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Investigating the Performance of the Healthcare Sector in the Provinces of Iran by Using a Window Analysis in Data Envelopment Analysis

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Abstract
Paying attention to the health of people in the community is one of the main challenges that has received much attention in recent years. Regarding the importance of the healthcare sector in the life of the community, evaluation of the performance of this sector is important. One of the most practical methods for evaluating performance is the use of data envelopment analysis approach. In this paper, changes 's performance of healthcare sector of Iranian provinces in terms of their performance in 1393-1396, using data envelopment analysis along with window analysis are considered. The results show that during 1393-1396, the performance of healthcare sector of the provinces West Azarbaijan, Zanjan, Qazvin, Kohkiluyeh and Boyer Ahmad have improved. performance of healthcare sector of the provinces Isfahan, North Khorasan, Kerman, and Yazd have gotten worse.

Keywords: Data Envelopment Analysis, Healthcare Section, Performance, Window Analysis.

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1. Introduction

Performance review is one of the important issues in evaluating the performance of different organizations. The concept of performance is very important. At the moment, this concept is used in all industries and many articles have been published in this field. In economics, much progress has been made in the field of performance, and the gained theories in this science are based on theories of the great economists and they have got little scientific and mathematical basis. For this reason, the world moves in a way that gains theories, the basis of which is mathematical science. One of this branches is Data Envelopment Analysis (DEA). Data envelopment analysis was introduced by Charnes et al in 1978 and then developed by other researchers. Data Envelopment Analysis is the most practical method for evaluating the performance in efficiency frontier. Data Envelopment Analysis, in addition to performance review, has many other applications such as productivity, resource allocation, and so on. In this study, we use data envelopment analysis to evaluate the performance of healthcare sector during 1393-1396. It is one of the main challenges in every country to survey community health. The health of people of community in the healthcare sector is checked. As a result, the healthcare sector has got a special place in the community, so that the performance of this sector affects the health of the community and also improves the human development index, which is a global indicator. Considering the importance of the healthcare sector, in this article reviews the performance of the healthcare sector in the provinces of Iran during 1393-1396. In Section 2, a review of the studies conducted in the healthcare sector will carry out using data envelopment analysis. In Section 3, the model introduces. In Section 4, we implement the model for real Iranian data

during 1393-1396. Section 5 summarizes the results of this study.

2 .An overview of the done studies

pay attention to healthcare sector has led that invest in this sector that increase productivity labor. An assessment of the performance of organizations is considered as one of the main pillars of the country's development, because one organization has gotten better performance, as a result plays an important role in the development of the country. An investigation about the healthcare sector's performance over the past decades has been the attention case of researchers, with many articles written under the healthcare sector and the health sector itself. In order to evaluate the performance, we need an efficient tool andalso the introduction has been pointed, the best and most commonly used approach is data envelopment analysis. Health sector today is one of the most important services sectors and it is necessary to try to evaluate the performance of the health system. One of the most important priorities of managers is improving healthcare efficiency in order to increase people's satisfaction. By increasing productivity in the organization, managers can achieve the highest organizational goals and the country's progress in the health sector [1]. By using DEA, Linna et al. Reviewed the cost-effectiveness of oral hygiene and its effective factors in the country. The results show the efficiency of 20 to 30 percent of the centers. It also showed that dental health, high unemployment rates and per capita primary care expenditures were more than cost-effective [2]. Due to the importance of government health and education expenditures in the G7 countries, Verhoeven et al. Have evaluated the efficiency of these costs. They consider the underlying causes of inefficiency in countries inappropriate in acquiring real resources such as teachers and medicine, and also point out that higher costs will be less efficient [3]. Using the Data

Envelopment Analysis, Alin et al. Obtained the effectiveness of the health sector in 34 OECD countries, which in the first stage analyzed DEA for 34 countries, and in the second phase, eight countries were eliminated to form a homogeneous group. More accurate results to be obtained. Eleven countries from 26 countries have well-functioning health systems, and in the remaining 15 countries there is a potential improvement in the health sector [4]. Angeliki Flokou et al., Using the Window-DEA method, reviewed the performance of the Greek NHS hospitals in 2009-2013 [5]. Many large-scaled public hospitals have established branched hospitals in China. Jia and Yuan are to provide evidence for strategy making on the management and development of multi-branched hospitals by evaluating and comparing the operational efficiencies of different hospitals before and after their establishment of branched hospitals [6]. Mohebifar et al reviewed the efficiency of 19 educational and medical centers and hospitals of Guilan University of Medical Sciences. Inputs of the number of physicians, number of nursing staff, number of other personnel and number of active beds are considered, and the outcomes of outpatient admission, hospital admission and the number of surgeries are considered as admission days [7]. Jahangiri et al. investigated the productivity of Imam Khomeini hospitals in Arak. The inputs included in this day-bed study, the number of working days each month, the number of general practitioners, the number of specialized doctors, and the number of other personnel and the outputs were considered, Number of outpatient visits, number of admissions, number of surgeries, Number of childbirths, and hospitalization [8]. Lotfi et al. investigated the productivity of 16 hospitals under the Iran University of Medical Sciences. The inputs include the

number of medical and specialized staff, the number of nursing and midwifery staff, the number of other staff and the number of active beds and the outputs considered, the number of busy beds, the number of surgeries and the number of clearance [9]. For further study in this respect can refer to Jahangiri in 1395, in which a systematic overview of the application of data envelopment analysis was conducted in Iranian hospitals. This article concludes that in the last seven years, the interest of Iranian researchers has increased the use of data envelopment analysis in hospitals, especially in Tehran, Yazd and Khuzestan provinces. In the next section, we introduce the used model to examine the performance of the healthcare sector [10].

3. Research Methodology

As already mentioned, data envelopment analysis is a nonparametric method that includes a set of mathematical models. As mentioned earlier, first the input-oriented CCR model was introduced as follows:

$$Min\ \theta$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io} \qquad \forall i$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \qquad \forall r$$

$$\lambda_j \geq 0 \qquad \forall j$$

The above model has a constant return to scale. Then the BCC model was introduced, which has a variable return to scale. A model that we want to use for investigating performance is the BCC model proposed by Banker et al. In the BCC model are used variable return to scale. The input-oriented BCC model is as follows:

$$Min\ \theta$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io} \qquad \forall i$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \qquad \forall r$$

$$\sum_{j=1}^{n} \lambda_j = 1$$
$$\lambda_j \geq 0 \qquad \forall j$$

The BCC model has been used to check the healthcare sector's performance with a window analysis. A window analysis is used to check changes over a period of time. Usually this time analysis is used that the number of the investigated units were low. This study examines changes in the healthcare sector over the period from 1393 to 1396. In the window analysis, we use DEA models in time-dependent conditions. This initial name was originally introduced in 1985. In the window analysis, each DMU is considered at any time as a different DMU (see Cooper for more information).

4. Solve the model with the real data of the health department

This study is a kind of applied study. The research community consists of the healthcare sector of the health system of Iran. Information is collected by library documentation, internet sites, statistics management and information technology of medical universities of medical provinces during the period Time was collected from 1393 to 1396. Using the analytical hierarchy process (AHP), indicators of the healthcare sector were determined. Finally, among the various indicators, the following indicators were used to examine the performance of the healthcare sector from the inputs and outputs below Has been:

Inputs: The ratio of the number of available beds to the population of the province, the ratio of the number of health centers and health houses to the province's population, the ratio of the number of laboratories, pharmacy and radiology to the population of the province.

Outputs: The ratio of the number of nurses to the population of the province, the proportion doctors of employee to the population of the province.

For each province, the above data has been collected during the period from 1393 to 1396. We have implemented the model for two three-year periods. The first period is from 1393 to 1395, and the second period is from 1394 to 1396. The results of model implementation are shown in Table 1. According to the columnar average in Table 1, the least efficiency is related to Kurdistan province in 2014.

Regarding the efficiency row changes in Table 1 for West Azarbaijan, Zanjan, Qazvin, Kohkiluyeh and Boyer Ahmad provinces, it can be concluded that these provinces have increased their performance over time.

For the provinces of Tehran, Sistan and Baluchestan and Qom changes in the performance score are fixed, which suggests that these provinces have steady behavior during the change of time. The provinces of Isfahan, North Khorasan, Kerman, and Yazd changes have declined their performance scores. Consequently, it can be concluded that these provinces have declined their performance over time. Other provinces have had different behaviors over a different time period.

5. Conclusions and suggestions

Considering that in many cases there is not standard of coordination for evaluation of educational, health and medical centers in Iran [12], Therefore the present study aims to determine the productivity of Iran's provinces in the healthcare sector by using A window analysis in data envelopment analysis has been done. The results of this study showed that the ability to identify decision making units that they have got the best performance among the units studied is one of the acclaim capabilities of data envelopment analysis.

In this regard, senior health managers cannot truly have done more accurate planning for capacity development of health services and save resources.

Table 1. Results of model

.		1393	1394	1395	1396	
East Azarbaijan	first period	0.94	0.81	1		0.92
	Second period		0.82	1	0.75	0.86
		0.94	0.815	1	0.75	
Western Azerbaijan	first period	0.83	0.83	0.83		0.83
	Second period		0.84	0.84	0.84	0.84
		0.83	0.835	0.835	0.84	
Ardebil	first period	1	0.73	0.73		0.82
	Second period		0.77	0.77	0.77	0.77
		1	0.75	0.75	0.77	
Esfahan	first period	0.73	0.73	0.73		0.73
	Second period		0.73	0.73	0.65	0.7
		0.73	0.73	0.73	0.65	
Ilam	first period	1	0.79	0.66		0.82
	Second period		0.78	0.65	0.75	0.73
		1	0.785	0.655	0.75	
Bushehr	first period	0.91	0.9	0.87		0.89
	Second period		0.9	0.87	0.9	0.89
		0.91	0.9	0.87	0.9	
Tehran	first period	1	1	1		1
	Second period		1	1	1	1
		1	1	1	1	
Chaharmahal va Bakhtiari	first period	0.82	0.72	0.78		0.77
	Second period		0.71	0.77	0.77	0.75
		0.82	0.715	0.775	0.77	
Southern Khorasan	first period	0.89	0.85	0.89		0.88
	Second period		0.79	0.8	0.8	0.8
		0.89	0.82	0.845	0.8	
Khorasan Razavi	first period	0.83	0.83	1		0.89
	Second period		0.83	1	0.83	0.89
		0.83	0.83	1	0.83	
North Khorasan	first period	0.91	0.94	0.91		0.92
	Second period		0.88	0.84	0.84	0.85
		0.91	0.91	0.875	0.84	
Khuzestan	first period	0.85	0.82	1		0.89
	Second period		0.81	1	0.81	0.87
		0.85	0.815	1	0.81	
Zanjan	first period	0.72	0.65	0.72		0.7
	Second period		0.8	0.86	0.84	0.83

		0.72	0.725	0.82	0.84	
Semnan	first period	0.79	1	0.79		0.86
	Second period		1	1	1	1
		0.79	1	0.895	1	
Sistan and Baluchestan	first period	1	1	1		1
	Second period		1	1	1	1
		1	1	1	1	
Fars	first period	0.67	0.74	0.71		0.71
	Second period		0.73	0.74	0.82	0.76
		0.67	0.735	0.725	0.82	
Qazvin	first period	0.81	0.91	0.91		0.88
	Second period		0.89	0.89	0.95	0.91
		0.81	0.9	0.9	0.95	
Qom	first period	1	1	1		1
	Second period		1	1	1	1
		1	1	1	1	
Kurdistan	first period	0.36	0.39	0.34		0.36
	Second period		1	0.44	0.67	0.7
		0.36	0.695	0.39	0.67	
Kerman	first period	0.8	0.8	0.8		0.8
	Second period		0.79	0.79	0.79	0.79
		0.8	0.795	0.795	0.79	
Kermanshah	first period	0.83	0.86	0.83		0.84
	Second period		0.88	0.84	0.84	0.85
		0.83	0.87	0.835	0.84	
Kohkiluyeh and Boyer Ahmad	first period	0.96	0.99	1		0.98
	Second period		1	1	1	1
		0.96	0.995	1	1	
Golestan	first period	0.81	0.74	0.81		0.79
	Second period		0.78	0.84	0.84	0.82
		0.81	0.76	0.825	0.84	
Gilan	first period	0.67	0.69	0.83		0.73
	Second period		0.68	0.83	0.73	0.75
		0.67	0.685	0.83	0.73	
Lorestan	first period	0.93	0.9	0.73		0.85
	Second period		0.86	0.73	1	0.86
		0.93	0.88	0.73	1	
Mazandaran	first period	0.98	0.73	1		0.9
	Second period		1	1	0.87	0.96
		0.98	0.865	1	0.87	
Markazi	first period	0.75	0.85	0.77		0.79
	Second period		0.83	0.75	0.74	0.77

		0.75	0.84	0.76	0.74	
Hormozgan	first period	1	0.85	1		0.95
	Second period		0.83	1	0.92	0.92
		1	0.84	1	0.92	
Hamedan	first period	0.93	1	0.77		0.9
	Second period		1	0.76	0.81	0.86
		0.93	1	0.765	0.81	
Yazd	first period	0.95	0.77	0.76		0.83
	Second period		0.8	0.78	0.78	0.79
		0.95	0.785	0.77	0.78	

Therefore, relying on the obtained results from the present study and based on the proposed model, they show that during 1393-1396, the performance of healthcare sector of the provinces West Azarbaijan, Zanjan, Qazvin, Kohkiluyeh and Boyer Ahmad have improved. These units can be arranged as reference units for other provinces in the healthcare sector. That is, these units are of all capacities in the indicators "The ratio of the number of available beds to the population of the province", "the ratio of the number of health centers and health houses to the province's population", "the ratio of the number of laboratories" and "pharmacy and radiology to the population of the province". So, for other units, they can be selected as a template. In this article, we examined the performance of the healthcare sector during the period from 1393 to 1396 within the context of data envelopment analysis. The model that we used to evaluate performance is the BCC model, which has a variable return to scale. The obtained results for the healthcare sector of the provinces during 1393-1396 show that the performance of most of the provinces has improved in the healthcare sector. Studies such as these studies are important not only in healthcare but in all sectors of the economy.

Therefore, based on the results of the above study as as an approach to improve productivity, other top managers of the health sector of other provinces of the country top managers of the health sector of the provinces West Azarbaijan, Zanjan, Qazvin, Kohkiluyeh and Boyer Ahmad can be put as the reference.

Another important point in the healthcare sector is that, in allocating health budgets to different provinces of the country, the new approach, due to the high accuracy and reliability, can be considered as an appropriate performance measure by planners.

In specially, in the current situation, the government's approach to allocating budget is based on performance-based budgeting. On the other hand, other provinces through improved quantitative and qualitative services, increased satisfaction of patients, continuous evaluation of the performance and increasing the number of physicians employed in the university can be directed towards efficiency and resource saving.

With the implementation of this study, can provide more effective approach to the top managers of healthcare sector to use more accurat planning for capacity development of healthcare services and saving resources.

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