Research on technological progress in the field of regional medical supply

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Abstract: Objective: To explore technological advances in the medical field. Method: DEA method. Results: During the study period, the total factor productivity of regional medical care in China continued to increase; technological progress was an important reason for the improvement of total factor productivity; the improvement of total factor productivity in the central and western regions was faster. Conclusion: The incentive arrangement for the new medical reform has improved the level of technological progress in the medical field.

1. Introduction

The Party Central Committee and the State Council have attached great importance to the sense of medical care of residents. Since 2009, a number of policies have been introduced to promote the reform of the medical system. Medical and health institutions are the core link of the new medical reform, and the significant improvement in supply efficiency is an important indicator of the effectiveness of the new medical reform. The purpose of this paper is to evaluate the changes in the efficiency of the medical system in the context of medical reform and to provide evidence for the continued improvement of medical reform in the new era.

2. Research methods

Many scholars use the DEA method to construct a regional health input-output model to evaluate the contribution of technological progress in the medical system. Zhang Ning, Hu Angang and Zheng Jinghai (2006) [1] Zhang Ning, Hu Angang, Zheng Jinghai. Application of DEA method to evaluate the health production efficiency in various regions of China [J], Economic Research, 2006 (7): 35-42.]] Using mortality and doctors to estimate regional health production efficiency; Fare et al. (1997) [2] Fare R., Grosskopf S., Lindgren B., & Poullier JP. Productivity growth in health-care delivery [J]. Medical Care, 1997, 35(4): 354-366.]] Estimated LMCD country Malmquist production index from 1974 to 1989, found that total factor productivity generally increased rapidly; Donna et al. (2004) [3] Donna Retzlaff-Roberts, Cyril F. Chang, & Rose M. Rubin.Technical efficiency in The use of health care resources: a comparison of OECD countries [J].. Health Policy, 2004, 69(1): 55-72.]] Estimate the technical efficiency of medical resource utilization in 27 OECD countries. This study uses the DEA method to estimate the supply efficiency, and the estimated parameters satisfy the relationship: Tfpch=Techch*Effch and Effch=Pech*Sech. Tfpch stands for total factor productivity, Techch stands for technology advancement index, Effch stands for technical efficiency index, Pech stands for pure technical efficiency, and Sech stands for scale efficiency. This decomposition means that in the dynamic process, the efficiency is the difference between the actual production level and the optimal production boundary at a certain point. The optimal production boundary is the relative optimal input obtained by calculating the medical input-output in the sample city. Combined composition. Thus, the efficiency improvement performance includes two parts of the optimal production possibility boundary shift and the movement of a point inside the production possibility set to the production boundary.

When Tfpch>1, it means that the urban medical efficiency is improved and improved, also called

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technological progress; otherwise, it is degradation. At this time, technological advancement refers to the application of technological inventions or innovations in the medical system. However, in reality, management inefficiencies or improper scale may result in the inability to use the technology, so as to be far from the maximum possible output level, so Tfpch Decomposition reveals the contribution of technological progress and efficiency to total factor productivity: Techch refers to technological progress contribution; Effch includes pure technical efficiency change index (PECH) to indicate management efficiency and scale efficiency change. The index (SECH) indicates whether the scale is optimal. When these indicators are greater than 1, they indicate improvement, and less than 1 indicates degradation.

When using the DEA method to estimate technical efficiency, the input is available in three aspects or combinations of available medical technicians, medical equipment inputs, and expenditures, and the output is the number of patients receiving treatment. For example, Ferrier and Valdmanis (1996) [4] Ferrier GD and Valdmanis V., Rural hospital performance and its correlates [J]., The Journal of Productivity Analysis. 1996, 38(7): 63-68.]] When the hospital efficiency is invested, the number of medical technicians, the number of beds, the price of personnel, and the price of the bed; the output is the acute hospitalization day, the intensive care unit, the inpatient day, the surgery, the outpatient visit, and the discharge. Puig-Junoy (2000) [5] Puig-Junoy, J. , Partitioning input cost efficiency into its allocative and technical components: an empirical DEA application to hospital. Socio-Economic Planning Sciences, 2000, (34): 199-218 .

Evaluate the productivity changes of the dental departments of 20 hospitals in the United States from 1988 to 1993, the number of months of work for physicians, and the number of ophthalmic beds; the output is cataract surgery, glaucoma surgery, strabismus surgery, and outpatient visits. The statistical indicators used in this study are mainly from the 2009-2016 China Statistical Yearbook and the China Health and Family Planning Statistical Yearbook. Some statistical indicators are calculated based on the relevant indicators in the above yearbook. The indicators of outpatient visits, inpatients, total assets of health institutions, health personnel, and expenditures of health institutions in 31 provinces, municipalities and autonomous regions were initially screened.

3. Research results

3.1 Continuous growth of factor inputs

Both the input and output of the medical supply system showed a rapid growth trend. In 2009-2016, the number of outpatients and inpatients increased by 13% and 19% annually, while the total assets of health institutions, health personnel and health institutions increased by 24%, 11% and 30% respectively. In this study, the number of outpatients and inpatients was two output indicators, and the total assets of the health institutions, the number of health workers, and the expenditures of health institutions were input indicators.

Table 1 Descriptive statistics of 31 provincial administrative regions in 2006-2019

	Year	mean	maximum value	minimum value	standard deviation
Outpatient visits (person)	2009	44726884	185256377	2570235	36095546
	2016	105469643	370428821	5802386	81019965
Hospitalization (person)	2009	1647763	4160296	67483	1061009
	2016	5654094	12975384	292532	3607823
Total assets of health institutions (ten thousand yuan)	2009	2633232	9484821	112567	2144710
	2016	12049991	29318495	693343	7576858
Health worker (person)	2009	175060	381760	10781	102469
	2016	360095	874110	29187	226712
Health agency expenditure (ten thousand yuan)	2009	1679302	6197870	57422	1407885
	2016	10298140	30527179	446050	7237938

3.2 Increase in contribution to technological progress

Using DEPA2.1, regional medical efficiency parameters were calculated using three inputs and two outputs under the scale return and output-oriented models. The mean value of total factor production change (Tfpch) is 1.123, and the technological advancement of medical supply contributes a lot. A five-year period greater than one in eight years indicates that the contribution of technological progress exceeds the contribution of factor inputs; three years less than one indicates that the demand for medical resources is extremely urgent, and the growth rate of investment exceeds the speed of technological progress. From the results of the Tfpch index decomposition, the improvement of total factor productivity is affected by different factors at different times. For example, in 2013, total factor productivity improvement was mainly achieved by technical efficiency (techch), indicating that more new technologies and medical devices were adopted at the time; management efficiency (effch) was relatively poor, pure technical efficiency (pech) and scale efficiency. (sech) are all getting worse. In 2014, in contrast, management efficiency is the main reason for the increase in total factor productivity. At this time, pure technical efficiency (pech) and scale efficiency (sech) are both greater than 1, significantly improved; and technical efficiency (techch) is in the stage of degradation. However, on the whole, the total factor productivity of medical and health care in all provinces in China has been increasing, indicating that technological progress in the medical field is constantly increasing.

Table 2 Changes in the Malquist Index and its decomposition in 2009-2016

	effch	techch	pech	sech	tfpch
2009	0.941	0.995	0.997	0.944	0.936
2010	0.82	1.782	0.833	0.985	1.461
2011	1.002	0.96	1	1.002	0.962
2012	1.009	1.044	0.997	1.012	1.053
2013	0.854	1.551	0.876	0.974	1.324
2014	1.225	0.629	1.171	1.046	0.771
2015	0.936	1.302	0.93	1.007	1.219
2016	0.836	1.503	0.87	0.961	1.257
Mean	0.953	1.221	0.959	0.991	1.123

3.3 The relatively large regional gap in the contribution of technological progress

Table 3 Changes in the Malquist Index and its decomposition in 2009-2016

	effch	**techch**	**pech**	**sech**	**tfpch**		**effch**	**techch**	**pech**	**sech**	**tfpch**
Beijing	1.089	1.028	0.993	1.097	1.120	Inner Mongolia	1.291	1.027	1.006	1.283	1.326
Tianjin	0.998	1.054	1.008	0.990	1.052	Chongqing	1.105	1.054	1.015	1.089	1.165
Hebei	1.021	1.021	0.987	1.034	1.042	Sichuan	1.026	1.041	0.988	1.038	1.068
Shanghai	1.109	1.038	1.015	1.092	1.151	Guizhou	1.220	1.029	1.030	1.184	1.255
Jiangsu	1.047	1.053	1.029	1.018	1.103	Yunnan	1.020	1.048	1.013	1.007	1.069
Zhejiang	1.288	1.035	0.998	1.291	1.333	Tibet	1.045	1.039	1.000	1.045	1.086
Fujian	0.975	1.051	0.983	0.992	1.025	Shaanxi	1.234	1.044	1.033	1.194	1.288
Shandong	1.002	1.030	1.000	1.002	1.032	Gansu	1.078	1.054	0.982	1.098	1.136
Guangdong	1.000	1.050	1.000	1.000	1.050	Qinghai	1.151	1.050	1.148	1.003	1.209
Mean	**1.059**	**1.040**	**1.001**	**1.057**	**1.101**	Ningxia	0.987	1.031	1.000	0.987	1.018
Shanxi	1.011	1.026	1.000	1.011	1.037	Xinjiang	1.043	1.048	1.038	1.005	1.093
Anhui	1.316	1.051	1.021	1.289	1.383	Guangxi	1.012	1.047	1.017	0.995	1.060
Jiangxi	0.994	1.036	0.996	0.998	1.030	Hainan	1.033	1.032	1.040	0.993	1.066
Henan	1.008	1.050	0.982	1.026	1.058	Mean	**1.096**	**1.042**	**1.024**	**1.071**	**1.141**
Hubei	1.171	1.026	1.046	1.119	1.201	Liaoning	0.995	1.05	0.971	1.024	1.044
Hunan	1.031	1.028	1.000	1.031	1.060	Heilongjiang	1.031	1.048	1.015	1.016	1.081
Mean	**1.088**	**1.036**	**1.008**	**1.079**	**1.128**	Jilin	0.978	1.025	0.977	1	1.002
						Mean	**1.001**	**1.041**	**0.988**	**1.013**	**1.042**

The estimated results for the provinces in 2009-2014 are averaged over four regions (see Table 3). The fastest improvement in total factor productivity of regional medical care is in the west, followed by the central and eastern regions, and the contribution of technological advancement in the medical supply in the Northeast is the lowest. From the decomposition results, the total factor productivity in the west depends on both management improvement (1.042) and technological progress (1.096), and the central region is similar. The increase in total factor productivity in the east is mainly due to management improvement (1.059), and the contribution of advancement (1.040) is relatively low. The Northeast Management Improvement (1.001) has a lower contribution and the technical progress has contributed significantly (1.041). From the perspective of provincial administrative units, Anhui is the province with the fastest technological advancement, and Tfpch has reached 1.383. In general, all provinces showed technological progress in 2009-2016, but management efficiency, pure technical efficiency, and scale efficiency contributed differently.

4. Conclusion

4.1 Significant improvement in supply side technology

Through the estimation of medical supply technology advancement in various provinces in 2009-2016, two main conclusions can be drawn: First, during the inspection period, the total factor productivity of regional medical care in China continued to increase. This shows that from the perspective of efficiency, China's new medical reform market-oriented medical system reform. Technological advancement is the main reason for the increase in total factor productivity. There are some incentive arrangements in the existing medical system that force hospitals to use more advanced technologies to increase production efficiency, and such incentive arrangements have not yet been clearly understood. Second, Western medical total factor productivity has improved even faster. The continuous improvement of technical efficiency during the inspection period was mainly due to the advancement of technology and the improvement of the efficiency of medical and health technologies, such as the deepening of research on pathogenic factors and the use of more effective technical equipment. The difference in technical contributions between the four regions can be explained by the fact that the western provinces have a larger technology gap than the eastern and central regions, and thus the efficiency is improved faster. This is because the medical technology in the western provinces is weak, and it is easier to achieve the increase in total factor productivity through technological advancement. In the eastern region, due to the relatively advanced technology, the contribution of technological progress in the total productivity increase is relatively small.

4.2 Promoting the utilization of new medical technologies

The design of China's medical reform policy supports the competition of medical institutions. This study supports the incentive mechanism for improving the technological progress of medical institutions through competition. Therefore, an important principle of medical reform is to encourage the use of new equipment, new technologies and new drugs to improve the level of diagnosis and treatment. However, we must also pay attention to avoid the transition of medical expenses and transfer to consumers. As the new medical technology and new drugs continue to appear and the total scale of medical expenditures continues to increase, the government should further improve the medical insurance system to reduce the proportion of consumers' self-paying due to technological progress. The increase in medical expenses has led to a new level of medical reform, improved medical supply technology, consumer benefits, and efficient government spending.

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