The Impacts of The Hierarchical Medical Policy On Health Resource Utilization Efficiency

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Abstract. The inefficiency in healthcare resource utilization has been a major constraint on the development of health and wellness services in China. To address this, the Chinese government initiated the development of a hierarchical medical system in 2015. This study employs a fixed effects model to evaluate the impact of the 2015 hierarchical medical policy on the efficiency of healthcare resource utilization in China between 2011 and 2020, including regional differences. The findings show that the policy significantly enhanced the overall efficiency of healthcare resource utilization in China. However, the policy's effects on healthcare utilization efficiency were mixed in the subsequent years, showing both positive and negative impacts. In the economically and policy-resource deprived central regions, the policy's effects were delayed. Further analysis indicated that higher levels of regional informatization could diminish the positive impact of the hierarchical medical policy on improving healthcare resource utilization efficiency. This research offers valuable recommendations for further advancing reforms in China's medical system and establishing a structured hierarchical medical framework.

Keywords: Hierarchical medical policy, Efficiency of healthcare resource utilization, Fixed effects model, Structure of Hierarchical medical treatment.

1. Introduction

Healthcare resources are indispensable for ensuring the health and well-being of citizens and have consistently been a critical area of focus in China's public health policy and research. Recognizing the importance of these resources, China has progressively increased its investment in the healthcare sector. According to the 'China Health and Wellness Development Statistics Bulletin', the estimated total health expenditure in 2022 reached 8,484.67 billion yuan, marking a significant increase of approximately 65% from 5,159.88 billion yuan in 2017. Despite this investment, challenges such as the unequal distribution of health resources, inefficiencies in the use of medical resources, and the persisting issues of accessibility and affordability of healthcare services are prevalent. Lessons from international examples, such as the United Kingdom and the United States [1], demonstrate that a structured three-tier medical service network, along with a standardized general practitioner system and an extensive primary healthcare service network, can facilitate an organized pattern of medical treatment and optimize the utilization of healthcare resources.

In response to these challenges, the Chinese government issued the 'Reform of the Medical and Health Care System' in 2009, with the aim of enhancing the primary healthcare system and improving the allocation of resources within primary healthcare facilities as a key objective of healthcare reform. This initiative led to the pilot implementation of hierarchical medical reforms in several cities. Further solidifying these efforts, the 'Guidance on Promoting the Construction of the Hierarchical Medical System' in 2015 set forth a vision to establish by 2020 a comprehensive model characterized by 'primary care first, bidirectional referral, separate treatment of acute and chronic diseases, and cohesive integration across different levels of healthcare.' The 'Healthy China 2030' plan builds on this model, advocating for a system that begins with primary healthcare and supports bidirectional referrals, enhances the coordination of health service resources across all levels, and efficiently manages both emergency and non-emergency medical situations. The rapid development of the

hierarchical medical system is a cornerstone for advancing the 'Healthy China' strategy in the new era, offering a foundational policy framework and direction for ongoing research in health economics.

The assessment of China's hierarchical medical policy's impact has led to divergent research outcomes. Data from the 'China Health Statistics Yearbook' reveal that in 2014, just before the 'Opinions' were officially introduced, primary healthcare institutions accounted for 57.40% of medical visits, with secondary and tertiary hospitals at 39.09%. By 2016, these percentages shifted to 55.05% for primary care and 40.05% for secondary and tertiary hospitals, nearly indicating a stagnation in the primary sector's ability to attract a greater share of medical visits relative to higher-level hospitals. This trend continued into 2020, where the distribution of medical visits further evolved to 53.17% for primary institutions and 42.92% for secondary and tertiary hospitals, thus further diminishing the intended gap. This pattern underscores a significant issue: the resources and quality of health services at primary healthcare institutions are not meeting expectations [2], eroding public trust in these facilities [3]. Analysis based on provincial panel data indicates that the objective to cultivate a structured hierarchical medical system has not been fulfilled [4]. Nonetheless, evidence shows that basic medical insurance schemes have successfully directed urban residents towards primary healthcare facilities [5], and health consortia have markedly increased the frequency of visits to secondary and lower-tier medical institutions [6].

Researchers have assessed the Hierarchical Medical Policy's effectiveness by studying its impact on health resource distribution and utilization. On the supply side, the focus is on the policy's role in alleviating major hospital overcrowding by reallocating resources for significant, rare, and chronic conditions [7] and enhancing primary care capabilities through incentives [8], ensuring efficient resource allocation across healthcare tiers [9]. Demand-side analysis centers on how the policy shapes patient behavior, guiding informed healthcare level choices to reduce unnecessary high-level hospital visits [10]. This includes investigating how policy affects patient awareness [11], satisfaction [12], and trust [13], ultimately influencing healthcare decisions.

These studies primarily assess primary care visitation rates following the Hierarchical Medical Policy's implementation, aiming to establish orderly medical consultations. However, evaluations typically focus on isolated provinces or cities, leaving the broader impact on the national healthcare reform goal—enhancing average medical resource utilization—unclear. The question of whether significant regional disparities exist in its effectiveness remains underexplored and lacks empirical evidence.

This article focuses on: First, exploring the theoretical link between hierarchical medical policy and healthcare resource utilization efficiency. Second, measuring healthcare resource utilization efficiency across China and regional disparities. Next, using a fixed effects model to assess the hierarchical medical policy's impact on this efficiency and its regional variability. Lastly, it offers policy recommendations for optimizing hierarchical medical policies, grounded in empirical findings [14].

2. Policy background

China's hierarchical medical policy journey started in the planned economy era, creating a three-tier network for medical and preventive care spanning urban, town, and rural settings. Yet, the economic reforms and opening-up of the 1980s, coupled with greater social mobility, saw a gradual departure from localized and tiered medical consultations, causing the hierarchical medical system to shift from orderliness to disorder.In March 2009, China launched healthcare reforms to define medical service levels and curb resource wastage from unstructured patient movement. The reforms focused on bolstering primary care, integrating all residents into a unified medical insurance framework, and enhancing urban and rural insurance standards and coverage. The goal was to equalize access to basic public health services nationwide. Since 2009, Chinese provinces have implemented hierarchical medical system pilots. In 2015, the government introduced guidelines for a tiered diagnosis and treatment system centered around family doctor contracts to strengthen primary

care. Residents establish contracts with these doctors as their initial healthcare providers. This system facilitates two-way referrals, distinguishes between urgent and routine care, and links different healthcare facilities. Patients are directed to higher-level care if primary care is inadequate, while long-term or chronic care post-hospitalization is managed by primary care providers. This structure optimizes the allocation of medical resources and ensures patients' ongoing care.

The hierarchical medical policy directs resources towards primary care, enhances grassroots medical services, and equilibrates medical service supply and demand, boosting health resource utilization efficiency [15]. By defining roles across healthcare levels, it ensures medical resources are logically allocated, enhancing both the capacity of primary care and the efficiency in larger hospitals, minimizing waste. Furthermore, the policy emphasizes non-market forces in resource allocation, diverging from traditional economic reservations about such interventions [16]. Under government direction, it demonstrates how public policy can positively influence resource distribution, enhancing primary care access and quality, and facilitating equitable medical resource use across regions, thus elevating overall health resource efficiency. This informs Research Hypothesis 1:

H1: The 2015 hierarchical medical policy has a positive impact on the efficiency of health resource utilization.

Smith’s policy implementation model identifies four critical elements: implementers, environment, strategies, and outcomes [17]. This framework acknowledges that various factors influence policy effectiveness, which can evolve over time. While new policies initially show positive results by addressing clear issues, their extended application can reveal gaps between intended and actual outcomes, question strategy effectiveness and resource use, and necessitate feedback-driven adjustments. This may diminish or reverse the policy's initial benefits. Hence, Research Hypothesis 2 is formulated:

H2: The effect of the 2015 hierarchical medical policy on healthcare resource utilization efficiency shifts dynamically throughout its implementation.

Unbalanced development theory highlights regional disparities in economic status, public services, and infrastructure, impacting hierarchical medical policy outcomes [18]. Hierarchical reforms risk deepening regional healthcare resource disparities [19]. Yet, the impact on reducing medical costs varies; regions with weaker infrastructure but substantial government subsidies see more significant benefits [20]. Eastern areas, being wealthier and better equipped, quickly adapt to and implement these policies. In contrast, the western regions, despite less economic development, benefit from focused government support, showing significant potential for enhancing healthcare efficiency due to their foundational gaps. The central regions, however, caught between the east's resources and the west’s incentives, may face implementation delays. This regional variability in policy impact informs the development of Hypotheses 3 and 4, underscoring the nuanced effects of hierarchical medical policies.

H3: The implementation of the 2015 hierarchical medical policy significantly varies in its impact on health resource utilization efficiency across different regions.

H4: Compared to the eastern and western regions, the impact of the 2015 hierarchical medical policy on health resource utilization in the central region is delayed.

Data and research design

2.1. Variable description

(1) The dependent variable

This study investigates the 2015 hierarchical medical policy's effect on healthcare resource utilization efficiency. It emphasizes the need to evaluate the overall efficiency of healthcare production factors—labor, capital, and technology—over individual factor efficiency. Drawing from the literature, we use the DEA-Malmquist index to calculate Total Factor Productivity (TFP) as our dependent variable, capturing the healthcare system's resource utilization efficiency comprehensively.

(2) The core explanatory variable

The core explanatory variable in this study is the implementation of the policy. This paper uses the 2015 hierarchical medical policy as a dummy variable, processing the sample database based on whether the policy was implemented in that year, with 'yes' coded as 1 and 'no' as 0.

(3) Control Variables

Drawing on prior research, this study identifies medical technology innovation and healthcare market competition as key influences on resource utilization efficiency. We measure medical innovation through the ratio of practicing nurses and physicians (PNPP) and market competition via the proportion of private non-profit hospitals (PNPH). To mitigate the impact of omitted variables and enhance accuracy, we also include factors directly linked to healthcare efficiency: per capita GDP (GDPPC), age dependency (AD), and population density (PD), ensuring a more precise analysis.

2.2. Data Sources

This study utilizes data from 2011 to 2020 for empirical analysis, considering data availability. It adopts Murray et al.'s approach for TFP input indicators, using total healthcare expenditure, health personnel count, and healthcare institutions' total assets to represent financial, human, and material resources, respectively [21]. For output indicators, following Lampe et al., it selects the number of healthcare visits and discharges as proxies for productivity [22]. The study's key explanatory variables are defined through specific dummy variables. Data on these and other control variables come from the 'China Health Statistics Yearbook' and regional 'Statistical Yearbooks'. with detailed explanations and descriptions available in Table 1 of this document.

Table. 1. Variable description and data source

Variable type	variable name	Variable meaning	Variable description	Data Sources
The dependent variable	TFP	Health service resource utilization efficiency	Formula (1)	China Health Statistics Yearbook
The core explanatory variable	REFORM2015	2015 hierarchical diagnosis and treatment policy	The 2015 hierarchical diagnosis and treatment policy takes the value 1 after the medical reform in 2015, otherwise it is 0	virtual variable
Control Variables	PNPP	Proportion of number of practicing physicians	Number of practicing doctors /Total number of health personnel	China Health Statistics Yearbook
	PNPH	Proportion of number of private hospitals	Number of private hospitals/total number of hospitals	China Health Statistics Yearbook
	GDPPC	GDP per capita	real GDP/total population	Regional Statistical Yearbook
	AD	Degree of aging	Population aged 65 and over/total population	Regional Statistical Yearbook
	PD	Population density	Population/Area	Regional Statistical Yearbook

2.3. Measurement method of medical and health resource utilization efficiency

In this study, we meticulously assess the utilization efficiency of medical and health resources across China, encompassing both national and regional dimensions. Our analytical approach integrates two robust model methodologies. We commence with the DEA-Malmquist index technique, pioneered by esteemed researchers including Fare R et al.[23], which adeptly discerns shifts in efficiency within temporal data arrays, offering a nuanced, dynamic assessment of efficiency.The augmentation in Total Factor Productivity (TFP) regarding China's medical and health resource utilization, transitioning from period t to the subsequent period t+1, is articulately delineated through the Malmquist index, as outlined below:

$$M_t^{t+1} = \frac{TFP_{t+1}}{TFP_t} \tag{1}$$

Formula (1) represents the Malmquist index from period t to period t+1, and represents the health resource utilization efficiency in period t and period t+1 respectively.

$$M_0(x_t, y_t, x_{t+1}, y_{t+1}) = [\frac{D_0^{t+1}(x_{t+1},y_{t+1})}{D_0^{t+1}(x_t,y_t)} \times \frac{D_0^t(x_{t+1},y_{t+1})}{D_0^t(x_t,y_t)})] \tag{2}$$

In the formula (2), $(x_t, y_t)$and(x_{t+1}, y_{t+1})represent the overall input-output situation of health resources from period t to period t+1, while and represent the reference to the technology in period t+1 and period t. distance function.

Dismantling the Malmquist index in Equation (2) from the perspective of health resource output, Equation (1) can be changed into Equation (3), that is, the Malmquist index of the change in TFP from period t to period t+1 is:

$$\mathrm{M_0^{t+1}(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{D_0^{t+1}(x_{t+1},y_{t+1})}{D_0^{t+1}(x_t,y_t)}} \tag{3}$$

Further decomposing the Malmquist index, it can be divided into two items: technical efficiency change index (EHCH) and technological progress index (TECH), and the Malmquist index can be expressed as formula (4) or expression (5):

$$\mathrm{M_t^{t+1} = EHCH \times TECH} \tag{4}$$

$$\mathrm{M_0(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{D_0^{t+1}(x_{t+1},y_{t+1})}{D_0^t(x_t,y_t)} \times [\frac{D_0^t(x_{t+1},y_{t+1})}{D_0^{t+1}(x_{t+1},y_{t+1})} \times \frac{D_0^t(x_t,y_t)}{D_0^{t+1}(x_t,y_t)})]} \tag{5}$$

Additionally, to delve into the evolving dynamics of China’s medical and health resources across various regions, this study assesses the enduring impact of health data utilization efficiency in the face of policy interventions, employing the Markov chain analysis method [33]. In this investigation, Total Factor Productivity (TFP) is categorized into ‘n’ distinct and non-overlapping states. The state transition probability matrix, an ‘n×n’ grid, captures the likelihood of a shift from one state to state ‘j’, with each matrix element reflecting such a transition probability. This matrix adheres to the principle that the sum of probabilities across each row equals unity, as articulated in Equation (6).

$$\mathrm{P} = \begin{pmatrix} \mathrm{p_{11}} & \mathrm{p_{12}} & \cdots & \mathrm{p_{1n}} \\ \mathrm{p_{21}} & \mathrm{p_{22}} & \cdots & \mathrm{p_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ \mathrm{p_{n1}} & \mathrm{p_{n2}} & \cdots & \mathrm{p_{nn}} \end{pmatrix} \tag{6}$$

2.4. Econometric model settings

To address the influence of individual-specific factors on health resource utilization efficiency that are either unobservable or challenging to quantify, this study employs the Hausman test to identify the most suitable econometric model. The findings indicate a significant correlation between individual effects and explanatory variables, with the P value reaching statistical significance at the

5% threshold. Consequently, the fixed effects model is deemed appropriate for the primary regression analysis. The specified measurement model is outlined as follows (7):

$$\mathrm{TFP_{it}} = \beta_0 + \beta_1 \mathrm{REFORM2015_{it}} + \beta_2 \mathrm{PNPP_{it}} + \beta_3 \mathrm{PNPH_{it}} + \beta_4 \mathrm{GDPPC_{it}} + \beta_5 \mathrm{AD_{it}} + \beta_6 \mathrm{PD_{it}} + \alpha_i + \epsilon_{it} \quad (7)$$

To empirically test Hypothesis 2 and Hypothesis 3, this study categorizes regions and examines the sequential effects of tiered diagnostic and treatment policies on health resource utilization efficiency across these regions. The primary regression analysis is structured using models represented by (8) and (9).

$$\mathrm{TFP_{it}^{r}} = \beta_0^{r} + \beta_1^{r} \mathrm{REFORM2015_{it}} + \beta_2^{r} \mathrm{PNPP_{it}} + \beta_3^{r} \mathrm{PNPH_{it}} + \beta_4^{r} \mathrm{GDPPC_{it}} + \beta_5^{r} \mathrm{AD_{it}} + \beta_6^{r} \mathrm{PD_{it}} + \alpha_i^{r} + \epsilon_{it}^{r} \quad (8)$$

$$\mathrm{TFP_{it}} = \beta_0 + \beta_1 \mathrm{REFORM2015_{it-n(n=N)}} + \beta_2 \mathrm{PNPP_{it}} + \beta_3 \mathrm{PNPH_{it}} + \beta_4 \mathrm{GDPPC_{it}} + \beta_5 \mathrm{AD_{it}} + \beta_6 \mathrm{PD_{it}} + \alpha_i + \epsilon_{it} \quad (9)$$

Among them, $\mathrm{TFP_{it}}$ is the resource utilization rate of the individual at time t, $\mathrm{REFORM2015_{it}}$ is the core explanatory variable; in addition $\mathrm{PNPP_{it}}$、$\mathrm{PNPH_{it}}$、$\mathrm{GDPPC_{it}}$、$\mathrm{AD_{it}}$、$\mathrm{PD_{it}}$ are control variables; and the superscript r represents the eastern, central and western regions of the region. The n represents the lag period, taking a constant, and $\beta_0$is the intercept. The others are coefficients, α_i is fixed individual effect, and ϵ_{it} is the error terms.

3. Results

3.1. TFP Measurement Results

Table 2 reveals that national Total Factor Productivity (TFP) generally trended upwards from 2011 to 2015, despite a minor decrease of 1.7% between 2013 and 2014. From 2015 to 2016, TFP surged, only to fall sharply from 2016 to 2017. However, from 2017 to 2020, the efficiency of national health resource utilization saw steady growth. This pattern aligns with the rollout of China's tiered healthcare policy post-2009. Initially, the 2009 healthcare reform fostered a consistent rise in TFP. The tiered healthcare policy further boosted efficiency in 2015. Nevertheless, subsequent policy shifts may have prompted a TFP reduction, a downturn not indicative of diminished policy impact but still affirmatively affecting outcomes. This observation preliminarily validates Hypothesis 1. In response to potential adverse societal effects from TFP declines, the government enacted measures, like the 2017 guidelines for medical consortium development, to rejuvenate TFP. Newly introduced variables might intersect or interfere with elements of the earlier tiered healthcare policy, potentially negating TFP gains. This scenario tentatively supports Hypothesis 2's validity.

Table. 2. China's Health Resource Utilization Rate and Its Decomposition, 2011-2020

Years	Technical Efficiency Change（EFFCH)	Technological Progress (TECHCH)	Scale Efficiency Changes (SECH)	Resource utilization (TFP)
2011-2012	0.985	0.958	0.985	0.964
2012-2013	0.993	1.043	0.993	1.042
2013-2014	0.995	1.024	0.995	1.047
2014-2015	0.994	1.052	0.994	1.074
2015-2016	0.978	1.608	0.978	1.551
2016-2017	1.004	0.683	1.004	0.735
2017-2018	1.016	1.020	1.016	1.046
2018-2019	1.000	1.009	1.000	1.037
2019-2020	1.023	1.182	1.023	1.252
Means	0.999	1.064	0.999	1.083

To examine regional disparities in healthcare utilization efficiency in China, this study categorizes the country into Eastern, Central, and Western regions, assessing health resource utilization efficiency across these areas from 2011 to 2020. According to Table 3, all regions witnessed efficiency improvements over their baselines during this timeframe, with each region's annual average exceeding 1, denoting substantial growth. Yet, a cross-regional analysis shows clear variations, with the Eastern, Central, and Western regions posting annual health resource utilization efficiency indices of 1.080, 1.081, and 1.087, respectively. These figures translate to annual growth rates of 8.0%, 8.1%, and 8.7% for the Eastern, Central, and Western regions, manifesting a declining trend from West to East. This pattern starkly contrasts with the economic development stages across these regions. When compared to the national average growth rate of 8.3% from 2011 to 2020, the Western region outperforms the national average, while the Central and Eastern regions lag behind. Thus, the differential impacts of the 2015-tiered healthcare policy across regions tentatively support Hypothesis 3.

Table. 3. China's Health Resource Utilization Rate and Its Decomposition, along with its regional breakdown, 2011-2020

Region	Province and city	EFFCH	TECHCH	SECH	TFP
Eastern	Beijing,Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan	1.002	1.066	1.002	1.080
Central	Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan	0.996	1.077	0.993	1.081
Western	Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	0.999	1.068	0.999	1.087

To analyze the dynamic changes in healthcare resource utilization efficiency across China, this study utilizes the K-means clustering method to evaluate the Total Factor Productivity (TFP) values

of provinces and cities within a year, involving 279 data points classified into three tiers: low, medium, and high efficiency. It sets a one-year period for calculating the stochastic transition probabilities of this efficiency. Through Markov chain analysis, this paper quantifies these probabilities for China and its three main regions, elucidating the dynamic transitions in Matrix Table 4. The analysis indicates that nationally, the likelihood of healthcare resource utilization efficiency remaining unchanged is relatively high.In the eastern region, a significant divergence in efficiency among cities emerges, likely influenced by disparate levels of economic development. Cities like Beijing, Shanghai, and Guangzhou, benefiting from superior resources and healthcare professionals, demonstrate higher efficiency. Conversely, smaller cities and rural areas in the east face resource limitations, yielding lower efficiency.The western region shows that cities with high efficiency are generally stable, yet therek's a considerable chance for regression to medium efficiency among half of these cities. Cities at medium efficiency face potential declines. In the central region, cities struggle to improve from low to higher efficiency states, with cities at medium or high levels displaying significant stability, especially at the medium level.This suggests that policies aimed at improving healthcare efficiency in the eastern and western regions might inadvertently affect the central region negatively, leading to the preliminary confirmation of Hypothesis 4.

Table. 4. National and Regional Healthcare Resource Utilization Efficiency Markov Chain Transition Probability Matrix

Region	Type			
Nationwide		Lower efficiency	Medium efficiency	High efficiency
	Lower efficiency	0.900	0.100	0
	Medium efficiency	0.015	0.927	0.058
	High efficiency	0	0.293	0.707
Eastern	Lower efficiency	1	0	0
	Medium efficiency	0	1	0
	High efficiency	0	0.125	0.875
Central	Lower efficiency	0.857	0.143	0
	Medium efficiency	0.019	0.925	0.056
	High efficiency	0	0.364	0.636
Western	Lower efficiency	0.833	0.167	0
	Medium efficiency	0.025	0.862	0.113
	High efficiency	0	0.429	0.571

The preliminary verification of the four hypotheses, based on the analysis of China's healthcare resource utilization efficiency, suggests initial support for our propositions. To reinforce the scientific rigor and the validity of the conclusions, this study employs empirical testing to further examine and substantiate each hypothesis.

3.2. Regression results

Table 5 outlines the initial regression findings on the 2015-tiered healthcare policy's effect on national health resource utilization efficiency, using six distinct regression models for assessment. Each model controls for city-specific effects and includes control variables. Model 1, linked to Equation (7), reveals REFORM2015's significant positive impact on healthcare efficiency (coefficient = 0.1489, standard error = 0.002), with 99% confidence level significance. This indicates the reform policy's notably positive influence on healthcare utilization efficiency, offering preliminary support for Hypothesis 1. Nonetheless, long-term effect analysis shows negative impacts in the second and third years after implementation. Specifically, Model 3 (Equation 9) notes a negative effect in the policy's second year (coefficient = -0.1609, standard error = 0.023), with 95% confidence level significance. Model 4 indicates a more pronounced negative effect in the third year (coefficient = -0.4778, standard error = 0.000). High R^2 values across all models signify robust

explanatory power. These outcomes affirm Hypothesis 2. Further analysis via Models 5 and 6 (Equation 9) observes a fourth-year positive policy rebound, which diminishes and loses significance by the fifth year. This pattern underscores the policy's fluctuating annual impact on efficiency, highlighting a dynamic trend.

Table. 5. Baseline regression results

The core explanatory variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
REFORM2015	0.1489***					
	(0.002)					
$(REFORM2015)^{-1}$		0.1849***				
		(0.001)				
$(REFORM2015)^{-2}$			-0.1609**			
			(0.023)			
$(REFORM2015)^{-3}$				-0.4778		
				(0.000)***		
$(REFORM2015)^{-4}$					0.3571	
					(0.000)***	
$(REFORM2015)^{-5}$						0.0733
						(0.458)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.5720	0.8560	0.7770	0.2973	0.2892	0.5440
N	279	279	279	279	279	279

Note: * indicates p<0.1, ** indicates p<0.05, *** indicates p<0.01.

In summary, although the 2015 tiered healthcare policy had a positive average effect on the efficiency of health resource utilization, it does not mean that the policy significantly enhanced health resource efficiency every year. This outcome underscores the complexity and multi-phase nature of the policy's impact, providing crucial empirical evidence for future policy formulation and adjustments.

3.3. Heterogeneity Analysis

To assess the heterogeneity in the effects of the 2015 tiered healthcare policy on health resource utilization efficiency across regions, this study adopts a regional classification for heterogeneity analysis. Table 6 shows that in the eastern region, REFORM2015 yields a coefficient of 0.1538 on efficiency, with a standard error of 0.065, statistically significant at the 90% confidence level. This result signifies a substantial and immediate positive impact of the policy on healthcare efficiency in the east. Conversely, in the central region, the coefficient stands at 0.1547 with a standard error of 0.143, lacking statistical significance. This indicates a minimal or indiscernible policy impact on efficiency for the central region in the year of implementation, though a marked negative effect (-0.1749 coefficient) emerges in the subsequent year. In the western region, the policy's effect coefficient is 0.1471, with a standard error of 0.055, significant at the 90% confidence level, denoting a positive impact on efficiency during the implementation year. Comparative regional analysis reveals significant heterogeneity in the policy's efficiency impact across provinces, corroborating Hypotheses H3 and H4.

Table. 6. Regional-level Comparative Regression Results

	Eastern	Central		Western
The core explanatory variable	REFORM2015	REFORM2015	$(REFORM2015)_{-1}$	REFORM2015
	0.1538	0.1547	-0.1749	0.1471
	(0.065) *	(0.143)	(0.076) *	(0.055) *
Control Variables	Yes	Yes	Yes	Yes
R^2	0.6673	0.6923	0.8551	0.6649
N	100	48	48	107

Note: * indicates p<0.1, ** indicates p<0.05, *** indicates p<0.01.

3.4. Robustness Test

(1) To rigorously evaluate and confirm the robustness and impact of regression coefficients derived from national and regional sub-sample empirical analyses in this study, the paper processes extreme values in the sample data to test result robustness. By excluding outliers from the initial dataset and performing regression analysis anew, findings exhibit consistency and stability in significance, direction, and magnitude relative to baseline regression outcomes.

(2) Given the data's sensitivity and variability, a truncation method was applied for meticulous data adjustment and processing, aiming to bolster the analysis outcomes' reliability and effectiveness. A subsequent comparison of regression outcomes pre- and post-adjustment reveals alignment with initial baseline findings, lending credence to the study's estimated results.

(3) Additionally, the study explores alternative total factor productivity measures, substituting DEA-Malmquist index model inputs with the number of hospital beds, healthcare facilities, and medical staff, and outputs with patient discharges and health check-up figures. The recalculated health resource productivity, replacing the original TFPMS indicators, was subject to baseline regression analysis. Post-substitution, the 2015 tiered healthcare policy's positive impact on health resource utilization efficiency remains significant, underscoring the empirical results' robustness.

4. Discussion

The primary objective of tiered healthcare reform is to elevate the national healthcare resource utilization rate. Initial regressions suggest that the tiered healthcare policy has not uniformly enhanced this rate. These is a researcher reveals that regional informatization levels markedly influence the efficiency of healthcare resource use in primary institutions [24]. This study investigates the impact of regional informatization on the efficacy of the tiered healthcare policy, quantifying informatization through the logarithm of regional internet broadband subscriptions, termed Informations (IFS). Model 1 in Table 7 reveals that while tiered healthcare reforms positively affect healthcare utilization rates, regional informatization exerts a negative impact. Introducing an interaction term between regional informatization and the tiered healthcare policy into Model 2 inversely affects the policy's influence on utilization rates, rendering the standalone effect of informatization non-significant. The interaction term's significance implies that in regions with advanced informatization, tiered healthcare reforms may fail to yield expected positive outcomes on utilization rates, possibly reverting to negative impacts. This pattern is speculated to arise from the increased online access to information on higher-tier hospitals in well-informatized areas, leading to higher registration and attendance at the expense of primary care facilities, thus undermining the structured tiered system and reducing policy effectiveness. This supports Hypothesis 2, positing that as regional informatization progresses, the initially positive impact of tiered healthcare policies on efficiency transitions to a negative influence.

Table. 7. The Impact of Regional Informatization Level on Healthcare Resource Utilization Rate

Comparison	Model 1	Model 2
REFORM2015	0.1403***	-0.5759*
	(0.000)	(0.053)
lnIFS	-0.1445***	0.0391
	(0.000)	(0.622)
REFORM2015*lnIFS		-0.2038
		(0.016) **
Control Variables	Yes	Yes
R^2	0.1379	0.1588
N	248	248

Note: * indicates p<0.1, ** indicates p<0.05, *** indicates p<0.01.

5. Conclusions and policy implications

As China moves towards high-quality economic development, the deepening of tiered healthcare system reform becomes increasingly pivotal. Consequently, improving the efficiency of health service resources emerges as a critical component of healthcare reform, essential for optimizing resource allocation and contributing to the populace's overall well-being. This study assesses the total factor productivity of healthcare resources across China's provinces and regions from 2011 to 2020, employing it as an indicator of healthcare resource utilization efficiency. It then examines the effects of the 2015-tiered healthcare policy on healthcare resource utilization efficiency both nationally and regionally. The empirical findings reveal that the 2015 policy significantly influenced healthcare resource utilization, with its positive impacts turning negative as regional informatization levels rise. Moreover, the policy's effects demonstrate regional heterogeneity, with differences in impact magnitude and direction mirroring the disparities in economic development and healthcare resource allocation. In the economically advanced, resource-abundant eastern regions and the western regions, where government support and policy measures are more favorable, the tiered healthcare policy has an immediate positive impact on healthcare resource utilization efficiency. Conversely, its influence in the central region is characterized by delayed effects.

Drawing from the study's findings, this paper outlines key policy recommendations:

(1) Develop and test region-specific tiered healthcare reforms to foster nationwide synergy in healthcare resource utilization efficiency. Governments should craft a tailored reform framework, reflective of regional variances in industrial composition, informatization, transportation, and demographics. Through diverse policy instruments and targeted reforms, it is possible to catalyze a cohesive enhancement in health service resource efficiency. Furthermore, bolstering cooperation between primary healthcare providers and larger hospitals, promoting data, resource, and technology sharing, will enable a seamless flow of medical information to tertiary institutions, boosting primary care capabilities and resource efficiency.

(2) Prioritize tiered healthcare policy awareness and heighten the sensitivity of policymakers to their prolonged impact. Implementing an exhaustive policy evaluation mechanism for a holistic view of policy outcomes is imperative. Focus should extend beyond the immediate to the enduring effects on socio-economic progression, living standards, and the public service framework, affirming the sustainability and lasting efficacy of policies. Establishing dedicated institutions for comprehensive analysis and oversight of healthcare reform impacts can furnish policymakers with critical insights into the enduring consequences of these policies.

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