

IMPORTANCE OF APPLYING DATA ENVELOPMENT ANALYSIS IN CASE OF HIGHER EDUCATIONAL INSTITUTIONS

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Abstract: *Today, the saying predominates better and better according to which a strong target rationalism has to characterize the higher educational institutions due to the scarce resources and the limitlessness of user demands. Now in Hungary, the funding of higher educational system goes through a total transformation thus the leadership has continuously to reckon with the changes of environment and, in tune with these ones, has to modify the goals existing already. Nowadays, it becomes more and more important to measure the effectiveness of the organizations – organizational units pursuing the same or similar activities relative to each other. Benchmarking helps this procedure. Benchmarking is none other than such a tool of analysis and planning which allows comparing the organizations with the best of the competitors. Applying the method with regard to the higher educational institutions is really nothing but a procedure which focuses on comparing processes and results of the institutions' different functional areas in order to bring to light the opportunities for the rationality as well as the quality and performance improvement. Those benefits could be managed and used as breakthrough possibilities which have been already developed/applied by other organizations and are given by the way leading to a more effective management. The main goal of my monograph is to show a kind of application of Data Envelopment Analysis (DEA) method in the higher education. DEA itself is a performance measuring methodology which is a part of benchmarking and uses the linear programming as a method. By means of its application, the effectiveness of different decision-making units can be compared numerically. In our forcefully varying environment, the managerial decision making can be largely supported in each case by such information that is numerically able to identify which organizational units and activities are effective or less effective. Its advantage is that there is no need to know any of the function-like relations itself for applying this method. The method interprets the effectiveness as a quotient which is defined by the inputs used in the functioning and the outputs arisen from the inputs. The method is already applied in other countries because, beyond its main benefit (being able to work with small element number), it is also suitable for measuring effectiveness of the non-profit sector. In spite of this, DEA methodology has not been really wide-spread in our country yet. The performance measurement forms an important part of the institutions' everyday operation since the resources are barely available and a targeted effective utilization helps to maintain a long-term and competitive functioning in the future.*

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1. Introduction

Almost in each country of the European Union, a comparative analysis method of some kind is used for measuring competitiveness of higher educational institutions. Data Envelopment Analysis (DEA) can be defined as such a linear, nonparametric programming method by means of which the effectiveness of the determined decision-making units can be compared on a totally mathematical basis. (Fenyves and Tarnóczy, 2014)

This study draws attention to that the performance measurement would also be required in case of the non-profit organizations performing same or similar activities and the application of DEA method could be a great support. Now, the biggest problem is caused by the fact that this method is still not widely known in Hungary.

2. Performance measurement and its role in the higher education

Performance measurement forms an important part of the controlling processes of higher educational institutions because it has a key role in the preparation, planning and feedback of managerial decisions on distributing the resources. (Lábas, 2014).

It is true that the comparison of plan and fact data to each other is suitable for measuring the performance but it can be considered as partly outmoded, due to the lengthy time range, because a continuous, real-time controlling action is needed nowadays due to the permanent change of environment.

According to the definition of Neely, Gregory and Platts (1995) : Performance measurement is defined as the process of quantifying the efficiency and effectiveness of action.

The categories of efficiency as well as effectiveness can also be defined as internal or external dimensions of the performance itself. The efficiency, the 'external' effectiveness can be grabbed by that the higher educational institutions do what they have to do (to do the right things) while, on the other hand, the effectiveness means that they do as they have to do (to do things right). These two dimensions cannot be separated from each other acutely since the improvement of effectiveness is useful only in that case if it happens in the interest of reaching the appropriate outcome

Consequently, the efficiency of an organization implies whether the organization follows the proper goals, while the organizational effectiveness indicates whether the organization is able to reach the appointed goals and to use the available resources economically. (Dobák, 1996).

3. Performance comparison

In 1985, Andrei Shleifer worded the theoretical basis of the regulatory performance comparison which presented that the data of natural monopolies providing same services and acting under similar conditions can be used for regulating other companies as well (Shleifer,1985).

Regarding that the effectiveness can be measured in case of the higher educational institutions as well, Shleifer proved that information resultant from other companies can be used for incentive even if the companies are not homogeneous but an adequate correction of the information originating from heterogeneous companies happens with respect to the observable differences. This is the essence of yardstick regulation.

Based on the logic of method, the followings can be worded in this case; if the applied technologies of the organizational units chosen for pattern are similar then the performance of the organizational units cannot be totally independent from each other, either. Namely, if a higher educational institution performs worse than the other institutions in the pattern then it can be influenced by not merely the technology or the environment.

The reasons lie in totally other matters since the other institutions, which can perform better, are operated among similar abilities.

My monograph is going to present benchmarking including DEA which can support the matching of the performances of higher educational institutions by means of defining the effective level and the deviation from that.

That higher educational unit has a better effectiveness – performance which is able to reach the same output level at a lower input level or able to reach a higher level output at the same level of input.

4. Benchmarking

Benchmark means such a reference point which other organizations cannot be matched or compared with. Accordingly, benchmarking determines the procedure when the above-mentioned reference point can be ascertained.

Numerous variants of comparative methodologies examining the relative effectiveness are known in case of the higher educational institutions operating in the environment regulated better and better. These analytical methods determine the current level of effectiveness actually based on data of the pattern. Performance of the individual organizational units included by the pattern is compared to the current level of effectiveness.

The following approaches can be applied to determine the level of effectiveness used for comparison:

- At first, the limit of effectiveness i.e. the maximum available performance needs to be determined and compared to performance of the others.
- Determining the average performance and comparing the others to it.

In practice, the second approach is more realistic because not only the most effective institution subsists in the market but operation of less effective participants can also be maintained. On the other hand, if the given benefits are applied suitably then it will greatly contribute to a long-term sustainable operation.

It can also be stated that whichever method will be applied, a lagging behind from the benchmark score indicates an inadequate performance, a performance deficiency.

However, a deviation from the determined effectiveness could have serious financial impacts so it matters how accurate and undistorted the given method is and what statistical error it works with.

(Pápai et al, 2012)

The consequences stated by the regulator as well as the conditions of application have to calculate with the uncertainty in the results since there is no need to suppose a performance lag behind each seeming backlog. (Pápai et al, 2012).

The regulatory comparative methods can be grouped in severally ways:

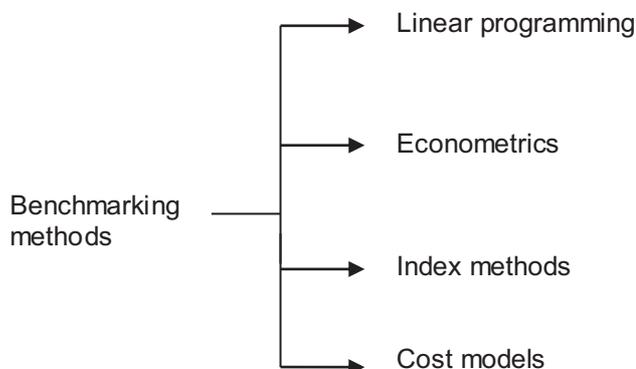


Figure 1: Grouping of benchmarking methods

Source: Own illustration

A kind of grouping possibility for benchmarking methods can be seen on Figure 1, within framework of which four main types have been determined.

Several factors need to be taken into account in order to choose the adequate methodology because it is true for each of listed above that these ones are comparative methods of examination.

A larger amount of data is required for applying the more complex methods, and nevertheless, it can also be ascertained how sensitive the given results are to specification of the model.

If the element number involved in the examination is small then, during the comparative analysis, such a method has to be applied which is less sensitive to the element number. Yet, in this case, a negative impact could arise from that the results are more unreliable and it is not certain that the supposed lag derives from the deviation of effectiveness but it can be possible that this is a consequence of the ignored heterogeneity.

Viewpoints helping to choose the appropriate methodology:

- Robustness
- Practical applicability
- Transparency
- Restrictive assumptions
- Consistency with the economic theory accepted with regard to running of organizations and the markets
- Consistency with statements, analyses having other purposes
- The regulatory burden should have a tolerable degree
- The data cannot be manipulated (Pápai et al, 2012)

In this study, the possibility of applying DEA method based on the linear programming process will be presented only.

5. DEA method

Data Envelopment Analysis (non-parametric, deterministic procedure) also known as enveloping surface analysis when an envelope meaning the limit of effectiveness has to be determined based on the functioning data of higher educational institutions.

Charnes, Cooper and Rhodes worked out the DEA methodology first in 1978. (Charnes et al, 1978). Charnes had redefined the method as a mathematical programming problem and, later, this performance measuring methodology unbrokenly developed thanks to the evolution of computers. (Charnes, 1994; Sherman – Ladino, 1995; Cooper et al., 2004a). However, it is important to mention that Farrel worded the basic idea of this analysis method in 1957. (Farrel, 1957)

The elementary aim of the method is to determine which units of the higher educational institutions having more input and output variables are operated efficiently and less efficiently:

- a decision making unit is not effective if there is another unit performing better with regard to every output;
- other decision making units, which can be considered as effective, are appointing a limit of effectiveness represented in an input-output coordinate system.

It can be concluded in summary that the envelope is appointing that limit where the maximum of effectiveness is and the less effective decision making units are located within this. Yet this limit of effectiveness is not fixed since the effectiveness can be improved anytime. In this way, the organizational units are put at performance disadvantage or advantage.

With regard to DEA analysis method, it is of outstanding importance that:

- DEA can also be applied in case of smaller element number because this is a nonparametric method,
- this banks upon input and output data themselves which are observed in reality. Accordingly, the method dispenses with the possible measuring errors and that the results come out not only based on activity of the leadership; thus the input data are not influenced by the unobservable and accidental effects.

Consequently, Data Envelopment Analysis does not take the effects of coincidences into account. The basic essence of this method resides in that it gives the lower enveloping surfaces of the higher educational institutions involved in the investigation by appointing the input and output coordinates in a two-dimensional space.

5.1. Advantages of using DEA methodology

Charnes describes DEA as a new way of organizing and analyzing data, which can result in new managerial and theoretical insights. They highlight the following properties of DEA which make it an attractive approach to data analysis:

- Focus on individual observations in contrast to population averages.
- Produce a single aggregate measure for each DMU in terms of its utilization of input factors to produce desired outputs.
- Can simultaneously utilize multiple outputs and multiple inputs with each being stated in different units of measurement.
- Can adjust for exogenous variables.
- Can incorporate categorical variables.
- Are value free and do not require specification or knowledge of a priori weights or prices for the inputs and outputs.
- Place no restriction on the functional form of the production relationship.
- Can accommodate judgement when desired.
- Produce specific estimates for desired changes in inputs and/or outputs for projecting DMUs below the efficient frontier onto the efficient frontier.
- Are Pareto optimal.
- Focus on revealed best-practice frontiers rather than on central-tendency properties of frontiers.
- Satisfy strict equity criteria in the relative evaluation of each DMU. (Charnes et al, 1994)

5.2. Application areas of DEA

Since the first application of DEA for measuring the efficiency of schools the technique has been applied in over 50 industries to date (Charnes, 1978). Some of the application areas include the financial industry, the airline industry, the healthcare industry, the brewing industry, transportation, athletics, the farming industry, the computer industry, the mining industry, the software industry, and the U.S. army and so on. (Paul, 1997)

In my opinion, DEA analysis method could be the most suitable for determining the relative effectiveness between the non-profit oriented budgetary

5.3. Possible types of analysis

Data Envelopment Analysis is a nonparametric multivariate statistical method. During its application, we are able to give an answer to the question which is about that how effectively an organizational unit transforms the expenditures ingested as inputs into outputs. Namely, the method is capable of determining which organizational unit has “the best practice” (Albright and Winston, 2007).

Depending on the purpose of the analysis, two main types can be distinguished in case of the method:

- input-oriented,
- output-oriented.

The input- and output orientation is two approaching possibilities of DEA. During the input oriented aspect, the investigation is focusing on that how many and what proportion of inputs are used in order to minimize the cost at the same output level. In case of the approach with an output oriented aspect, we determine that how much the quantity of output can partially be increased without changing the quantity of inputs (Farrel, 1957; Charnes et al., 1978).

At the same time, it is complicated even more by the fact which is about that, when the effectiveness is measured, we have to take into account that not every input is utilized in the same way because, in case of the resources,

- if we assume the same integration then we need to calculate with returns having a constant rate (CRS - Constant Return to Scale),
- if no then we should henceforth calculate with returns having a variable rate (VRS – Variable Return to Scale) (Cooper et al., 2004a.).

So it can be determined that DEA method gives the limit effectiveness. In turn, knowing the curve of limit effectiveness, those parameters can be specified which apply to the non-effective units and the optimum state can be achieved by correcting the parameters mentioned before (Tofallis, 2001).

6. In conclusion

Taking the described into account, it can be concluded that Data Envelopment Analysis is suitable for measuring the effectiveness of the higher educational institutions. Many countries already apply it almost routinely for measuring the relative effectiveness of different organizational units doing the same activities. I think that DEA method would successfully be applied and adapted for market segment as well considering the stable mathematical background of the method and the departmental characteristics of the higher educational institutions. My aim is, on the one hand, to perform further researches and, during my researches, to start off and apply DEA methodology with regard to the higher educational institutions in order to make their operation more competitive and to make them capable of reacting upon the changes of environment in time and taking over the already well-operated practices from each other.

On the other hand, establishing a ranking list about the given institutions would be important for the authority and the outside world itself as well in order to acquaint the market outlets as well as the employers with such a ranking list.

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