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Extended Abstract

Evaluating the Water and Wastewater Enterprises in Provincial Water Sector Using Mathematical Programming Model

J. Rezaee [1*] ***, H. Eydmohammadzadeh*** [2], ***M. Faghihnasiri*** [3] ***and A. Garshasbi*** [4]

Introduction

The optimal allocation of resources has always been a challenging issue for human life. It is important especially in allocating the factors of production in order to insert the choices that among other allocating options yield better living standards for humans.

The best allocation is achieved if factors are used in an "efficient" methods Understanding the concept of "efficiency" is the starting point in this process.

Objectives

In this paper, the operational efficiencies of the Iranian provincial Water and Wastewater Enterprises are investigated. It is also examined whether the existing resources are allocated in an efficient manner. Economic development is simply formed over efficient allocation.

Methodology

Using non-parametric methods, which are mathematical programming, we will evaluate the efficiency of companies.

In the non-parametric methods, there is no need to specify any production function. More than one output can be considered in these methods. Data envelopment analysis is one of the non-parametric methods that use programming techniques to analyze a companies efficiency. The DEA model is formulated as follows (Banker et al., 1984):

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$$Minimize\ \theta \qquad (1)$$

$$S.t\ -\sum_{r=1}^{s} u_r Y_{ro} + \sum_{r=1}^{s} \lambda_j Y_{ij} \geq 0 \quad j = 1,2,...,n \qquad (2)$$

$$\theta \sum_{i=1}^{m} v_i X_{io} - \sum_{i=1}^{m} \lambda_j X_{ij} \geq 0 \qquad (3)$$

$$\lambda \succ 0 \qquad (4)$$

Parametric methods are useful for analyzing efficiency with just one output or multiple outputs that can be converted into one.

Assume that we are going to compare two educational units that have more than one output. For example, the number of graduates and accepted scientific papers in reputed journals in each unit can be used as outputs. If

1- M.A. in Economics, Faculty member, Institue For Trade Studies & Research, E-mail: jrezaea@yahoo.com (Corresponding Author)
2- M.A. in Economics, Faculty member, Allameh Mohadese Noori, E-mail: H_mohazadeh@yahoo.com
3- Ph.D. in Economics, Assistant professor, University of Payame Noor, E-mail: marjanin@yahoo.com
4- M.A. in Economics, Expert, Deputy Ministry for Planning and Economic Affairs, E-mail:h_garshasbi13@yahoo.com
*- Corresponding Author

we are not able to integrate these two outputs then the parametric method cannot be used (Cooper et al., 1999). This is because there would be no unique output to estimate a frontier production function. Moreover, in parametric methods we should specify the production function form and classical assumptions about random error terms may be violated.

Discussion of Result

In this study the DEA model is used to solve the problem. In this method, first, we created a virtual unit which is a linear combination of the other units. Then to evaluate the efficiency, we compared the output of the virtual unit obtained based on the inputs of a decision unit with the real output of that unit (Charnes et al., 1994).

In this paper, using the inputs and outputs for the Iranian year of 1385, we assess the efficiency of the provincial Water and Wastewater Enterprises with the DEA model. We have used both Constant Return to Scale (CRS) and Variable Return to Scale (VRS). Table (1) shows the results of the model.

Table 1-Efficiency of the provincial water utility companies in year 2006

Returns to Scale	SE (Scale Efficiency)	AE (Allocative Efficiency)	TE (Technical Efficiency)	Province
Decreasing	۰/785	۰/934	۰/733	East Azarbayjan
Decreasing	۰/843	۰/829	۰/699	West Azarbayjan
Increasing	۰/997	۰/558	۰/566	Ardebil
Decreasing	۰/816	۰/766	۰/626	Esfehan
Increasing	۰/993	۰/527	۰/523	Khozestan
Increasing	۰/759	1	۰/759	Ilam
Increasing	۰/851	۰/840	۰/715	Boshehr
Constant	1	1	1	Tehran
Increasing	۰/929	۰/722	۰/671	Chaharmahal and Bakhtiyari
Decreasing	۰/956	۰/739	۰/706	Khorasane Razavi
Increasing	۰/744	۱	۰/744	Southern Khorasan
Increasing	۰/730	۰/985	۰/719	Northern Khorasan
Constant	1	1	1	Zanjan
Increasing	۰/815	1	۰/815	Semnan
Constant	1	1	1	Sistan and Balochestan
Constant	۰/818	1	۰/818	Fars
Constant	1	1	1	Qazvin
Increasing	۰/803	۰/875	۰/702	Qom
Increasing	۰/969	۰/549	۰/527	Kurdistan
Decreasing	۰/999	1	۰/999	Kerman
Increasing	۰/990	۰/736	۰/729	Kermanshah
Constant	1	1	1	Kohkeloye and Boyerahmad
Increasing	۰/936	۰/908	۰/850	Golestan
Decreasing	۰/942	۰/520	۰/490	Gilan
Decreasing	۰/969	۰/793	۰/768	Lorestan
Constant	1	1	1	Mazandaran
Constant	1	1	1	Markazi
Constant	1	1	1	Hormozgan
Constant	1	1	1	Hamedan
Increasing	۰/987	۰/733	۰/724	Yazd
	۰/219	۰/867	۰/796	Average

Conclusion

The results showed that for year 1385 the average of the technical efficiency index of companies was 0.796 which is not an ideal number. Besides. only 9 companies were operating in 100 percent efficiency. However, allocated efficiency of the companies was in average of 0.867, which was fair, such that 14 companies in this index were efficient. In addition, the scale efficiency was in average of 0.921, which showed better status. Finally, it can be concluded that 21 percent of the network capacity is not used and benchmarking from Hamedan Company can optimize the performance of the network as well as using network capacity completely.

Keywords: Technical Efficiency, Management Efficiency, Scale Efficiency, Data Development Analysis, Mathematical Programming.

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