USE OF COEFFICIENT OF SCALE EFFICIENCY IN THE MANAGEMENT OF PUBLIC AUTHORITIES

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Abstract

Recently the economies of many countries are affected by the lingering depression or have started a period of moderate growth. Independently of the real state of the economy many companies are still in loss, objectively forced to dismiss their employees, and many even go bankrupt. However, there is generally a sector which resists these trends and the economic situation around. It is the public sector. The reasons can be found in bargaining power, the importance of the sector to national economies, political power, etc. Public authorities are labeled by the public as inefficient institutions. If we wanted to claim the correctness of this claim, we should objectively define efficiency and set possibilities how to quantify the efficiency. Finally, it is important to correctly interpret the results of the analysis and take appropriate corrective action.

Keywords: scale efficiency, public health authority, outputs, inputs.

JEL Classification: H54.

Introduction

The world economic system to European national economies, including the Czech economy, hit in recent years the economic crisis. Many companies had to accept the job cuts, could not meet its commitments, many have ceased their activities due to insolvency.

Generally, these economic processes affect the public sector to a lesser extent, the Czech Republic is that aspect of the characteristic. The public sector is generally defined as the infrastructure to provide public goods (in a simplified system of public authorities). For purposes of this paper is the definition used by Samuelson and Nordhaus (1995), who defined public goods in terms of two characteristics: non-exclusion (cannot be effectively excluded a citizen from the consumption of such good) and indivisibility in consumption (the production of additional units of public good there is no further additional unit costs). By production of public goods are produced only fixed costs. At this time, this definition does not match reality - the state provides a range of goods, which is defined as public, but that only one of the above-defined characteristics (in such cases, the authors talk about club or merits goods). A concrete example for this statement is a public higher education in the Czech Republic - though it may satisfy the requirement of indivisibility in consumption, the state can (and do) to exclude specific individuals from the consumption of that good.

In this paper we consider the public goods provided by the State any goods except those which it produces in order to realize profits, and those which provide private parties.

In the Czech Republic, the public sector is often described as ineffective. But it is questionable whether they supported the claim. If we want to explicitly confirm or disprove the effectiveness, it is necessary to define the concept of efficiency in relation to administrative offices and propose an objective procedure for quantifying the effectiveness of interpretation of results. Context outlined above define the basic aims of this paper:

1. To define efficiency as an economic category is also applicable to production of public goods,
2. To measure and demonstrate the procedure for quantifying the effectiveness of the administrative offices of the segment,
3. To interpret the results of the analysis with practical outcomes in the management,
4. To suggest principles of implementation results in terms of state control.

Methods

Literature review

Existing evidence suggests the effectiveness of maintaining the order of specified targets in order to maintain a logical sequence of process knowledge and subsequent application of results. It is necessary to correctly define and use the term efficiency. Administrative offices are specific branches, in contrast to business subjects, they require the different determination of effectiveness. Generally it can be considered as a favorable ratio of inputs and outputs, however, in the economics literature the concept of efficiency is
defined more comprehensively – the "economic efficiency" is a condition where resources are deployed in an optimal way in a given economic system.

Vochozka (2008) divided the concept of efficiency, as described in the literature, by way of their orientation and measuring as follows:

1. Criterion of efficiency is the maximum output (or combination of outputs)
2. Criterion of efficiency is the minimum amount of inputs (costs) at a given level of output (or combination of outputs)
3. Criterion of efficiency is fulfilling the conditions of the existence of the particular system.

The basic layout of the concept of efficiency by analysis of the economic literature shows Figure 1.

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Public authorities and their activity – especially outputs of those institutes – are defined very strictly in the law, respectively in two basic legislative acts – first Organic law of the Czech Republic which is saying that the state and therefore the institute acting for the state, is allowed to do only what is permit, and second it is a special law (for example in the case of public health authorities law Nr. 258/2000 Sb., about the protection of public health). Special legislative act describes and define the minimal required quality and volume of output of services provided and thanks to Organic law of the Czech Republic are these minimum quantity and quality considered as a maximal.

When choosing an appropriate concept of efficiency, therefore, we must focus on efficiency in terms of inputs. Law determines the amount of output, or a specific volume of public goods, and the public authority therefore has no legal possibility to change the volume of outputs. Selected concept of efficiency must be able to work with a fixed set output. Concept which is there is scale efficiency which defined Farrell (1957). Company is technically efficient when it cannot produce the same volume of goods with less quantity of one produced factor, not increase the volume of second production factor. As an input is here not only production factor but also technologies or production technique. The technical efficiency distinguished by some authors (eg Hassan, 2005) is the pure technical efficiency (in cases where there is no wastage of
inputs) and fixed technical efficiency (the organization operates with a constant, optimal output, in which the company may not be purely technically efficient).

As a proper method for fixed technical efficiency calculation seems to be Data Envelopment Analysis (DEA), by authors Charnes, Cooper a Rhodes (Cooper et al, 2006, Cooper et al, 2000, Cooper et al, 1999). The method is described in detail in chapter 4. Methods.

**Measuring of scale efficiency**

DEA was made by economists Charnes, Cooper and Rhodes as a nonparametric multiple data test. As an advantage is a possibility to taste several production factors (inputs) to several products (outputs). The broad principle of DEA is summarized as follows: the specific production factors (inputs), or the sum of the weighted factor, we assign the volume of production achieved (outputs), or sum of weighted products. Using (for example) a simple correlation and regression analysis, least squares method, we create a production function. Then move to the highest output value. The moved curve becomes the data envelopment curve (output), and at the same time the relative scale efficiency. The result is an achieved rate of scale efficiency of individual institutions. It can be reliably identify inefficiencies in the outputs that lie under the envelopment curve. However, the point (in exceptional cases, multiple points) lying on the envelopment curve cannot be regarded as effective or as ineffective. Furthermore, such a point we consider that value as fixed-technical efficient (especially in relation to the calculation rate of fixed technical inefficiency). The method of calculating the DEA is not precisely defined and should be chosen for a particular situation a proper method of calculation (especially in relation to the production function).

**Cost DEA**

To determine the management of administrative offices with entrusted resources is used Cost DEA which goes out of concept of technical efficiency defined by M. J. Farrell (1957) and ideas of Gérard Debreu. Authors of DEA (Cooper et al, 2006, Cooper et al, 2000, Cooper et al, 1999) describes the relationship of single kinds of efficiencies with Cost DEA on the basis of plot that is shown on the Figure 2.

![Figure 2. Technical, allocation and cost (due to the author sometimes total) efficiency](image)

The picture shows on axis x and y value of production factors (L – labor, K – capital). Further there is a segment of isoquant q that means combination of production factors that gives certain amount of one output or combination of several outputs. Point P then means higher combination of inputs which gives the same quantity of outputs as in the case of the segment of isoquant. However higher amount of production factors (inputs) for reaching the P point are needed.

Farrell (1957) defines coefficient of scale efficiency as a proportion of distances Q point and P point from zero point:

\[
0 \leq \frac{d(0,Q)}{d(0,P)} \leq 1
\]  

(1)

Cooper then created in P point line (in this case signed b) which conforms to the shape \( b = c_1 \cdot L + c_2 \cdot K \) (two production factors, two weights). Line b is supposed to be expression of allocative
efficiency. Line \( b \) is then moved nearer to zero point so it touches the segment of isoquant and on the line \( a \) is created \( S \) point. Newly created line \( b' \) is expression of cost (or total) efficiency.

Farrel expressed the relationship so:

\[
c \cdot x^* = \min_x c \cdot x, \tag{2}
\]

where \( x^* \) means optimal solution of production factors (resources), \( c \) vector of costs of organization.

Cooper went right out of this relation and created following concept of cost efficiency:

\[
0 \leq \frac{d(0, R)}{d(0, Q)} \leq 1, \tag{3}
\]

Thanks to synthesis of Farrell’s definition of new distances is got relationship:

\[
\frac{d(0, R)}{d(0, P)} \cdot \frac{d(0, Q)}{d(0, P)} = \frac{d(0, R)}{d(0, P)} \cdot 0 \leq \frac{d(0, R)}{d(0, P)} = \frac{c \cdot x^*}{c \cdot x_0} \leq 1, \tag{4, 5}
\]

where \( x_0 \) means chosen value of costs (inputs).

Whether the variables are used in the context of my research the relationship looks so:

\[
0 \leq \frac{d(0, R)}{d(0, P)} \frac{d(0, Q)}{d(0, P)} = \frac{c \cdot w_{i_e}}{c \cdot w_{i}} \leq 1 \tag{6}
\]

where \( w_{i_e} \) means value of inputs on the curve of efficiency frontier, \( w_{i} \) value of real inputs.

According to limitation of previous models (mainly possibility to set and use the weight of their amount) is necessary to specify and formulate the method having regard to the used sample of public authorities.

**Material**

After researching possibilities of application of the defined models was decided to rewrite the meant models into one that is applicable for the environment of public authorities, especially public health authorities in this contribution. In the Czech Republic there are 13 regional hygienic stations and Hygienic station of main city. In terms of ties to the state budget are they state agencies, established by the Ministry of Health of the Czech Republic. All date about their activities are publicly available, so we have all available information completed and collected according to uniform methodology (according to the law on budgetary rules and laws on protection of public health and its implementing regulations, specifically from FIN 2-04 statement and the statement about activities of public health protection).

If we start from the basic information about DEA, we must determine data appropriate and proper to the analysis. So there were set four inputs:

1. Consolidated revenues and expenses without personal expenses: it calculates relative expenses due to public health authorities’ efficiency.
2. Personal expenses: The indicator evaluates independently the relation between personal expenses and provided public services. It includes expenses relating to wages, other payments for realized work, the statutory insurance and transfers to the fund for cultural and social needs.
3. Fixed assets.

For the purpose of evaluation of output (provided services) were chosen realized opinions and decisions classified with respect to the individual fields (epidemiology, hygiene of children and youth, general and communal hygiene, industrial hygiene and hygiene for food and objects of common use). By virtue of the DEA there are consistent data covering more than 99% of the organization with no causality between staff and the number of performances. From the DEA, we excluded control protocols (number of inspections per employee and average salary is fixed, so there is causality among the number of inspections carried out and the amount of resources to groups of items 50). It means ten provided public services (or public goods). Reviewed data are for the years 2004–2006.

Weights were set thanks to correlation and regression analysis. Law and reached results were taken into account. In the case of public health authorities there were results got in the last four years (results got from the whole history of public health authorities).
We can get the result thanks to calculation distances both inputs and outputs. For this contribution the way based on outputs was chosen. The formula of it is:

\[
\text{max } \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}} = \frac{w_0}{w_{0o}}
\]

where \(c\) means weights of inputs (made different by indexes), \(s\) direction of envelopments curve, \(w_{0o}\) represents value of outputs on the curve corresponding to the efficiency border, \(w_0\) value of real outputs, \(\text{max } w_0\) is also coefficient of scale efficiency.

**Results and discussion (Figures, tables and equations)**

From above mentioned assumption implies first of all to derive weights for the indicators of inputs and outputs of hygienic stations. Weights are an expression of viewpoints and decisions on the results of hygienic stations. The breakdown of the weights is applied so-called criteria tree (Figure 3).

![Figure 3. Criteria tree](image)

Analysis we obtained production curve, envelopment curve and scale efficiency coefficients of individual Hygienic stations.

The resulting production curve has a shape of \(y = a \cdot b^x\). This is an exponential curve in the shape of \(a = 699,739 \cdot 1,000002367\). Moving the production curve we got an envelopment curve in the shape of \(y = a = 1118,449 \cdot 1,000002367\).

![Figure 4. Scale efficiency curve](image)

Comparing the extent of the effectiveness of public health authorities in selected periods, we calculate the fixed rate of technical efficiency reached the conclusion that the most effective state administration service in terms of cost and produced public service Regional Public Health Authority based in Jihlava.
conducted in 2004 (it achieved technical efficiency of a fixed rate 1), the least efficient state administration carried out in 2004, the Regional Public Health Authority of Morava and Slezsko based in Ostrava (it achieved fixed technical efficiency 0.32). The table number 1 contains aggregated results for the period in the form of a harmonic average.

Table 1. Effectiveness rate of public health authorities in selected periods

<table>
<thead>
<tr>
<th>Public Health Authority</th>
<th>DEA Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region Vysočina</td>
<td>0.9590</td>
</tr>
<tr>
<td>South Moravia</td>
<td>0.9243</td>
</tr>
<tr>
<td>Middle Bohemia</td>
<td>0.8927</td>
</tr>
<tr>
<td>Prague</td>
<td>0.8751</td>
</tr>
<tr>
<td>Olomouc</td>
<td>0.8408</td>
</tr>
<tr>
<td>Plzeň</td>
<td>0.6398</td>
</tr>
<tr>
<td>Pardubice</td>
<td>0.6050</td>
</tr>
<tr>
<td>Zlín</td>
<td>0.5987</td>
</tr>
<tr>
<td>Hradec Králové</td>
<td>0.5791</td>
</tr>
<tr>
<td>Ústí nad Labem</td>
<td>0.5641</td>
</tr>
<tr>
<td>South Bohemia</td>
<td>0.5609</td>
</tr>
<tr>
<td>Karlovy Vary</td>
<td>0.4205</td>
</tr>
<tr>
<td>Liberec</td>
<td>0.3834</td>
</tr>
<tr>
<td>Morava, Slezsko</td>
<td>0.3606</td>
</tr>
</tbody>
</table>

Managerial system

The analysis and obtained outcomes suggest the definition of three areas in which the acquired knowledge should be used in the process of improving the operation and effectiveness of public health authority in the Czech Republic.

The field of strategic management – the change of strategic approach to public health authorities management suppose:

1. Analysis of the set of public goods provided by the state (to involve not only public health protection, but also all provided public goods, clearly define them by the law and to cancel inefficient activities);
2. To define the possibilities of financing of various public services in relation to the concept of Kaldor-Hicks efficiency – the state (legislature, the government) should determine the utility of services to the state and citizens by the implementation of cost-benefit analysis on macro-economic level);
3. To determine which actions the state ensures for public funds and which ones the private sector in the free market;
4. To create the simpler legislative framework for state administration service and the providing of public goods;
5. To limit the influence of political leaders on conceptual and operational procedures (in connection with Act No. 218/2002 Coll. about the Civil Service, as amended).

Conceptual management area – change of the management structure of the Ministry of Health Service in relation to subordinate organizations. The conceptual control of public health authorities on level of the department of public health is recommended. The following measures are expected:

1. Optimization of information flows in relation to subordinate organizations by the Ministry of Health Service - there can be identified three control centres:
   a) the department of the Health Head Officer: s/he manages the professional staff and affects financial management of public health authorities (profiles the public health department and the department of strategy, protection management and support of public health);
   b) the department of directly-managed organizations: it affects the financial management of public health authorities;
   c) other ministerial departments: solves specific aspects of operations and financial management of public health authorities;
2. To change the manner and style of financial management of health centers: operating funds, funds for salaries and investment funds considered as one kind of funds;
3. To apply a degree of discretion, (especially in relation to the financing and management costs), but consistently demand required outcomes. Ministry of Health Service should specifically:
   a) to consider as a key indicator a fixed achievement level of technical efficiency; 
   b) to relieve causal relationship between the number of workers of the health center and the number of regular checks; 
   c) to apply DEA method to all health disciplines separately and reached the minimal limit of attained values for each of them separately (following the application of the method required by law);
4. To create limits of fixed technical efficiency for individual fields to zero implementation period; 
5. To set the rates of fixed technical efficiency of individual branches annually ever for a three-year period; 
6. To fix a contract with executive directors providing for the requirements of the state administration service and rewards for their accomplishment.

The area of operational management – Operational management decides on implementation of a particular method to specific workplaces, working groups and individuals. Prerequisite level of operational management is the departmental accounting. Its meaning is crucial for the hygienic station regardless of the possibility of applying DEA. While many economists (eg Samuelson PA, Nordhaus WD, 1995) describe the public good so that the production of additional units of goods is not necessary to expend additional costs (all costs of the inspection stations are fixed), we must realize that in the long term (unspecified) of the fixed costs become variable costs. Even in the short term it is possible to find particular variable costs (eg office supplies, costs of consultancy and advisory services, etc.).

Conclusion

Aim of this paper and the proposed methodological approach is not a criticism of the current state of the management or administrative authorities of protection of public health, but finding ways and possibilities to improve the situation. It is obvious that the verification of applications in terms of public health authorities in the Czech Republic the Ministry of Health Service must decide. Managers of public health authorities should be interested in identifying the cause of the partial ineffectiveness of its regional offices, based on management contracts, and with the help of DEA methods, and then eliminate them.

The example of public health authorities is illustrated one possible solution to the efficiency of administrative authority in its complexity. Authors are sure of the matter that after its completion, further verification and generalization can be applied in other areas of state government. This issue is gaining urgency, timeliness and effective solution in terms of state administration and the authors have tried to set a broad contribution to open debate on this most important societal issues.

References


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