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Efficiency Evaluation of Health Poverty Alleviation in Township Hospitals in Liangshan Yi Region based on DEA Model

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Abstract: This paper analyzes the input-output efficiency of township hospitals in Liangshan Yi region in health poverty alleviation using DEA model. Results show that the comprehensive efficiency of health poverty alleviation in township hospitals in Liangshan Yi region is relatively high, and the government's resource input on health poverty alleviation is generally well utilized, although there is a large gap between the comprehensive efficiency value and the average value for some hospitals. Scale efficiency is the main factor affecting the comprehensive technical efficiency, so the existing resource allocation mode should be changed, and the resource input structure of non-DEA effective health institutes should be adjusted according to the characteristics of residence and disease occurrence in Yi region. Non-DEA effective hospitals generally show a large gap between the actual value and ideal value of resource input, so the existing utilization efficiency can be improved by enriching the forms and channels of health poverty alleviation.

Keywords: Health poverty alleviation; Yi region; Township hospitals; DEA efficiency evaluation

1. Introduction

Since 2016, the state has carried out a health poverty alleviation project to ensure that poor areas and people in poverty have access to basic medical and health services, so as to effectively solve the problem of poverty caused by illness. Liangshan Yi region in Sichuan province is the concentration zone of deep poverty. Among the 17 counties and cities in the prefecture, 11 counties (mainly those with a high degree of yi nationality) are listed as key counties for national poverty alleviation and development, accounting for nearly one-third of Sichuan province. The poverty of this area, in both depth and breadth, is severe than that of the whole province and other regions in the country, and is mainly concentrated in a single ethnic group. There are more than 28,600 archived poor households and 35,300 disease-cased poor households in this area, and the proportion of disease-caused poor households is over 60%, which is far higher than the national average of 44%."Disease-caused poverty" has become the biggest obstacle for the impoverished people in Yi region to get rid of poverty. Through evaluating the health poverty alleviation efficiency of township hospitals in Liangshan Yi region and its influencing factors, an in-depth analysis of the current service capacity of township hospitals was carried out, which helps to optimize the allocation of health poverty alleviation resources in the region, improve the resource structure of township hospitals, and improve the overall health level of the Yi region. On the basis of referring to the existing literature research methods, this paper mainly considers the input and output indexes of township hospitals in Liangshan Yi region in health poverty alleviation. Data envelopment analysis was carried out to objectively measure the effectiveness of health poverty alleviation in all sample hospitals and the internal differences were studied, in order to provide references for the formulation of health poverty alleviation policies and efficient and sustainable development in the future.

2. Variable Selection and Data Processing

Data Envelopment Analysis (DEA) method is a non-parametric evaluation method based on linear programming technology, which is mainly used to study the efficiency of a group of decision making units (DMU) with multiple inputs and outputs. This method can not only avoid the impact of different units selected by input-output data, but also avoid the impact of subjective factors. It focuses on measuring the individual value of DMU rather than the quantitative average value, and has unique advantages in analyzing the health poverty alleviation capability and efficiency of township hospitals in Liangshan Yi region. Firstly, DEA can be well meet the characteristics of multiple inputs and outputs in health poverty alleviation. Secondly, it is able to further understand the specific use of DMU resources through differ-

ence analysis, sensitivity analysis and efficiency analysis, so as to provide decision makers with improvement suggestions.

2.1. Variable selection

On the basis of referring to the existing literature and considering the availability of data, this paper establishes some representative input and output indicators through careful screening.

2.1.1. Input indicators

Number of health personnel (X_1): Total number of health technicians multiplied by the incidence of poverty in the region.

Total fixed assets (X_2): Total fixed assets at the end of the year multiplied by the incidence of poverty in the region.

Expenditures for health and poverty alleviation operations (X_3): The annual expenditure is multiplied by the proportion of the number of visits of archived impoverished population to the number of visits of total population in this area.

2.1.2. Output indicators

Number of visits of archived impoverished population (Y_1): The total number of outpatient, emergency and inpatient visits of poor households.

The number of family doctors signing up for the archived poor population. (Y_2): The total number of signed family doctors for archived poor population.

Income from the medical treatment of the poor (Y_3): The total annual business income multiplied by the proportion of the number of visits of archived impoverished population to the number of visits of total population in this area.

2.1.3. Data processing

All the data used in this paper for the health poverty alleviation efficiency evaluation of township hospitals in Liangshan Yi region are from the field and network survey of 30 township hospitals in Ganluo, Zhaojue, Jinyang, Puge and Yuexi counties of Liangshan Yi autonomous prefecture in Sichuan province from July 2018 to September 2018. Of the 30 sample hospitals selected, 7 township hospitals were central hospitals, and the remaining 23 were general hospitals. Based on DEA's CCR model and BCC model, each township health hospital was taken as a DMU ($DMU_1, DMU_2 \ldots DMU_{25}$), EXCEL2010 was used to build a database, and DEAP2.1 software was adopted for data analysis.

3. Data Processing Results and Analysis

3.1. Analysis of total technical efficiency, pure technical efficiency and scale efficiency

In this paper, after introducing the input data and output data into DEA calculation model, the results of DEA efficiency coefficient of township hospitals in Liangshan Yi region were calculated, as shown in following table.

Table 1. Calculation results of health poverty alleviation efficiency of township hospitals

firm	crste	vrste	scale	
DMU1	0.395	1	0.395	drs
DMU2	0.384	1	0.384	drs
DMU3	0.243	0.262	0.928	drs
DMU4	0.459	1	0.459	drs
DMU5	0.585	1	0.585	drs
DMU6	0.752	1	0.752	drs
DMU7	0.312	0.729	0.428	drs
DMU8	1	1	1	-
DMU9	0.802	0.852	0.942	drs
DMU10	0.948	0.986	0.962	irs
DMU11	1	1	1	-
DMU12	1	1	1	-
DMU13	0.822	0.841	0.978	irs
DMU14	1	1	1	-
DMU15	0.963	0.964	0.999	irs
DMU16	0.737	1	0.737	drs
DMU17	0.638	0.657	0.972	drs
DMU18	1	1	1	-
DMU19	1	1	1	-
DMU20	0.824	0.9	0.915	irs
DMU21	0.976	0.976	1	-
DMU22	0.709	0.936	0.757	irs
DMU23	1	1	1	-
DMU24	1	1	1	-

DMU25	1	1	1	-
DMU26	0.913	1	0.913	irs
DMU27	0.35	0.918	0.381	irs
DMU28	1	1	1	-
DMU29	0.677	0.678	0.998	irs
DMU30	0.768	0.787	0.976	irs
mean	0.775	0.916	0.849	

Note: "firm" represents the sample in the example, "crste" stands for comprehensive efficiency, "vrste" is pure technical efficiency, "scale" refers to scale efficiency, crste=vrste×scale. "drs" means decreasing returns to scale, "-" means the constat returns to scale, "irs" means increasing returns to scale.

3.1.1. Total technical efficiency analysis

The average overall technical efficiency (crste) of the 30 sample hospitals is 0.775, and that of 10 hospitals is 1. This shows that these hospitals have reached the optimal output value in terms of technology and scale in the use of fixed assets, human resources, business expenditure and other inputs for health poverty alleviation. Twenty hospitals with overall technical efficiency less than 1 are not overall effective. This shows that the existing township hospitals have low utilization efficiency of personnel, assets and other resources, and the proportion and structure of relevant resources need to be adjusted appropriately. From the perspective of proportion, the proportion of overall effective hospitals is 33.3%, and their efficiency are low. The efficiency level of sample hospitals varies greatly. Among them, there are 13 hospitals whose total efficiency level is significantly lower than the average level (0.775), and the DMU3 is only 0.243, indicating that their utilization efficiency of resources in health poverty alleviation only accounts for 24.3% of that of the effective samples. Of all central hospitals (DMU1—DMU7), there is no one that is DEA effective in terms of overall technical efficiency, and the average score of them is only 0.447. All central hospitals are decreasing returns to scale. Of the 23 general hospitals, 10 are overall effective, with an average score of 0.875, which is much higher than the average overall efficiency score of the central hospitals; and 3 general hospitals are decreasing returns to scale. Therefore, in terms of input-output efficiency of health poverty alleviation, general hospitals are generally better than central hospitals. However, it should be pointed out that there is a difference in the function of general hospitals and central hospitals in poverty alleviation. General hospitals mainly provide preventive health care, health education, health conditions improvement and other health poverty alleviation work for the poor population. In contrast, central hositals are not only responsible for the basic functions of general hospitals, but also undertake the technical guidance for the prevention, health care and medical technology of general hospitals within the region.

3.1.2. Decomposition efficiency analysis

In terms of pure technical efficiency, the average pure technical efficiency score of 30 sample hospitals is higher, which is 0.916, and there is certain room for improvement. Among them, 17 hospitals with pure technical efficiency score of 1 and efficency of 56.7%. The input factors of these hospitals have reached the best state, and the resources have been fully utilized. At the same time, of the 13 non-DEA effective hospitals, 5 hospitals score higher than the average score, and 1 hospital (DMU3) has pure technical efficiency of 0.262, which is significantly lag behind other hospitals. The scale efficiency mainly measures whether the decision making unit is in the most suitable scale of production. Among the 30 hospitals, 11 have a scale efficiency value of 1, indicating that these hospitals have reached the scale effective status and the input-output ratio of resources will increase. Among the 19 non-DEA effective hospitals that the DEA is not effective, 9 are increasing returns to scale, that is, increasing resource input and output will obtain a greater increase; while 10 are decreasing returns to scale, indicating that the growth rate of output is greater than that of resource input, and the internal resource allocation and utilization efficiency need to be improved.

3.1.3. Analysis of factors restricting decomposition efficiency and total efficiency

Figure 1 and figure 2 show the distribution relationship between the comprehensive technical efficiency and the pure technical efficiency as well as that between the comprehensive technical efficiency and the scale efficiency, respectively. In general, in the scatter diagram, the more the distribution of the scatter is close to the diagonal line, the larger the influence and restriction of this efficiency on the overall efficiency is. In figure 1, the scattered points are more concentrated in the upper half of the scatterplot, with relatively more scattered points far away from the diagonal; while in figure 2, the scattered points are mostly distributed above or near the diagonal. Therefore, the scale efficiency has a stronger impact and greater contribution to the comprehensive technical efficiency. It can be considered that in health poverty alleviation, the poor performance of comprehensive technical efficiency of township hospitals in Liangshan Yi region is mainly affected by low scale efficiency.

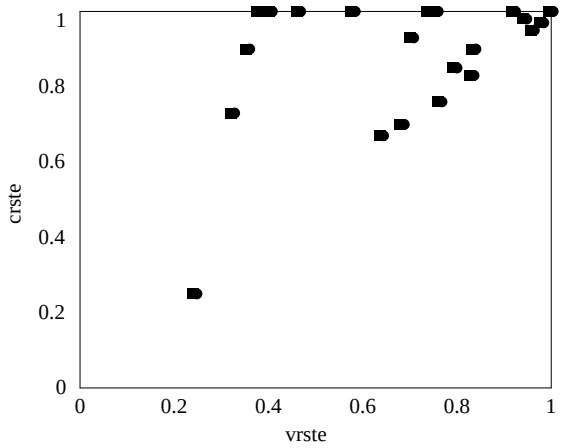

Figure 1. Comprehensive technique-pure technical efficiency scatterplot

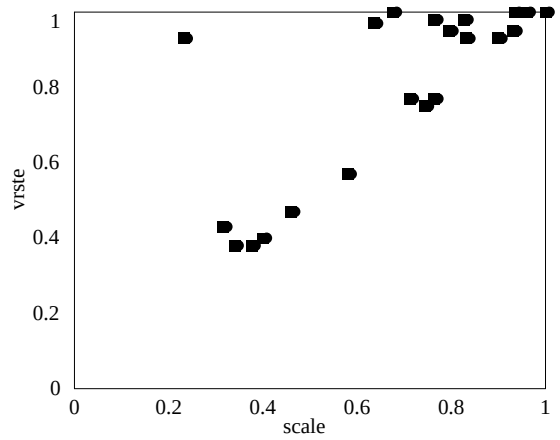

Figure 2. Comprehensive technique-scale efficiency scatterplot

4. Conclusions and Policy Recommendations

Through establishing input-output index system and using DEA method, this paper evaluates the health poverty alleviation efficiency of 30 township hospitals in Liangshan Yi region in 2017. The research results are summarized as follow:

First, the comprehensive efficiency of health poverty alleviation of township hospitals in Liangshan Yi region is at a high level, the overall utilization of health poverty alleviation resources is good, and the government's resources input on health poverty alleviation has been well utilized on the whole. The main reason causing the average level of overall comprehensive efficiency is due to pulling effect of some hospitals with high comprehensive efficiency. The regional distribution of comprehensive efficiency of health poverty alleviation is not balanced, and the comprehensive efficiency value of some hospitals is far from the average value, so the overall efficiency of health poverty alleviation still has great room to improve. At the same time, the comprehensive efficiency of sample hospitals in health poverty alleviation is mainly limited by its scale efficiency, in fact the influence of pure technical efficiency is relatively small. In terms of health poverty alleviation resources, it is necessary to change the traditional allocation mode based on population size or township, and further optimize the scale of health hospitals according to the living characteristics and living habits of the Yi region, so as to form a new allocation mode.

Secondly, realizing the constant returns to scale state of DEA effective hospitals and reaching the optimal state of health poverty alleviation. The health poverty alleviation ability of township hospitals can be further by improving their medical technology level and specialization degree. About one-third of the hospitals are still in the stage of increasing returns to scale, and the amount of relevant resources is far less than the actual demand for realizing the optimal efficiency of health poverty alleviation. For such type of hospitals, the extension development mode

should be adopted to expand the scale of township hospitals and increase the input appropriately. Seven central hospitals at all in the stage of decreasing returns to scale, indicating its deficiency in the utilization of the input resource elements. Therefore, it is necessary to adjust the proportion and structure of resource input in the central hospitals, constantly optimize the allocation structure of medical and health resources, and effectively improve the utilization efficiency of human resources, beds, fixed assets and other resources.

Thirdly, it can be seen from the projected value analysis of non-DEA effective hospitals that these hospitals have low out, large resource redundancy, and low efficiency of resource utilization. Based on this, the policy design can further increase the preferential treatment of poor people in primary hospitals and improve the preferential treatment in township hospitals. In addition, it is also feasible to increase channels and forms of health poverty alleviation activities on the basis of existing resource inputs, such as classified treatment for the poor population with major diseases and chronic diseases in the region, establishing health dynamic health management files and disease return visit system, so as to improve existing degree of resource utilization.

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