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Manpower Efficiency in Electricity Producer Companies in the View of Economic Management; Some Approaches for Increment of Efficiency in Inefficient Companies by DEA

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Abstract

Nowadays, successful organizations are those that have responsible and efficient manpower. Organizations are always in varying and ever change owned equipments, approaches, careers and procedures, and lead them to up to date. Maintenance of an organization in competition with other organizations requires successive review on skills, abilities, efficiency of manpower and renews them. Improvement in manpower efficiency in the recent decades has been increasingly growing. Specially, because of governmental supports on instructional subsidies.

In that, manpower nor as production factor, but assume as combiner of other factors in production function and because of so far haven't been

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presented any scientific model about manpower, in this article, after assessment of effectiveness indices on efficiency of the above companies from aspect of economic management by DEA, the amount of efficiency of electricity producer companies and roots of inefficiency related to the units has calculated. Then with presentation of some approaches that are based on linear programming, some suggestions have presented for creation of efficient companies from aspect of managerial and economic approaches.

Keywords: Data Envelopment Analysis; Economic management; Linear programming; Efficiency; Decision making units; Multiple objective programming; common set of weights

1 Introduction

Data Envelopment Analysis (DEA), as developed in Charnes et al. [1] (CCR model), does not require any a priori weights for inputs and outputs. DEA is value-free, which is strength and a weakness. This strength is sufficient to delineate the DEA technically-efficient DMUs from the DEA technically-inefficient DMUs in multiple-input and multiple-output analysis, without any need for a parametric specification. However, values (prices/costs) must be introduced into the measurement problem to measure technical efficiency.

As a means of introducing values into a DEA analysis, one might assume that the production unit faces fixed input and output prices for all inputs and outputs, then, efficiency measures may be defined relative to these exact prices.

Between these value-free and value-exact approaches, Thompson et al. [8,9] used DEA to analyze six Texas sites for location of a high energy physics lab. They used boundary conditions (bounds) for the virtual multipliers in DEA standard models. Solutions to these models identified only one efficient DMU for location of the lab in Texas.

Recently, a series of possible approaches for setting bounds on factor weights in DEA have been put forward. The general approaches are presented in Dyson et al. [4], Charnes et al. [2], Roll et al. [6,7].

Imposing bounds on factor weights, limits the flexibility of DEA in assigning individual sets of weights to each of the participating DMUs. In the extreme case, when no flexibility is allowed, a Common Set of Weights (CSW) is applied for the assessment of all DMUs. This is the usual approach in all engineering, and most economic efficiency analyses. Such a common set can serve as a yardstick to which the results of the ordinary ("flexible") DEA outcomes are compared.

Some methods to find CSW are proposed in Roll et al. [6,7] and Hosseinzadeh et al. [5]. The main difficulties about these methods are imposing the bounds on variables, and nonlinearity of models.

The paper is organized as follows: Section 2 provides a short background about basic DEA models. The CSW notion in DEA is presented in section 3. To demonstrate the feasibility of the proposed procedure, an illustrated example is presented in section 4. Section 5 closes with conclusion.

2 Basic DEA models

The evaluation of a DMU has long been recognized to be a problem of considerable complexity. This evaluation becomes more difficult when it involves multiple inputs and multiple outputs, in that a set of weights has to be determined to aggregate the outputs and inputs separately to form a ratio as the efficiency. To do so, DEA approach is proposed, which allows every DMU to select their most favorable weights while requiring the resulted ratio of the aggregated outputs to the aggregated inputs of all DMUs to be less than or equal to 1.

Consider n DMUs, each consumes varying amounts of m different inputs to produce s different outputs. In the model formulation, and denote, respectively, the nonnegative input and output values for DMU_p, the DMU under consideration.

The seminal programming statement for the (input oriented) CCR model is:

$$\max \frac{\sum_{r=1}^{s} u_r y_{rp}}{\sum_{i=1}^{m} v_i x_{ip}} \tag{1}$$
$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \quad j = 1, ..., n,$$
$$u_r,\ v_i \geq \epsilon \quad r = 1, ..., s,\ i = 1, ..., m,$$

where v_i $(i = 1,\ \ldots,\ m)$ and u_r $(r = 1,\ \ldots,\ s)$ are the weights associated with input i and output r, respectively and ϵ is a non archimidian infinitesimal.

The presented model is a linear fractional programming problem and can be solved by transforming to a linear programming problem as:

$$\max \sum_{r=1}^{s} u_r y_{rp} \tag{2}$$
$$\text{s.t} : \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \quad j = 1, ..., n,$$
$$\sum_{i=1}^{m} v_i x_{ip} = 1$$
$$u_r,\ v_i \geq \epsilon \quad r = 1, ..., s,\ i = 1, ..., m.$$

Dual of (2) is as follows:

$$\min \theta - \epsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+) \tag{3}$$

$$\text{s.t}: \sum_{j=1}^{n} \lambda_j x_{ij} - \theta x_{ip} + s_i^- = 0 \quad i = 1, ..., m,$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{rp} \quad r = 1, ..., s,$$

$$\lambda_j,\ s_r^+,\ s_i^- \geq 0 \quad j = 1, ..., n,\ r = 1, ..., s,\ i = 1, ..., m.$$

Inefficient DMU_p can project on efficiency frontier by following projection:

$$(X_p, Y_p) \rightarrow (\theta^* X_p - s^{-*}, Y_p + s^{+*})$$

In (3) DMU_p is an efficient DMU if and only if:
i) $\theta^* = 1$,
ii) $s_r^{+^*} = s_i^{-^*} = 0$ for each i and r.
where,"$*$" shows the optimal solution.

3 Common set of weights

Apart of from the restriction that no weight may be zero, weights on inputs and outputs are only restricted by the requirement that they must not make the efficiency of any DMU more than 1. The advantage of allowing such freeness on the weights is that, a best efficiency rating is associated to each DMU. However, in this flexibility, some of the weights may be assigned an exceedingly small value. Also, as a different model is run for each DMU, the set of weights will typically be different for each DMU, and it is unacceptable that the same factor has widely different weights. To control the flexibility of weights, the bounded DEA models are proposed.

Imposing bounds on factor weights, limits the flexibility of DEA in assigning individual sets of weights to each of the participating DMUs. In the extreme case, when no flexibility is allowed, a CSW is applied for the assessment of all DMUs. This is the usual approach in all engineering, and most economic efficiency analyses. Such a common set can serve as a yardstick to which the results of the ordinary ("flexible") DEA outcomes are compared. A method to find CSW is proposed in Hosseinzadeh et al. [5]. They considered following multiobjective problem:

$$\max \left\{ \frac{\sum_{r=1}^{s} u_r y_{r1}}{\sum_{i=1}^{m} v_i x_{i1}}, \frac{\sum_{r=1}^{s} u_r y_{r2}}{\sum_{i=1}^{m} v_i x_{i2}}, ..., \frac{\sum_{r=1}^{s} u_r y_{rn}}{\sum_{i=1}^{m} v_i x_{in}} \right\} \tag{4}$$

$$\text{s.t}: \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \quad j = 1, ..., n,$$
$$u_r,\ v_i \geq \epsilon \quad r = 1, ..., s,\ i = 1, ..., m.$$

(4) is a fractional programming with multiple objectives, in which each objective function has goal equal 1. By introducing n deviational variables and as no priority is considered for the objective functions, they converted (4) as follows:

$$\min \sum_{j=1}^{n} z_j \tag{5}$$
$$\text{s.t}: \sum_{r=1}^{s} u_r y_{rj} + z_j \sum_{i=1}^{m} v_i x_{ij} - \sum_{i=1}^{m} v_i x_{ij} = 0 \quad j = 1, ..., n,$$
$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \quad j = 1, ..., n,$$
$$u_r,\ v_i \geq \epsilon \quad r = 1, ..., s,\ i = 1, ..., m, \qquad z_j \geq 0 \quad j = 1, ..., n.$$

In (5), instead of solving n linear programming problem, only one nonlinear programming problem is solved and the efficiency for all DMUs are obtained by the achieved CSW as follows:

$$e_p = \frac{\sum_{r=1}^{s} u_r^* y_{rp}}{\sum_{i=1}^{m} v_i^* x_{ip}}$$

4 Application

The study and research in the effects of management economics approaches on increment of manpower productivity is important because of following reasons:

Today's, staff don't recruit in industrial, service units and organizations until do physical works only base of managers thought, but they have thought themselves. They both think and do physical works. Management economics approaches have important effects in increment of manpower productivity in producer companies. The manpower key role is thereat that only human can improve quantity and quality of himself work, present new plans, resolve problems by himself creativity, increase his efficiency and find cost decrement ways. In other word, manpower is only one factor that can changes in himself and his environment.

The managers increase manpower productivity with affection on participation possibly and decision making, exertion of reward and punishment, creating of friendly relation with the staff and constantly improvement in the affairs.

Therefore the role of management is distinguished in the organization objectives and it is necessary that do some studies and researches until recognize effected factors on management way and its effect on staff, then determine indices for their measurement until from appraisal this indices in companies, determine their strong and weakness points in view of economic management approaches and then present necessary proposals to their improvement.

DMUs in this appraisal are heat power stations in throughout of the country (vapoury, gas and compound cycle power stations). There are many indices about managerial approaches in heat power stations which after study and discussion with power stations experts and the scope of management in Tavanir company have determined following key indices: Information about the management (oldness-experience-educational course and etc. The cost of reward and punishment, total number of staff, the cost of research and presentation of method and recipe, satisfaction of staff about managerial approaches, and so forth. In order to determine of the above indices amount in the varying power stations was required two kind of information as follows:

I. Some information that must get from varying units of power stations, such as information related to the cost of reward, research and so forth that for this purpose an information from designed.

II. Some information that must got from the staff, such as effectiveness of management approaches between them. For this purpose a questionnaire designed and completed by 20 per cent of the staff at random. At last this study performed on basis of received data from to 10 power stations. With due to number abundance of purposed indices, following inputs have determined as combination of above indices.

Inputs	Outputs
1. Cost of per head 2. Education and experience of management board	1. satisfaction of staff about management

Table 1. Inputs and outputs

Above data is related to 1999 for the heat power stations in throughout of the country.

5 Conclusion

With performance of CCR model that considering purposed population seems the beat model, following results is obtained:

5.1 Results

With attention to selected indices and combination of them, inputs and outputs have calculated on basis of the questionnaires and data forms as following table.

DMU	Input1	input2	Output
01	0.49317	0.96654	0.89555
02	0.48369	0.98980	0.84530
03	0.34632	0.97640	0.95473
04	0.54484	0.95277	1.00000
05	0.69094	0.92339	0.83291
06	1.00000	0.95390	0.99482
07	0.57672	1.00000	0.93614
08	0.43292	0.84319	0.94335
09	0.44820	0.98153	0.48875
10	0.83123	0.95258	0.83413

Table 2. Inputs and outputs

Obtained results from performance of the software on quantities of table 2 are explained in the table 3.

DMU	NLP	CCR
01	0.83	0.85
02	0.76	0.78
03	0.87	1.00
04	0.94	0.94
05	0.81	0.81
06	0.94	0.94
07	0.84	0.84
08	1.00	1.00
09	0.77	0.81
10	0.78	0.78

Table 3. Efficiencies by NLP and CCR models

In the table 3, first column until fifth show the code of power station, the amounts of obtained efficiency from performance models (6), (3) and the amounts of slack variables. With see to columns 2 and 3 in the table (3) we understand that can use model (6) as a suitable estimation for CCR model. For calculation by CCR model, it must be solved this model to number of DMUs of linear programming. In this case the amount of efficiency for all DMUs will obtain only with solving model (6) one time.

5.2 Proposals

In return to table (3) and performing calculations will observe with considering new inputs and slack variable, only in 10 the studied power stations will maintained staff satisfaction in the available level with economy in the first input nearly amount of 700 million toman. The preference calculations can consider in decision making of major managers in electricity industry.

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