beta_{11} EducationCat4_{it}} + \boldsymbol{\beta_{12} EducationCat5_{it}} \\ & + \boldsymbol{\beta_{13} EducationCat6_{it}} + \boldsymbol{\beta_{14} EducationCat7_{it}} + \varepsilon_{it}\end{aligned}$$

In addition, we ran a triple-difference (difference-in-difference-in-difference) regression, interacting resident insurance, post-period and an indicator variable for a higher quality, major hospital, in order to estimate the percent change in utilization for resident insurance beneficiaries after the introduction of CMI in larger urban hospitals.

$$\begin{aligned}\boldsymbol{s_{it}} = {} & \boldsymbol{\beta_0} + \boldsymbol{\beta_1 PostYear_{it}} + \boldsymbol{\beta_2 ResidentInsurance_{it}} \\ & + \boldsymbol{\beta_3 MajorHospital_{it}} + \boldsymbol{\beta_4}(\boldsymbol{PostYear_{it}} \times \boldsymbol{ResidentInsurance_{it}}) \\ & + \boldsymbol{\beta_0} + \boldsymbol{\beta_1 PostYear_{it}} + \boldsymbol{\beta_2 ResidentInsurance_{it}} \\ & + \boldsymbol{\beta_3 MajorHospital_{it}} + \boldsymbol{\beta_4}(\boldsymbol{PostYear_{it}} \times \boldsymbol{ResidentInsurance_{it}}) \\ & + \boldsymbol{\beta_7}(\boldsymbol{PostYear_{it}} \times \boldsymbol{ResidentInsurance_{it}} \times \boldsymbol{MajorHospital_{it}}) \\ & + \boldsymbol{\beta_8 AgeCat2_{it}} + \boldsymbol{\beta_9 AgeCat3_{it}} + \boldsymbol{\beta_{10} AgeCat4_{it}} + \boldsymbol{\beta_{11} AgeCat5_{it}} \\ & + \boldsymbol{\beta_{12} Gender_{it}} + \boldsymbol{\beta_{13} EducationCat2_{it}} + \boldsymbol{\beta_{14} EducationCat3_{it}} \\ & + \boldsymbol{\beta_{15} EducationCat4_{it}} + \boldsymbol{\beta_{16} EducationCat5_{it}} \\ & + \boldsymbol{\beta_{17} EducationCat6_{it}} + \boldsymbol{\beta_{18} EducationCat7_{it}} + \varepsilon_{it}\end{aligned}$$

The dependent variable s_{it} is the natural log of the real spending outcome of interest for patient i in year t. $Y_{\geq 2014}$ is the indicator variable for years 2014 and 2015, capturing the pre-post difference in real spending. β is the coefficient of interest, as the variable captures the interaction between being a beneficiary of resident insurance and the $Y_{\geq 2014}$ indicator variable for the 24 months after CMI was adopted (2014 and 2015). In other words, the estimated β represents the pre-post difference for resident insurance beneficiaries compared to the pre-post difference for employee insurance beneficiaries: the difference-in-difference estimate. We focus on that interaction to understand the impact of CMI availability for resident insurance beneficiaries. To disentangle this impact from other individual-level characteristics that influence medical spending and broader trends, we control for a series of other variables. age_{it} is an age group fixed effect for person i in year t. We group ages into five-year categories. $gender_i$ controls for whether patient i is male or female; $education_i$ controls for the educational attainment level of patient i. We also include an interaction variable between gender and age. In sensitivity analyses with additional controls for pre-reform trends, we also estimated difference-in-differences with fixed effects for each year (to control for trends across years that are similar for all patients) and years interaction with resident insurance; results from these specifications including all year interactions $\beta_{2011} - \beta_{2015}$ were similar to those reported below.

Finally, estimated a regression to provide a reference point regarding incentives towards seeking care from a hospital, especially one of a higher quality. We run a logit equation to estimate the effect of distance from a hospital on an individual's decision to seek care there. This methodology, sometimes referred to as "differential difference" estimation (see work by Einav et al. (2016)[15] and McClellan et al. (1994).[16] The regression can be summarized by the expression

$$\mu_i = \alpha_i - \beta_i d_i,$$

where μ_i represents the utility from using a major urban hospital, including any individual-specific α_i that may reflect perception of the higher quality of care, less the travel costs associated with d_i, the distance of that patient from the nearest major hospital, relative to their local one (e.g., the township health center). Since we have township data for each individual in our data set, we estimate distance to a major hospital by using the distance between their township and the closest major urban tertiary hospital as a proxy, and then examine how this distance interacts with patterns of inpatient utilization and spending in the post-CMI period.

Role of the funding source

The funders had no direct role in the study design, data collection, data analysis, interpretation, or writing of the report.

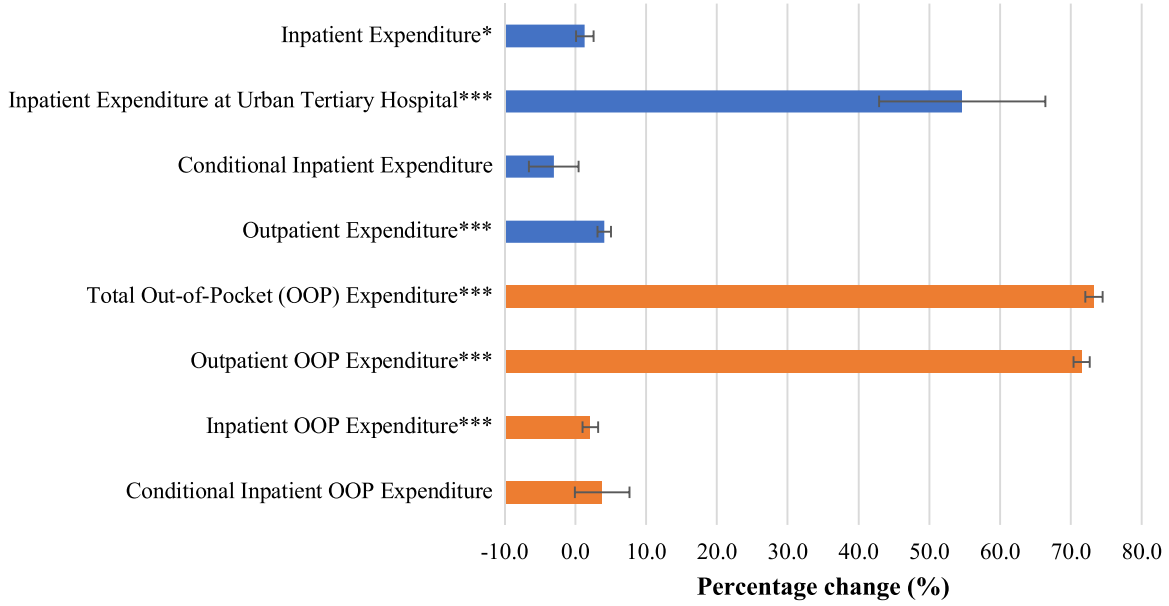

Figure 2. Effects of CMI on Healthcare Expenditures
Notes: The figure above shows the results of the difference-in-difference estimation. The significance indicators show *** at the 0•01 level, ** at the 0•01 level, and * at the 0•05 level. The dependent variable of interest shows various variables representing spending. Each outcome includes the same set of controls in the regression, which include year fixed effects, age grouped in 5-year bins, gender, education level, and an interaction between age and gender. 'Expenditure' refers to the total annual amount in RMB that a patient spent on that type of care. 'Conditional' refers to a sample restricted to patients that had positive spending of that type during the after years (2014-2015). 'OOP' refers to out-of-pocket spending. 'Inpatient Expenditure at Urban Tertiary Hospital' refers to a triple difference-in-difference equation that interacts post-period, hospital tier and total inpatient expenditure. The error bars show the 95% confidence interval.

Results

Table 1 shows the summary statistics of our sample. Average age in 2011 was 61•9, with 46•8% male. The primary outcome variables by individuals' insurance type, in 2011 and 2015, the first and last years of our study period. The total number of patients represents all the patients in our data set. Since not every individual will experience a hospitalization in every year, some variables have a restricted number of observations. For example, the percentage of resident insurance beneficiaries who were hospitalized was 9•6% in 2011 and 16•6% in 2015. "Conditional inpatient expenditure" refers to inpatient expenditures conditional on having an inpatient admission in that year. Similarly, conditional inpatient out-of-pocket (OOP) expenditure refers to OOP spending among those who were hospitalized. For example, among those with a hospitalization in 2011, residents on average spent 1,339 RMB more than employees did; by 2015, that gap had narrowed to only 178 RMB on average. Total spending climbs significantly for both groups throughout the years in question (see Table 1).

Parallel pre-reform (2011-13) time trends

We first confirm approximately parallel pre-reform time trends of outcomes between the treated and control groups. We are specifically interested in the trends in spending from 2011 to 2013, the period prior to the introduction of catastrophic insurance for our treatment group. As noted, resident insurance beneficiaries have less generous coverage and therefore it is not surprising that they have a higher share of spending that is out-of-pocket. However, as long as the pre-reform trends are similar, the better-insured employees can serve as a comparison group capturing the temporal trend in healthcare utilization in China during this period of rapid economic growth and utilization increase. While the actual monetary value of spending differs across the resident and employee insurance groups, with resident insurance beneficiaries typically spending less (although with higher out-of-pocket payments), the trends in spending are similar.

For employee insurance beneficiaries, spending increases roughly 35% during those years, while resident insurance beneficiary spending increases by roughly 50%, from a lower base level of spending. The two groups both see modest increases in inpatient spending from 2011 to 2013, and similar increases in total outpatient spending, albeit from a lower base (since outpatient visits are typically much less costly than inpatient admissions).

Total out-of-pocket spending increases by roughly 200-300 RMB for both groups during the pre-reform period, although resident insurance beneficiaries bear higher out-of-pocket costs. Inpatient out-of-pocket spending is decreasing for both groups before the introduction of CMI, while outpatient out-of-pocket costs actually increase during the same period. These trends demonstrate how differing levels of spending by the two groups still show similar trends prior to the introduction of CMI.

The impact of CMI: Regression results

We estimate effects of CMI on inpatient and outpatient expenditures based on difference-in-difference regression analyses, reported in Figure 2. The empirical results show that CMI led to significantly greater medical utilization and expenditures for resident insurance beneficiaries, closing part of the gap between them and their better-insured counterparts covered by employee insurance. Specifically, the difference-in-difference empirical results show that resident insurance beneficiaries enjoyed a small, statistically significant increase in the probability of using any inpatient care after they were covered by CMI, relative to the increase for employees. Their inpatient expenditure increased by 1•3% ($p = •0344$), relative to the UEBMI comparison group (Figure 2, first bar). Thus, it appears that catastrophic medical insurance for resident insurance beneficiaries relaxed the constraint on accessing expensive medical care, as intended. For those who did experience an inpa-

Table 1
Summary Statistics for Beneficiaries of Resident Insurance and Employee Insurance

Period	Insurance Type	Total Number of Patients	Mean Total Annual Expenditure (RMB)	Mean Annual Conditional Inpatient Expenditure (RMB)	% With Hospital Admission	Mean Annual Total Outpatient Expenditure (RMB)	Mean Annual Total OOP (RMB)	Mean Annual Conditional Inpatient OOP (RMB)
Pre-CMI (2011)	Resident	59588	2024	11028	9.6	969	1275	6057
	Employee	12141	4425	17794	12.1	2325	1030	4718
Post-CMI (2015)	Resident	57971	4011	14874	16.6	1544	2028	6694
	Employee	13758	8164	25042	19.0	3444	1953	6516

Notes: The table above shows the summary statistics for our data set by insurance type, in 2011 and 2015, the first and last years of our study period. The total number of patients represents all the patients in our data set, but some variables have a restricted number of patients. The variables which show conditional expenditure refer only to patients with positive expenditure in the years in question, which naturally is a smaller subset of the data, since not every individual seeks care in every year. The percent of the total number of patients who were admitted to the hospital, therefore incurring some level of positive spending, is the same for conditional inpatient expenditure and conditional inpatient OOP expenditure. Spending variables are CPI-adjusted to represent real spending in 2015 RMB.

tient admission, conditional inpatient spending was not statistically significantly higher.

However, there did appear to be greater inpatient utilization at higher-tier hospitals, as shown by our difference-in-difference-in-difference regression interacting resident insurance with an indicator for the post-period and indicator for a higher hospital tier (Figure 2, second bar). Village clinics, township health centres, and county-level hospitals are grouped together as the reference category, while urban tertiary hospitals are their own subgroup. The results show that inpatient spending by resident insurance beneficiaries in the after period at urban tertiary hospitals increased by 43•6% ($p < •001$). This large increase from a small base suggests that CMI enabled some patients to access higher-level providers perceived to be of higher quality or more appropriate given the severity of their condition.

The difference-in-difference regression results also suggest that outpatient expenditure increased by 4•1% ($p < •001$), slightly greater than the increase in inpatient spending, perhaps because outpatient care is complementary to inpatient care (i.e., follow-up specialist visits after an inpatient admission). Thus, both inpatient and outpatient overall resource use increased among resident insurance beneficiaries, relative to employee insurance beneficiaries, when the former began to enjoy CMI.

Whether out-of-pocket spending decreases or increases after this change in overall spending is the focus of our final set of analyses. The orange rows show the estimated effect of CMI introduction on various categories of out-of-pocket (OOP) spending. Total OOP spending increases by 73•3% ($p < •001$) for the resident insurance, post-CMI group. Inpatient OOP expenditure increases by 2•1% ($p < •001$), while outpatient OOP expenditure increases by 71•5% ($p < •001$). Inpatient OOP spending conditional on positive spending does not exhibit a statistically significant change (3•8%, $p = •0542$). These findings show that CMI provides greater financial protection from increases in OOP spending on inpatient care than outpatient care, since outpatient OOP spending constitutes the majority of the total increase in OOP spending. With the introduction of CMI, out-of-pocket spending increased across both types of visits, but particularly for outpatient costs which are not a primary target of CMI. This does not necessarily indicate that there were greater overall increases in outpatient use relative to inpatient use, because inpatient spending is covered by the CMI. However, it is important to note for the spending categories that exhibited the highest percent increase (i.e. inpatient expenditures at urban tertiary hospitals, total OOP expenditure and outpatient OOP expenditure) that the large percent increase could have occurred in part because of the smaller starting base. Moreover, as shown previously in Table 1, out-of-pocket spending as a share of total expenditures declines for resident insurance beneficiaries over the study period, despite their increase relative to the comparison group. Specifically, OOP spending represented 63% of total expenditures for residents in 2011, declining to 51% in 2015. For employee insurance recipients, OOP spending as a share of total expenditures stayed roughly constant at 23% (Table 1).

Thus, the data suggests that residents' increased use of medical resources, including in higher-tier settings, led to an increase rather than decrease in OOP spending, although this increase in OOP spending declines as a portion of total spending.

Other analyses

As a further empirical probe into this result, we estimated a differential distance regression to assess residents' willingness to pay for care that is perceived to be of higher quality, after CMI coverage. In order to quantify willingness to pay for higher quality health care, we code the distance between a resident insurance beneficiary's hometown and the nearest urban tertiary care centre (the highest quality tier of health care provider in their choice set). Our differential distance analysis builds on the triple-difference analysis mentioned above, similar to the analyses of Einav et al. (2016)[15] and McClellan et al. (1994).[16] We find that the distance to an urban tertiary care centre does impact the decision to seek care there: an increase in distance of 1km from an urban hospital decreases the probability of seeking care from such a hospital by log-odds -0•0056, or odds 0•499. This means that an increase in distance of 1km (approximately 1•28 mins by car) reduces the probability of going to an urban hospital by 0•33. Therefore, resident insurance beneficiaries' statistically significant increase in treatment at urban tertiary hospitals after CMI is consistent with better insurance coverage relaxing their constraint on choosing a more distant provider of higher perceived quality.

In sensitivity analyses with additional controls for pre-post trends, we also estimated difference-in-differences with fixed effects for each year (to control for trends across years that are similar for all patients) and years interaction with resident insurance; results from these specifications including all year interactions were similar to those main results.

Discussion

Key results

The results of this study indicate that when more robust coverage is implemented for catastrophic expenses, spending increases across the board—for both inpatient and outpatient care. Access to CMI enabled insurance recipients to spend more overall, and they on average ended up paying more out-of-pocket.[1]

Higher spending results not only from greater utilization of health services, but from greater utilization at larger urban hospitals, rather than nearby village clinics, township health centres, or community health centres. These changes in utilization and spending may be determined as much by the physician as by the patient. Under a fee-for-service system, physicians in China have had incentives to prescribe medications[17,18] and treatments[19] (though some of these incentives were removed in 2009 health care reforms). Resident insurance beneficiaries obtained more care at urban hospitals than before CMI, and may have been able to follow-through with additional diagnostic tests and therapies recommended by their treating physicians, given that insurance would cover a substantial part of the expenditures. Physicians at larger urban hospitals are likely to prescribe more expensive care, especially as they have access to treatment options perceived by both patients and providers to be of higher quality. The differential distance calculations explored above provide support for this hypothesis. Distance to an urban hospital reduces care-seeking from these types of facilities; however, post-CMI rates of expenditure at these hospitals increased significantly (from a small base). Clearly, demand for inpatient services at urban hospitals by individuals with resident insurance is price-elastic. While distance may be a deterrent, reduction in the share of costs borne out-of-pocket relaxes the constraint on willingness and ability to pay for urban hospital care.

Greater post-CMI spending might also result from fewer patients self-discharging from hospitals early or even ignoring physician recommendations to be hospitalized altogether. Despite self-discharge rates decreasing from 2003 to 2011, rates remain high, especially for rural populations, with 2011 estimates at 33•7% for rural groups compared to 27•2% for urban.[20] With greater financial coverage for catastrophic payments, patients may feel more comfortable following doctors' recommendations and remaining in the

[1] In other words, although they were paying a smaller share of the "pie," the bigger "pie" led to their share of the "pie" being larger than before the change.

hospital, thereby incurring greater inpatient and out-of-pocket fees than they would have otherwise.

Limitations

Despite the strengths of a patient-level pre-post analysis with a comparison group, our study has several important limitations. The pre-treatment parallel trends and post-CMI effects could be better captured were the time period of our data to extend wider than the 2011 to 2015 range. Difference-in-difference relies on the assumption that the treatment and control groups have parallel trends; while we do our best to establish this trend with data from 2011 through 2013, data from earlier than 2011 would strengthen this assumption. Further, since the addition of CMI to resident insurance occurred in Tongxiang in January 2014, we have only two years of data after the policy change, so will be missing any cumulative or longer-term effects not captured in the first two years. More recent data could confirm the increase in various types of spending and give further insight into the long-term effects of CMI on spending.

Our data was also restricted to patients in the system with hypertension and diabetes, a subset of the population who regularly seek treatment for chronic conditions. Therefore, our spending increase estimates could be upwardly biased compared to a dataset which included patients who were healthier and did not seek care as often. On the other hand, those with more serious conditions than hypertension and diabetes may benefit more (e.g. cancer, heart attack, stroke, kidney failure), so our estimates could be an underestimate for that group. Because our results are only based on a subset of individuals with pre-existing conditions, our results are not entirely representative of the entire population.

In addition, while difference-in-difference analysis, i.e., pre- and post-CMI comparison with a control group, is a statistical method often used to assess the causal impact of a change relative to the control group, there may be variables missing from our data that we were not able to control for in our regression analyses.

Finally, by design our study only explores the effect of CMI on the rural population of Tongxiang. Further research could expand the study of CMI to examine the effect of CMI on urban populations, or other regions in China.

Generalizability

This study provides additional empirical evidence for better understanding the effects of China's nationwide efforts to bolster UHC and provide greater financial coverage to reduce disparities in access and outcomes. Understanding how CMI may actually increase different types of expenditure by incentivizing more and better-quality care is essential for future initiatives aimed at improving population health and protecting against high costs of care.

Our research suggests that CMI must be paired with other initiatives in order to continue to provide better financial coverage, especially given the potential misalignment of supply-side incentives in China's health system. Research shows that reorienting care towards outpatient rather than inpatient care,[21] or moving away from fee-for-service toward bundled payment or mixed FFS with capitation and pay-for-performance[22] can have positive effects. In addition, our study supports a growing body of evidence on policies that seek to mitigate rural-urban disparities in access to quality care,[23,24] which are exacerbated by differences in income and other economic outcomes.[25]

Our study also points to a need for more targeted health care aid. Narrowing the gap between the coverage of employee and resident insurance is one step towards reducing illness-induced poverty and improving the security of rural Chinese livelihoods. Further research studying health outcomes of CMI and other initiatives targeting vulnerable populations would be valuable.

Contributors

Min Yu and Karen Eggleston designed the study and coordinated the research team to compile and analyse the data. Jieming Zhong, Ruying Hu, Xiangyu Chen, Chunmei Wang, and Kaixu Xie linked the Tongxiang datasets to create the distinctive individual panel dataset and identify the CMI policy change. Merrell Guzman, Xiaotong Gui, Sandra Tian-Jiao Kong, Tingting Qu, and Karen Eggleston analysed the data and drafted the paper. All authors reviewed the final manuscript.

Data sharing statement

The data analysed in this study is proprietary personal health information for which researchers must apply for access to the local health officials to obtain de-identified data. Our data use agreement precludes sharing the patient-level data with other researchers until they have gone through the same ethical review and approval process as for this study.

Declaration of Competing Interest

All authors declare no competing interests. The funding sources played no role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

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Supplementary materials

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.lanwpc.2021.100174.

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