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Analysis of the role of medical insurance in the "Health shocks-consumption upgrading" model: evidence from China

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Abstract

Background The COVID-19 pandemic has brought significant health shocks worldwide, along with a certain burden on healthcare systems. China's healthcare security system has been continuously improved and has essentially achieved universal coverage. Moreover, the health impact of COVID-19 on the Chinese population is diminishing, and the trend of consumption upgrading is becoming more pronounced.

Methods Based on the Ramsey-Cass-Koopmans model, this study constructs a theoretical model of "health shocks-consumption upgrading" to deduce the impact of health shocks on consumption upgrading. We examine the results of the theoretical model using provincial panel data from China spanning from 2002 to 2019 and employing the system GMM estimation method. Furthermore, based on a moderation effect model, we explore the mechanism of basic medical insurance systems in this model.

Results The theoretical model deduces that health shocks lead to a decline in consumption upgrading, which is empirically confirmed. Additionally, the results of moderation effect analysis demonstrate that basic medical insurance systems play a positive moderating role in the "health shocks-consumption upgrading" model. Among the basic medical insurance systems, the New Rural Cooperative Medical Scheme (NRCMS) primarily acts as a positive moderator.

Conclusion Health shocks lead to consumption downgrading, while basic medical insurance systems help to diversify medical risks, alleviate health shocks, reduce precautionary savings, and thereby promote consumption upgrading.

Keywords Health shocks, Medical insurance, Consumption upgrading

Introduction

The primary driver of China's economic growth is consumer spending [1]. With the continuous improvement in both the level and quality of consumption, consumption upgrading has gradually become a key impetus for high-quality economic development. As Foellmi and Zweimüller [2] conclude, consumption upgrading contributes significantly to economic growth. Similarly, Alonso-Carrera and Raurich [3] argue that a higher proportion of minimum consumption requirements in GDP, or consumption downgrading, inhibits economic growth. Consumer upgrading reflects an increase in the overall

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spending levels of residents and a structural shift in specific categories of consumption. It is also a direct manifestation of the public's aspirations for a higher quality of life. However, the COVID- 19 pandemic at the end of 2019 severely impacted China's consumption sector, with significant effects on residents'consumption awareness and structure. According to the China Statistical Yearbook, the Engel coefficient in 2020 and 2021 increased to 30.2 and 29.8, respectively, compared to 28.22 in 2019, reflecting an increase of 1–2 percentage points. This suggests that health shocks led to a consumption downgrade. This may be because the uncertainty caused by health shocks increased people's spending on necessities, such as food, while reducing expenditure on higher-tier goods.

In this study, the t children's education erm "health shock" refers to the potential occurrence of illness, disability, or mortality among residents as a result of health risks. This can lead to the loss of daily life capabilities or restrictions in labor supply, potentially resulting in significant negative impacts on residents' quality of life, labor efficiency, economic income, and other related aspects. In the empirical literature on health shocks, early scholars utilize the number of days missed from work and studies due to health issues as a definition for health shocks [4–6]. However, this method lacks precision. Some scholars have proposed using self-assessed health conditions to represent health shocks [7]. Subsequently, researchers seek objective variables that could serve as proxies for health shocks. Wagstaff [8] explores the death of employed family members, the number of long-term hospitalizations, and BMI index as indicators of health shocks. Mitra et al. [9] use disability and morbidity rates as health shocks, measured by "days unable to carry out normal activities", "days bedridden due to illness/injury" and "hospitalization". Our study contends that objective variables such as hospitalization shocks, morbidity rates, and catastrophic health expenditures better capture the health shocks experienced by households.

Based on the definition of health shocks, it is evident that health shocks can have severe consequences for residents and household economies, primarily including reduced income levels, crowding out of consumption expenditure, and depletion of household assets. Kadiyala et al. [10] found, using propensity score matching, that mortality rates significantly affect household consumption levels and structures, particularly for poor households. Sophie et al. [11], using fixed-effects models, examined the economic impact of health shocks such as disability and illness on working-age adults in Vietnam. Their findings indicate that these shocks severely undermine household consumption, especially in female-headed households and rural families.

Health shocks differ from other types of uncertainty shocks, as health is a characteristic of individual life that cannot be traded in the economy and can only be partially improved through medical interventions. Furthermore, due to the presence of family genetic factors, improving or promoting health through medical means is limited. Therefore, common strategies to mitigate health shocks mainly encompass informal approaches and formal methods. The informal methods include asset liquidation [12, 13], household borrowing [14, 15], and social transfers [16]. However, these approaches can impose significant welfare losses on households. Thus, medical insurance is generally considered a formal mechanism to mitigate health shocks, as it can directly compensate for medical expenses [17]. Medical insurance can alleviate the harm caused by health shocks, reduce residents'risk uncertainty and precautionary savings, and thereby influence changes in consumption behavior.

Our study specifically examines the impact of various basic medical insurance policies on consumption upgrading under health shocks. In China, the social medical insurance system covers more than 95% of the population. The social basic medical insurance system in China consists of three parts: urban employee basic medical insurance, the New Rural Cooperative Medical Scheme (NRCMS), urban residents'basic medical insurance (URBMI), and urban–rural residents'basic medical insurance (URRBMI) (since 2016, NRCMS and URBMI have been merged into the URRBMI). Among these, urban employee basic medical insurance is mandatory, and employees have no choice in participation, making it impossible to construct a binary explanatory variable. However, other types of basic medical insurance are voluntary, allowing the construction of binary explanatory variables in regression analysis. Therefore, this study focuses on examining the moderating role of NRCMS, URBMI, and URRBMI in the impact of health shocks on consumption upgrading.

A substantial body of literature has highlighted the significant impact of health shocks on consumption, with most studies agreeing that such shocks have a pronounced negative effect on residents'consumption patterns. Additionally, research examining the expenditure structure of specific consumption categories reveals differences in how health shocks affect various consumption components. A common finding across studies is that health shocks typically reduce household consumption, often through the mechanism of precautionary savings. For example, Starr-McCluer et al. [18] analyze household-level financial data and show that health shocks prompt households to increase their savings, leading to a reduction in current consumption. In terms of consumption structure, Dercon [5], using data from Ethiopia, discovers that health shocks significantly

reduce consumption by females, with non-food expenditure dropping by 24%, indicating a decline in overall consumption. Similarly, Gertler et al. [19], drawing on household data from Indonesia, find that health shocks lead to a substantial decrease in labor force participation and income levels, which in turn depress household consumption. Lindelow et al. [7] observe that disease shocks have a notable negative impact on both household income and consumption expenditure. Islam et al. [14], using a large panel dataset from rural Bangladesh, also confirm the significant negative effect of health shocks on household consumption. Finally, Dhanaraj [20], based on macro-level data, shows that during and after severe health crises, households in developing countries are unable to maintain their usual consumption levels.

Based on empirical data, some studies have found that health shocks significantly increase household medical and health expenditures, decrease spending on other shared consumption, and thereby have an uncertain impact on overall household consumption. Wagstaff [8] utilizes sample data from the Vietnam region and found that health shocks significantly reduce residents' household food consumption expenditure but significantly increase medical expenditure. Overall consumption levels also rise as the growth in medical expenses outweighs the decline in food expenditures. Wagstaff [21] finds that catastrophic health expenditures disrupt daily life purchases for households, leading to a reduction in the consumption of non-medical necessity goods. Considering that the developmental consumption in this study includes healthcare expenditures, health shocks may result in women increasing their medical and health expenditures, potentially causing an increase in developmental consumption. It is evident that health shocks primarily lead to a decrease in residents' non-medical consumption expenditures, but the overall impact on consumption, including medical expenditures, remains uncertain.

Based on the relevant literature examining the impact of health shocks on household consumption patterns, the majority of studies suggest that health shocks lead to a reduction in overall household consumption. Kadiyala [22] analyzes data from rural Ethiopian households and finds that major health shocks, such as severe illnesses and fatalities, result in a decline in durable goods consumption, thereby negatively affecting consumption upgrading. Similarly, Mohanan [23], using micro-level survey data, shows that households facing health shocks are able to maintain consumption levels for essentials like food, housing, and festivals, but experience a decrease in education expenditures, reflecting a trend of consumption downgrading. Additionally, Mitra et al. [9] analyze panel data and conclude that while health shocks significantly increase medical expenditures, they only temporarily smooth non-medical total expenditures, particularly reducing education spending. This clearly exerts a substantial inhibitory effect on consumption upgrading.

While the majority of empirical research indicates a negative impact of health shocks on non-medical consumption, some scholars present different findings, suggesting that health shocks can, in certain cases, promote consumption upgrading, particularly for women. Cai et al. [24] argue that when women experience health shocks, there is a notable increase in household consumption expenditures. Although the impact on basic consumption is not significant, the increase in development-related expenditures is substantial and exceeds the overall rise in household consumption, indicating that women's health shocks can positively influence household consumption upgrading.

Furthermore, in response to the adverse effects of health shocks on residents' consumption upgrading, some scholars have proposed corresponding risk mitigation and protection mechanisms. Wagstaff [8] suggests mitigating the risk of health shocks by selling productive assets within households, potentially leading to future consumption declines. Sun and Yao [25] explore the correlation between health shocks and children's education, and find that the occurrence of health shocks significantly decreases enrollment rates. Households mitigate health shocks by reducing education expenditures, thereby causing consumption downgrading. Alam and Mahal [26] arrive at a similar conclusion using relevant data from Tanzania. Islam and Maitra [14] analyze that selling livestock can mitigate health shocks to some extent, but this comes at the cost of significant long-term consequences. On the other hand, utilizing small family loans can significantly alleviate health shocks without incurring high costs.

This study innovates compared to previous research in the following aspects: Firstly, this study refines the Ramsey-Cass-Koopmans model and proposes a theoretical framework for the role of health insurance in the "health shock-consumption downgrade" nexus. Secondly, diverging from prior research which mainly focuses on the impact of health shocks on household consumption downgrade, this study delves deeper by empirically analyzing the effect of health insurance specifically within the context of the "health shock-consumption downgrade" relationship. Thirdly, it scrutinizes the pathways through which health insurance operates, sequentially examining the moderating effects of NRCMS, URBMI, and URRBMI.

The rest of the paper proceeds as follows. Sect."Theoretical model"presents the theoretical framework for the impact of social medical insurance on health shock and consumption downgrading. Sect."Data and empirical modal"describes the data and empirical strategy for identifying the impact of social medical insurance.

Sect."Results"contains my main estimates results, robustness test and interaction effect and heterogeneity analysis results. In Sect."Discussion", we conclude with a discussion of policy implications.

Theoretical model

The impact of health shocks on consumption upgrading primarily occurs through two distinct pathways. The first pathway involves a direct increase in medical expenditures resulting from health shocks. Research by Dobkin et al. [27] demonstrates that hospitalization shocks lead to a direct rise in out-of-pocket medical costs. The second pathway is indirect, arising from a reduction in disposable income and a diminished household labor supply [14, 28–30]. Both the increase in medical expenditures and the decline in household income have a direct negative effect on non-medical consumption expenditures. Furthermore, survival expenditures-particularly food-are typically characterized by income rigidity, as they are essential for basic living and do not exhibit significant variation in response to income fluctuations. In contrast, development-related and discretionary expenditures are more elastic to changes in income, and thus more likely to undergo substantial adjustments when income levels fluctuate [31, 32]. Consequently, health shocks can also lead directly to consumption downgrading. The combined effects of these two pathways are expected to produce a consumption downgrading index that excludes healthcare expenditures. Therefore, this paper focuses primarily on examining the impact of health shocks on consumption upgrading, excluding the influence of healthcare expenditures.

Most early studies on the impact of health shocks on consumption were based on the Consumption-based Capital Asset Pricing Model (CCAPM), which primarily elucidates the mechanisms through which health shocks affect household financial assets and consumption. Research by Berkowitz et al. [33] finds that health shocks reduce household asset income, and the decline in total household assets or income reduction leads to a decrease in consumption levels. Edwards [34] introduces health expenditure into the consumer utility function and finds that health shocks affect consumption by influencing marginal utility and risk aversion.

Based on existing theoretical analysis, this study investigates the impact of health shocks on consumption upgrading by referring to assumptions of the Ramsey-Cass-Koopmans model. From the perspective of individual consumer behavior decisions. The Ramsey-Cass-Koopmans model is a crucial tool for analyzing the dynamic relationship between consumption and capital accumulation in economic growth. In the model's long-term equilibrium, the economy evolves along a balanced growth path, where the growth rates of all variables remain constant. This path reflects the growth trend of the economy under optimal intertemporal consumption behavior. Specifically, the savings rate adjusts in response to changes in economic conditions, thereby influencing the dynamic trajectory of economic growth. Building on this framework, this paper treats the savings rate as an endogenous variable, determined by households' consumption and saving decisions, and examines how the occurrence of health shocks may affect household consumption, thereby altering the economic growth path. As a result, optimal intertemporal consumption behavior will also change. This forms the basis of the "health shock-consumption upgrading" theoretical model explored in this paper. Therefore, the objective function of individual utility can be represented as follows:

$$max\int_{t=0}^{\infty} e^{-\rho t}\frac{\left[C_t^{S\sigma_1}C_t^{F\sigma_2}M_t{}^{1-\sigma_1-\sigma_2}\right]^{1-\theta}}{1-\theta}dt \tag{1}$$

In this context, t represents a specific moment in an individual's lifetime. We assume that the individual allocates all of their income to various types of consumption over their lifetime. C_t^S denotes survival-type consumption expenditures, while C_t^F represents development and leisure-type expenditures (excluding healthcare expenditures). A key focus of this paper is to determine how health shocks influence the upgrading of household consumption. Therefore, based on the utility function with a constant relative risk aversion coefficient θ, we also introduce healthcare expenditures M_t. Here, θ represents the coefficient of relative risk aversion and can also be interpreted as the elasticity of marginal utility with respect to consumption (in absolute terms), which is the inverse of the substitution elasticity between consumption at any two points in time. $\sigma_1, \sigma_2, 1-\sigma_1-\sigma_2$ can be viewed as the respective shares of three types of consumption in wealth W. Finally, ρ represents the discount rate.

The individual's income budget constraint is as follows:

$$\int_{t=0}^{\infty} \mathrm{e}^{-\mathrm{rt}}C_t dt = \int_{t=0}^{\infty} \mathrm{e}^{-\mathrm{rt}}(C_t^S + C_t^F + M_t)dt \le W \tag{2}$$

In Eq. (2), W represents the sum of an individual's initial wealth at time t and the present value of their lifetime labor income, r denotes the interest rate. Construct the Lagrangian equation based on Eqs. (1) and (2).

$$L = \int_{t=0}^{\infty} e^{-\rho t}\frac{\left[C_t^{S\sigma_1}C_t^{F\sigma_2}M_t{}^{1-\sigma_1-\sigma_2}\right]^{1-\theta}}{1-\theta}dt + \lambda_2\left[\mathrm{W} - \int_{t=0}^{\infty} e^{-rt}(C_t^S + C_t^F + M_t)dt\right] \tag{3}$$

The first-order condition of the Lagrangian equation is:

$$e^{-\rho t}\left[C_t^{S\sigma_1}C_t^{F\sigma_2}M_t{}^{1-\sigma_1-\sigma_2}\right]^{-\theta}\sigma_1 C_t^{F\sigma_2-1}C_t^{S\sigma_1}M_t{}^{1-\sigma_1-\sigma_2} = \lambda_2 e^{-rt} \tag{4}$$

Taking the derivative with respect to time on both sides of Eq. (4), we obtain:

$$\frac{\dot{C_t^F}}{C_t^F} = \frac{r-\rho+(1-\theta)\sigma_1\frac{\dot{C_t^S}}{C_t^S}-(1-\theta)(1-\sigma_1-\sigma_2)\frac{\dot{M_t}}{M_t}}{[1-(1-\theta)\sigma_2]} \quad (5)$$

$\frac{\dot{C_t^F}}{C_t^F}$, the Euler equation, represents the growth rate of an individual's consumption, which we approximate as the degree of consumption upgrading. Since survival consumption expenditure entails the necessary expenses to sustain life, it can be assumed to remain constant in the short term. Based on this assumption, $\frac{\dot{C_t^S}}{C_t^S} = 0$ in this study. After rearranging the above equation, the formula for the impact of health shocks on consumption upgrading is as follows:

$$\frac{\dot{C_t^F}}{C_t^F} = \frac{r-\rho-(1-\theta)(1-\sigma_1-\sigma_2)}{[1-(1-\theta)\sigma_1]}\frac{\dot{M_t}}{M_t} \quad (6)$$

where $\frac{\dot{M_t}}{M_t}$ represents health shocks. From the above equation, it can be observed that the impact of health shocks on consumption upgrading depends on the magnitude of $r-\rho-(1-\theta)(1-\sigma_1-\sigma_2)$, and when the interest rate equals the discount rate, this coefficient is negative. Therefore, we believe that in most cases, the impact of health shocks on consumption upgrading is negative.

Data and empirical modal

Data source

This study primarily constructs panel data of Chinese provinces from 2002 to 2019, with data sourced from various statistical yearbooks and the China Economic Information Network (CEInet) statistical database. The main variables involved include per capita consumption expenditure and its subcomponents, resident hospitalization rate, average number of medical visits per capita, unemployment rate, urbanization rate, sex ratio, education level (percentage of population with college education or above), average household size, dependency ratio, marital status (percentage of population with spouse), social security level (ratio of per capita net transfer income to per capita disposable income), proportion of tertiary industry output, proportion of agricultural output, and fixed asset investment growth rate.

Variable choice

The dependent variable is consumption upgrading (CUP, in yuan). This study primarily analyzes four indicators: the proportion of survival consumption expenditure (CUP1), the proportion of development and discretionary expenditure (CUP2, excluding healthcare expenditure), the proportion of development and discretionary expenditure (CUP3, including healthcare expenditure), and healthcare expenditure (MED, logarithmically transformed in the empirical analysis). Specifically, we define development and discretionary expenditure (CUP3) as the total of spending on daily necessities, transportation and communication, education and entertainment, healthcare, and other goods and services. However, since healthcare expenditure is directly impacted by health shocks, CUP2 serves as the main proxy variable for consumption upgrading examined in this study, while CUP1 is used for robustness checks. The regression results for CUP3 and MED help assess the role of healthcare expenditure.

The main explanatory variables in this study include health shocks and health insurance, with health insurance serving as a moderator variable. Health shocks are quantified using the resident hospitalization rate (H_RATE, %) and the average number of medical visits per capita (NUM_EMP, times), with the selection of these indicators also serving as a robustness check. Health insurance is represented by the participation rate in basic medical insurance (MEDICAL, %), which includes employee medical insurance, the New Rural Cooperative Medical Scheme, the Urban Resident Basic Medical Insurance, and the Urban–Rural Resident Basic Medical Insurance.

Moreover, based on the findings of numerous scholars, factors such as marital status, unemployment rate, gender, education level, and household size have been shown to significantly influence consumption [16, 19, 21, 35, 36]. Therefore, drawing on the aforementioned literature, we control for these factors in our empirical model. Additionally, variables such as social security level, fixed asset investment, the proportion of tertiary industry output, and the proportion of agricultural output are included to control for the potential macro-level effects of social security, asset investment, and industrial output on consumption. Accordingly, the control variables in this study are specified as follows. The unemployment rate (Unemp, %), urbanization rate (Urban, %), sex ratio (Gender, female = 1), education level (Edu, %, percentage of the population with a college education or above), average household size (H_size), dependency ratio (Dpd_rate, %), marital status (Marry, %, percentage of the population with a spouse), social security level (Social security, %, ratio of per capita net transfer income to per capita disposable income), the proportion of tertiary industry output (Tertiary_gdp, %), the proportion of agricultural output (Agri_gdp, %), and the fixed asset investment growth rate (Fixed_asset, %).

Descriptive statistical results

Table 1 presents the descriptive statistics of the main variables, wherein all consumption and income data were

Table 1 Descriptive statistics of main variables

Variable	Variable definitions	Mean	Sd	Min	Max
CUP1	The proportion of survival consumption expenditure	60.30	4.410	49.14	75.96
CUP2	The proportion of development and discretionary expenditure (excluding healthcare expenditure)	32.37	3.550	20.85	44.38
CUP3	The proportion of development and discretionary expenditure (including healthcare expenditure)	40.01	4.510	24.04	51.97
lnMED	Healthcare expenditure (logarithmically transformed)	6.210	0.720	4.120	7.910
THC	Continuous variable, representing total household consumption	8085	5041	1758	30,642
C_food	Continuous variable, representing food consumption	2712	1337	840.4	7389
C_dress	Continuous variable, representing clothing consumption	659.9	345.0	109.4	2032
C_house	Continuous variable, representing housing consumption	1408	1493	153.8	11,104
C_daily	Continuous variable, representing daily consumption	488.8	312.6	78.19	1842
C_trco	Continuous variable, representing transportation consumption	1021	740.7	118.6	3721
C_eec	Continuous variable, representing education and entertainment consumption	939.0	622.6	104.7	3692
C_med	Continuous variable, representing healthcare consumption	632.9	433.8	61.36	2727
C_other	Continuous variable, representing other consumption	249.9	182.6	44.36	1204
H_rate	Continuous variable, representing hospitalization rate	10.09	5.830	1.680	24.10
Med_vst	Continuous variable, representing average number of medical visits	3.510	2.500	0.380	11.65
Medical	Continuous variable, representing basic health insurance coverage rate	63.06	37.13	0	109.9
Unemp	Continuous variable, representing unemployment rate	3.520	0.710	1.200	6.500
Gender	Binary variable, representing gender (female = 1)	104.2	3.870	92.25	123.2
Marry	Continuous variable, representing marital status	72.75	3.700	56.08	78.75
Edu	Continuous variable, representing education level	10.41	7.030	0.790	50.49
H_size	Continuous variable, representing household size	3.180	0.410	2.330	5.030
Dpd_rate	Continuous variable, representing total dependency ratio	37.44	6.860	19.27	57.58
Social security	Continuous variable, representing social security level	19.66	5.090	3.320	34.19
Urban	Continuous variable, representing urbanization rate	49.64	16.81	15.66	89.60
Tertiary_gdp	Continuous variable, representing share of tertiary sector output	44.13	9.390	29.42	83.50
Agri_gdp	Continuous variable, representing share of agricultural output	20.07	10.57	0.750	55.79
Fixed_asset	Continuous variable, representing fixed asset investment growth rate	18.56	13.51	− 62.65	65.93

adjusted for inflation using the Consumer Price Index (CPI).

Empirical model

Based on the theoretical analysis in the preceding sections, it can be inferred that basic medical insurance may play a certain moderating role in the impact of health shocks on residents'consumption upgrading. Existing studies mostly use fixed effects to analyze provincial panel data. However, considering that residents'consumption behavior is dynamically changing, fixed effects models are primarily used for analyzing static panel data and are not applicable. Therefore, this study primarily employs the System Generalized Method of Moments (GMM) model for the relevant analysis, and further explores the moderating effects of the basic medical insurance system based on this.

System Generalized Method of Moments (GMM) estimation

Resident consumption upgrading is subject to dynamic changes, influenced by past consumption habits, and is a long-term adjustment and supply–demand matching outcome, characterized by significant intertemporal features and path dependence. Given the characteristics of consumption upgrading mentioned above, this study primarily adopts the following form of dynamic panel model for system GMM estimation:

$$C_{y_{it}} = \sum_{j=1}^{N} \alpha_j C_{y_{it-j}} + \beta M_{it} + \gamma H_{it} + \delta Z_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (7)$$

$$(\mathrm{t} = 1, \ldots, 18;\ \mathrm{i} = 1, \ldots, 31)$$

In Eq. (7), y represents the dependent variable, i denotes the region, corresponding to the 31 provinces, municipalities, and autonomous regions of China, and t represents the year, covering the period from 2002 to 2019, with a total of 18 time periods. $C_{y_{it}}$ represents the consumption upgrading indicator, $C_{y_{it-j}}$ is the lagged term of consumption upgrading with j being the lag order; M_{it} represents the basic medical insurance system, indicated by the participation rate in basic medical insurance; H_{it} represents health shocks, with its regression

coefficient indicating the direct impact of health shocks on consumption upgrading. Z_{it} denotes the control variables, mainly including the unemployment rate, sex ratio, marital status, education level, average household size, dependency ratio, social security level, urbanization rate, proportion of tertiary industry output, proportion of agricultural output, and fixed asset investment growth rate. λ_t represents the time fixed effects of "period t" consumption upgrading, used to control for the impact of common shocks, such as economic crises, policy changes, etc., which may also have varying degrees of influence on consumption upgrading. u_i represents the regional fixed effects, which are included to control for time-invariant variables at the regional level, such as geographical location, resource endowments, cultural traditions, and institutional environment.

While investigating the impact of health shocks on consumption upgrading, this study is more concerned about the mechanism of the basic medical insurance system in this impact. Therefore, on this basis, this study further constructs a moderation effect model.

Interaction effect model

As only interaction terms are added to the regression model of the impact of health shocks on consumption upgrading, this study continues to employ the System Generalized Method of Moments (GMM) analysis to regress the following equation:

$$C_{y_{it}} = \sum_{j=1}^{N} \alpha_j C_{y_{it-j}} + \beta M_{it} + \gamma H_{it} + \theta M_{it} \times H_{it} + \delta Z_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (8)$$

In the above equation, if both β and θ are statistically significant, it indicates the presence of a moderation effect.

Results

Basic results

This study employs Stata 15.1 for GMM regression analysis, with the proportions of survival consumption expenditure, development and discretionary consumption expenditure (excluding healthcare expenditure), absolute value of development and discretionary consumption expenditure (including healthcare expenditure), and healthcare expenditure as the dependent variables, and hospitalization rate as the health shock variable. Specifically, the 1–2 lags of health shocks are set as GMM instrumental variables in the Stata command settings. Gender, education level, marital status, and household size are designated as exogenous variables. The final results are presented in Table 2.

Combining the test results shown in the Table 2, the AR(2) statistic is not significant, indicating that there is no second-order autocorrelation in the disturbance term differences. Therefore, the hypothesis of no autocorrelation in the disturbance term is accepted, and the model is considered valid. The Hansen test statistics are all not significant, supporting the hypothesis that "all instrumental variables are valid." Since the lag orders of instrumental variables in the regression model of this study are all less than 2, the resulting number of instrumental variables is not large, which to some extent limits the loss of degrees of freedom. The Hansen test statistics demonstrate good confidence in the test effect. The subsequent section only presents the test results in the table, without further explanation.

In Table 2, Models 1 to 4 examine the impact of hospitalization rate on the proportion of survival consumption expenditure, expenditure on development and hedonic consumption (excluding c_med), expenditure on development and hedonic consumption (including c_med), and healthcare expenditure. The results show that the health shock, as represented by the hospitalization rate, has a significant negative impact on consumption upgrading. In Model 1, the regression coefficient of the hospitalization rate on the proportion of survival consumption expenditure is significantly positive, while in Model 2, the regression coefficient on the proportion of development and discretionary consumption expenditure is significantly negative. This indicates that as the impact of hospitalization shock increases, residents tend to allocate more expenditure to survival consumption and less to development and discretionary consumption, thereby significantly experiencing consumption downgrading. Furthermore, Model 3 shows that the effect of hospitalization shock on the proportion of development and discretionary consumption expenditure, including healthcare expenditure, is not significant. Evidently, health shocks may increase residents'expenditure on healthcare and preventive care, leading to insignificant regression results. This is validated in the regression results of Model 4, where the regression coefficient of hospitalization shock on the absolute value of healthcare expenditure is significantly positive.

The regression results for other control variables in Model 2 indicate that marital status has a significantly negative effect on consumption upgrading, suggesting that individuals without spouses exhibit higher levels of consumption upgrading. This can be explained by the fact that households without spouses generally have lower total consumption expenditures and are less likely to have children, meaning they do not incur typical

Table 2 The impact of hospitalization shocks on residents'consumption upgrading

variable	Model 1 CUP1	Model 2 CUP2	Model 3 CUP3	Model 4 lnMED
L.y	0.3638***	0.3121***	0.2872***	− 0.0037
	(0.0452)	(0.0524)	(0.0371)	(0.0442)
H_rate	0.0752*	− 0.0682**	0.0011	0.0447***
	(0.0426)	(0.0339)	(0.0414)	(0.0042)
Gender	− 0.0773	0.0315	− 0.0075	0.0000
	(0.0617)	(0.0360)	(0.0454)	(0.0045)
Edu	0.0617	0.0008	− 0.0583	− 0.0096**
	(0.0659)	(0.0818)	(0.0642)	(0.0039)
Marry	− 0.1463*	− 0.1013**	0.1250**	0.0453***
	(0.0772)	(0.0466)	(0.0613)	(0.0093)
Unemp	0.4868	0.1258	− 1.0859*	− 0.2250***
	(0.6747)	(0.5259)	(0.5977)	(0.0505)
H_size	2.0663**	− 2.7166***	− 2.1679**	− 0.0243
	(0.7903)	(0.7257)	(0.8438)	(0.0901)
Dpd_ratio	− 0.0672	0.1215**	− 0.0199	− 0.0099**
	(0.0565)	(0.0508)	(0.0494)	(0.0041)
Urban	0.0131	0.0057	− 0.0070	0.0238***
	(0.0312)	(0.0164)	(0.0278)	(0.0024)
Social security	− 0.4486***	0.3092***	0.4407***	0.0008
	(0.0604)	(0.0359)	(0.0339)	(0.0028)
Tertiary_gdp	− 0.0658	− 0.0262	0.0093	0.0025
	(0.0452)	(0.0463)	(0.0413)	(0.0032)
Agri_gdp	− 0.0599	− 0.0618	0.0723	− 0.0007
	(0.0598)	(0.0400)	(0.0598)	(0.0046)
Fixed_asset	0.0952***	− 0.0335***	− 0.0813***	− 0.0045***
	(0.0142)	(0.0090)	(0.0176)	(0.0012)
_cons	60.2023***	27.3892**	23.6402***	2.6327**
	(12.6287)	(10.6222)	(5.4691)	(1.0398)
N	521	521	521	521
Arellano-Bond AR(1) Test	− 4.18***	− 3.46**	− 4.33***	− 4.01***
Arellano-Bond AR(2) Test	− 0.22	1.01	− 1.35	− 2.5
Hansen overidentification test	28.44	28.79	29.33	28.99

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

family-related expenses such as education or child-rearing costs. As a result, their income is more likely to meet higher-level consumption needs. Similar views are expressed by Horioka and Terada [35], who argue that in India, brides must pay a large dowry, whereas in countries such as South Korea (and China), the groom is required to bear marriage-related expenses, such as housing and car purchases, which can influence the consumption patterns of married households. Additionally, Golley and Tyers [36] support this perspective, suggesting that the competition among boys to marry scarce girls leads to excessive savings.

Robustness test

To validate the effectiveness of the regression results, this study employs residents'outpatient visits as a proxy for hospitalization shocks as the health shock variable and conducts robustness tests. The regression results are presented in Table 3.

The regression results in Table 3, using average resident visits as the health shock variable, are largely consistent with those using hospitalization shocks, indicating a certain robustness of the negative effect of health shocks on consumption upgrading.

Although the results in Table 3 differ from those in Model 3 of Table 2, both indicate that the impact of

Table 3 Robustness test of the impact of average resident visits on consumption upgrading

variable	Model 1 CUP1	Model 2 CUP2	Model 3 CUP3	Model 4 lnMED
L.y	0.5021***	0.5274***	0.5156***	0.3249***
	(0.0524)	(0.0461)	(0.0210)	(0.0253)
Med_vst	0.2633**	− 0.2271**	− 0.1294	0.0579***
	(0.1292)	(0.0849)	(0.1090)	(0.0056)
Gender	− 0.0639	− 0.0010	− 0.0571	− 0.0042
	(0.0577)	(0.0388)	(0.0433)	(0.0042)
Edu	0.0250	− 0.0421	− 0.1097*	− 0.0084**
	(0.0971)	(0.0493)	(0.0641)	(0.0041)
Marry	− 0.0709	− 0.1068**	0.0134	0.0246***
	(0.0861)	(0.0515)	(0.0534)	(0.0074)
Unemp	0.7228	− 0.4360**	− 0.8077***	− 0.1639***
	(0.4897)	(0.1583)	(0.1654)	(0.0436)
H_size	2.2391**	− 1.6778**	− 1.7286**	− 0.2195**
	(1.1185)	(0.7433)	(0.8637)	(0.0855)
Dpd_ratio	− 0.1238*	0.0286	− 0.0340	0.0152**
	(0.0640)	(0.0253)	(0.0306)	(0.0047)
Urban	0.0003	0.0467***	0.0410**	0.0162***
	(0.0253)	(0.0118)	(0.0178)	(0.0023)
Social security	− 0.3387***	0.0580**	0.1555***	0.0224***
	(0.0484)	(0.0199)	(0.0236)	(0.0033)
Tertiary_gdp	− 0.0238	− 0.0356	0.0030	0.0015
	(0.0571)	(0.0397)	(0.0486)	(0.0044)
Agri_gdp	− 0.0012	− 0.0441	0.0511	0.0125**
	(0.0473)	(0.0329)	(0.0425)	(0.0050)
Fixed_asset	0.0715**	− 0.0359***	− 0.0801***	− 0.0073***
	(0.0222)	(0.0094)	(0.0131)	(0.0012)
_cons	41.8287**	29.9820**	31.0337**	2.0544**
	(13.9993)	(11.3477)	(10.5333)	(1.0437)
N	521	521	521	521
Arellano-Bond AR(1) Test	− 4.44***	− 3.22**	− 4.86***	− 3.91***
Arellano-Bond AR(2) Test	0.18	0.86	− 1.19	1.62
Hansen overidentification test	29.37	30.32	29.97	29.04

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

health shocks on consumption is not significant. Therefore, it is not meaningful to explore whether the regression coefficients are positive or negative. Additionally, considering that CUP3 represents consumption upgrading, which includes healthcare expenditure, there is a strong endogeneity issue due to the mutual causality between it and the explanatory variables. Hence, the analysis in the following sections primarily focuses on CUP1, representing "the proportion of survival consumption expenditure", and CUP2, representing "consumption upgrading excluding healthcare expenditure". CUP3 and CUP4 are included in the table solely to illustrate the impact of health shocks on "healthcare expenditure" and "consumption upgrading including healthcare expenditure".

Furthermore, we consider the potential influence of unobserved variables on the impact of health shocks, which could affect the results of consumption upgrading. Therefore, we conduct a placebo test by systemically generating 500 random values for the core explanatory variable, H_rate, and re-estimating Models 1, 2, and 4 from Table 2. This process produces 500 estimated values, and the results are presented in Fig. 1. As shown in Fig. 1, the distribution is approximately normal with a mean centered around zero, indicating that the t-values fluctuate around zero. This further supports the conclusion that

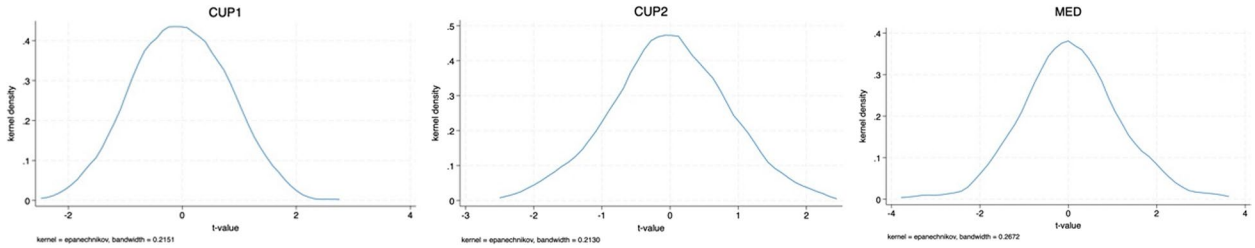

Fig. 1 Robustness Test of H_rate Randomization

hrate_random has no significant effect on CUP1, CUP2, and ln_MED, as confirmed by the robustness test.

Interaction effect analysis

Following the theoretical implications of moderation effects, this study constructs the interaction term between health shocks and the basic medical insurance participation rate. This interaction term is then incorporated into the GMM regression model using Stata commands similar to those used in the previous sections. However, in models containing the medical insurance variable, only the first and second-order lags of this variable are set as GMM instrumental variables.

The dependent variables are the proportions of survival-oriented consumption expenditure and development and leisure-oriented expenditure (excluding healthcare expenditure). Hospitalization rate and average resident visits are employed as health shock variables. In the regression models where survival-oriented consumption expenditure serves as the dependent variable and average resident visits as the explanatory variable, robustness tests of moderation effects are conducted. The results of these moderation effects regressions are presented in Table 4.

In Table 4, the variable "treat1" represents the interaction term between hospitalization shocks and health insurance. Model 5 and Model 6 both demonstrate that the coefficient of treat1, representing the interaction between hospitalization shocks and consumption upgrading, is significant. This suggests that the basic medical insurance system moderates the impact of health shocks on consumption upgrading, with a positive moderation effect. In Model 5, the significant negative coefficient of treat1 indicates that the basic medical insurance system significantly reduces the positive effect of hospitalization shocks on survival-oriented consumption expenditure, thus promoting consumption upgrading. In Model 6, the significant positive coefficient of treat1 suggests that the basic medical insurance system significantly mitigates the negative effect of hospitalization shocks on development and leisure-oriented expenditure, thereby fostering consumption upgrading.

Additionally, we have plotted the moderation effect graphs for Columns 2 and 4 of Table 4 (Figs. 2 and 3). In these, "medical" represents the coverage rate of basic medical insurance, "H_rate" represents the hospitalization rate, and "Fitted Values" indicates the marginal effect of hospitalization rate on survival consumption expenditure (CUP1). As shown in Fig. 2, "medical" effectively mitigates the enhancing effect of "H_rate" on "CUP1," demonstrating a significant moderation effect. Specifically, when "medical" is 0 (blue), "Fitted Values" increase as "H_rate" rises. When "medical" is 50 (red), "Fitted Values" begin to decline. When "medical" reaches 100 (green), the rate of decrease in "Fitted Values" accelerates, and the overall value is the lowest. This suggests that the "medical" variable moderates the relationship between "H_rate" and "Fitted Values," with higher "medical" values making the negative relationship (i.e., an increase in "H_rate" leading to a decrease in "CUP1") more pronounced. In other words, as the coverage of medical insurance expands, the consumption downgrading effect caused by the rise in hospitalization rate is suppressed, allowing consumption to upgrade.

In Fig. 3, it can be observed that, since "CUP2" and "CUP1" are inversely coded, the slope of the moderation effect curve is exactly the opposite of that in Fig. 2. "Medical" effectively strengthens the enhancing effect of "H_rate" on the dependent variable, and the moderation effect is significant.

Table 5 conducts robustness tests of the moderation effect by replacing health shocks with the average number of resident visits. In Table 5, the variable treat2 represents the interaction term between the average number of resident visits and the basic medical insurance participation rate. The significance of this term indicates a significant moderation effect of medical insurance. Moreover, based on the regression coefficients in the models, this moderation effect appears to be positive. This further validates the robustness of the regression results presented earlier, confirming the significant positive moderation effect of medical insurance on the impact of health shocks on resident consumption upgrading.

Table 4 Moderation effect test of the basic medical insurance system

Variable	Model 5		Model 6	
	CUP1	CUP1	CUP2	CUP2
L.y	0.3638***	0.2955***	0.3121***	0.2031**
	(0.0452)	(0.0680)	(0.0524)	(0.0701)
H_rate	0.0752*	0.0266	− 0.0682**	− 0.0175
	(0.0426)	(0.0550)	(0.0339)	(0.0607)
Medical		0.0348***		− 0.0391***
		(0.0047)		(0.0057)
Treat1		− 0.0021***		0.0021***
		(0.0004)		(0.0004)
Gender	− 0.0773	− 0.0084	0.0315	0.0040
	(0.0617)	(0.1015)	(0.0360)	(0.0647)
Edu	0.0617	0.2100**	0.0008	− 0.1587
	(0.0659)	(0.0781)	(0.0818)	(0.0967)
Marry	− 0.1463*	− 0.0387	− 0.1013**	− 0.1800**
	(0.0772)	(0.1098)	(0.0466)	(0.0552)
Unemp	0.4868	− 0.1140	0.1258	− 0.0051
	(0.6747)	(0.8674)	(0.5259)	(0.9191)
H_size	2.0663**	1.6371	− 2.7166***	− 2.3540**
	(0.7903)	(1.3001)	(0.7257)	(0.8482)
Dpd_ratio	− 0.0672	0.0214	0.1215**	− 0.0358
	(0.0565)	(0.0519)	(0.0508)	(0.0495)
Urban	0.0131	− 0.0389	0.0057	0.0552***
	(0.0312)	(0.0260)	(0.0164)	(0.0143)
Social security	− 0.4486***	− 0.3256***	0.3092***	0.2397***
	(0.0604)	(0.0821)	(0.0359)	(0.0589)
Tertiary_gdp	− 0.0658	− 0.0788	− 0.0262	− 0.0074
	(0.0452)	(0.0592)	(0.0463)	(0.0302)
Agri_gdp	− 0.0599	0.0369	− 0.0618	− 0.0867*
	(0.0598)	(0.0807)	(0.0400)	(0.0511)
Fixed_asset	0.0952***	0.0556***	− 0.0335***	0.0022
	(0.0142)	(0.0164)	(0.0090)	(0.0140)
_cons	60.2023***	47.4323**	27.3892**	44.5522**
	(12.6287)	(21.6084)	(10.6222)	(17.5139)
N	521	521	521	521
Arellano-Bond AR(1) Test	− 4.18***	− 4.28***	− 3.46***	− 3.17***
Arellano-Bond AR(2) Test	− 0.22	1.03	1.01	1.57
Hansen overidentification test	28.44	27.46	28.79	27.56

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

Heterogeneity analysis

As mentioned in the introduction, China's basic medical insurance system includes the NRCMS and URBMI, which respectively cover rural and urban residents. After 2016, these two schemes were integrated into the URRBMI. Therefore, in this section, we categorize basic medical insurance into three systems: NRCMS, URBMI, and the post- 2016 URRBMI. We then examine the moderating effects of each system on the impact of health shocks on consumption, which constitutes the heterogeneity analysis.

Moderating effects of the NRCMS

We investigate the moderating effect of the NRCMS on the impact of health shocks on consumption upgrading. The regression results are presented in Table 6.

In Table 6, the variable treat3 represents the interaction term between the NRCMS and hospitalization shocks.

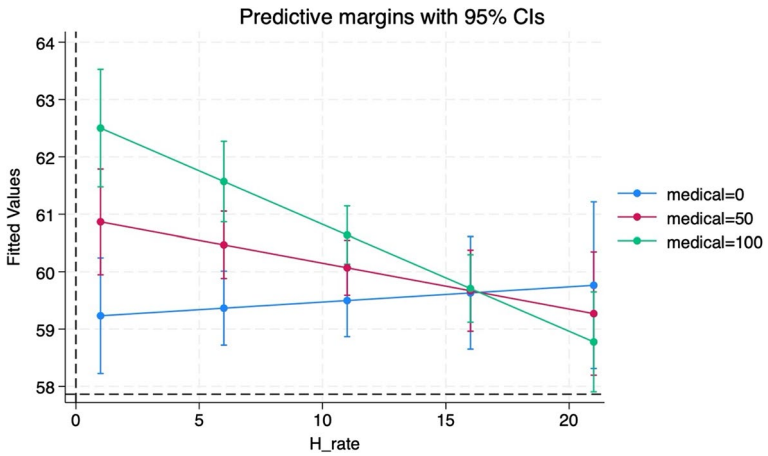

Fig. 2 The Interaction Effect of basic medical insurance between H_rate and CUP1 in model 5. Note:1. Figure 2 illustrates that the participation rate in basic medical insurance (medical) plays a moderating role in the influence of the hospitalization rate (H_rate) on the survival-oriented consumption expenditure (CUP1). 2. The horizontal axis in Fig. 2 represents the explanatory variable, the hospitalization rate (H_rate), while the vertical axis represents the predicted value of the explained variable, the survival-oriented consumption expenditure (CUP1). 3. The blue, red, and green broken lines in Fig. 2 represent the changes in survival-oriented consumption expenditure as the hospitalization rate increases when the participation rates in basic medical insurance are 0, 50%, and 100%, respectively. This is used to compare the differences in the impact of the hospitalization rate on survival-oriented consumption under different coverage rates of basic medical insurance

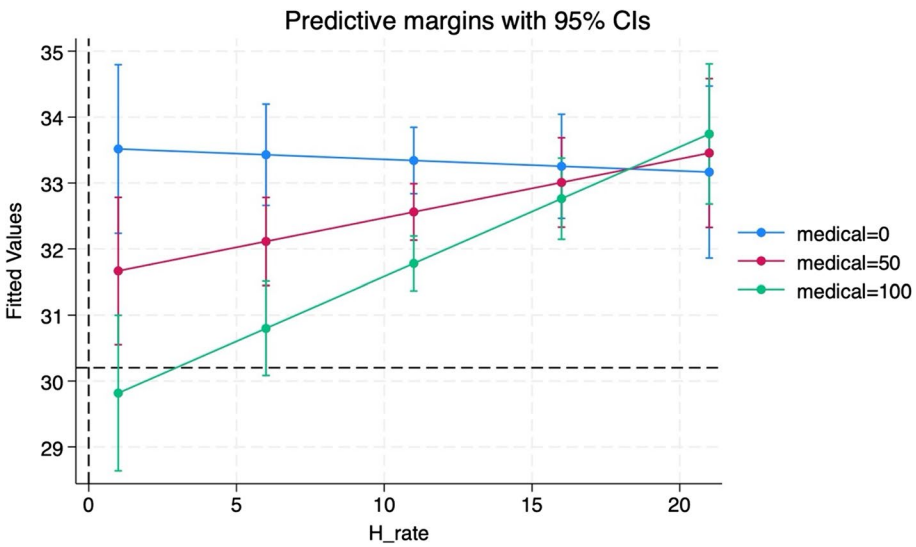

Fig. 3 The Interaction Effect of Medical between H_rate and CUP2 in model 6. Notes: 1. Figure 3 illustrates the moderating role of basic medical insurance coverage rate (medical) in the relationship between hospitalization rate (H_rate) and hedonic consumption expenditure (CUP2). 2. The x-axis represents the hospitalization rate (H_rate), while the y-axis displays the predicted values of hedonic consumption expenditure (CUP2). 3. The blue, red, and green lines in Fig. 3 correspond to basic medical insurance coverage rates of 0%, 50%, and 100%, respectively. These lines demonstrate how hedonic consumption expenditure changes as the hospitalization rate increases, allowing for a comparison of the differential impacts of hospitalization rates on hedonic consumption under varying levels of basic medical insurance coverage

The regression coefficient of this interaction term is statistically significant, highlighting the substantial moderating effect of the NRCMS. In Model 7, the coefficient of this interaction term is significantly negative, suggesting that the NRCMS significantly reduces the positive effect of health shocks on survival-oriented consumption expenditure, thereby promoting consumption upgrading. In Model 8, the coefficient of this interaction term is significantly positive, indicating that the NRCMS significantly mitigates the negative effect of health shocks on development and leisure-oriented expenditure, thereby facilitating consumption upgrading. Therefore,

Table 5 Robustness test: moderation effect of the basic medical insurance system

Variable	Model (5)		Model (6)	
	CUP1	CUP1	CUP2	CUP1
L.CUP1	0.4794***	0.2941***	0.5274***	0.2545***
	(0.0592)	(0.0697)	(0.0461)	(0.0627)
Med_vst	0.2387*	0.5421**	− 0.2271**	− 0.2322
	(0.1345)	(0.1711)	(0.0849)	(0.1601)
Medical		0.0125***		− 0.0192***
		(0.0035)		(0.0041)
Treat2		− 0.0035**		0.0029**
		(0.0011)		(0.0012)
Gender	0.0041	− 0.0336	− 0.0010	− 0.0377
	(0.0532)	(0.1197)	(0.0388)	(0.0698)
Edu	0.0982	0.1506	− 0.0421	− 0.1321**
	(0.0763)	(0.0938)	(0.0493)	(0.0641)
Marry	− 0.0654	− 0.1073	− 0.1068**	− 0.0916
	(0.0726)	(0.1029)	(0.0515)	(0.0698)
Unemp	0.5502**	0.2539	− 0.4360**	− 1.1715*
	(0.1969)	(0.8305)	(0.1583)	(0.7065)
H_size	1.6030	2.3572*	− 1.6778**	− 1.7073
	(1.0612)	(1.3309)	(0.7433)	(1.3404)
Dpd_ratio	0.0141	0.0229	0.0286	− 0.0040
	(0.0292)	(0.0580)	(0.0253)	(0.0344)
Urban	− 0.0403**	− 0.0573*	0.0467***	0.0669**
	(0.0192)	(0.0295)	(0.0118)	(0.0228)
Social security	− 0.1325***	− 0.1513***	0.0580**	0.0624*
	(0.0239)	(0.0288)	(0.0199)	(0.0358)
Tertiary_gdp	− 0.0250	− 0.0637	− 0.0356	− 0.0407
	(0.0576)	(0.0743)	(0.0397)	(0.0283)
Agri_gdp	− 0.0170	0.0186	− 0.0441	− 0.1041*
	(0.0530)	(0.0898)	(0.0329)	(0.0609)
Fixed_asset	0.0924***	0.1064***	− 0.0359***	− 0.0193*
	(0.0202)	(0.0245)	(0.0094)	(0.0112)
_cons	30.3713**	47.3554**	29.9820**	46.9057**
	(12.1372)	(20.3080)	(11.3477)	(15.8400)
N	521	521	521	521
Arellano-Bond AR(1) Test	− 4.43***	− 4.22***	− 3.22***	− 3.08***
Arellano-Bond AR(2) Test	− 0.48	− 1.28	0.86	0.95
Hansen overidentification test	29.45	28.09	30.32	28.187

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

the NRCMS exhibits a positive moderating effect in the regression analysis of health shocks on resident consumption upgrading.

In addition, we have also drawn the moderation effect diagrams for columns 2 and 4 in Table 7 (Figs. 4 and 5). To more intuitively display the results of the moderation effect, for the moderating variable, only two values, 2 and 100, are taken here to represent low-level participation in the insurance and high-level participation in the insurance respectively.

As can be seen from Fig. 4, the New Rural Cooperative Medical Scheme (NRCMS) effectively inhibits the enhancing effect of the hospitalization rate (H_rate) on the survival-oriented consumption expenditure (CUP1), and plays a significant moderating effect. The results show that with the increase in the coverage rate of the New Rural Cooperative Medical Scheme, the increase

Table 6 Moderating effects of the NRCMS on the impact of health shocks on resident consumption upgrading

Variable	Model 7		Model 8	
	CUP1	CUP1	CUP2	CUP2
L.y	0.3638***	0.1008	0.3121***	− 0.0430
	(0.0452)	(0.0674)	(0.0524)	(0.0616)
H_rate	0.0752*	0.8948***	− 0.0682**	− 1.3411***
	(0.0426)	(0.2211)	(0.0339)	(0.2487)
NRCMS		0.2439***		− 0.3657***
		(0.0487)		(0.0632)
Treat3		− 0.0169***		0.0247***
		(0.0034)		(0.0043)
Gender	− 0.0773	− 0.0627	0.0315	0.1360
	(0.0617)	(0.1194)	(0.0360)	(0.1376)
Edu	0.0617	0.0122	0.0008	− 0.0668
	(0.0659)	(0.0701)	(0.0818)	(0.0583)
Marry	− 0.1463*	− 0.2891**	− 0.1013**	0.0679
	(0.0772)	(0.1246)	(0.0466)	(0.1327)
Unemp	0.4868	− 0.6486	0.1258	0.3725
	(0.6747)	(0.5206)	(0.5259)	(0.5864)
H_size	2.0663**	− 3.8589**	− 2.7166***	2.2585
	(0.7903)	(1.2246)	(0.7257)	(1.4529)
Dpd_ratio	− 0.0672	0.3694***	0.1215**	− 0.1542*
	(0.0565)	(0.0747)	(0.0508)	(0.0865)
Urban	0.0131	− 0.0208	0.0057	0.0241
	(0.0312)	(0.0474)	(0.0164)	(0.0755)
Social security	− 0.4486***	− 0.3345***	0.3092***	0.3507***
	(0.0604)	(0.0827)	(0.0359)	(0.0626)
Tertiary_gdp	− 0.0658	0.0095	− 0.0262	− 0.0489
	(0.0452)	(0.0564)	(0.0463)	(0.0332)
Agri_gdp	− 0.0599	− 0.0924	− 0.0618	− 0.0789
	(0.0598)	(0.0866)	(0.0400)	(0.0810)
Fixed_asset	0.0952***	0.0654***	− 0.0335***	0.0079
	(0.0142)	(0.0196)	(0.0090)	(0.0130)
_cons	60.2023***	77.7449***	27.3892**	27.6318
	(12.6287)	(18.7882)	(10.6222)	(26.1355)
N	521	273	521	273
Arellano-Bond AR(1) Test	− 4.18***	− 3.33**	− 3.46***	− 2.25***
Arellano-Bond AR(2) Test	− 0.22	0.81	1.01	1.23
Hansen overidentification test	28.44	27.02	28.79	24.56

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

in survival-oriented consumption caused by the rise in the hospitalization rate is suppressed, and ultimately the overall consumption level is upgraded.

The slope of the curve in the moderation effect diagram of Fig. 5 is exactly the opposite of that in Fig. 4. Medical insurance significantly and inversely moderates the negative effect of the hospitalization rate (H_rate) on the hedonic consumption expenditure (CUP2). This result also indicates that with the increase in the coverage rate of the New Rural Cooperative Medical Scheme, the downgrade of hedonic consumption caused by hospitalization will decrease, ultimately promoting the upgrading of the overall consumption level.

To conduct a robustness test, we replace hospitalization shocks with the average number of resident visits. In this analysis, treat4 represents the interaction term between the New Rural Cooperative Medical Scheme

Table 7 Robustness test: moderating effect of the NRCMS

Variable	Model (7)		Model (8)	
	CUP1	CUP1	CUP2	CUP1
L.y	0.4794***	0.0957	0.5274***	0.1288**
	(0.0592)	(0.0906)	(0.0461)	(0.0636)
Med_vst	0.2387*	1.2224***	− 0.2271**	− 1.4320**
	(0.1345)	(0.2522)	(0.0849)	(0.4830)
NRCMS		0.0634***		− 0.0966***
		(0.0102)		(0.0284)
Treat4		− 0.0158***		0.0230**
		(0.0023)		(0.0071)
Gender	0.0041	0.1129	− 0.0010	0.0821
	(0.0532)	(0.1563)	(0.0388)	(0.0795)
Edu	0.0982	0.0196	− 0.0421	− 0.0056
	(0.0763)	(0.0806)	(0.0493)	(0.0734)
Marry	− 0.0654	0.1199	− 0.1068**	− 0.1104
	(0.0726)	(0.1444)	(0.0515)	(0.0933)
Unemp	0.5502**	1.1133**	− 0.4360**	− 0.4932
	(0.1969)	(0.5058)	(0.1583)	(0.4941)
H_size	1.6030	1.9210	− 1.6778**	− 2.5451*
	(1.0612)	(1.7262)	(0.7433)	(1.5163)
Dpd_ratio	0.0141	0.1152*	0.0286	0.0123
	(0.0292)	(0.0602)	(0.0253)	(0.0492)
Urban	− 0.0403**	− 0.1437**	0.0467***	0.1429***
	(0.0192)	(0.0461)	(0.0118)	(0.0401)
Social security	− 0.1325***	− 0.1146**	0.0580**	− 0.0691
	(0.0239)	(0.0550)	(0.0199)	(0.0606)
Tertiary_gdp	− 0.0250	− 0.0079	− 0.0356	− 0.0239
	(0.0576)	(0.0654)	(0.0397)	(0.0372)
Agri_gdp	− 0.0170	− 0.1109	− 0.0441	− 0.1159
	(0.0530)	(0.1209)	(0.0329)	(0.0872)
Fixed_asset	0.0924***	0.0887***	− 0.0359***	0.0038
	(0.0202)	(0.0243)	(0.0094)	(0.0101)
_cons	30.3713**	25.3194	29.9820**	40.8812**
	(12.1372)	(24.1328)	(11.3477)	(16.6257)
N	521	273	521	273
Arellano-Bond AR(1) Test	− 4.43***	− 3.68***	− 3.22***	− 2.55***
Arellano-Bond AR(2) Test	− 0.48	− 0.66	0.86	1.28
Hansen overidentification test	28.44	26.78	30.32	28.02

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

and the average number of resident visits. The results, presented in Table 7, remain consistent, supporting the robustness of the findings.

In addition, we also randomly assigned values to the H_rate (hospitalization rate) 500 times and then reran Model 7 and Model 8 in Table 7. The results are shown in Fig. 6. The results indicate that the randomized H_rate does not significantly affect the dependent variable, which proves that the significance of the basic regression results in Table 7 is not obtained by chance.

Moderating effects of the URBMI

Considering the URBMI system as a moderating variable, we explore its impact on the relationship between health shocks and consumption upgrading. The regression results are presented in Table 8.

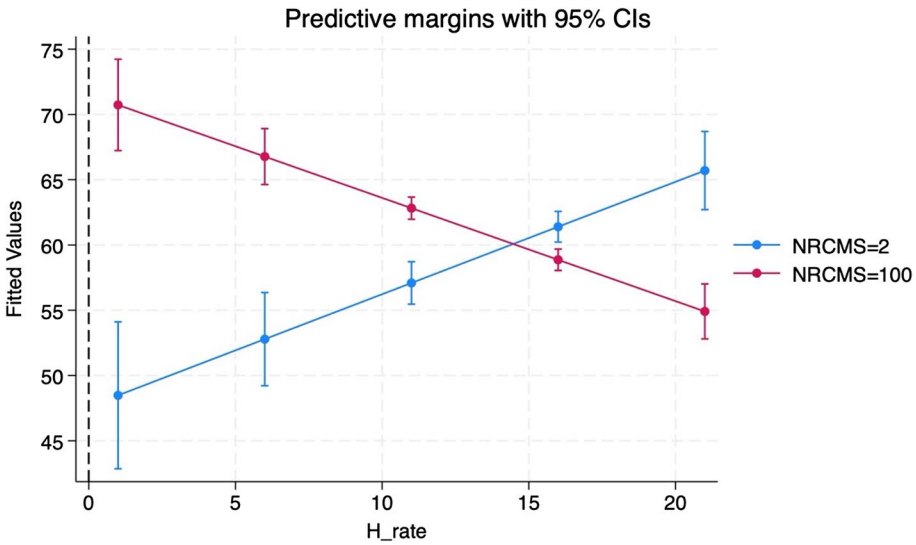

Fig. 4 The Interaction Effect of NRCMS between H_rate and CUP1 in model 7. Note: 1. Figure 4 illustrates the moderating effect of the New Rural Cooperative Medical Scheme (NRCMS) enrollment rate on the relationship between inpatient admission rate (H_rate) and survival-related consumption expenditure (CUP1)。 2. The x-axis in Fig. 4 represents the inpatient admission rate (H_rate), while the y-axis shows the predicted values of survival-related consumption expenditure (CUP1). 3. The blue line in Fig. 4 represents the variation in survival-related consumption expenditure as the inpatient admission rate increases, for NRCMS enrollment rates of 2% and 100%, highlighting the moderating role of NRCMS enrollment rate in this relationship

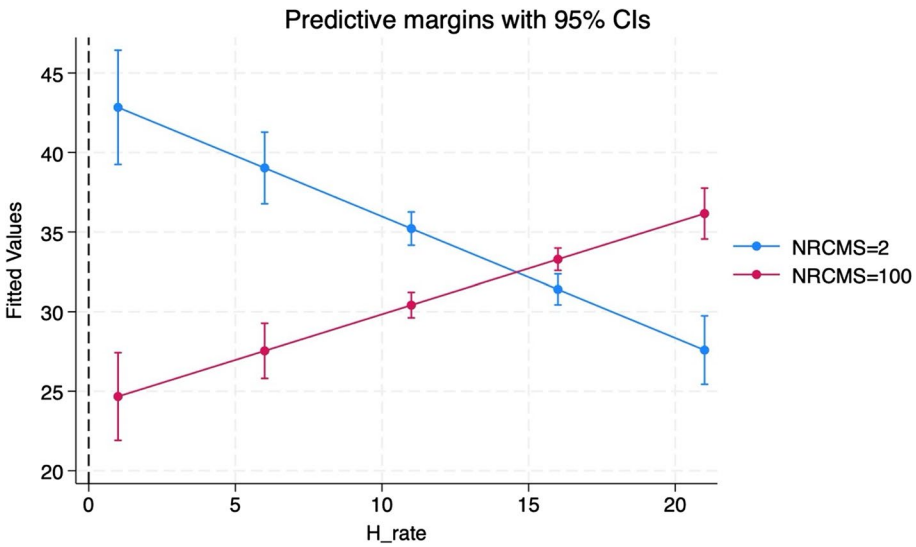

Fig. 5 The Interaction Effect of NRCMS between H_rate and CUP2 in model 8. Note: 1. Figure 5 illustrates the moderating effect of the New Rural Cooperative Medical Scheme (NRCMS) enrollment rate on the relationship between inpatient admission rate (H_rate) and hedonic consumption expenditure (CUP2). 2. The x-axis in Fig. 5 represents the inpatient admission rate (H_rate), while the y-axis shows the predicted values of hedonic consumption expenditure (CUP2). 3. The blue line in Fig. 5 represents the variation in hedonic consumption expenditure as the inpatient admission rate increases, for NRCMS enrollment rates of 2% and 100%, highlighting the moderating role of NRCMS enrollment rate in this relationship

In this context, treat5 represents the interaction term between the urban residents'health insurance scheme and hospitalization shocks. The regression results in Table 8 indicate that the URBMI does not exhibit a significant moderating effect on resident consumption upgrading. Subsequently, we proceed to further analyze the consumption upgrading effect of the integrated urban and rural resident medical insurance system.

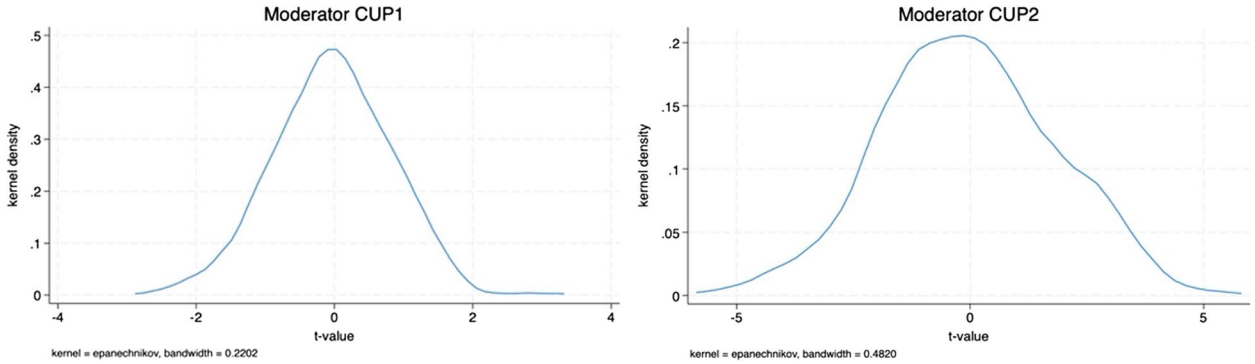

Fig. 6 Robustness Test of the Moderating Effects under H_rate Randomization

Moderating effects of the URRBMI

In this section, we utilize panel data from provincial levels covering the period from 2017 to 2019 to roughly estimate the impact of the integrated URRBMI on resident consumption upgrading. The regression results are presented in Table 9.

In Table 9, treat6 represents the interaction term between the Urban and Rural Residents'Basic Medical Insurance and hospitalization shocks. The regression results presented in Table 9 indicate that the URRBMI does not have a statistically significant moderating effect on the upgrading of resident consumption. The the moderation of the URRBMI is significant, and the overall regression findings are not conclusive. This may be attributed to the relatively short duration and the limited data available from the provincial panel dataset.

Furthermore, the impact of the 2016 integration of the URRBMI system on consumption is primarily observed among rural residents. The integration combined the previously separate systems: the NRCMS for rural residents and the URBMI for urban residents. This merger standardized contribution and benefit levels across the two groups. For rural residents, the reform likely led to increased contribution and benefit standards, which in turn may have influenced their consumption patterns. In contrast, the impact on urban residents appears to be minimal, which helps explain why the overall effect of the URRBMI integration is not statistically significant.

Discussion

Health shocks exacerbate the risk of medical expenditure and lead to changes in household consumption patterns. Meanwhile, healthcare insurance schemes help to diversify medical expenditure risks, alleviate health shocks, reduce precautionary savings among households, and increase disposable income, thus smoothing household consumption and promoting consumption upgrading. To verify this mechanism, this paper constructs a theoretical model of "health shocks-consumption upgrading". Building upon this framework, we conduct empirical analysis using a system GMM model based on provincial panel data from 2002 to 2019 in China.

From the basic regression results, it is evident that health shocks significantly reduce the extent of consumption upgrading among residents, including increasing survival-oriented expenditure and decreasing development and leisure-oriented expenditure. This aligns with the viewpoints of many scholars, as health shocks lead to deteriorating health conditions and increased medical burdens, necessitating higher expenditure on food and housing to maintain health [8, 13, 26]. Additionally, the increase in medical expenses also decreases residents'expenditures in other areas such as entertainment, transportation, and education, ultimately leading to consumption downgrading [5, 21, 22, 37].

Household size has a significantly negative impact on consumption upgrading, with larger households being associated with lower levels of consumption upgrading. This can be attributed to the fact that as household size increases, consumption expenditures also rise. With a constant income level, meeting the consumption needs of each family member may require a trade-off with consumption downgrading. As noted in the studies by Curtis et al. [38] and Yang and Chen [39], larger households are likely to allocate a larger share of their expenditures to basic survival-oriented needs, such as food, clothing, and housing.

The total dependency ratio has a significant positive effect on consumption upgrading. Clearly, households with a higher proportion of dependents, such as the elderly and children, tend to incur more expenses on education and cultural entertainment, thereby promoting consumption upgrading. This finding aligns with the conclusions of Curtis et al. [38]. Ge et al. [40] also note

Table 8 Moderating effects of the urbmi on the impact of health shocks on resident consumption upgrading

Variable	Model 9		Model 10	
	CUP1	CUP1	CUP2	CUP1
L.CUP1	0.3638***	0.1442*	0.3121***	0.0215
	(0.0452)	(0.0797)	(0.0524)	(0.0856)
H_rate	0.0752*	0.0532	− 0.0682**	− 0.0141
	(0.0426)	(0.0766)	(0.0339)	(0.0955)
UEBMI		− 0.0239		− 0.0694
		(0.0396)		(0.0538)
Treat5		− 0.0022		0.0056
		(0.0027)		(0.0042)
Gender	− 0.0773	− 0.0116	0.0315	0.1066
	(0.0617)	(0.0798)	(0.0360)	(0.0666)
Edu	0.0617	0.0557	0.0008	− 0.0460
	(0.0659)	(0.1565)	(0.0818)	(0.1154)
Marry	− 0.1463*	− 0.2442**	− 0.1013**	− 0.1117
	(0.0772)	(0.1243)	(0.0466)	(0.1130)
Unemp	0.4868	0.4879	0.1258	− 0.5231
	(0.6747)	(0.9984)	(0.5259)	(0.7100)
H_size	2.0663**	− 0.1586	− 2.7166***	− 6.4706**
	(0.7903)	(2.2242)	(0.7257)	(2.4087)
Dpd_ratio	− 0.0672	0.0983	0.1215**	0.2562**
	(0.0565)	(0.1403)	(0.0508)	(0.1130)
Urban	0.0131	− 0.0578	0.0057	0.0645
	(0.0312)	(0.0633)	(0.0164)	(0.0507)
Social security	− 0.4486***	− 0.4530***	0.3092***	0.4322***
	(0.0604)	(0.0634)	(0.0359)	(0.0647)
Tertiary_gdp	− 0.0658	− 0.0739	− 0.0262	− 0.0116
	(0.0452)	(0.0709)	(0.0463)	(0.0408)
Agri_gdp	− 0.0599	− 0.1673**	− 0.0618	− 0.0033
	(0.0598)	(0.0694)	(0.0400)	(0.0435)
Fixed_asset	0.0952***	0.0805***	− 0.0335***	0.0140
	(0.0142)	(0.0231)	(0.0090)	(0.0119)
_cons	60.2023***	82.7749***	27.3892**	30.3903**
	(12.6287)	(16.2190)	(10.6222)	(15.0284)
N	521	306	521	306
Arellano-Bond AR(1) Test	− 4.18***	− 3.60**	− 3.46***	− 2.97***
Arellano-Bond AR(2) Test	− 0.22	1.26	1.01	1.13
Hansen overidentification test	28.44	29.12	28.79	26.71

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

Table 9 Moderating effects of the urrbmi on the impact of health shocks on resident consumption upgrading

Variable	Model 11		Model 12	
	CUP1	CUP1	CUP2	CUP1
L.CUP1	0.9872	0.5776**	− 0.2610	0.0414
	(4.1826)	(0.2546)	(2.7284)	(0.2272)
H_rate	− 0.5132	1.1640	− 0.4704	0.0000
	(6.4688)	(1.2250)	(3.0481)	(.)
URRBMI		0.2089		0.0201
		(0.3089)		(0.0784)
Treat6		− 0.0139		− 0.0010
		(0.0193)		(0.0043)
Gender	0.8142	0.1220	0.5167	0.1219
	(6.5247)	(0.1371)	(2.7730)	(0.1918)
Edu	0.0962	− 0.1041	− 0.4752	0.1912
	(1.9806)	(0.4192)	(2.3504)	(0.3564)
Marry	− 0.2614	− 0.1631	0.6938	0.3494
	(1.6946)	(0.2007)	(1.3341)	(0.6250)
Unemp	− 14.6267	0.0000	− 10.1800	0.0000
	(151.2354)	(.)	(69.8111)	(.)
H_size	− 1.0495	0.0000	− 0.1659	0.0000
	(43.1850)	(.)	(19.8605)	(.)
Dpd_ratio	0.5127	0.1217	− 0.3872	0.0411
	(2.7412)	(0.2796)	(0.8627)	(0.2946)
Urban	0.4587	0.0300	− 0.1117	− 0.1717
	(2.9199)	(0.1352)	(2.4966)	(0.4768)
Social security	1.5897	0.0000	1.4914	− 0.0274
	(15.9932)	(.)	(8.5958)	(0.5830)
Tertiary_gdp	− 1.5226	0.0481	− 0.3452	− 0.0254
	(13.0963)	(0.3117)	(5.1275)	(0.3015)
Agri_gdp	− 0.3547	− 0.1083	− 0.2016	0.0662
	(3.6342)	(0.1186)	(1.2043)	(0.1495)
Fixed_asset	− 0.9444	− 0.1347	− 0.2585	0.0636
	(6.8571)	(0.1480)	(2.9897)	(0.2544)
_cons	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
N	62	62	62	62
Arellano-Bond AR(1) Test	− 4.18***	− 3.60**	− 3.46***	− 2.97***
Arellano-Bond AR(2) Test	− 0.22	1.26	1.01	1.13
Hansen overidentification test	28.44	29.12	28.79	26.71

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

that households with fewer children tend to have higher savings.

The level of social security has a significant positive impact on consumption upgrading, indicating that higher levels of social security correspond to greater consumption upgrading among residents. This finding is consistent with the research by Börsch [41] and Coote [42], which confirm that the redistributive effect of social security contributes to increasing the consumption levels and consumption willingness of low-income populations.

Furthermore, past research has found that medical insurance helps to mitigate health risks associated with chronic diseases in rural elderly households, reducing

the likelihood of poverty caused by illness [43]. Building upon this, our study innovatively constructs a model of the moderating effect of basic medical insurance system, analyzing its role in the "health shocks-consumption upgrading" relationship. According to the regression results, the basic medical insurance system significantly reduces the negative impact of health shocks on consumption upgrading, indicating that it plays a positive moderating role in the effect of health shocks on consumption upgrading.

Moreover, utilizing a moderation effect model, this study further examines heterogeneity, with particular emphasis on the moderating roles played by different types of basic medical insurance systems within the "health shocks-consumption upgrading" framework. Existing literature provides support for the mitigating impact of the New Rural Cooperative Medical Scheme (NRCMS) on health shocks. For instance, research by Chen and Jin [44] indicates that the NRCMS significantly reduces mortality rates among pregnant women and children, highlighting its role in alleviating health shocks for these vulnerable groups. In addition, studies by Liang and Lu [45] suggest that the NRCMS contributes positively to both the overall and mental health of rural elderly populations, further reinforcing its capacity to mitigate health shocks.

The results of our analysis demonstrate that the NRCMS exerts a positive moderating effect on the relationship between health shocks and consumption upgrading. This effect is likely attributable to the longer establishment period of the NRCMS, which was launched in 2003, and its extensive coverage, encompassing approximately 700–800 million rural residents. Consequently, the NRCMS plays a significant role in moderating the impact of health shocks on consumption upgrading. In contrast, the URBMI and the URRBMI, established more recently in 2007 and 2016, respectively, have shorter operational histories and cover a smaller population of 200–300 million people. As such, these insurance schemes do not exhibit significant moderating effects on consumption upgrading in our analysis.

These findings are consistent with prior research, such as Liu and Zhao [46], which suggests that while urban health insurance schemes significantly enhance the efficiency of medical service utilization during hospitalization shocks, they do not substantially reduce out-of-pocket medical expenditures for residents.

This study has certain limitations. On one hand, the theoretical model is based on individual consumption behavior, whereas the empirical analysis uses provincial-level data. Given this discrepancy, it is necessary to clarify the reasoning behind the choice of provincial data. We argue that theoretical models are simplifications and abstractions of the real world, designed to facilitate the understanding and explanation of phenomena. This abstraction allows the model to be applicable not only at the individual level but also at higher levels of aggregation, such as provincial data. Therefore, applying provincial-level data remains valid, and the conclusions drawn are still relevant.

On the other hand, many social and economic phenomena manifest at both the individual and aggregated levels. For instance, individual consumption behavior can be influenced by macroeconomic factors such as the provincial economic environment and policy context. Conducting analysis at the provincial level thus provides insights into how these macro factors collectively impact individual behavior. However, we acknowledge that using provincial-level data may introduce potential endogeneity issues, such as aggregation bias, ecological fallacy, and interpretation challenges. To address these concerns, we plan to use micro-level data, such as the China Family Panel Studies (CFPS) and the China Household Finance Survey (CHFS), in future research to conduct further robustness checks and mitigate these biases.

Another limitation arises from the fact that the NRCMS is primarily designed for rural residents, while the URBMI targets urban residents. Since macro-level data does not distinguish individual characteristics or macroeconomic factors between urban and rural areas, analyzing national-level data may not accurately reflect the policy impacts of NRCMS and URBMI. Therefore, the use of macro-level panel data to examine the effects of different health insurance systems may have inherent limitations, which could result in empirical findings that diverge from expectations. In future studies, we plan to use micro-level survey data to explore the evolving effects of the NRCMS, URBMI, and the integration of urban–rural health insurance policies on consumption upgrading across urban and rural residents, and to investigate how these effects evolve over time.

Conclusions

This study asserts that health shocks have a significant negative impact on residents'consumption upgrading, with basic medical insurance systems playing a critical positive moderating role in this relationship. Specifically, the NRCMS demonstrates a strong positive moderating effect on consumption upgrading among Chinese residents.

On August 29, 2024, the National Healthcare Security Administration (NHSA) of China, along with other relevant departments, issued the "Notice on the Implementation of the Basic Medical Insurance for Urban and Rural Residents in 2024", which clarifies the financial subsidies and individual contribution standards for the year. The

notice also highlights the need to strengthen enrollment in residents'local areas, improve incentive structures, and refine financing policies.

Based on recent policy developments, this study offers several recommendations for improving the resident basic medical insurance enrollment mechanism. First, urban and rural health insurance should cover all non-employed residents, while employee health insurance should extend to all employed individuals. Household registration restrictions should be relaxed to allow non-local residents to enroll in local insurance schemes. Second, policies should ensure the enrollment of migrant workers and those in emerging industries, with targeted support and subsidies for financially vulnerable groups. Third, the transfer and continuity of insurance coverage should be streamlined, including facilitating transitions between employee and urban–rural insurance, reducing waiting periods, and addressing duplicate enrollments. A dynamic contribution adjustment mechanism should be implemented, linking contributions to residents' income and economic conditions. Lastly, cross-regional medical payment settlement services should be enhanced to improve healthcare access and efficiency across regions.

These recommendations aim to further enhance the inclusivity and effectiveness of China's basic medical insurance systems, promoting broader access to healthcare and greater equity in the distribution of medical benefits.

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Authors' contributions
Wang and Hu had full access to all of the data in this study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Wang, and Hu led the conception and design of the study. Hu and Zhu did the statistical analysis and interpreted the data. Hu drafted the manuscript, Wang critically revised the manuscript. All authors read and approved the final manuscript.

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Data availability
The data used in this study were obtained from the China National Bureau of Statistics and are publicly available. If necessary, the authors are more than willing to provide the original data.

Declarations

Ethics approval and consent to participate
Our data we used in this paper comes from National Bureau of Statistics, which is not required ethical approval.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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