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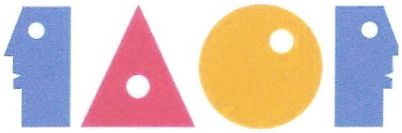

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ANALYZING THE PERFORMANCE OF PRIVATE UNIVERSITIES BY USING DATA ENVELOPMENT ANALYSIS AND MALMQUIST PRODUCTIVITY INDEX ANALYSIS METHODS IN CHINA

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Abstract

The study use BBC model of Data Envelopment Analysis (DEA) and Malmquist Productivity Index to evaluate the performance of twenty three private universities in Shandong Province of China. The thesis clarifies the purpose, content and key factors of the performance evaluation for private universities. The thesis also puts forward advice to help improve the performance based on the proved study results and provides basis for optimizing allocation of resources and evaluating private universities in a scientific way. The thesis aims to promote development of private universities and the development of the whole higher education.

Key words: private universities; performance evaluation; DEA; malmquist

Introduction

Private universities in China carry traits of the age and its own characteristics. It is the result of the four decades' reform and opening up. It was born and grows along with the development of public education amid the social transition from planned economy to market economy. It also develops rapidly with deepening social and economic reforms (QUE, FEI & WANG, 2019). Shandong province is the cradle of Chinese private education, a big province of education and large number of students. The private higher education also grows rapidly in 1990s with the number and size of universi-

ties increasing rapidly. By the end of 2017, the total number of private universities across the province reaches twenty three and the undergraduates' number reaches 184 thousand, taking account of 34. 33% of the total number of local universities, 18. 1% of the total number of undergraduates respectively. The flourishing private universities speed up the popularization of higher education of Shandong province.

The existence of private universities is totally dependent on the multiple choices of students under the competing mechanism. Faced with pressure from domestic and foreign educational markets, private universities must emphasize its own quality and effectiveness (Corazon & Guzman, 2011). Concerns over the quality of private higher education arouse the concerns and actions to initiate accountability of performance of private universities in all sectors of society. For self- development of universities and governments and society, the scientific evaluation of private universities are especially important (Bangi, 2014).

Literature Review

DEA model is the mainstream method to evaluate universities performance. Johnes (2006) discussed advantages and disadvantages of multiple methods to evaluate efficiency of universities. He deems that DEA has notable advantages in handling processes of multiple inputs and multiple output. He also put forward multiple extended models to improve applications of DEA model. He also evaluated more than one hundred universities in the U. K., the results show that their technical efficiency and scale efficiency stands on relatively high level on the whole. Johnes (2006) used DEA and distance function to calculate Malmquist productivity index of one hundred and twelve universities between the year of 1996 and 2004. The result shows that the Malmquist productivity of universities grew at 1. 5% every year on average during the period with the average growth rate of 2. 3% in technology and the decrease of 0. 8% in technical efficiency every year. Thanassoulis and Portela (2002) used DEA to evaluate composition of costs, efficiency and productivity of the U. K. universities.

The result shows that increase of scale efficiency and adjustment of students mix can increase 20% to 27% students. He also used Malmquist productivity index to evaluate the change of productivity of the U. K. Bayraktar (2013) used DEA and stochastic frontier analysis to evaluate the quality management efficiency of Turkey's public and private universities. That proves the relevance between quality management factors and performance factors. DEA research results show that private universities of relatively high quality management efficiency attach importance to performance factors which stakeholders focus on. However, public universities perform relatively better in teaching and

research. Xue (2015) use three- stage DEA model and Malmquist productivity index to study the performance of sixteen universities in JiangSu province between the year of 2009 and 2013. He deems that the level of economic development and educational level have notable influence on universities performance.

Through literature review, it was found that the application of DEA to universities performance is relatively extensive and mature and also proves the effectiveness of DEA. DEA is mainly applied to the public universities performance's evaluation. The study targets the performance evaluation of private universities and expands the coverage and content of DEA theory.

Research Methods

The study decides the evaluation factors of DEA by consulting professionals of private universities' performance evaluation. BCC model of DEA is adopted to measure private universities' performance evaluation, calculate technical efficiency and scale efficiency and discuss the reasons of DEA invalid units and give relevant advice. Then Malmquist productivity index is used to measure technical efficiency and predict the development trend of private universities.

The Model of DEA

Charnes, Cooper and Rhodes (1978) put forward relative efficiency-based multiple- input and multiple output method of analysis——Data Envelopment Analysis or DEA. They established the first model of DEA——CCR model (Charnes, Cooper & Rhodes) to evaluate scale and technical efficiency of decision making units or DMU. Based on axiomatic model, Banker, Charnes and Cooper (1984) offered another model evaluating scale and technical efficiency——BCC model (Banker, Charnes & Cooper). The model replaces constant returns to scale with variable return to scale to make it more convenient to measure relative efficiency of decision units in different returns to scale. In the model of BCC, technical efficiency is divided into pure technical efficiency and scale efficiency which serves as the basis of measuring relative efficiency under the same return to scale. (Bo, 2002).

The basic logic of DEA is to see every evaluated factor as a DMU, and DMUs make up of the evaluated group. The effective production surface should be made through the comprehensive analysis of the ratio of input and output and the calculation based on the variants, namely the weights of input and output factors of DMU. Besides, the effectiveness of DEU should be confirmed in accordance with the distance between each DMU and effective production surface. Projection method can also be used to point out the reasons leading to ineffective DMU and what we should do and how much

we should do.

CCR and BCC are the two basic models of DEA and have the widest coverage. The models' applications are decided by the targets and purposes of performance evaluation. The input and output projects of universities are complicated and influenced by internal and external factors. The returns to scale are variable. Therefore, the thesis chooses input- oriented model- BBC as the model of evaluation.

The Analysis of Malmquist Productivity Index

The Analysis of Malmquist Productivity Index was first put forward by Malmquist (1953), Caves (1982) first used it in calculating changes of productivity. Then it was integrated with the theory of DEA built by Charnes and has been widely applied in the calculation of productivity. Traditional DEA cannot distinguish changes brought by approaching or getting far from relative efficiency and changes of efficiency frontier as time going by (Flegg, Allen, Field & Thurlow, 2003). Therefore, empirical analysis by Malmquist index analysis can help know the directions and trends of the evolvement of production efficiency.

The Source of Data and Research Tools.

The data were produced between the year of 2014 and 2017. The sources of the data mainly come from the investigation of basic statistics of private universities in Shandong province, Statistical Yearbook of Education in Shandong Province, Statistical Yearbook of Shandong Province, The Teaching Quality Report of the Undergraduates in Shandong Province and Report on Employment quality of Universities in Shandong Province which are issued by Shandong Province Office of Education and other universities, the official statistics of different schools. The calculating tools include DEA computing software DEAP2. 0.

Research Findings

In accordance with the traits and working content of private universities, the input factors are as follows: the number of full- time teachers, the number of administrative staff, the number of high- level teachers, the number of books, the value of teaching and research facilities and the area of classrooms; the output factors are as follows: the number of students, the employment rate, the number of advantaged and characteristic majors, funds for projects, the number of research results and the number of patents. Twenty- three private universities are included as the decision- making units of DMU and the statistics are input into DEAP2. 0, the calculating results are as follows.

Table 1. The analyzing results of Malmquist productivity index and DEA of private universities

DMU	crste	vrste	scale		effch	techch	tfpch
1	0. 789	0. 882	0. 894	drs	1. 082	1. 116	1. 207
2	1	1	1	-	1	0. 873	0. 873
3	1	1	1	-	1	0. 918	0. 918
4	0. 813	1	0. 813	drs	1	1. 137	1. 137
5	1	1	1	-	1	0. 667	0. 667
6	0. 971	1	0. 971	drs	1. 01	1. 052	1. 062
7	0. 759	0. 834	0. 909	drs	1. 005	1. 083	1. 087
8	0. 754	0. 764	0. 987	drs	1. 099	0. 979	1. 076
9	1	1	1	-	1	0. 941	0. 941
10	1	1	1	-	1	0. 803	0. 803
11	1	1	1	-	1	1. 006	1. 006
12	0. 988	1	0. 988	drs	0. 965	1. 025	0. 989
13	0. 881	1	0. 881	drs	1. 043	0. 995	1. 038
14	1	1	1	-	1	0. 92	0. 92
15	0. 819	1	0. 819	drs	1. 069	1. 038	1. 11
16	1	1	1	-	1	1. 002	1. 002
17	1	1	1	-	1	0. 899	0. 899
18	1	1	1	-	1	1. 061	1. 061
19	1	1	1	-	0. 936	0. 647	0. 606
20	0. 762	0. 769	0. 991	irs	0. 969	1. 073	1. 039
21	1	1	1	-	1	0. 984	0. 984
22	1	1	1	-	1	1. 044	1. 044
23	1	1	1	-	1	1. 08	1. 08
Mean	0. 94	0. 98	0. 97		1. 007	0. 962	0. 969

Comprehensive technical efficiency analysis

The comprehensive technical efficiency results of fourteen universities testifies to the effectiveness of their DEA, accounting 61% of the whole number of evaluated schools. Twenty- three universities average efficiency is 0. 94. Of all the evaluated universities, nine universities' comprehensive technical efficiency is less than one, demonstrating that their DEA is ineffective. Besides, from the perspective of distribution of total efficiency of decision units, the smallest efficiency value is decision unit eight, the efficiency value is 0. 75 only.

Five of nine universities have

ineffective DEA are due to low scale efficiency. The results show that eight of nine universities with ineffective DEA have decreasing returns to scale, demonstrating the waste of resources in these universities. Besides, for universities with scale efficiency of less than one and decreasing returns to scale, even they expand the size and increase input, they will not have bigger output. Therefore, they should control the expansion of their sizes and avoid their blind investment of resources. Of all decision units, only the return to scale of DMU ten is increasing (irs). That demonstrate input should be added to increase output.

Malmquist productivity index analysis

Malmquist productivity index analysis is the product of technical efficiency changes and technical progress. Technical efficiency can be further divided into pure technical efficiency and scale efficiency. If DEA is used to calculate output- oriented Malmquist productivity index and the result is more than one, that means Malmquist index has positive growth; otherwise, the efficiency decreases.

Average value of Malmquist productivity index changes of thirteen universities is more than one, demonstrating that in the observation period of 2014- 2017, the educational input-output efficiency increases. That means if the input of all productivity factors remain unchanged, the educational productivity can still increase. And the increased productivity belongs to the educational efficiency growth brought by pure technical progress excluding all the tangible productivity factors. Value of Malmquist productivity index changes of ten universities is less than one. The main reason is that technical progress value decreases. That means their education technological level decreases. So dynamics of educational input- output efficiency decline. Data shows that average value of Malmquist productivity index changes of all universities is 0. 969, demonstrating that the productivity of private universities is declining.

The Projective Analysis of DEA Invalid Units

For the universities with invalid DEA, reasons can be found in the projective analysis of decision units in production frontier. DEA can be effective through improving the volume of resources of universities and output.

Input redundancy rate equals to the proportion of the subjection of original data and targeted data of input factors and targeted data. The mean value shows that the four universities with invalid performance have redundancy in all the input factors. The biggest redundancy exsts in books, reaching 52. 74%, and the area of classrooms goes second, reaching 43. 5%.

Table 2. Projective analysis of input factors.

Input factors	Input redundancy rate				
	DMU1	DMU7	DMU8	DMU20	Mean value (mean)
Full- time teachers	13. 39%	23. 33%	30. 93%	30. 01%	24. 41%
Administrative staff	13. 39%	17. 64%	57. 63%	30. 01%	29. 67%
High- level teachers	52. 28%	12. 64%	51. 18%	33. 69%	37. 45%
books	18. 63%	53. 93%	41. 03%	97. 39%	52. 74%
Teaching facilities	27. 28%	12. 64%	30. 93%	30. 01%	25. 21%
Area of classrooms	54. 90%	12. 64%	30. 93%	75. 54%	43. 50%

Table 3. Projective analysis of output factors

Output factors	Insufficient rate of output				
	DMU1	DMU7	DMU8	DMU20	Mean value
Students enrolment	0. 00%	0. 00%	0. 00%	0. 00%	0. 00%
Employment rate	1. 06%	1. 27%	2. 54%	34. 23%	9. 77%
Characteristic majors	97. 56%	99. 42%	99. 23%	97. 49%	98. 43%
Research funds	0. 00%	96. 89%	100. 00%	0. 00%	49. 22%
Research results	0. 00%	0. 00%	99. 98%	99. 27%	49. 81%
Patents	0. 00%	2. 90%	99. 91%	0. 00%	25. 70%

Output insufficiency rate equals to the proportion of the subjection of original data and targeted data of output factors and targeted data. The mean value of 98. 43% shows that the four universities' insufficient rate concentrates in the factor of characteristic majors.

The insufficient output in factors of external research funds and research results are relatively notable.

Conclusion

The study uses BCC of DEA and Malmquist productivity index factor analysis to evaluate the performance and analyze productivity index changes. The result shows that:

The model of DEA is a suitable method to evaluate such multiple inputs and multiple output evaluation objects as universities. It can calculate the relative efficiency of universities and also offers concrete advice to invalid units. The data shows that most of private universities have good per-

formance and can utilize resources effectively. What results to invalid performance is the serious waste of resources. The sizes of universities should be controlled or different outputs should be improved without changing sizes. The main reason of low scale efficiency is redundancy of hardware facilities like classrooms. That is relevant to impulse of expanding private universities. The output of characteristic majors and research results is relatively insufficient. Therefore, existing resources should be fully utilized and policies should be published to increase output and efficiency of running universities.

Between 2014 and 2017, Malmquist productivity index of private universities in Shangdong province declines somewhat, but the extent is modest. The overall efficiency is mainly changed by technological advance. Therefore, it can be concluded that the main reason of decreasing productivity index is backsliding of technology, namely, the non- material factor of the backsliding of educational technology level of private universities. Compare to the performance analysis results under comprehensive factors, Malmquist productivity index of some universities with effective DEA comprehensive performance is less than one and is even far less than other schools. Therefore, even though the resources utilization level is relatively good on the whole, their educational technology level is declining. Efforts need to be made to improve management level, quality of educating and teaching and add educational and research output.

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