The Technical Efficiency of Public Libraries in the Czech Republic

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Abstract

The purpose of this article is to define and evaluate the development of the aggregated technical efficiency of public libraries in the Czech Republic from 1993 to 2014. To simulate technical efficiency, the Data Envelopment Analysis Model (The BCC model) was chosen. To evaluate the production units (the unit of the Czech Republic from 1993 to 2014 and its production is given by the sum of real homogenous units, i.e. the public libraries operating in a given area and in a given time), two input variables (the recalculated number of employees and the library collection) and two output variables (the number of registered readers and the number of loans) were analysed. Two basic models were simulated – the M1 model oriented to inputs and the M2 model oriented to outputs. Correlation between the input and output variables was researched using Pearson's coefficient. Within the range of the M1 and M2 basic models, partial models were simulated. All of the basic and partial models identically showed eight efficient periods of public libraries in the Czech Republic (1995, 1997, 1999–2000, 2002–2005). Public libraries were, according to the chosen variables, inefficient in the remaining 16 observed years.

Keywords

DEA evaluation model, public library efficiency, technical efficiency.

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1. Introduction

Libraries are the most numerous cultural facilities in the Czech Republic. Public libraries constitute the largest share in this representation. According to the Registry of the Ministry of Culture, there were 5,360 public libraries in the Czech Republic at the 31st December 2014. Spilková (2014) states that the Czechs may be classified as above-average and conservative readers who are used to buying books and supplying their home libraries. Nevertheless, it is also true that the Czech Republic has the most extensive library network in the world. Public libraries provide public services at the state, regional and local level. According to Ochrana (2007), one of the key problems of promoting a public service that shows the characteristic attributes of a public good is the question of how much of that service shall be provided to the citizens. Another public services problem is identifying demand. Also there is currently a discussion on the influence of public service pricing on efficiency or on the optimal level of the transactional costs of public services promotion. As Manzoor (2014) states: the public administration is responsible for the efficient, freely available and non-discriminatory provision of public services; in the sense of multidimensional demand. That is why public services shall be treated not only from the cost-benefit analysis view, but also from the customer value view. In this sense the liability approach of management of the public service organizations and guarantees fulfil an essential role. From the view of public services management, Denhardt and Denhardt (2000) compare the priorities of the Old Public Administration (based on political theory), the New Public Management (based on economic theory) and the New Public Service (based on democratic theory). The New Public Management mainly prioritizes the economic rationality, decentralization, the customers' interests; public services are provided by non-government and private agencies. The New Public Service emphasizes democratic principles, the inhabitants' interests, knowledge and strategic approach based on multiple tests of rationality (political, economic and organizational) and the public services are provided by non-government organizations, private agencies and public organizations. The Old Public Administration enforces the law and a rigid conception, hierarchy and bureaucratic management, clients and constituents; public services are mainly provided by government organizations. Other groups of seemingly independent problems relating to public services are represented by the limited public resources at all budget levels, the changing needs of society and development mainly in information technologies. Konvit (2015) states that *the orientation to a paper book only will automatically move the libraries towards museums – only those interested in history will visit them.*

Faced with these problems, public libraries have to advocate and prove their services' utility, efficiency, quality and also modernity. Founders (the public administration) have to prove the economy, efficiency and effectiveness of the expended public resources. Many research studies have been made in this context. Stenström and Haycock (2014) researched the factors that influenced political decision-making on the financing of public libraries in Canada. They draw attention to the strong positon of the quality relationships between libraries and the local community. According to Michnik (2015), libraries usually have a low political priority; nevertheless, the specific local politicians' approaches to libraries in Sweden are given mainly by the political composition, the library plan and the population size. Mikušová, Meričková and Stejskal (2014) evaluated the evidence of public financing of the public libraries' production. Aabø (2007) elaborated the economic value of public library services. On the basis of the investigation and the contingent valuation method, concretely the willingness to pay (WTP) and the willingness to accept compensation (WTA) methods, he observed the willingness of consumers to pay for public library services in Norway. The ROI method (Return on Investment) offers a comparable attitude. Řehák et al. (2013) and Stejskal et al. (2013) applied the ROI method for the valuation analysis of public libraries.

Performance evaluation, including the quality of public library services, is still a commonly discussed theme at the international, national, regional and local levels. Following this fact, the indexes, indicators and parameters of public libraries' performance are set. The International Federation of Library Associations and Institutions – IFLA Directive (2012) is the default source. It defines the performance indexes that can be used for the valuation, observation and benchmarking of public libraries' economic performance. In the

Czech Republic, besides the IFLA Directive, the Methodological Instruction of the Ministry of Culture (2011) can be used. It defines the standards of the public library and information services provided by libraries founded or operated by municipalities and regions in the area of the Czech Republic. The Instruction further provides the defined standards measurements indicators.

This article looks at the performance of public libraries in the Czech Republic from the view of technical efficiency and observes the public libraries as a whole, where the Czech Republic is the production unit. Efficiency is a key parameter of the organizations' economic performance, including those promoting public services (see Jackson, 1993). Most often, efficiency is expressed depending on the valued variables. Hollingsworth and Peacock (2008), and Dooren, Bouckaert and Halligan (2010) define economic efficiency, and the technical and allocation efficiency within it. Economic efficiency is the ability of an organization to produce the set amount of production within the given technology, using minimum costs. Abdourahmane, Bravo-Ureta and Rivas (2001) define technical efficiency as the ability of an organization to produce the maximum volume of output using a given volume of inputs within a given technology, while they confirm the efficiency definition by Debreu (1951, in Kroupová, 2010). According to the above-mentioned authors, allocation efficiency is the ability to choose the optimal combination of production factors. The allocation efficiency is qualified by the equity of the marginal products ratio of each pair of inputs and of the market prices ratio of the same pair of inputs.

The aim of the article is to define and evaluate the aggregated technical efficiency of public libraries in the Czech Republic from 1993 to 2014.

The observed period 1993–2014 (22 years) captures the public libraries during almost the whole of the modern Czech Republic's 23-year history.

The aggregated technical efficiency of the public libraries will be proved according to the Data Envelopment Analysis Method (DEA). Whereas it is a method based on the input – output principle, primarily two questions, Q1 and Q2 will be observed through the chosen input and output parameters.

Q1: In the Czech Republic, in which years were the organization and provision of public library services technically efficient?

Q2: Which of the chosen input and output parameters influenced the results for technical efficiency the most?

It shall be noted that the answers to the above set questions will be limited by the choice of input and output parameters.

We can find numerous applications of the DEA method for evaluating libraries' technical efficiency. The individual cases show that different variants of the DEA method can be used for evaluating both microeconomic and macroeconomic problems. Vitaliano (1998) used the DEA method to define the efficiency of 184 libraries in New York. Reichmann and Sommersguter-Reichmann (2010) were researching and comparing the efficiency and productivity of 68 universities in North America and Europe. De Carvalho et al. (2012) were investigating the efficiency of 37 Rio de Janeiro Federal University associated libraries using the DEA model in 2006–2007. Shahwan and Kaba (2013) evaluated the efficiency of 11 academic libraries from the United Arab Emirates, Qatar, Oman, and the Kingdom of Saudi Arabia using the DEA model. Stroobants and Bouckaert (2014) evaluated the efficiency of 79 public libraries in Flanders using the DEA and FHD models. Li and Yang (2014) also defined public libraries' efficiency in the USA according to the aggregated indexes and in the conditions of 51 USA states, using the DEA model. Clark (2015) made three models in his study – the Human Resources Model, the Materials Model and the Budget Model, with which he investigated the technical efficiency of 26 university libraries, using the DEA model, including the Super Efficiency Model.

2. Public Libraries in the Czech Republic

Public Libraries in the Czech Republic are founded by the state, regions and the municipalities (according to the Czech Statistical Organization there were 6,254 municipalities in the Czech Republic at the 31st December 2014). Most of the municipality public libraries do not have independent legal form; they are the communities' organizational units and their activities are paid from the municipality budget or from specific grants from the different budgets. In larger towns, public libraries have their own legal form; they are usually the allowance organizations of the towns. The founders' allowance for the operation of the public libraries makes up the largest part of their incomes. Regions found public libraries with regional functions. The state is the founder of two libraries, the National Library of the Czech Republic and the K. E. Macan Library and Printing Press for the Blind (see Table 1). A key role in the public libraries system is played by the National Library of the Czech Republic. It is defined as a library with a universal collection, with the addition of specialized collections. This library keeps a permanent historic collection. It ensures equal access

for everyone to all of the public library and information services and to the rest of its services. The National Library of the Czech Republic is the centre of the libraries' system, it carries out the coordination, vocational, information, educational, analytic, research, standardization, methodological and advice activities.

The legislative definition of the libraries' organization and tasks in the Czech Republic is primarily established by Law No. 257/2001 Coll. of 29 June 2001 on Libraries and the Terms of Operating Public Library and Information Services (Library Act). The libraries' activities are also governed by other professional regulations (the ISO series), methodologies and recommendations, e.g. the Good Library Standards (The National Library, 2015) and Libraries to Libraries Services (The National Library, 2014).

The Good Library Standards contain 10 categories: (a) opening hours for the public; (b) the library collection and information resources generation; (c) location of the library in the municipality; (d) the library area intended for users; (e) study places for library users; (f) access to the Internet and information technologies; (g) the library websites presentation; (h) the library electronic catalogue on the Internet; (i) the library employees and their education; (j) measuring library users' satisfaction. In this context it is necessary to underline that according to Flynn (2012) the standards go beyond measures of efficiency and include cycle times, courtesy, accessibility and other aspects of quality. The Office for Public Management Ltd and OPM and CIPFA (2004) have defined six principles of good governance in the public services. These principles are the functional underlay for the standardization of public services in European countries.

Public libraries in the Czech Republic are among the most numerous institutions that provide public services; besides nurseries and primary schools.

Libraries provide free public library and information services. However, the loaning service is conditional on the reader's registration. Libraries may ask readers to cover the costs expended on administration processes that are connected with the users' evidence (registration charges). The Library Act defines the types of library and information services which the library is allowed to ask payments for. The payments must correspond to the actual costs incurred (e.g. access to documents and to audio and video records, including interlibrary loans).

From the view of providing public services in the area of library and information services, public libraries are key institutions that are characterized by unlimited access and universal collections. In addition to public libraries a comparable number of specialized libraries operate in the Czech Republic. Besides the specialized library collection (e.g. the museum and gallery libraries) they cater for a more or less closed group of readers (university, school, hospital libraries). Libraries in primary schools, secondary schools and universities account for the largest proportion of specialized libraries.

From Table 1 it is obvious that the total number of libraries in the Czech Republic reduced by 25% during the period 1993–2014. Specialized libraries, mainly school ones, accounted for most of this reduction; they were reduced by 2,065. The number of public libraries decreased by 14%. Up to 2005 the number of public libraries was relatively stable in the Czech Republic, circa 6,000 libraries. After 2005 their slight decline accelerated not only because of cancelling the long-closed municipalities' libraries, but also because of their merging. The number of libraries was also influenced by public administration reform and the change in financing of the former library units. The largest reduction in public libraries occurred between 2005 and 2008. The number of libraries stabilized in 2010, up to 31st December 2014 there were 5,360 libraries. From Table 1, we can see the change in the number of state libraries. This was caused by the transfer of the state scientific libraries to the regional libraries on the 1st January 2002. Only public libraries form the subject of this research of technical efficiency.

Table 1 The System and the Number of Libraries in the Czech Republic from 1993 to 2014.

Types of Libraries	1993	2014
State Libraries*	11	2
Regional Libraries**	-	13
Basic Libraries ***	6 227	5 345
Total Public Libraries	6 238	5 360
Specialized Libraries****	6 406	4 190
Total Libraries in the Czech Republic	12 644	9 550

Notes: *the National Library of the Czech Republic; the K. E. Macan Library and Printing Press for the Blind; also in 1993, the state scientific libraries (established by the Ministry of Culture); **established by the relevant regional authorities; ***established by the relevant communal authorities; ****may also be established by other legal entities.
Source: National Library of the Czech Republic (2015).

3. Efficiency and Technical Efficiency

Commonly efficiency measures and evaluates the difference between the input and output values. Nevertheless, a universal definition of this term is lacking in the inconsistent terminology of the authors who publish on this topic. There are several approaches

to the evaluation and measurement of public services' efficiency, depending on whether they are evaluated from the view of the public spending programmes, projects or the sub procedures. It is possible to meet some examples where efficiency is taken as the independent evaluation in the frame of a researched theme (e.g. evaluation of a system in the field of healthcare, culture, education); then economic efficiency is mentioned the most often.

Economic efficiency has two dimensions: technical and allocative efficiency. Economic (or cost) efficiency requires both. Technical or operational efficiency refers to the output–input ratio compared to a standard ratio, which is considered optimal or ideal (and so can never exceed 100%). Both output- and input-oriented efficiency can be defined. Output efficiency focuses on the maximization of output for a given set of inputs, or alternatively, input orientation aims at the minimization of inputs for a given set of outputs. Allocative efficiency refers to the use of inputs in optimal proportions given their respective prices and production technology. For example, allocative efficiency in input selection involves selecting the mix of inputs (e.g. labour and capital) which produce a given quantity of output at minimum cost, based on prevailing input prices (see Evans, Tandon, Murray and Lauet, 2000; Hollingsworth and Peacock, 2008; Vaňková and Vrabková, 2014).

In the conditions of public services, efficiency is seen as a partial parameter of performance – in the frame of the Four 'E's (4E) conception (economy, efficiency, effectiveness and equity). In this conception, efficiency is attained if the expenses related to ensuring certain processes (inputs) do not exceed the profits attained at the output of the process (Bovaird and Löffler, 2009; Dooren, Bouckaert and Halligan, 2010; Flynn, 2012). Talbot states that performance is developed in relation to issues such as accountability, user choice, customer service, efficiency, results, effectiveness, resource allocation and creating public value (Talbot in Ferlie, Lynn and Pollitt, 2007). Performance in public services is bound directly to performance and management in the public sector. The literature most commonly deals with performance in relation to efficiency. Efficiency, a term used primarily in economics, generally denotes the most suitable use of resources in production. Samuelson and Nordhaus (2010) state that optimal efficiency in the economy is attained if the available resources and technologies are used to provide consumers with the goods and services they desire the most.

The concept of technical efficiency, resp. efficiency is often terminologically confused with the term of productivity. As an example, we can give Jääskeläinen and Lönnqvist (2011), according to whom the factors affecting productivity are commonly classified into inputs, processes (transformation of inputs into outputs) and outputs. Also Lovell et al. (1993) state that efficiency is a component of productivity and they refer to the comparison between actual and optimal amounts of inputs and outputs.

Farrell (1957) defined technical efficiency as the ability of the production units to maximize output at a given level of inputs; or to minimize inputs by reaching the required level of outputs. Technical efficiency is the object of DEA – Data Envelopment Analysis.

4. Methodology: The DEA–BCC Model

Technical efficiency, as termed in DEA, is the most commonly examined under the assumption of either the input or output orientation. Under the input orientation, the DEA efficiency scores are interpreted as the required input contractions to make a decision-making unit (DMU) efficient, keeping the level of outputs fixed. Under the output orientation the efficiency scores correspond to the required output expansions to make a DMU efficient, keeping the input levels fixed. Hence, in the input orientation the inputs behave as variables and the outputs as the model parameters, while in the output orientation the outputs are the variables and the inputs the constants.

For this article the DEA–BCC Model has been chosen. This model assumes the variable returns to scale. Two basic variants have been calculated – the BCC Input-Oriented (1) and the BCC Output-Oriented (2). The mathematical notation is defined by Cooper, Seiford and Tone (2007, 91–94).

For evaluating the U_q production unit, the two models – z model (input-oriented) and g model (output-oriented) try to find a virtual unit characterized by the $X\lambda$ and $Y\lambda$ inputs, that are a linear combination of the rest units' inputs and outputs from a given set; and that are better (or are not worse) than the inputs and outputs of the evaluated U_q unit. For the virtual unit's inputs and outputs it must hold true that $X\lambda \leq \theta_q x_q$ and $Y\lambda \geq y_q$ are the input and output vectors of the U_q unit. The U_q unit is stated as effective, if a virtual unit with the given characteristics does not exist; or more precisely the virtual unit is identical to the evaluated unit. It holds true that $X\lambda = x_q$ and $Y\lambda = y_q$. This happens if the variable $\theta = 1$. For analysis of the units' efficiency with the variable returns to scale it is necessary to extend the default model of the convexity condition $e^T\lambda = 1$. The objective 15 functions' optimal value of the z model is $z = 1$, of the g model it is $g = 1$. (Jablonský and Dlouhý, 2015; Cook and Zhu, 2013).

Fractional formulation of primary input-oriented BCC–DEA model is presented below:
maximize

$$z = \sum_{i}^{r} u_i\, y_{iq} + \mu,$$

subject to

$$\sum_{i}^{r} u_i\, y_{ik} + \mu \leq \sum_{j}^{m} v_j\, x_{jk,} \quad k = 1, 2, \ldots, n$$

$$\sum_{j}^{m} v_j\, x_{jq} = 1$$

$$u_i \geq \varepsilon, \quad i = 1, 2, \ldots, r$$
$$v_j \geq \varepsilon, \quad j = 1, 2, \ldots, m$$
$$\mu - free$$

Primary output-oriented BCC–DEA model with variable return to scale. Fractional formulation of this model has the following form:

minimize

$$g = \sum_{i}^{m} v_j\, x_{jq} + v,$$

subject to

$$\sum_{i}^{r} u_i\, y_{ik} \leq \sum_{j}^{m} v_j\, x_{jk} + v, \quad k = 1, 2, \ldots, n$$

$$\sum_{i}^{r} u_i\, x_{iq} = 1,$$

$$u_i \geq \varepsilon, \quad i = 1, 2, \ldots, r$$
$$v_j \geq \varepsilon, \quad j = 1, 2, \ldots, m$$
$$v - free$$

The concept of efficiency has been traditionally related to the ratio of outputs over inputs of a certain firm relative to others. However, in a multiple input-output setup it is necessary to attach weights to inputs and outputs, which reflect their relative rate of usage, in order to calculate the ratio of weighted outputs over weighted inputs. DEA is a non-parametric technique which is based on this logic and uses linear programming to determine optimal weights which minimize the distance between the frontier and the DMU under consideration, subject to disposability and convexity constraints. The major advantage of DEA is that it does not require the specification of a production function: it just uses a set of inputs that DMUs want to minimize and a set of outputs that DMUs want to maximize. (Tziogkidis, 2012).

4.1   Chosen input and output parameters

The type and the number of input parameters were chosen in accordance with the number of observed periods, real data and findings by other authors. De Carvalho et al. (2012) evaluated the following inputs – the number of workers, the number and extent of book volumes. They evaluated the following outputs – the number of consultations, the number of loans (circulations), the number of registrations and the number of users. Shahwan and Kaba (2013) set three outputs – circulation, the number of book acquisitions and the number of registered members. They set three input factors – the number of books, the number of

library employees and the academic year 2010/2011 expenditures. Stroobants and Bouckaert (2014) chose one input – expenditures (total expenditures during a calendar year) and one output – circulation (total number of loans and renewals in a calendar year for the main library and all branch libraries). Li and Yang (2014) chose one input – Total full-time equipment expenditures and seven outputs – number of library visits, number of reference transactions, total circulation, total of registered borrowers and total operating revenue.

To simulate technical efficiency we have chosen two inputs (X):

• $x1$ – employees (recalculated number), $x2$ – book collection in thousands of items;

and two outputs (Y):

• $y1$ – the number of registered readers, in thousands, $y2$ – loans in thousands of items.

Two basic models M1 and M2 have been simulated in this sense. The M1 model focuses on inputs and the M2 model focuses on outputs. Further, some partial models have been simulated within the basic M1 and M2 models. They test the chosen input or output, see Table 2.

Table 2 Construction of the input and output parameters of the individual models, conditions of efficiency and inefficiency

	Inputs (X)	Outputs (Y)	efficient/inefficient e
M1	$x1, x2$	$y1, y2$	$e_z = 1, e_z < 1$
M2	$x1, x2$	$y1, y2$	$e_g = 1, e_g > 1$
M1x_1	$x1$	$y1, y2$	$e_z = 1, e_z < 1$
M1x_2	$x2$	$y1, y2$	$e_z = 1, e_z < 1$
M2y_1	$x1, x2$	$y1$	$e_g = 1, e_g > 1$
M2y_2	$x1, x2$	$y2$	$e_g = 1, e_g > 1$

As stated in Table I, it is necessary to look at the resulting e numbers according to either their input or output orientation. For the efficient units it holds true that $e_{z,g} = 1$. Nevertheless, in the input-oriented models the unit is inefficient if $e_z < 1$; in the output-oriented models the unit is inefficient if $e_g > 1$.

4.2   Data collection

The choice of variables has been made so that it reflects the key parameters of a public library main process – the off-site and on-site loaning of documents that are collected and stored in a library. The input and output variables' values within the observed 22 years are the results of all of the Czech Republic public libraries (CZ1993 – CZ2014). The input and output variables' characteristics (n=22) are shown in Table 3.

The *x*1 input variable – *the library collection in thousands of items* represents a collection of the chosen, structured, registered and professionally handled documents that are collected and stored in a library. This collection is available to users for off-site and on-site loans and for the provision of other library and information services. The *x*2 input variable – *the number of employees* represents the average number of library employees – the average registered number of employees converted into full time employees per year.

The *y*1 output variable – *registered readers in thousands of persons* – a natural person or an entity who was during the observed period newly registered in a library or the registration was renewed. This person is entitled to borrow documents (off-site or on-site) from the library collections and to use other library and information services. Only the first (one) registration of a user in a library in a reported year is counted. The *y*2 output variable – *loans in thousands of items* (thousands of loans) is one library's off-site or on-site loan to one user; is carried out and registered by a library. A loan renewal requested by a user is counted as a loan, too (before the loan period expiration).

Table 3 Characteristics of the input and output variables

n = 22 (CZ1993–CZ2014)	maximum	minimum
*x*1 – Library collection in thous. of items.	64 741	58 881
*x*2 – average number of employees	5 386.6	4 373
y1 – readers in thous. of persons	1 538	1 398
*y*2 – loans in thous. of items	72 825	56 549

n = 22 (CZ1993–CZ2014)	mean	standard deviation
*x*1 – Library collection in thous. of items	61 480.55	1 868.84
*x*2 – average number of employees	5 022.53	249.31
*y*1 – readers in thous. of persons	1 465.86	41.01
*y*2 – loans in thous. of items	65 826.09	4 929.92

The input and output variables' data sources were the statistic databases of The National Library of the Czech Republic, The National Information and Consulting Centre for Culture and the Czech Statistical Office. The mentioned statistic databases are based on the individual libraries' statements. The libraries maintain a Library Date-Book issued by The Librarian Institute of The National Library of the Czech Republic as a basis for the library statistics.

The relationship between the chosen input and output parameters was researched (see Table 4) using Pearson's coefficient *r* whose volumes move within <-1;1>. Significance of the correlation coefficient *t* was tested with t_{krit} (0,975; n-2), when H_0 is rejected if *t* is bigger than a quantile of the Student's t-distribution t_{krit}. The probability of the H_0 rejection was tested by p-value in the critical region 0.05.

As evident from Table 3, there is a strong correlation (*r = 0.73*) between the size of a library collection and the number of library employees. Another strong correlation was found between the number of readers and the number of loans (*r = 0.76*). A weak correlation was found between the size of a library collection and the number of loans (*r = 0.30*). There was no correlation among the remaining variants.

Table 4 Linear correlation between the input and output parameters

n = 22	r	t	p val
*x*1, *x*2	0.7266	7.3275	0.000
*x*1, *y*1	-0.2015	1.4252	0.161
*x*1, *y*2	0.2998	2.1769	0.034
*x*2, *y*1	-0.2191	1.5560	0.126
*x*2, *y*2	0.0765	0.5316	0.597
*y*1, *y*2	0.7610	8.1269	0.000

5. Empirical Analysis Results

5.1 Results of the aggregated technical efficiency

The results of the aggregated technical efficiency according to the individual models are shown in Table 5. This table therefore answers question Q1: In the Czech Republic, in which years were the organization and provision of public library services technically efficient?

All of the basic models (M1 and M2) and the partial models (M1x_1, M1x_2, M2y_1, M2y_2) consistently indicate 8 efficient periods for public libraries in the Czech Republic. The Czech Republic public libraries were efficient, as determined by the chosen input and output variables, during the period of 1993–2014, in 1995, 1997, 1999, 2000, 2002, 2003, 2004 and 2005. It means that for the larger part of the observed period (64%) the libraries were inefficient.

Table 5 The resulting *e* values according to the individual models

Period	M1	M2	M1x1
CZ1993	0.9892	1.0404	0.9890
CZ1994	0.9931	1.0233	0.9931
CZ1995	1.0000	1.0000	1.0000
CZ1996	0.9990	1.0042	0.9990
CZ1997	1.0000	1.0000	1.0000
CZ1998	0.9930	1.0228	0.9926
CZ1999	1.0000	1.0000	1.0000
CZ2000	1.0000	1.0000	1.0000
CZ2001	0.9971	1.0068	0.9971
CZ2002	1.0000	1.0000	1.0000
CZ2003	1.0000	1.0000	1.0000
CZ2004	1.0000	1.0000	1.0000
CZ2005	1.0000	1.0000	1.0000
CZ2006	0.9641	1.0417	0.9641
CZ2007	0.9562	1.0549	0.9562
CZ2008	0.9493	1.0642	0.9493
CZ2009	0.9412	1.0851	0.9412
CZ2010	0.9366	1.0739	0.9363
CZ2011	0.9313	1.0520	0.9313
CZ2012	0.9259	1.0607	0.9259
CZ2013	0.9222	1.0755	0.9216
CZ2014	0.9155	1.0703	0.9151

Period	M1x2	M2y1	M2y2
CZ1993	0.8529	1.0404	1.1829
CZ1994	0.8626	1.0233	1.1026
CZ1995	1.0000	1.0000	1.0000
CZ1996	0.9778	1.0042	1.0394
CZ1997	1.0000	1.0000	1.0000
CZ1998	0.9559	1.0228	1.1256
CZ1999	1.0000	1.0000	1.0000
CZ2000	1.0000	1.0000	1.0000
CZ2001	0.9812	1.0068	1.0109
CZ2002	1.0000	1.0000	1.0000
CZ2003	1.0000	1.0000	1.0000
CZ2004	1.0000	1.0000	1.0000
CZ2005	1.0000	1.0000	1.0000
CZ2006	0.9132	1.0417	1.0601
CZ2007	0.8998	1.0549	1.0806
CZ2008	0.9025	1.0642	1.0941
CZ2009	0.8993	1.0998	1.0892
CZ2010	0.9032	1.0740	1.0906
CZ2011	0.8759	1.0520	1.0834
CZ2012	0.8559	1.0607	1.0991
CZ2013	0.8652	1.0755	1.1342
CZ2014	0.8356	1.0703	1.1631

Information is fulfilled by Table 6 where the chosen characteristics of the *e* technical efficiency results are shown. Table 6. shows the numbers of efficient units ($e_{z,g} = 1$), the e average value, the *e* standard deviation and the worst *e* value (the least efficient period) according to the individual models.

Table 6 Summary characteristics of the technical efficiency results.

	M1	M2	M1x1
$e_{z,g} = 1$	8	8	8
mean *e*	0.9733	1.0307	0.9733
standard deviation	0.0311	0.0306	0.0312
$e_{z(min.)}{<}1$ or $e_{g(max)}{>}1$	0.9155	1.0851	0.9151
worst period	CZ2014	CZ2009	CZ2014

	M1x2	M2y1	M2y2
$e_{z,g} = 1$	8	8	8
mean *e*	0.9355	1.0314	1.0616
standard deviation	0.0602	0.0319	0.0581
$e_{z(min.)}{<}1$ or $e_{g(max)}{>}1$	0.8356	1.0998	1.1829
worst period	CZ2009	CZ2009	CZ1993

Based on the results of the basic M1 and M2 models, the years 2014 and 2009 were the least efficient periods. From the view of the partial models, the year 2014 was the least efficient period for book collection usage, the year 2009 for the number of employees. The number of readers was the least efficient in 2009 and the number of loans was the least efficient in 1993.

Figure 1 shows the e technical efficiency trend. It is an interesting finding that from 1995 to 2005, in other words for 11 consecutive periods, except for two featureless deviations in 1998 and 2001, the Czech Republic public library services as a whole was provided at a stable level of efficiency. A setback occurred in 2006 when the efficiency worsened significantly.
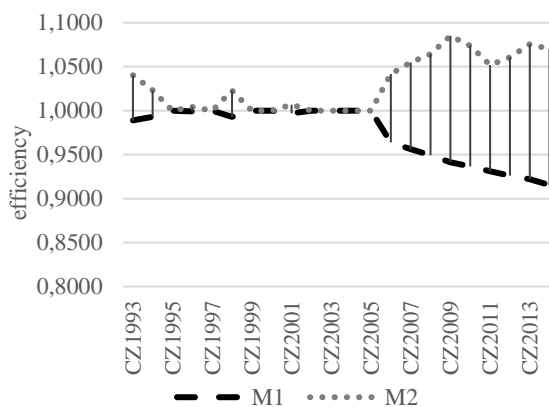
Figure 1 Results of the M1 and M2 models

5.2 Causes of inefficiency

Causes of inefficiency in the range of the chosen inputs and outputs can be seen in the partial models (M1x$_1$, M1x$_2$, M2y$_1$ and M2y$_2$) and they answer Q2: Which of

the chosen input and output parameters influenced the results for technical efficiency the most?

Nevertheless, Figure 1 also shows the efficiency development with the basic M1 and M2 models indicating the possible inefficiency causes. From the view of the input-oriented models the causes of inefficiency were given as the high number of public library employees. 5,127 employees (converted into full-time employees) worked in public libraries in 1993. In the following years, the number of employees decreased by 15% (4,373 employees in 1997). But from 1998, the number of employees began to increase, peaking in 2012 (5,387 employees). The stated facts are also illustrated by the results of the project called The Libraries' Benchmarking that was realized by The National Library of the Czech Republic. Richter (2013, 2015) states that the comparison of Czech, Slovak and German libraries shows that the number of employees (converted to full-time employees) per the number of inhabitants in the Czech Republic and Slovak Republic is twice up to three times higher than in the case of the German libraries.

The library collection size nominally shows a growing trend, but the average circulation (number of one book loans per year) is 0.94 only. This can be explained by the fact that the National Library of the Czech Republic and the regional (science) libraries belong to the category of public libraries that also fulfil an archival and conservation role; and in a different range they take advantage of the right to an obligatory copy. Yet this benchmarking project confirms that the German libraries' collections are, in most cases, twice as small as the Czech and Slovak ones.

The whole volume of the public libraries' collections is usually kept in the same extent because this type of library is not intended for an archival function; i.e. new books are continuously bought or gained a different way; and approximately the same amount of media is simultaneously phased out. Nevertheless, the above-mentioned research shows that the German libraries generally permutate their collections three times faster than the Czech and Slovak ones.

The number of loans variable represents a weak spot on the outputs side. Nominally the largest number of loans was realized in 1999 – 2005. Since 2006 the number of loans was decreasing faster than the number of readers. The number of loans per one reader was the highest in 2004 (48 books per one reader per year) and the lowest in 1993 (40 books per one reader per year).

6. Discussion

During the period 1993–2014, the number of public libraries was decreasing; yet it is possible to state that the Czech Republic library network is larger than average (see Spilková, 2014; Richter, 2015). The research shows that during the last 9 years the Czech Republic public libraries' technical efficiency was growing worse from both the input-oriented DEA model view and the output-oriented DEA model view. In the case of the input oriented model, public libraries were the least efficient in the latest observed year 2014. In the case of the output-oriented model, public libraries were the least efficient in 2009 and the following years. One can assume that, from the view of the chosen input and output variables, the aggregate technical efficiency of the Czech Republic public libraries will continue to worsen if the number of loans does not grow significantly and the number of employees does not reduce. From the view of the partial models, the number of employees as the inputs and the number of loans as the outputs influence the worsening of the aggregated technical efficiency of the public libraries the most. This also confirms that there is a linear correlation between the library collection size and the number of employees; and also between the number of loans and the number of readers. No correlation was proved between the library collection size and the number of loans, which indicates the urgency to renew and reduce the library collection. No correlation was proved between the number of employees and the number of loans or the number of readers. This indicates the necessity to reduce the number of employees.

Through evaluation of the public libraries' technical efficiency, the article also highlights other possibilities of the DEA models' usage. Here, a production unit is the state over 22 periods. Its production (input and output parameters) is given by the sum of the real homogeneous organizations (the public libraries) operating in its area in a given time. As mentioned above, the DEA model enables a specific way of efficiency evaluation. It is characterized by the choice of the DEA model variant, mix of the chosen input and output parameters, the observed period, the choice and range of homogenous production units. In most cases the authors draw attention to the evaluation limits when using the DEA model. It consists in the choice of the input and output parameters and of their combinations. Nevertheless, many of them see an opportunity in them, e.g. Faucett and Kleiner (1994) highlighted the DEA model's benefits and opportunities as follows: *Because DEA allows direct comparisons of DMUs, it is called an ideal method for examining, evaluating, and improving the productivity of public sector organizations*. Stroobants and Bouckaert (2014) see options for efficiency evaluation using the FHD and DEA models for efficiency comparisons in time, and for monitoring the factors that improve or worsen efficiency.

To summarize, we can say that the technical efficiency evaluates the key technical parameters of the processes that are mostly bounded to the input costs and the output revenues. In the case of library inputs (library collection, employees) from the accounts it is possible to get quite an exact figure for the labour or material costs that are linked to a library service (loan). In a new proposal (from the 14th April 2016), the National Library of the Czech Republic newly addresses the need to improve the range, content and quality of public library collections. The proposal is made as the Standard for the Library Collection Refilling and Actualization. This standard follows up on the Good Library Standard and assumes that a smaller and high quality collection is used much more than a collection that is huge but with a large proportion of old, damaged and outdated books and where new titles are low in average quality. The recommended ideal values belong to the basic indicators of the proposed Standard: (i) the annual renewal of the library collection at 10%; (ii) the library collection circulation (the average loan of one book unit) in range of 2 – 3; (iii) degrees of the library collection activation of 90%. Nevertheless, in the case of library outputs (the number of readers or the number of loans) it is not possible to express the exact sum of revenues because libraries do not receive direct payments for their services. The output parameters predicate about the service production volume, therefore about the demand (respectively the satisfied demand) for the public services, too. These indicia are important not only for a library but also for the library founder who finances its operation from public budgets.

The public library services do not lie just in loaning documents, their services structure is more varied. That is why these research results should be judged only in the context of those chosen input and output parameters that predicate about one, though key, service – the documents loaning. It is also necessary to underline that the documents loaning itself may be off-site or on-site, with librarian assistance or without it. The reader's visit can take several minutes or several hours. Thus special consumer services enter the process of this service. It changes this service process, quality and volume, cp. Jääskeläinen and Lönnqvist (2011). Irwin and St-Pierre (2014) criticize the predominant focus of the efficiency valuation in the public libraries conditions. This valuation is based on the traditional output indicators – the circulation statistics, programme attendance, and visits (in person or online). These valuations demonstrate just the partial results of the public library activities and do not show their real value. The see a reasonable evaluation of public libraries in the organizational culture evaluation. They propose their own *Framework for Cultural Change and Evaluation*, that comes from concrete metrics and self-evaluation.

Opinions about the future of public libraries differ. Matthaeidesová (2004) sees the library as a community centre that brings together and unites the inhabitants through different educational, informative and leisure time projects and activities. Agee, Vodeb and Vodeb (2015) state, in the context of the spatial accessibility research for public libraries in Slovenia, that the travel distance to the nearest library is very important, even more so than access to the online database. Public libraries conserve and care for the Slovenian language and extend the local social life. Also the PLOLIB-ODL Study (The National Library) acknowledged that presently a wide range of public libraries' activities proceed in the field of open and distance learning all over Europe. Potivínský et al. (2015), in the framework of a research report on public libraries' community activities, underline that public libraries are inherently predestined to be the natural community centres that, thanks to their low threshold and the inhabitants' trust, provide services to everyone, without distinction of their education or social status. Conversely, according to Konvit (2015), a library of the future will be an intersection of the real public space and a virtual information space for education, entertainment and information. The difference between the traditional and digital library will not lie in the mission but in the processes of meeting the applicants' needs. The stone building will be replaced by the ICT platform. One way or another, public libraries have to adjust their service offer to demand, technological progress and public priorities.

7. Conclusion

The article observes and evaluates the evolution of the chosen input and output variables of the Czech Republic public libraries from a 22-year-long perspective. The technical efficiency of two inputs, namely library collection and the number of employees; and of two outputs, the registered readers and the number of loans in public libraries were estimated by the input and output oriented DEA models with variable returns to scale. Using the DEA model to evaluate technical efficiency also brings some limitations (see Cooper et al., 2007; Cook and Zhu, 2013; Jablonský and Dlouhý, 2015), which was also evaluated in this article. The results show the relative level of efficiency of the aggregated form of public libraries and should only be considered within the above-mentioned inputs and outputs.

The chosen inputs and outputs were technically efficient in the first half of the evaluated period, that is from 1993 to 2005. From 2006 to 2014 the libraries' inputs and outputs were used inefficiently. From the inputs point of view the library collections were less efficient than the employees. And from the outputs

point of view the loans were less efficient than the readers. This confirms the results from the Czech and German public libraries comparison made by Richter (2015). The comparison reveals outdated library collections hence the low turnover of library documents in Czech public libraries.

Measuring and rating the economic performance and also its development brings valuable information not only for the public services organizations but also for the public services guarantors. The possibility to compare the real effects of the public allocation programmes with their intentions formulated in public policies and decided by public choice creates prerequisites to fulfil the public services' effectiveness. Due to the absence of a price mechanism, the possibilities to rate the efficiency of public goods production are limited; mainly in the case of those public goods that are provided to the citizens and users free of charge. Also, public library services belong to this kind of public goods. As required by law, libraries provide their key services free of charge, maximally for an annual administrative fee (reader fee for off-site loans of the library documents). And in this respect, the Czech public libraries do not differ from other public libraries in Europe.

Rating the public libraries' efficiency is an urgent theme; especially in periods of long-term and deep deficits in public budgets (Sharma et al., 1999; De Witte and Geyes, 2011). Nevertheless, in the public libraries conditions, efficiency also resonates with the development of new technologies, mainly the digitization of library services, a change in the population's lifestyle and, in the case of the Czech Republic (CR), the densest network of public libraries in Europe (Quick et al., 2013).

The demand for the services of public libraries is influenced by many factors, which include primarily demographic trends, the changing lifestyles of the population, new technologies and latent competition in the form of the Internet and other types of libraries.

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