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Research Article

Effects of Drug Price Changes on Patient Expenditure: Evidence from China's Zero Markup Drug Policy

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Global society is dedicated to lowering healthcare costs. In China, the rapid growth in drug expenditure has been a major factor in the surge in patient expenditure. To alleviate the negative effect of this phenomenon, China launched the zero markup drug policy (ZMDP) in 2009. However, there is limited direct evidence of its effectiveness in reducing patient costs. Using claims data from January 2012 through May 2016 for enrollees in China's New Rural Cooperative Medical Scheme (NRCMS) in 25 counties, we investigated the changes in patient expenditure before and after the ZMDP's implementation. We found that the ZMDP significantly reduced outpatients' total expenditure (23.66%), reimbursable expenses (24.42%), out-of-pocket (OOP) costs (54.62%), and the OOP costs ratio (14%). Compared with outpatients, the ZMDP's implementation significantly reduced inpatients' total expenditure (5.82%) and reimbursable expenses (8.61%) but showed no significant relationship between OOP costs and the OOP costs ratio. Thus, it is important to distinguish outpatients from inpatients, as the ZMDP only significantly reduces outpatients' OOP costs. We believe that the difference between outpatients and inpatients in the share of drug expenditure (in the total expenditure) when visiting doctors and the shift from drug expenditure to other expenditure categories can explain the ineffectiveness of the policy for inpatients. Therefore, future reforms should focus on reducing inpatient costs.

1. Introduction

During China's planned economic period, the government provided medicines at well below market cost and heavily subsidized public medical institutions [1, 2]. In 1954, to alleviate the heavy financial burden of government subsidies for public medical institutions, the government allowed them to add a 15% markup to the cost of drug purchases based on the drug prices charged to consumers [3, 4]. This policy rapidly improved the financial situation of public medical institutions. However, it also stimulated drug abuse and led to overprescription in public medical institutions, leading consumers to incur high medical costs [5].

To alleviate the negative effects of this phenomenon, the Chinese government implemented a nationwide reform of county-level public hospitals in 2012 [6]. The central component of the reform was the zero markup drug policy (ZMDP), which removed the previously allowed 15% profit margin for drug sales and required public medical institutions to sell drugs with zero markup [7, 8]. To compensate for the potential drug revenue loss, the government allowed hospitals to raise the prices of medical services [9]. To protect the development of traditional Chinese medicine, the government implemented the ZMDP only for Western medicines, exempting herbal or Chinese-patented drugs [10].

Many scholars have investigated the effect of the ZMDP on healthcare and drug expenditure at the hospital level [11]. While the ZMDP has reduced drug expenditure and increased medical service costs, it has had no significant effect on total healthcare expenditure [12]. Prior research has also examined the effect of the ZMDP by analyzing the changes in overall hospital or physician revenue and has found limited evidence of direct measures of changes in patient expenditure before and after the ZMDP's implementation [13]. Meanwhile, owing to the differences in patient characteristics, the results of changes in overall hospital or physician revenue do not provide an objective picture of the ZMDP's effect on patient expenditure [14]. Moreover, few studies have explored the effect of the ZMDP using city-level patient expenditure data [15, 16]; however, city-level data have strong limitations. On the one hand, city-level hospitals have not achieved general planning goals, and each hospital has a different reimbursement policy, which results in endogeneity problems caused by patient self-selection. On the other hand, more than 60% of China's population lives in rural areas, and rural inhabitants mainly seek medical treatment at county-level hospitals [17]. In addition, most prior studies have only scrutinized the effect of the ZMDP on either outpatients or inpatients; however, there are large differences in the drug expenditure share and price elasticities of demand between outpatients and inpatients [18].

Using administrative data from the New Rural Cooperative Medical Scheme (NRCMS), we exploit the variation in the timing of the ZMDP's implementation across counties to investigate the effects of drug price changes on outpatient and inpatient expenditure. The NRCMS includes enrollment information and insurance claims for all enrollees in 25 counties. Moreover, the registered rural population obtain their health insurance from the NRCMS, and NRCMS funds are pooled by counties [19], so patients can only be reimbursed for health insurance claims in the county in which their hukou is registered, which precludes the self-selection bias of the sample due to regional differences in reimbursement rates.

Our study contributes to the literature in the following ways. First, it fills the research gap regarding the effects of the ZMDP on patient expenditure, since the extant literature has largely concentrated on the ZMDP's effect on provider-centric rather than patient-centric outcomes. Second, our study is the first to assess the differential effects of the ZMDP on outpatient versus inpatient expenditure, which have been conflated in the prior studies. Finally, compared to the small number of extant studies that have explored this phenomenon at the city level, we use county-level administrative record data with larger quantities and more comprehensive information to more accurately reflect the policy effects.

2. Materials and Methods

2.1. Data. Due to official requirements regarding the confidentiality time limits of administrative record data, we obtained the enrollment information and insurance claims from January 2012 to May 2016 for all NRCMS enrollees in 25 counties of China; the data were pooled in a cross-sectional manner [20]. The data contained a wealth of information on patient expenditure, including total expenditure, reimbursable expenses, and out-of-pocket (OOP) costs. The OOP costs ratio, as another measure of patient cost burden, can indicate potential financial risks and the strength of government healthcare payments [21]. Therefore, we calculated the OOP costs ratio as the total OOP expenditure divided by total patient expenditure. We ensured that inpatients' OOP costs ratio was not the same as that officially reported by the NRCMS for inpatient care, as many hospital services are not covered by the NRCMS. Therefore, we set the OOP costs ratio at 100%. Moreover, we distinguished between outpatients and inpatients to assess whether the ZMDP differently affected the two patient types. We obtained more than 25 million samples, which, to the best of our knowledge, is the largest amount of data collected in the field to date. Table 1 reports the summary statistics of our key variables.

The ZMDP was gradually implemented in different periods; hence, there was a difference in whether a given patient was affected by the ZMDP. In our sample, some hospitals implemented the ZMDP in the fourth quarter (Q4) of 2012, while other hospitals implemented it in Q4 of 2013. All counties eventually adopted the ZMDP between 2012 and 2016. Based on the differences in the timing of the ZMDP's implementation, we used a staggered difference-in-differences (DID) approach for the estimation. We used the patients affected by the ZMDP in different periods as the treatment group and those not affected as the control group. This meant that even though patients may have been treated in the same hospital, they may have been assigned to different groups in different periods.

2.2. Methods. We used the DID approach to estimate the pre- and postchanges in all outcomes in intervention hospitals in different counties. Since the ZMDP was rolled out at the county level, our primary analysis used a staggered DID method to determine the relationship between the ZMDP's implementation and patient expenditure. We also clustered the standard errors at the county level. The DID estimation was

$$Y_{i,h,t} = \alpha_0 + \beta \mathrm{ZMDP}_{i,h,t} + \gamma X_i + \lambda_h + \eta_t + \varepsilon_{i,h,t}, \qquad (1)$$

where $Y_{i,h,t}$ are the dependent variables (expenditure) of patient i, who was admitted to hospital h at time t, and they denote total expenditure, reimbursable expenses, OOP costs, and the OOP costs ratio. The independent variable is whether the county in which the patient is located implemented the ZMDP in that year, and β is the estimation coefficient. The covariates X_i include the patient's age, sex, marital status, occupation (farming or other), education (below junior or junior high school and above), patient disease type (four digits from the ICD-10), and the physician. λ_h and η_t denote the hospital-level and time-fixed effects, respectively. $\varepsilon_{i,h,t}$ is the residual term. To further analyze the ZMDP's effect on health outcomes, we replaced $Y_{i,h,t}$ in (1) with the following variables measuring health outcomes: cured or improved at discharge, unhealed at discharge, and in-hospital mortality.

For the staggered DID empirical specification to estimate the causal effect of the ZMDP, we ensured that the control and treatment groups exhibited parallel pretrends in the outcome variables of interest. This approach was intended to alleviate the potential concern that the effects demonstrated

Table 1: Summary statistics.

Variable	Obs.	Mean (¥)	Std. dev.
Panel A: outpatient			
Total expenditure	20,522.821	170.1585	86.217
Reimbursable expenditure	21,197.513	108.7778	72.7833
Out-of-pocket expenditure	21,087.162	54.4946	47.1948
Out-of-pocket expenditure ratio	21,685.369	0.3492	0.2415
Panel B: inpatient			
Total expenditure	6,119.941	3,442.8703	3,960.4644
Reimbursable expenditure	6,123.357	3,089.7193	3,317.6142
Out-of-pocket expenditure	5,373.733	1,423.4942	2,143.95
Out-of-pocket expenditure ratio	5,472.566	0.3697	0.1819

by the ZMDP might be due to time trends; that is, if the policy had not been implemented, there would have been corresponding variations across the hospitals over time. We used an event study approach to test the parallel pretrend assumption:

$$Y_{i,h,t} = \alpha_0 + \sum_{k=-6}^{8} \beta_k \text{ZMDP}_{i,h,t} + \gamma X_i + \lambda_h + \eta_t + \varepsilon_{i,h,t}, \quad (2)$$

where β_k denotes the difference between the hospitals that have and have not implemented the ZMDP in quarter k. The remaining variables are defined in the same manner as those in (1).

To understand the supply side of healthcare's role in the ZMDP's effect on patient expenditure, we established the following regression equations for each of the hospital revenue categories:

$$Y_{h,t,c} = \alpha_0 + \beta \text{ZMDP}_{h,t,c} + \lambda_h + \eta_t + \delta_c + \varepsilon_{h,t,c}, \quad (3)$$

where $Y_{h,t,c}$ is the dependent variable (revenues) of hospital h, who suffered from revenue category c and was admitted to time t. δ_c represents the fixed effects of the revenue category. The remaining variables are defined in the same manner as those in (1).

To assess whether there was heterogeneity in the ZMDP's effect on patient expenditure among patients with different types of diseases, we constructed the following regression equation:

$$Y_{i,d,h,t} = \alpha_0 + \beta \text{ZMDP}_{i,h,t} + \gamma X_i + \delta_d + \lambda_h + \eta_t + \varepsilon_{i,h,t}, \quad (4)$$

where $Y_{i,d,h,t}$ is the dependent variable (expenditure) of patient i, who suffered from disease d and was admitted to hospital h in time t. δ_d represents the fixed effects of the disease types. The remaining variables are defined in the same manner as those in (1).

3. Results

3.1. Effect of the ZMDP on Patient Expenditure. Panel A of Table 2 shows the effect of the ZMDP on outpatient expenditure. Column 1 indicates that the estimate of β for the total expenditure per outpatient visit is significant. Specifically, the implementation of the ZMDP significantly reduces outpatients' total costs by 23.66% ($1 - \exp^{-0.27}$). Columns 2–3 in Panel A of Table 2 depict the effect of the ZMDP on reimbursable and OOP costs. The coefficients of policy implementation reveal that the ZMDP significantly reduces reimbursable expenses by 24.42% ($1 - \exp^{-0.28}$) and OOP costs by 54.62% ($1 - \exp^{-0.79}$). Column 4 demonstrates that the ZMDP significantly reduces the OOP cost ratio by 14%.

Panel B of Table 2 shows that the inpatient expenditure estimates are similar to those of the outpatients in Panel A of Table 1. Regarding the ZMDP's overall effect, the estimate of β in Column 1 is significant, suggesting that the policy change has a significant effect on the total expenditure per inpatient admitted. Specifically, the implementation of the ZMDP significantly reduces inpatients' total expenditure by 5.82% ($1 - \exp^{-0.06}$). The estimate of β for reimbursable expenses is significantly negative, which means that the ZMDP significantly reduces inpatients' reimbursable expenses by 8.61% ($1 - \exp^{-0.09}$). Column 3 displays the effects of the ZMDP on OOP costs; the estimate of β is insignificant, suggesting that on average, the policy change has no measurable effects on inpatients' OOP costs. Column 4 reveals the effects of the ZMDP on the OOP costs ratio. The estimate of β is marginal and insignificant, implying that, on average, the policy change has no measurable effect on inpatients' OOP costs ratio.

The regression outcomes in Table 1 indicate that implementation of the ZMDP significantly reduces outpatients' total expenditure, reimbursable expenses, OOP costs, and the OOP costs ratio. However, compared with outpatients, the ZMDP significantly reduces inpatients' total expenditure and reimbursable expenses but does not have a significant effect on inpatients' OOP costs and the OOP cost ratio.

One potential concern about the above regression outcomes is whether patient expenditure could have trended prior to the ZMDP's implementation; that is, whether the regression results in Table 2 could have been generated by events other than the ZMDP's implementation. To rule out this concern, we performed an event analysis using the regression model presented in (2). Figures 1 and 2 present the regression outcomes of the ZMDP for outpatients and inpatients, respectively. Figures 1 and 2 show that, first, all regression coefficients are insignificant before the ZMDP's implementation, meaning that the results pass the parallel trend test, there is no trend prior to the ZMDP's implementation, and that the validity of the DID regression results is guaranteed. Second, there is a significant difference in the ZMDP's effect on outpatients and inpatients. Compared with inpatients, outpatients' OOP and OOP costs ratio are more significantly affected by the policy.

We attribute the above results to two factors. First, there is a significant difference in the share of drug expenditure in the total expenditure between outpatients and inpatients (Figure 3), so the increase in drug consumption increases health expenditure [22]. Figure 3 shows that prior to the ZMDP's implementation, outpatient and inpatient drug costs accounted for approximately 60% and 45%,

Table 2: The effect of the ZMDP on patient expenditure.

	Total expenditure (1)	Reimbursable expenditure (2)	Out-of-pocket expenditure (3)	Out-of-pocket expenditure ratio (4)
Panel A: outpatient				
ZMDP	−0.27*** (0.04)	−0.28*** (0.05)	−0.79*** (0.25)	−0.14*** (0.03)
N	20,491.145	21,052.088	21,047.900	21,645.847
*R*2	0.61	0.73	0.68	0.71
Panel B: inpatient				
ZMDP	−0.06** (0.03)	−0.09** (0.04)	−0.06 (0.07)	0.00 (0.03)
N	6,109.817	6,113.293	5,363.901	5,462.369
*R*2	0.66	0.64	0.80	0.69

Note. ZMDP, zero markup drug policy. The coefficients show that the estimated, natural log-transformed dependent variables can be roughly interpreted as the percentage changes before and after the ZMDP's implementation. The results control for patients' demographic characteristics, disease type, and physician; they are based on cross-sectional individual data, and the numbers in the parentheses are standard errors clustered at the county level. Panel A presents the ZMDP's effect on outpatient expenditure; panel B depicts the ZMDP's effect on inpatient expenditure. ***, ** , and * denote the significance at the 1%, 5%, and 10% levels, respectively.

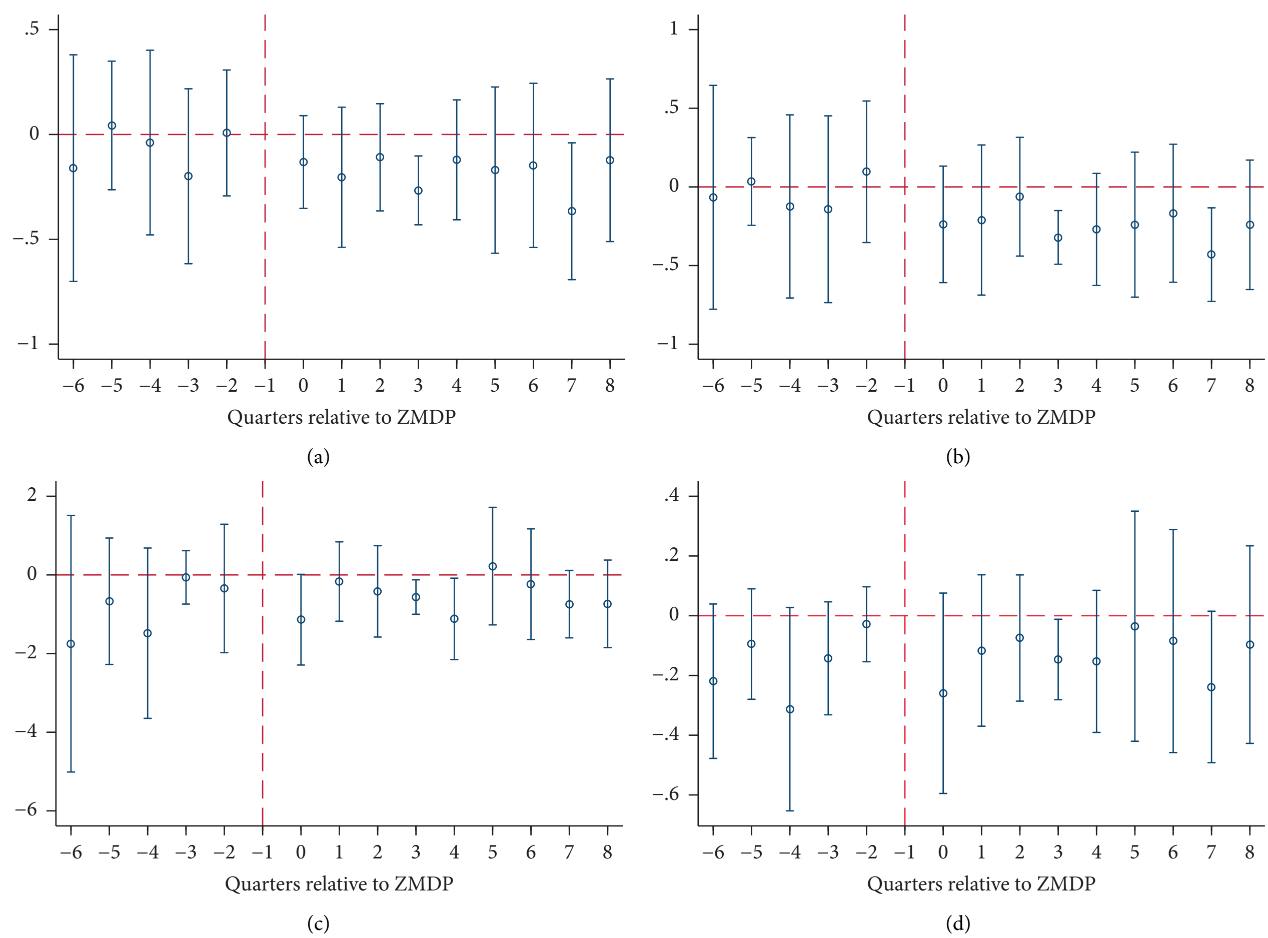

Figure 1: Event study: outpatient costs. *Note*. The y-axis denotes the estimated coefficient of the ZMDP variable in different regressions. (a) Outpatient expenditure (log). (b) Reimbursable expenditure (log). (c) Out-of-pocket expenditure (log). (d) Out-of-pocket ratio (%).

respectively. The ZMDP's introduction directly reduced drug prices; hence, although our results show that both outpatient and inpatient total expenditure and reimbursable expenses decline significantly after the ZMDP's implementation, its effect on outpatients is greater in terms of both significance and the absolute value of the coefficient. Further, the lower share of drug expenditure in the total expenditure renders the policy's effect on inpatients' OOP costs and the OOP costs ratio as insignificant.

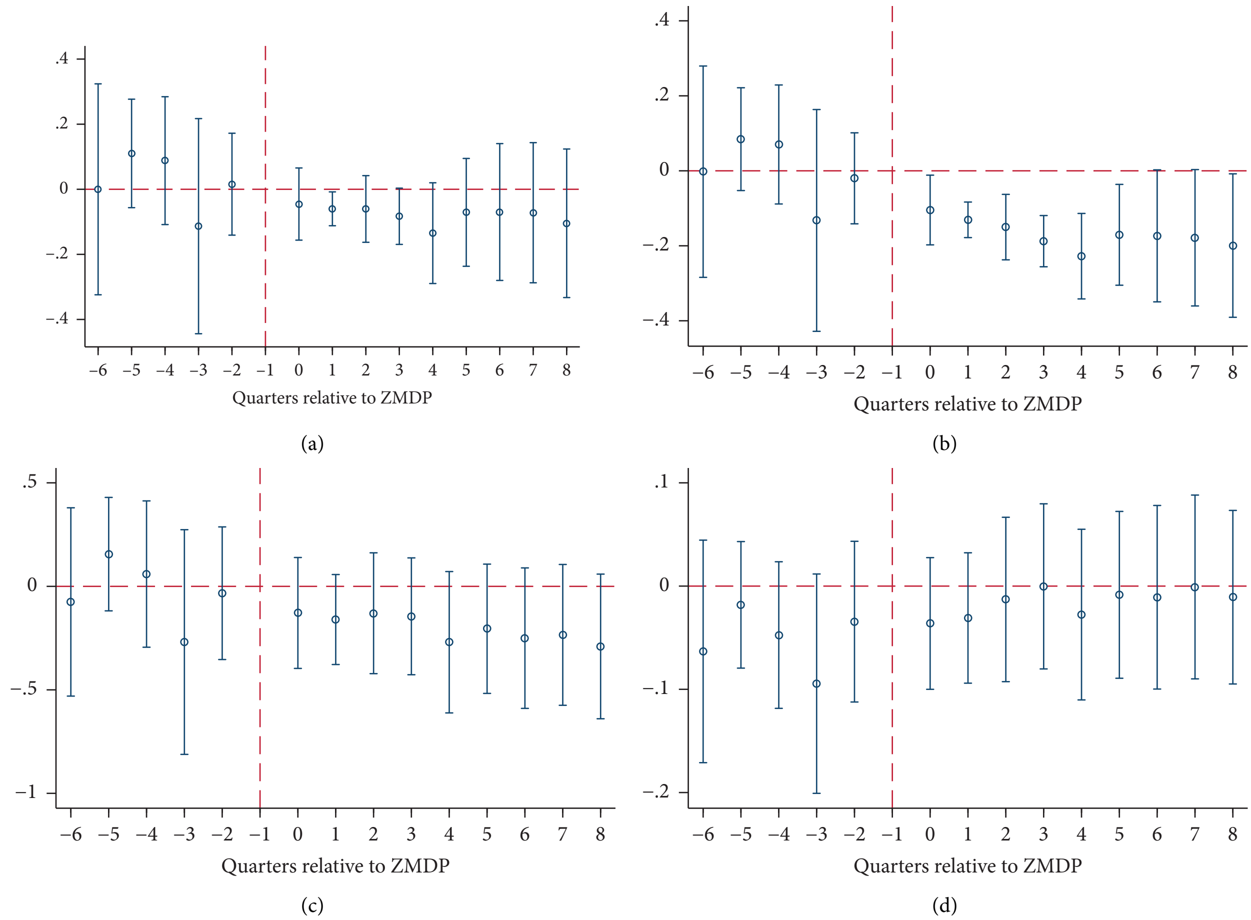

FIGURE 2: Event study: inpatient costs. *Note*. The y-axis denotes the estimated coefficient of the ZMDP variable in different regressions. (a) Inpatient expenditure (log). (b) Reimbursable expenditure (log). (c) Out-of-pocket expenditure (log). (d) Out-of-pocket ratio (%).

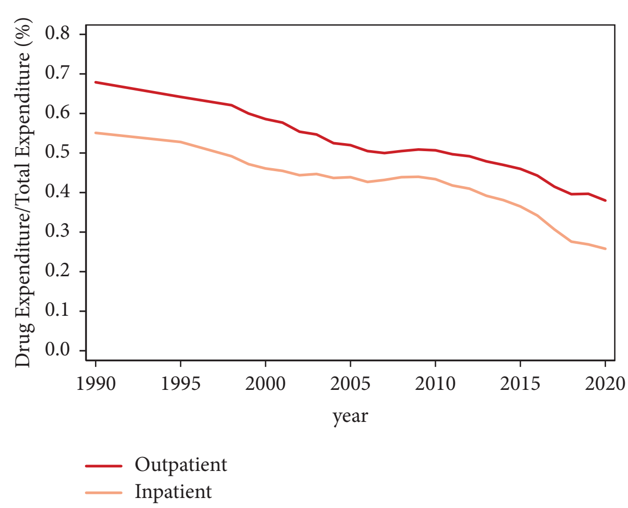

FIGURE 3: The share of drug expenditure in the total expenditure.

Second, the supply side of healthcare (i.e., hospitals and physicians confronting reductions in revenue under the ZMDP) may have increased the provision of other lucrative services, such as diagnostic tests and medical consumables, to achieve a shift from drug expenditure to other expenditure categories [23]. However, because the price elasticity of demand is higher for outpatients than for inpatients, hospitals and physicians can shift more costs from drugs to other services for inpatients than for outpatients. Due to data limitations, we were unable to obtain the expenditure per patient for each expenditure category; therefore, we obtained the hospital-level outpatient and inpatient expenditure for each category by collecting annual reports from our sample hospitals. We obtained the results (Table 3) using the same regression method as that in (3).

3.2. Effect of the ZMDP on Patient Expenditure by Disease Type. The above results suggest that the effects of the ZMDP differ between outpatients and inpatients. Therefore, we next determined whether there were differential effects of the ZMDP among patients' different disease types by performing a heterogeneity analysis across disease types. Figure 4 displays the heterogeneous effects of the ZMDP on outpatient expenditure based on different disease types. The change in total expenditure shows that the ZMDP has a significant effect on patients with circulatory, respiratory, skin, and external morbidities. In terms of changes in OOP costs, the ZMDP has a significant effect on respiratory diseases. Figure 5 shows the effect of the ZMDP on inpatients with different disease types. Panel A indicates that the ZMDP significantly reduces the total expenditure on infectious, metabolic, eye, circulatory, respiratory, skin, and perinatal diseases. Panel C demonstrates that the ZMDP significantly reduces OOP costs for skin and pregnancy-related ailments.

4. Discussion

Thus far, we establish that the ZMDP's implementation significantly reduces outpatients' total expenditure, reimbursable expenses, OOP costs, and the OOP cost ratio. The ZMDP's implementation significantly reduces inpatients' total expenditure and reimbursable expenses but does not significantly affect their OOP costs or the OOP costs ratio. However, the previous literature has asserted that the effects of the ZMDP come at the expense of patient health outcomes (Carlson et al. [24]; Shi et al. [25]). Therefore, we assessed how the changes in patient expenditure brought about by the ZMDP's implementation affected patient health outcomes. Subject to the data limitations, we followed Lu and Pan [26], who used inpatients' discharge status as a proxy for health outcomes and included cured or improved at discharge, unhealed at discharge, and in-hospital mortality. Table 4 presents the regression outcomes. The regression coefficients of each variable are not significant, meaning that a reduction in patient expenditure is not achieved at the expense of patient health outcomes.

The ZMDP's goal is to make health services affordable to patients [27]. However, the extant literature has debated whether this goal has been achieved [28, 29], as there is no single indicator for evaluating the effectiveness of the ZMDP's implementation. Accordingly, we provide new insights into this debate. Specifically, we reveal that the ZMDP's effect on reducing costs is more significant for outpatients than for inpatients.

We also show that the ZMDP can still be considered effective in terms of its effect on overall welfare as it reduces outpatients' overall expenditure without compromising their health outcomes, which can relieve the pressure on the government's public health expenditure [30]. We further reveal that the assessment of the policy effects should focus not only on short-term effects but should also include long-term effects [31]. In the heterogeneity test, we found that the ZMDP effectively reduced the OOP costs for outpatients with respiratory diseases. In the COVID-19 context, the ZMDP may also have had unintended benefits. For example, without the ZMDP, patients with respiratory illnesses may have been less likely to visit hospitals because of the cost [32], and COVID-19-like respiratory illnesses may have resulted in more serious consequences. Accordingly, we suggest that future assessments of the policy effects should focus on both the short- and long-term effects [31].

From the policy perspective, our findings may increase interest in expanding the effects of the ZMDP. For the policy to reach a wider range of people, we suggest that the following points should be considered in the policy's future implementation: first, transfer payments and inpatient subsidies should be increased. Although China has conducted healthcare payment reforms [33], based on the ZMDP's implementation effect, consideration should be given to increasing inpatients' transfer payments, reimbursement rates, and providing more types of reimbursed medicines in the future. Second, the intensity of the ZMDP's support for different disease types must be modified. Some chronic diseases may require long-term care and payments, and the ZMDP may fail to effectively reduce costs for patients with such diseases [34]. Therefore, the policy should provide differentiated levels of support for patients with different disease types. Third, the role of commercial insurance and private hospitals should be strengthened. To implement the ZMDP, the government has provided many financial subsidies, resulting in a heavy financial burden [35]. Given the current dominance of public hospitals in China and the fact that citizens mainly rely on the government to provide insurance [36], we suggest the need for appropriate market-oriented healthcare sector reforms to give full play to the role of commercial insurance and private hospitals in the future. Fourth, the government's supervision of hospitals should be strengthened. Since the implementation of the ZMDP, the "excessive medical care" phenomenon has often occurred [11]. Therefore, to increase hospitals' operation efficiency and decrease patient costs and the government's financial burden, the government should strengthen the supervision of hospitals as well as doctors' behavior [37].

Our study has several limitations. First, our analysis relied on government administrative data. Although these records were more reliable after being subjected to validation and random audits by the National Health and Family Planning Commission, we were unable to distinguish between first-time versus repeat visits in the sample per episode accounted for. Second, we could not accurately test behavioral models because we did not have access to data on each expenditure category. Finally, we only examined the short-term effect of

Table 3: The effect of the ZMDP on hospital revenue.

	Total expenditure	Drug	Registration	Diagnostic	Examination	Laboratory	Therapeutic treatment	Operation
Panel A: outpatient								
ZMDP	−0.11* (0.06)	−0.15* (0.09)	0.07 (0.07)	0.00 (0.00)	0.02 (0.14)	0.09 (0.09)	0.08 (0.11)	−0.2 (0.15)
N	577	586	577	571	581	582	586	575
*R*2	0.91	0.83	0.83	0.79	0.89	0.91	0.85	0.89
Panel B: inpatient								
ZMDP	−0.03 (0.04)	−0.1** (0.05)	−0.01 (0.06)	0.67** (0.28)	0.46** (0.2)	0.33* (0.17)	−0.09 (0.08)	−0.15 (0.12)
N	548	558	553	545	564	564	548	563
*R*2	0.94	0.94	0.88	0.89	0.89	0.84	0.85	0.96

Note. ZMDP, zero markup drug policy. The coefficients show that the estimated, natural log-transformed dependent variables can be roughly interpreted as the percentage changes before and after the ZMDP's implementation. The numbers in the parentheses are standard errors clustered at the county level. The control variables consist of hospital tier, the number of hospital employees, and the number of hospital beds. ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

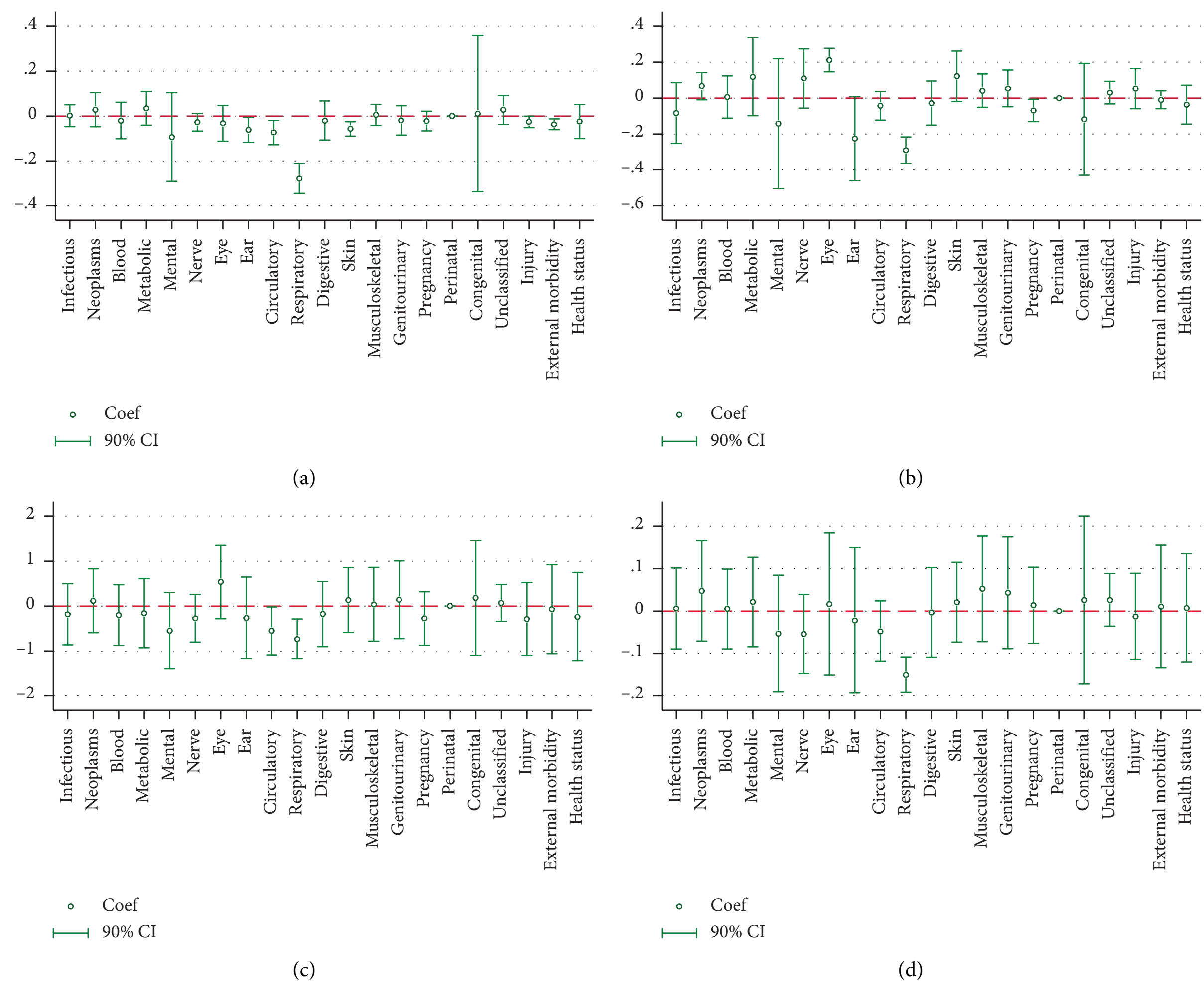

Figure 4: Effect of the ZMDP on outpatient expenditure by disease type. *Note.* The y-axis denotes the estimated coefficient of the ZMDP variable in different regressions. The control variables consist of patients' demographic characteristics and physicians. CI: confidence interval. (a) Outpatient expenditure (log). (b) Reimbursable expenditure (log). (c) Out-of-pocket expenditure (log). (d) Out-of-pocket ratio (%).

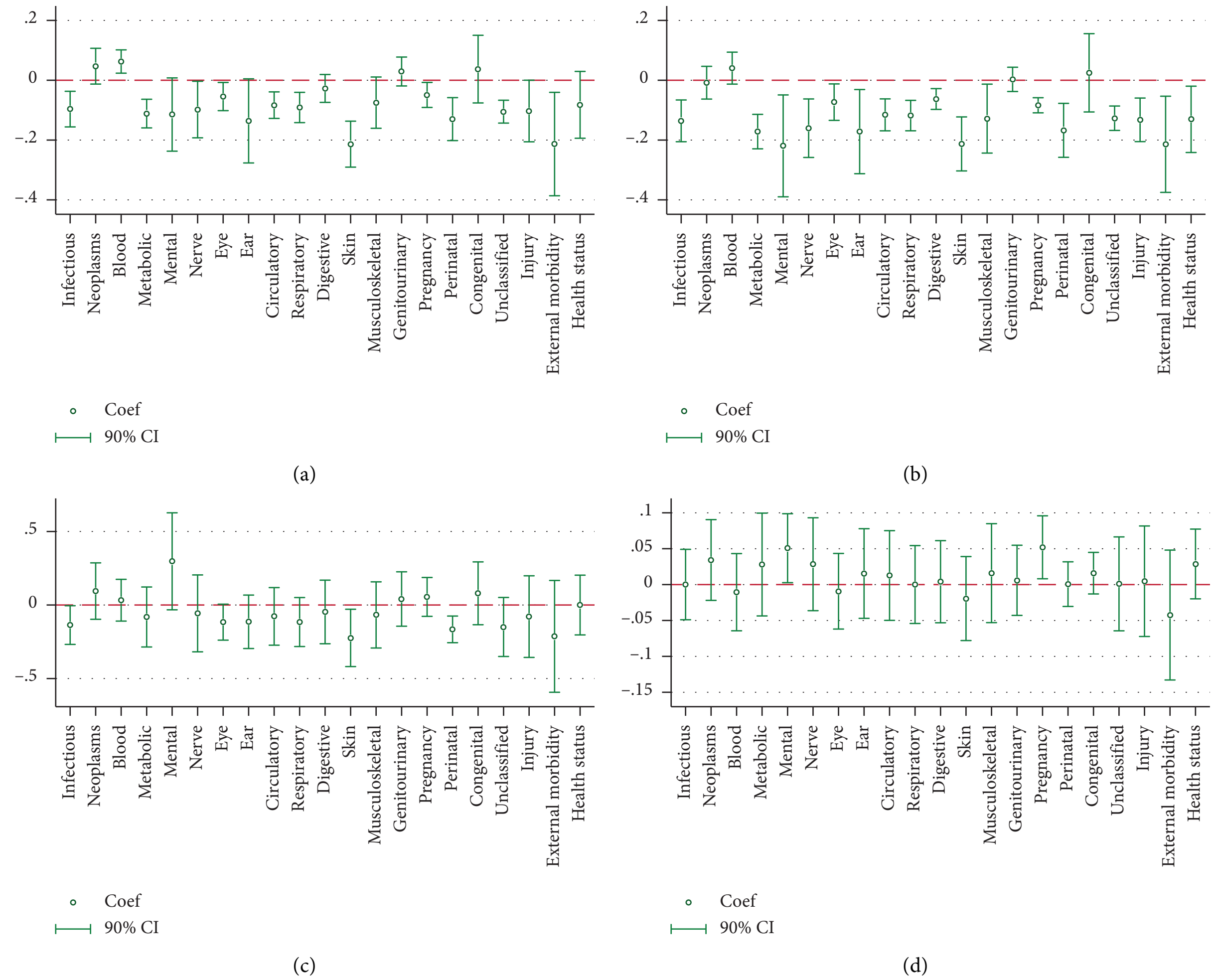

Figure 5: Effect of the ZMDP on inpatient expenditure by disease type. *Note*. The *y*-axis denotes the estimated coefficient of the ZMDP variable in different regressions. The control variables consist of patients' demographic characteristics and physicians. CI, confidence interval. (a) Inpatient expenditure (log). (b) Reimbursable expenditure (log). (c) Out-of-pocket expenditure (log). (d) Out-of-pocket ratio (%).

Table 4: The effect of the ZMDP on patient health outcomes.

	Cured or improved at discharge	Unhealed at discharge	In-hospital mortality
ZMDP	0.00 (0.00)	−0.00 (0.00)	0.00 (0.00)
N	6,125.210	6,234.188	6,234.188
*R*2	0.17	0.16	0.14

Note. ZMDP, zero markup drug policy. The results are based on cross-sectional individual data and control for inpatients' demographic characteristics, disease type, and physician. The numbers in the parentheses are standard errors clustered at the county level. Specifically, the actual coefficient (standard error) of the ZMDP for cured or improved patients at discharge is 0.0014 (0.0019), for unhealed at discharge is −0.0016 (0.0019), and for in-hospital mortality is 0.0002 (0.0003).

the ZMDP. Studying its long-term effects requires more data and other empirical strategies. These are important issues that should be addressed in the future research.

5. Conclusions

China launched the ZMDP in 2009 to reduce patients' healthcare costs. We examined the policy's effect using unique administrative data and found that its implementation significantly reduced total and reimbursable expenses. However, for OOP costs, the ZMDP only led to a significant reduction for outpatients. Inpatients found the ZMDP to be ineffective due to the differences between outpatients and inpatients in the share of drug expenditure when visiting doctors, as well as the shift from drug expenditure to other expenditure categories. Further, the ZMDP significantly reduced outpatients' OOP costs for respiratory diseases and inpatient-outpatient expenditure for skin and perinatal ailments. If future policies aim to improve patient well-being to a greater extent, reforms should focus on lowering inpatient costs and expenses for patients with chronic illnesses. Simultaneously, the government should conduct market-oriented reforms of health outcomes, give full play to the role of commercial insurance and private hospitals, and reinforce medical supervision in public hospitals.

Data Availability

The data used to support this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors' Contributions

The study was designed by all the authors. Data collection was led by DT and analyzed by all authors. The manuscript was written by SC and XL and reviewed by DT. XL had final responsibility for the decision to submit for publication.

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References

[1] K. Eggleston, L. Ling, M. Qingyue, M. Lindelow, and A. Wagstaff, "Health service delivery in China: a literature review," *Health Economics*, vol. 17, no. 2, pp. 149–165, 2008.

[2] J. Wang, P. Li, and J. Wen, "Impacts of the zero mark-up drug policy on hospitalization expenses of COPD inpatients in Sichuan province, western China: an interrupted time series analysis," *BMC Health Services Research*, vol. 20, no. 1, p. 519, 2020.

[3] W. Yip, T. Powell-Jackson, W. Chen et al., "Capitation combined with pay-for-performance improves antibiotic prescribing practices in rural China," *Health Affairs*, vol. 33, no. 3, pp. 502–510, 2014.

[4] G. G. Liu, S. A. Vortherms, and X. Hong, "China's health reform update," *Annual Review of Public Health*, vol. 38, no. 1, pp. 431–448, 2017.

[5] W. C. M. Yip, W. Hsiao, Q. Meng, W. Chen, and X. Sun, "Realignment of incentives for health-care providers in China," *The Lancet*, vol. 375, no. 9720, pp. 1120–1130, 2010.

[6] W. C. M. Yip, W. C. Hsiao, W. Chen, S. Hu, J. Ma, and A. Maynard, "Early appraisal of China's huge and complex health-care reforms," *The Lancet*, vol. 379, no. 9818, pp. 833–842, 2012.

[7] L. Li, "The challenges of healthcare reforms in China," *Public Health*, vol. 125, no. 1, pp. 6–8, 2011.

[8] W. Liang, *The Biggest Action of New Round Health-Care Reform Is the Implementation of Zero-Markup Policy in All Health Care Facilities*, Xinhua Net, 2018, https://www.xinhuanet.com/fortune/2018-03/05/c_1122486204.htm.

[9] W. Yip and W. Hsiao, "China's health care reform: a tentative assessment," *China Economic Review*, vol. 20, no. 4, pp. 613–619, 2009.

[10] X. Shi, D. Zhu, X. Man et al., "The biggest reform to China's health system": did the zero-markup drug policy achieve its goal at traditional Chinese medicines county hospitals?" *Health Policy and Planning*, vol. 34, no. 7, pp. 483–491, 2019.

[11] H. Fu, L. Li, and W. Yip, "Intended and unintended impacts of price changes for drugs and medical services: evidence from China," *Social Science and Medicine*, vol. 211, pp. 114–122, 2018.

[12] H. Yi, G. Miller, L. Zhang, S. Li, and S. Rozelle, "Intended and unintended consequences of China's zero markup drug policy," *Health Affairs*, vol. 34, no. 8, pp. 1391–1398, 2015.

[13] X. Zhang, H. Lai, L. Zhang, J. He, B. Fu, and C. Jin, "The impacts and unintended consequences of the nationwide pricing reform for drugs and medical services in the urban public hospitals in China," *BMC Health Services Research*, vol. 20, no. 1, p. 1058, 2020.

[14] L. Ding and J. Wu, "The impact of China's national essential medicine policy and its implications for urban outpatients: a multivariate difference-in-differences study," *Value in Health*, vol. 20, no. 3, pp. 412–419, 2017.

[15] L. Li and Q. Yu, "Does the separating of hospital revenue from drug sales reduce the burden on patients? Evidence from China," *International Journal for Equity in Health*, vol. 20, no. 1, p. 12, 2021.

[16] D. Zhu, X. Shi, S. Chen, X. Ye, and P. He, "Impacts of price changes on public hospital reforms in China: evidence from 25 million patients at tertiary hospitals," *Health Policy and Planning*, vol. 37, no. 10, pp. 1307–1316, 2022.

[17] Y. Zhang, Q. Ma, Y. Chen, and H. Gao, "Effects of public hospital reform on inpatient expenditures in rural China," *Health Economics*, vol. 26, no. 4, pp. 421–430, 2017.

[18] Z. Zhou, Y. Su, J. Gao, L. Xu, and Y. Zhang, "New estimates of elasticity of demand for healthcare in rural China," *Health Policy*, vol. 103, pp. 255–265, 2011.

[19] Q. Meng, H. Fang, X. Liu, B. Yuan, and J. Xu, "Consolidating the social health insurance schemes in China: towards an equitable and efficient health system," *The Lancet*, vol. 386, no. 10002, pp. 1484–1492, 2015.

[20] D. Liu, D. Tsegai, D. Litaker, and J. von Braun, "Under regional characteristics of rural China: a clearer view on the performance of the new rural cooperative medical scheme," *International Journal of Health Economics and Management*, vol. 15, no. 4, pp. 407–431, 2015.

[21] C. Gao, F. Xu, and G. G. Liu, "Payment reform and changes in health care in China," *Social Science and Medicine*, vol. 111, pp. 10–16, 2014.

[22] Ö Alkan and K. Elmali, "The determination of the factors affecting pharmaceutical consumption in respect to provinces in Turkey," *Mediterranean Journal of Social Sciences*, vol. 6, no. 6, pp. 356–363, 2015.

[23] H. Fang, X. Lei, J. Shi, J. Shi, and X. Yi, *Physician-induced Demand: Evidence from China's Drug price Zero-Markup Policy*, National Bureau of Economic Research, Cambridge, MA, USA, 2021.

[24] J. J. Carlson, S. D. Sullivan, L. P. Garrison, P. J. Neumann, and D. L. Veenstra, "Linking payment to health outcomes: a taxonomy and examination of performance-based reimbursement schemes between healthcare payers and manufacturers," *Health Policy*, vol. 230, pp. 234–245, 2019.

[25] J. Shi, L. Liang, and M. Hou, "The impacts of China's drug price zero-markup policy on medical expenditures and health

outcomes," *China Economic Review*, vol. 79, Article ID 101949, 2023.

[26] L. Lu and J. Pan, "The association of hospital competition with inpatient costs of stroke: evidence from China," *Social Science and Medicine*, vol. 230, pp. 234–245, 2019.

[27] Z. Ni, J. Jia, L. Cui, S. Zhou, and X. Wang, "The impact of China's zero markup drug policy on hospitalization expenses for inpatients in tertiary public hospitals: evidence based on quantile difference-in-difference models," *Healthcare*, vol. 9, no. 7, p. 908, 2021.

[28] W. Yip, H. Fu, A. T. Chen et al., "10 years of health-care reform in China: progress and gaps in universal health coverage," *The Lancet*, vol. 394, no. 10204, pp. 1192–1204, 2019.

[29] B. Wu, "Physician agency in China: evidence from a drug-percentage incentive scheme," *Journal of Development Economics*, vol. 140, pp. 72–89, 2019.

[30] B. Jiang, R. J. Zhou, and X. L. Feng, "The impact of the reference pricing policy in China on drug procurement and cost," *Health Policy and Planning*, vol. 37, no. 1, pp. 73–99, 2022.

[31] P. Giani, S. Castruccio, A. Anav, D. Howard, W. Hu, and P. Crippa, "Short-term and long-term health impacts of air pollution reductions from COVID-19 lockdowns in China and Europe: a modelling study," *The Lancet Planetary Health*, vol. 4, no. 10, pp. 474–482, 2020.

[32] J. Feng, H. Song, and Z. Wang, "The elderly's response to a patient cost-sharing policy in health insurance: evidence from China," *Journal of Economic Behavior and Organization*, vol. 169, pp. 189–207, 2020.

[33] W. Jian, M. Lu, K. Y. Chan et al., "Payment reform pilot in Beijing hospitals reduced expenditures and out-of-pocket payments per admission," *Health Affairs*, vol. 34, no. 10, pp. 1745–1752, 2015.

[34] W. Yip and W. C. Hsiao, "Non-evidence-based policy: how effective is China's new cooperative medical scheme in reducing medical impoverishment?" *Social Science and Medicine*, vol. 68, no. 2, pp. 201–209, 2009b.

[35] Z. Peng, C. Zhan, X. Ma et al., "Did the universal zero-markup drug policy lower healthcare expenditures? Evidence from Changde, China," *BMC Health Services Research*, vol. 21, no. 1, pp. 1205–1211, 2021.

[36] H. Wang, "A dilemma of Chinese healthcare reform: how to re-define government roles?" *China Economic Review*, vol. 20, no. 4, pp. 598–604, 2009.

[37] W. Yu, X. Liu, F. Zhao, M. Li, and L. Zhang, "Control of unreasonable growth of medical expenses in public hospitals in Shanghai, China: a multi-agent system model," *BMC Health Services Research*, vol. 20, no. 1, pp. 490–516, 2020.