Empirical Analysis on Allocation Efficiency of Higher Education Resources Based on Hierarchical Microgrid

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Abstract: the Allocation Efficiency of Educational Resources is More Important Than the General Educational Output. Based on the Hierarchical Microgrid and the Theory of Resource Allocation and Regional Education as the Theoretical Basis, This Paper Comprehensively and Systematically Analyzes the Educational Allocation in Colleges and Universities by Comprehensively Applying the Theories and Methods of Economics, Statistics and Pedagogy. the Data Envelopment Analysis (Dea) Method, Bcc Model and Ccr Model Are Used to Quantitatively Evaluate the Allocation Efficiency of Educational Resources in Chinese Universities. Tobit Regression Analysis is Used to Find out the Main Factors That Affect the Efficiency of University Education Resource Allocation. in the Aspect of Scale Income, No Matter from the Overall Point of View, or from the Perspective of Region and Type, Most of Higher Education in China is in the State of Constant or Decreasing Scale Income. When the Scale of Colleges and Universities is Small, the Use Efficiency of Resources with High Cost Per Student is Low; with the Expansion of Scale, the Use Efficiency of Resources with Low Cost Per Student is High. This Paper Makes a Comparative Analysis of the Middle East and the West, and Provides Empirical Support for the Institutional Innovation of the Balanced and Effective Development of Higher Education in the Perspective of New Urbanization in China.

1. Introduction

Education is the Most Fundamental Cause of a Nation, Involving Thousands of Families, Benefiting Future Generations and Affecting the Future, Destiny and Long-Term Stability of the Country. in the 1980s, Data Envelopment Analysis (Dea) Method Was Applied to the Evaluation of Higher Education Efficiency in Western Countries [1]. Due to the Shortage of Capital and Financial Constraints, and from the Distribution of Education Investment to All Levels of Education, the Proportion of Higher Education Investment in Chinese Total Education Investment is Obviously on the High side. At Present, There is a High Demand for the Government to Increase Investment in Basic Education. Therefore, Governments At All Levels Will Allocate a Large Part of Education Investment to Basic Education [2]. This is Very Harmful to the Current Situation of Large-Scale Education in a Developing Country Like Us. Because At Present and for a Long Time to Come, the Available Educational Resources of Colleges and Universities in China Are Relatively Insufficient. as a New Network Structure Composed of Multiple Distributed Micro Sources and Loads According to Certain Topological Structure, Microgrid Provides Stable and Economic Power Supply for Loads [3]. At the Same Time, the Unlimited Expansion of Educational Demand, the Rising of University Tuition, the Shortage of Educational Resources, and the Shortage of Funds in Colleges and Universities Make It a Hot Spot to Improve the Efficiency of Running a University. Efficiency Has Always Been the Core Issue That Must Be Concerned about in the Allocation of Higher Education Resources [4]. in This Paper, Dea Data Envelopment Analysis Method is Used to Study the Resource Allocation, So as to Judge the Resource Use Efficiency of Each Year.

2. Research Methods and Model Establishment

Dea Method is Used to Evaluate the Relative Efficiency of Multiple Inputs and Multiple Outputs.

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This Paper Uses Ccr and Bcc Models in Dea Method to Measure the Three Efficiency Values of the Allocation of Educational Resources in Colleges and Universities: Technical Efficiency, Pure Technical Efficiency and Scale Efficiency, So as to Provide Policy Recommendations to Improve the Allocation Efficiency of Educational Resources in Colleges and Universities. Data Envelopment Analysis Can Be Used to Evaluate the Relative Efficiency of Decision-Making Units and Provide Room for Improvement According to the Results. When Selecting, There Must Be Homogeneity between Them. Selection of Input and Output Items for Each Decision Unit. with the Increase of the Number of Micro-Sources, the Calculation and Communication Costs of the Central Controller Are Greatly Increased, Which Has Certain Limitations on the Micro-Grid Topology [5]. This Model Can Be Used to Deal with Multiple Input and Output Situations, and the Selection of Cone Can Reflect the Preferences of Decision Makers. Practice Shows That Dea is an Accurate and Reasonable Evaluation Method, Which Has Become an Important and Effective Analysis Tool in Many Fields Including Education [6]. in Addition, the Dea Method is Used to Evaluate the Efficiency, At the Same Time, According to the Gap between the Actual Production Level and the Production Frontier, the Improvement Target Value of Each Non Efficiency Evaluation Unit is Obtained, Which is of Great Significance for Improving the Efficiency of Higher Education Resource Allocation.

2.1 Ccr Model under Crs Model

The CCR model assumes that there are n units, each of which has m types of inputs (representing the consumption of resources) and s types of outputs (representing the amount of information on effectiveness). For all decision units, each input and output value can be obtained, which must be positive and positively correlated. Here, each university is regarded as a decision unit (DMU), which includes a variety of input factors and output factors [7]. The output has reached the maximum relative to the input, that is, the decision unit is located on the curve of the production function. The so-called “scale efficiency” refers to the state in which the input is neither too large nor too small, i.e., the state in which the scale returns are between increasing and decreasing, i.e., the optimal state in which the scale returns are unchanged. DEA method has clear economic significance. It can not only reflect the input-output efficiency of the evaluated unit, but also further decompose this efficiency into scale efficiency and technical efficiency, thus comprehensively evaluating the production situation of the decision-making unit.

2.2 Bcc Model under Variable Scale Return (Vrs) Model

BCC model is based on CCR model, considering variable return of scale (VRS) and adding a convexity assumption. The selection of input, output and decision-making units of these projects must reflect the interest of analysts or managers in the elements related to the evaluation of the relative effectiveness of decision-making units. So that effective decision-making units can also compare the level of efficiency. The basic idea is to exclude a decision unit from the decision unit set when evaluating it. BCC model has the variability of scale income, expanding the scope of application of CCR model. For DMUs that are not DEA efficient, their input and output indexes can be “projected” on their respective relative effective surfaces to improve their inefficiency.

Assuming that DMUj, j = 1,2, ..., n means there are n decision units, (xj, yj) are the inputs and outputs of DMUj. Each decision unit has m kinds of inputs and s kinds of outputs (information indicating effectiveness). Then DMU0' s relative effectiveness evaluation model based on inputs is:

$$
\begin{aligned}
&s.t.\sum_{j=1}^{n}\lambda_j\theta_j + S^- = \theta X_0\\
&\sum_{j=1}^{n}\lambda_j Y_j - S^+ = Y_0\\
&\lambda_j \geq 0, \quad j = 1,\cdots,n\\
&S^- \geq 0, \quad S^+ \geq 0
\end{aligned}
$$

The essence of DEA is to achieve the goal of DEA efficiency by adjusting the input quantity and

output quantity of ineffective decision-making units according to the previous numerical analysis. And scale efficiency can be used to measure whether the decision-making unit is in the state of “optimal production scale” when the production technology department changes, which helps to understand whether the management and allocation of resources are appropriate.

3. Index and Data Selection

3.1 Dea Model Index and Data Selection

Indicators of educational resources input: 1) human resources: total number of full-time teachers. 2) Material resources: total fixed assets. 3) Financial resources: total education funds. The units of different inputs and outputs are not required to be consistent. Can be number, area, cost, etc. Although the choice of input and output is different when DEA model analyzes university efficiency, the number of students or graduates is usually used as output, while the number of academic staff or non-academic staff is also often used as input, and the number of published articles is often used as research output, which is the usual choice of researchers. At the same time, DEA can deal with the efficiency evaluation of multi-output and multi-input, and there is no need to set its relative importance between input and output to solve the problem of subjective weight determination and summation [8]. With the emergence of complex variable topology of microgrid, it is necessary to set up different control objectives, such as stability, economy and safety, according to the different interests involved in the planning and operation of microgrid. All decision-making units must operate under the same market conditions; input and output items used to show the performance characteristics of all decision-making units must be the same, but the intensity or range of input and output items may be different. Regardless of the type of “production unit”, the material input is at least the same in terms of the required land, housing and other necessary equipment. This kind of material can be divided into tangible and intangible material. In addition, a large number of input and output indicators will lead to the increase of the effective number, thus reducing the evaluation function of the method [9]. Data of DEA model comes from China Education Expenditure statistical yearbook, China Education Statistical Yearbook and China population Yearbook from 2012 to 2017, and the data is obtained after integration.

3.2 Tobit Model Index Determination and Data Source

Tobit model analysis is carried out, and pure technical efficiency is selected as the dependent variable, which includes urbanization rate, economic development level of provinces (cities), investment in education funds, allocation structure of education resources and years of education per capita. For the system of colleges and universities, this kind of input is very extensive, that is, including the input of students, and the input of schools also includes other aspects. Generally speaking, the more DMUs there are, the more the relationship between input and output can be defined. Therefore, the selection of DMUs can be determined according to the rule of experience obtained by some scholars according to the proven experience, that is, the number of units evaluated is at least twice the total number of input and output projects. The economic level variables of provinces (cities) are expressed in per capita GDP of each province (city); The scale of investment in education funds is expressed by the natural logarithm of the investment in funds by provinces (cities) and districts. In fact, these choices are largely determined according to different research angles or research purposes and consideration of data availability. The purpose of optimizing the allocation of resources is to fully realize all kinds of explicit functions of higher education with as little consumption of human, material and financial resources as possible, namely the three major functions of cultivating talents, serving the society and developing science. Tobit model's data come from China Statistical Yearbook, China University Statistical Yearbook, China Education Funds Statistical Yearbook and China Education Statistical Yearbook from 2012 to 2017. Relevant data are calculated. A large part of the social service output does not belong to the direct output of colleges and universities, but is an indirect output after the talents trained and scientific research achievements created by colleges and universities are integrated into society, so social

service indicators are not adopted.

4. Empirical Analysis

4.1 Measure the Allocation Efficiency of Educational Resources in Colleges and Universities

Through DEAP2.1 software to measure the efficiency of the allocation of educational resources in colleges and universities, it is necessary to implant various input-output index data into the model to calculate the technical efficiency value, pure technical efficiency value and scale efficiency value (see Table 1). Due to improper management of managers, resources cannot be fully utilized, resulting in waste of input factors. Second, due to the strengthening of competition, the profit-making space of each unit is reduced, and due to the unchanged management mode, the relative profit-making ability of some original resources is reduced, resulting in waste. This is in line with Chinese current situation. At present, China is in a period of transition, and various systems are not perfect. Educational resources are mainly the planned allocation of government financial investment, which has obvious disadvantages [10]. Technical efficiency is a comprehensive index to evaluate the configuration capability and utilization efficiency of DMU. Generally speaking, technical efficiency = pure technical efficiency × scale efficiency. Comparing with the original data, we can see that the resource allocation of colleges and universities is slightly higher than the average level in each output index, but it is far higher than the average value in each input index. In the same level of colleges and universities, the efficiency of economically developed areas is relatively low, especially in Beijing, Shanghai and Guangdong. This is not difficult to understand, because these areas are economically developed areas, higher education investment is relatively large, DEA evaluation model is relatively effective.

Table 1 2012-2014 Changes of Input-Output Efficiency Indexes of Universities in Different Regions

Region	Technical efficiency	Pure technical efficiency	Scale efficiency
East	0.902	0.899	0.873
Central section	0.911	0.906	0.891
West	0.832	0.781	0.802

Through data comparison, the technical efficiency values of the eastern, central and western regions fluctuated in a certain range from 2012 to 2014. In terms of technical efficiency values, the optimal value is 0.911 in the central region, 0.902 in the eastern region, and 0.832 in the western region. Of course, the differences among the three regions are not obvious. The reason may be that 985 colleges and universities have gathered a large number of advantageous educational resources, but the scale of their output is limited. However, the educational capacity of these areas is limited. Therefore, no matter how much investment is made, it is impossible to increase the corresponding scale of output. As far as the education industry referred to in this paper is concerned, we can think that the first reason for the ineffectiveness of production technology is the improper change of various factors within the system, such as the low management level of colleges and universities themselves, the improper use of existing resources, the lack of innovation of regional government on the education management system of regional colleges and universities, etc. Therefore, the stability of system operation and management decision-making in the allocation of educational resources in colleges and universities is not enough, and its low efficiency also restricts the improvement of the allocation efficiency of educational resources in colleges and universities in the western region. When the microgrid is slightly disturbed, decentralized control is only used to maintain the voltage stability of the system. When serious interference occurs, the upper and lower controllers are coordinated according to the voltage stability risk index to keep the system running stably. As far as the allocation of educational resources in common colleges and universities in East China is concerned, the level of educational development in common colleges and universities depends to a certain extent on the level of regional economic development. Under the conditions of Chinese weak national strength and limited educational investment, it is extremely important and urgent to explore the appropriate scale of education, effectively improve the utilization rate of

educational resources, give full play to the effective efficiency of educational resources, and enhance the market competitiveness of education running schools.

4.2 Factors Influencing the Efficiency of the Allocation of Educational Resources in Colleges and Universities

In order to better grasp which factors affect the comprehensive efficiency of the allocation of educational resources in colleges and universities and how significant the factors affect, it is necessary to put the processed data into Tobit regression model analysis, and the results are shown in Table 2. The part caused by inefficient pure technical efficiency can be improved through short-term adjustment, while the part caused by inefficient scale efficiency needs long-term adjustment.

Table 2 Factors Affecting The Efficiency of the Allocation of Educational Resources in Colleges and Universities

Project	Correlation coefficient	Standard deviation	T statistics
Constant term	1.8462	0.6858	5.64
Regional economic development level	0.0162	0..3162	3.24
Distribution structure of educational resources	-0.3571	0.1665	-1.25
Investment in Education	0.5462	0.3265	2.19
Urbanization rate	-0.2543	0.1268	-2.28

Through longitudinal comparative analysis, we can see that the allocation efficiency of educational resources in various colleges and universities in our country has been improved to varying degrees, which is mainly due to the macro-system innovation in the field of higher education during the “Tenth Five-Year Plan”. The model analysis shows that the factors that obviously affect the allocation efficiency of educational resources in colleges and universities include the level of regional economic development, the level of investment in educational funds and the level of education per capita. The factors that have no significant impact are the allocation structure of educational resources and the level of urbanization. The source of university economies of scale is also well explained: fixed costs constitute an important source of economies of scale. In the short term, higher education costs can be divided into fixed costs and variable costs. When the micro grid is subject to slight interference, the decentralized control is only used to maintain the voltage stability of the system; when serious interference occurs, according to the voltage stability risk index, the upper and lower controllers are coordinated to maintain the stable operation of the system. The development of higher education needs a large amount of investment, and it is a reasonable choice to implement the cost compensation policy in the case of insufficient resources at this stage. This shows that it is difficult to improve the utilization efficiency of higher education resources only by focusing on the “quantity” of urbanization without improving the “quality” of urbanization. We should pay attention to improving the efficiency of the allocation of educational resources in Colleges and universities, and call for a new type of people-oriented urbanization.

5. Conclusion

The technical efficiency, pure technical efficiency and scale efficiency of the allocation of higher education resources in 29 provinces of China from 2012 to 2014 are calculated by data envelopment analysis (DEA). From the above study, we know that the inefficiency of total technical efficiency is caused by the inefficiency of pure technical efficiency or scale efficiency. At present, China is in the period of reform and opening up, and vigorously developing economy. There is a strong demand for talents in economic management and engineering construction, which will inevitably lead to a variety of educational resources tend to this type of colleges and universities, and at the same time, make more students apply for these types of schools. According to the average modeling method, the controllable power electronic devices in microgrid are modeled in the form of controlled voltage source and controlled current source. In terms of technical efficiency, the overall level of allocation of educational resources in colleges and universities in various provinces needs

to be improved, and there is room for improvement in the western region compared with the central and eastern regions. Some universities may have unreasonable allocation of scientific research resources, which leads to low efficiency of scientific research input and output. Different regions have made different efforts in the allocation of university resources. Less developed regions have made great efforts to improve the allocation efficiency while fully recognizing the shortage of resources. At the same time, the government should give priority to the key areas of financial expenditure for higher education and strive for an even distribution of per capita educational funds and per capita public funds in colleges and universities.

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