Performance Evaluation of the Public Libraries in USA Using Data Envelopment Analysis

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Abstract

This paper examines how well the public libraries in each state of USA combine their resources to support the largest amount of possible services to the community. It also investigates how to improve the performance of the inefficient libraries at state level. Data envelopment analysis (DEA) technique is employed for this research purpose. BCC model is utilized in order to consider the size effect. The DEA results indicate that all states operate fairly efficiently on the whole although there is still a little room for improvement. The analysis also provides the set of target values for improvement for those states that were found inefficient so that the inefficient states can reach the best practice frontier. It is the first time to introduce DEA to measure the public library performance at the state level in USA. The results provide the guidance for government budgeting process. For those states that do not perform efficiently in terms of public library service, our results give the strong indication on how to use the minimum budget and manpower to maintain the same level of public library services.

1. Introduction

Evaluation of library performance has been one of the most important areas in the library field, especially at the present time when libraries have been facing serious budget cuts. Broadly speaking, library performance can be assessed from two aspects—effectiveness and efficiency. According to Shim (2013), effectiveness refers to "the extent to which library services meet the expectations or goals set by the organization" while efficiency "measures the library's ability to transform its inputs (resources) into production of outputs (services), or to produce a given level of outputs with the minimum amount of inputs" (p. 312). Of the two aspects, efficiency has received comparatively less attention in the library literature, yet it should be holding more meaning and importance to decision-makers of the parent institution. Though relatively smaller in number, articles have been published on the measurement of library performance efficiency, especially for benchmarking purposes. One technique used for this type of measurement purpose is Data Envelopment Analysis (DEA).

Traditionally, single factor productivity measures are applied to focus on the different aspects of the library operations. However, single factor productivity measure provides relatively insignificant amount of information when considering the effects of economies of scale, the identification of benchmarking policies, and the estimation of overall performance measures of libraries. A new technique which can analyze the library performance in the complex operation environment is immediately needed. The introduction of DEA technique opens a new way to analyze the library performance. Different from those single factor productivity measures that reflect only partial aspects of library performance, DEA can be applied to assess overall performance.

As a frontier efficiency analysis, DEA can objectively assess the performance of the examined units. In addition, it requires no prior assumption on the specification of the best practice frontier.

Furthermore, it permits the inclusion of random errors if necessary. DEA is understood to be a very good technique for the assessment of efficiency of public sector non-profit organizations. It has the strength of providing quantitative information on the extent of inefficiency and on what is needed to become efficient. It identifies best-practice that can act as a benchmark (Reichmann, 2004).

2. Data Envelopment Analysis

2.1. Overview

Data envelopment analysis (DEA) technique is employed for this research purpose. This technique is often used for performance measurement and benchmarking. It uses linear programming to determine the relative efficiencies of a set of homogeneous (comparable) units. Each of the various DEA models seeks to determine which of the n decision making units (DMUs) define an envelopment surface that represents the best practice. It is important to note that DEA calculations produce only relative efficiency measures. The relative efficiency of each DMU is calculated in relation to all the other DMUs, using the actual observed values for the outputs and inputs of each DMU. The DEA calculations are designed to maximize the relative efficiency score of each DMU, subject to the condition that the set of weights obtained in this manner for each DMU must also be feasible for all the other DMUs included in the calculation. DEA produces a piecewise empirical external production surface, which in economic terms represents the revealed best practice production frontier – the maximum output empirically obtainable from any DMU in the observed population, given its level of inputs (Charnes et al., 1994).

2.2. Mathematical Formulation

The BCC model is used when a variable returns to scale relationship is assumed between inputs and outputs. It is named BCC after Banker, Charnes and Cooper who first introduced this methodology. The BCC model measures technical efficiency. The convexity constraint in the model formulation ensures that the composite unit is of similar scale size as the unit being measured. The efficiency score obtained from this model gives a score which is at least equal to the score obtained using CCR model.

Consider n DMUs to be evaluated, DMU_j (j=1,2…n) consumes amounts $X_j = \{x_{ij}\}$ of inputs (i=1, 2, …, m) and produces amounts $Y_j = \{y_{rj}\}$ of outputs (r=1 ,…, s). The efficiency of a particular DMU_0 can be obtained from the following linear programs (input-oriented BCC model [Banker et al., 1984]).

$$\min_{\theta,\lambda,s^+,s^-} \quad z_0 = \theta - \varepsilon \cdot \vec{1}s^+ - \varepsilon \cdot \vec{1}s^- \qquad (1)$$

$$\begin{aligned} s.t. \quad & Y\lambda - s^+ = Y_0 \\ & \theta X_0 - X\lambda - s^- = 0 \\ & \vec{1}\lambda = 1 \\ & \lambda,\ s^+, s^- \geq 0 \end{aligned}$$

The above equation is called the envelopment form, or primal form. The multiplier form or dual form is given as:

$$\max_{\mu,,\nu} \quad w_0 = \mu^T Y_0 + u_0 \qquad (2)$$

$$\begin{aligned} s.t. \quad & v^T X_0 = 1 \\ & \mu^T Y - v^T X + u_0 \vec{1} \leq 0 \\ & -\mu^T \leq -\varepsilon \bullet \vec{1} \\ & -v^T \leq -\varepsilon \bullet \vec{1} \\ & u_0 \text{ free} \end{aligned}$$

If the convexity constraint ($\vec{1}\lambda = 1$) in (1) and the variable u_0 in (2) are removed, the feasible region is enlarged, which results in the reduction in the number of efficient DMUs, and all DMUs are operating at constant returns to scale. The resulting model is referred to as the CCR model.

A number of extensions to basic DEA models have been introduced in the literature. These extensions are valuable additions to the methodology of DEA.

Briefly, DEA has a rich literature base of over 4000 papers (Emrouznejad et al., 2008) and several books (e.g. Charnes et al., 1994; Cooper et al., 2000; Cooper et al., 2004; Cooper et al., 2006; Cooper et al., 2011) for those who require detailed information on this technology. In summary, each DEA model seeks to determine which of the n DMUs define an envelopment surface that represents best practice, referred to as the empirical production function or the efficient frontier. Units that lie on the surface are deemed efficient in DEA while those units that do not, are termed inefficient. DEA provides a comprehensive analysis of relative efficiencies for multiple input-multiple output situations by evaluating each DMU and measuring its performance relative to an envelopment surface composed of other DMUs. Those DMUs forming the efficient reference set are known as the peer group for the inefficient units. As the inefficient units are projected onto the envelopment surface, the efficient units closest to the projection and whose linear combination comprises this virtual unit form the peer group for that particular DMU. The targets defined by the efficient projections give an indication of how this DMU can improve to be efficient.

3. DEA Applications in Libraries

DEA technique was first developed by Charnes, Cooper, and Rhodes in 1978. It has been used in various fields, including health care, finance, education, transportation, and has been well documented in both operations research and economics literature (Shim, 2003). Emrouznejad et al. (2008) did very extensive literature searches, which identified more than 4000 research articles published in journals or book chapters that employed DEA technique (p. 152).

Research literature on the measurement of library performance is comparatively limited. Easun's Ph.D. dissertation (1992) appears to be the first work that applied DEA techniques to libraries. It aimed at identifying efficiencies in resource management in selected school libraries in California. The earliest research article the authors identified in this field was written by Kwack (1993). The researcher measured the efficiency of 20 national university libraries for three years (1989-1991) using the DEA model. For the purpose of the analysis, the researcher established three input variables (library staff, area of library space, and number of library books) and two output variables (reader visits and circulation of books) (Kwack, 1993).

Another early research article that reported the application of DEA technique to the library field was written by Chen and published in 1997. The researchers evaluated the relative performance of 23 university and college libraries via a DEA model. The perspectives of the evaluation were those of library administrators. The model comprised of four output measures (reader visits, book circulation, reference transaction and on-line search, and interlending service) and three input items (library staff, book acquisition expenditure and area of library space). The analysis results showed that 11 out of the total 23 university libraries were relatively efficient. These 11 efficient libraries could be further categorized into three groups: highly robust group, middle robust group, and low robust group. The author concluded that DEA is "a powerful evaluation tool which estimates mathematically the maximum possible aggregate efficiency score by integrating the combination relationships of inputs and outputs of 23 non-profit comparative libraries" (Chen, 1997, p. 198).

Vitaliano (1998) used DEA technique to determine the relative efficiency of 184 public libraries in New York State of United States. The researcher selected four types of programmatic inputs: total holdings of all items (books, audiovisual, maps, etc.), total hours of operation per week, new books purchased and total serial subscriptions currently active. The outputs were annual total circulation of all library materials and in-library use of materials measured by the number of reference questions answered. The result of the analysis indicated that the average library could reduce its inputs of holdings, new book purchases, serials and hours by about one-third and provide the same level of service to its patrons if it were to organize itself as effectively as the best of its peers.

Sharma et al. (1999) assessed the performance and resource utilization efficiency of 47 public libraries in Hawaii using DEA technique. They selected three output measures—circulation, reader visits, and reference transactions and four input categories—collection, library staff, days open, and nonpersonal expenditures. The analysis results showed that 14 of the total 47 libraries were efficient. The authors concluded that the overall inefficiency was mainly because of technical inefficiency. Only the size of collection, among the various library-specific and community-specific variables that were considered, had a positive and significant effect on library performance.

Worthington (1999) did an efficiency analysis of 168 New South Wales local government libraries by means of DEA.

The analysis results revealed that 9.5 percent of local government libraries were overall technically efficient in the provision of services, 47.6 percent were pure technically efficient, and 10.1 percent were scale efficient. The analysis also revealed that the presence of exogenous factors and scale effects should be the cause for a major portion of the differences in observed efficiency between different groups of local government libraries.

Hammond (2002) reported a study that assessed the relative efficiency of public library services using DEA. The purpose of the research was to examine the relationship between library inputs and library outputs in multi-outlet library systems. The data of the survey observations for 1995/1996 were calculated, which resulted in technical and overall efficiency scores for 99 UK public library systems. The conclusion of the assessment was that although many library systems were efficient or near-efficient, there was a tail of inefficient operations.

Shim (2003) assessed the relative technical efficiency of 95 academic research libraries using DEA. The data was the annual statistics (1996 and 1997) from the Association of Research Libraries (ARL). Five output variables were selected: the total number of interlibrary lending transactions filled, total number of interlibrary borrowing transactions filled, number of people who participated in group presentations or instructions, number of reference transactions excluding directional questions, and the total number of circulation including renewals. The researcher identified two types of inputs, discretionary and nondiscretionary, including seven discretionary inputs (total volumes held, net volumes added during the period, monographs purchased in volumes, total number of current serial copies, number of full-time professional staff, number of full-time support staff, number of full-time equivalents of hourly student employees) and three nondiscretionary inputs (total full-time student enrollment, total full-time graduate student enrollment, and total full-time instructional faculty). The researcher concluded that DEA, if with the proper model of library inputs and outputs, should be capable of revealing the best practices in the peer groups and technical efficiency score for each library (Shim, 2003).

Reichmann (2004) reported the results of an analysis of the technical efficiency of 118 randomly selected university libraries from German-speaking countries (Austria, Germany, Switzerland) and English-speaking countries (United States, Australia and Canada) via DEA. The inputs for the calculation included library staff measured in fulltime equivalents and book materials held. The outputs were the number of serial subscriptions, total circulations, regular opening hours per week, and book materials added. Only 10 out of the total 118 university libraries were found to be fully efficient. No significant differences were found between libraries from English-speaking and German-speaking countries or between small and large university libraries.

Reichmann and Sommersguter-Reichmann (2006) analyzed the performance differentials of university libraries from 6 countries (i.e. Australia, Austria, Canada, Germany, Switzerland and the United States) via DEA technique in an intercountry comparison. They also investigated institutional settings' impact on library efficiency. The inputs selected for the analysis were the number of library employees who work for payment by a deadline (converted into full-time equivalents) and the total number of book materials counted in bookbinder volumes. The outputs were measured via the proxies—the number of serial subscriptions (SADD), the number of total circulations (CIRC), the number of regular opening hours per week (WHOURS) and the number of book materials added (BADD). The analysis revealed that almost one-third of the university libraries were technically efficient. It also found considerable differences in technical efficiency between European and non-European university libraries.

Jang (2009) analyzed 565 public libraries in Korea. He classified these public libraries into three categories (Group 1—large size, Group 2—middle size, and Group 3—small size libraries) and calculated their relative efficiency by means of AHP (Analytic Hierarchy Process) and DEA Models. The average efficiency of these three groups of libraries was 0.89, 0.72 and 0.60 respectively.

Noh (2011) reported the results of an assessment of university library efficiency via DEA. The researchers understood the importance of the selection of input variables and output variables for this kind of analysis and took careful steps in choosing the variables reflective of the changing environment of university libraries. The selected input variables included budget, librarians, books, serials, e-journals, Web databases, e-books, computers, developed databases. The output variables were circulation books, users, Web site visits, and database uses. The analysis results showed that the efficiency of university libraries varied significantly with or without the inclusion of electronic resources in the evaluation yet it did not differ significantly with different operational bodies. The analysis results also confirmed decision making units (DMUs) with a 100 percent efficiency rate and a low efficiency rate. The researcher proposed benchmarking DMU models for inefficient DMUs to increase their efficiency.

De Carvalho et al. (2012) applied DEA modeling to a convenience sample of 37 libraries that were affiliated to a federal university in Rio de Janeiro. Data was collected from the university's managerial database. The researchers selected three inputs (number of employees, area and number of volumes) and four outputs (consultations, loans, enrolments and user traffic) for the assessment of library efficiency performance. Based on the DEA model, scores that quantified efficiency status for each library unit were estimated. These estimated scores made possible the ranking and provision of operation plans for each unit, which should be of help to managers in improving their library efficiency.

Hwang, Shieh, and Hsieh (2012) proposed and applied a DEA model for the evaluation of the using efficiency of e-resources in libraries. With this model the researchers did efficient analysis, slack variable analysis, and sensitivity analysis of e-resources. They chose as evaluation targets 12 databases among the e-resources of a research-oriented university in Taiwan. The inputs (target user number and purchase fee of databases) and outputs (connections, searches, and downloads) were selected based on the reviewed literature. The analysis results confirmed the advantages of DEA technique in evaluating the using efficiency of databases as compared to other methods. It allowed the researchers to calculate the maximum value of efficiency of each database, and make comparisons and suggestions for improvement.

4. Research Objectives

DEA technique has been applied to performance assessment of various types of libraries. While a few evaluations focused on public libraries' performance (e.g. Vitaliano, 1998; Sharma et al., 1999; Hammond, 2002; Jang, 2009), no research has been done to assess the overall public library performance efficiency at state or country level.

This paper aims to examine how well the public libraries in each state of USA combine their resources to support the largest amount of possible services to the community. How to improve the performance of the inefficient libraries is also a key issue that will be investigated.

5. Models and Methodology

5.1. Selection of Data and Variables

The data set used in this paper is downloaded from Institute of Museum and Library Services Website (http://www.imls.gov/research/public_libraries_in_the_us_fy_2010_tables.aspx). The data set includes the information of Public Libraries in the United States Survey (Fiscal Year 2010). All the data are aggregated at the state level. The variables were selected based on traditional performance ratios, availability of the data and experts' opinion. There are two inputs (total FTE and total operating expenditures) and five outputs (Number of Library Visits, Number of Reference Transactions, Total Circulation, Number of Registered Borrowers, and Total Operating Revenue) in the model.

5.2. DEA Model

The diagram for the DEA model is provided in Figure 1. Input orientation (the LP is oriented to minimize inputs) was selected for the DEA models in this research since we are more interested in minimizing the consumption of inputs subject to attaining the desired output levels. Furthermore, the level of services provided by the public libraries in each state may not be controlled. BCC model is utilized in order to consider the size effect.

Figure 1. DEA model

6. Results

The data were processed using DEA Solver PRO. Table 1 summarizes the raw information of the sample. The sample includes the aggregate information about public library services in the state level for 51 states in USA.

Table1: Summary Statistics

	Max	Min	Average	SD
Total FTE	12353	219	2733	2785
Total Operating Expenditures	1261061	14040	211167	254286
Library Visits	178979	2436	30805	33315
Number of Reference Transactions	34925	409	6051	7640
Total Circulation	245410	2713	48278	50604
Number of Registered Borrowers	22276	281	3354	3828
Total Operating Revenue	1289759	14888	221582	260651

It can be seen easily from Table 1 that the standard deviation for each of the chosen variables is quite large. In addition, the difference of the maximum and minimum value of each variable is significant. Therefore, we can conclude that there exists significant variation in each of the input and output variables. Thus, BCC model is a good choice since it can deal with the size effect. Since the input oriented model is adopted, technical efficiency scores in this paper can be interpreted as the proportion of inputs (total FTE and total operating expenditures) that could produce the state's output vector (library visits, number of reference transactions, total circulation, number of registered borrowers and total operating revenue) if the studied state was operating on the frontier. Table 2 provides the DEA results.

Table 2: DEA Results

	BCC
Average Score	0.96
Standard Deviation	0.05
Maximum Efficiency Score	1.00
Minimum Efficiency Score	0.83
Number (and %) of Efficient DMUs	20(39%)
# Efficient DMUs exhibiting IRS	6
# Efficient DMUs exhibiting CRS	10
# Efficient DMUs exhibiting DRS	4

Table 2 shows that most of the public libraries in USA operate very efficiently. The average technical efficiency score reaches as high as 0.96. 39% of the states have their public library services operate efficiently. In addition, the standard deviation of the DEA scores is only 0.05, which indicates the performance of public libraries in USA are quite close. Among the 20 efficient states, 6 states operate under increasing returns to scale, 10 states operate under constant returns to scale and 4 operate under decreasing returns to scale. Furthermore, 6 states appear in reference set more than 10 times. They are the robustly efficient units. Those states are likely to remain efficient unless there were significant changes in their operations. 9 states appear in reference set no more than twice. They are the weakly efficient units and their efficiency scores may drop below 1.0 if there was a small drop in the value of an output variable (or a small increase in the value of an input variable). The efficiency score distribution is provided in Figure 2.

Figure 2: DEA Efficiency Score Distribution

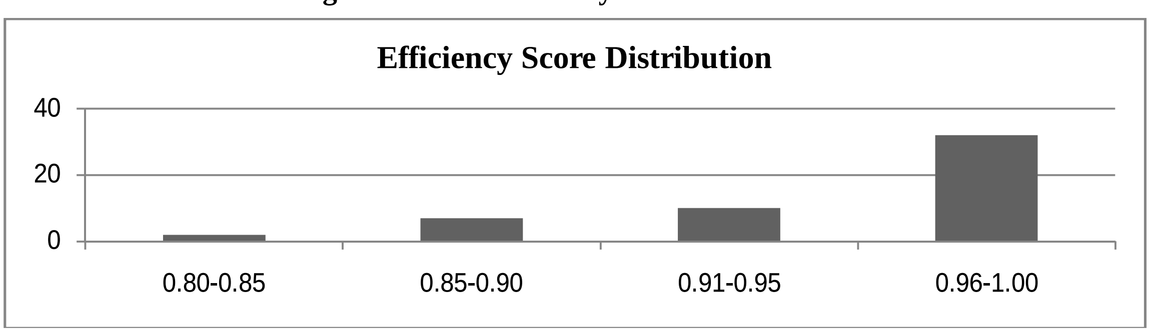

Figure 2 indicates that the distribution of efficiency scores is skewed towards the higher efficiency scores, which implies that all the states in the study perform very well in their public library services. The efficiency score of the majority states lies between 0.96 and 1 (efficient). No state has an efficiency score lower than 80%. The average technical efficiency score of 0.96 suggests that the USA public libraries could use 4% less resources including labour and operating expenditure to provide the same level of services in theory. Table 3 provides the detailed guidance on how the inefficient states should reduce their FTE and total operation expenditure to become efficient for some of the DMUs in the analysis.

Table 3: Reference Set

DMU	Score	Reference set (lambda)											
Alabama	0.939	Kentucky	0.110	Mississippi	0.509	North Carolina	0.203	North Dakota	0.074	Tennessee	0.103		
Alaska	1.000	Alaska	1.000										
Arizona	1.000	Arizona	1.000										
Arkansas	0.992	Kentucky	0.132	Mississippi	0.140	North Carolina	0.013	North Dakota	0.440	Tennessee	0.275		
California	1.000	California	1.000										
Colorado	0.998	California	0.024	Nevada	0.737	Ohio	0.233	Oregon	0.006				
Connecticut	0.828	California	0.036	Kentucky	0.364	Nevada	0.505	North Carolina	0.094				
Delaware	1.000	Delaware	1.000										
District of Columbia	1.000	District of Columbia	1.000										
Florida	1.000	Florida	1.000										
Georgia	0.963	Kentucky	0.150	Louisiana	0.045	North Carolina	0.805	Ohio	0.000				
Hawaii	0.988	Mississippi	0.039	North Dakota	0.796	Tennessee	0.165						
Idaho	0.984	Kentucky	0.043	Montana	0.716	North Carolina	0.001	Utah	0.240				
Illinois	1.000	Illinois	1.000										
Indiana	0.968	Kentucky	0.678	Louisiana	0.017	Ohio	0.305						
Iowa	0.917	Kentucky	0.218	Montana	0.122	North Carolina	0.083	Utah	0.577				
Kansas	0.866	Delaware	0.221	Kentucky	0.491	Utah	0.288						
Kentucky	1.000	Kentucky	1.000										
Louisiana	1.000	Louisiana	1.000										
Maine	0.875	Kentucky	0.084	Mississippi	0.041	Montana	0.856	North Carolina	0.019				
Maryland	0.891	California	0.018	Kentucky	0.132	Louisiana	0.118	Nevada	0.446	North Carolina	0.104	Ohio	0.183
Massachusetts	0.870	California	0.056	Kentucky	0.201	North Carolina	0.414	Ohio	0.061	Utah	0.268		
Michigan	0.964	California	0.098	Kentucky	0.416	North Carolina	0.210	Ohio	0.276				
Minnesota	1.000	Minnesota	1.000										
Mississippi	1.000	Mississippi	1.000										
Missouri	0.926	Kentucky	0.558	North Carolina	0.155	Ohio	0.118	Utah	0.170				
Montana	1.000	Montana	1.000										
Nebraska	0.964	Kentucky	0.112	Montana	0.380	North Dakota	0.309	Tennessee	0.078	Utah	0.121		
Nevada	1.000	Nevada	1.000										
New Hampshire	0.838	Kentucky	0.152	Montana	0.741	Nevada	0.043	Utah	0.064				
New Jersey	0.943	California	0.151	Illinois	0.202	Louisiana	0.647						
New Mexico	0.982	Arizona	0.066	North Carolina	0.038	North Dakota	0.763	Tennessee	0.133				
New York	0.941	California	0.605	Illinois	0.356	Ohio	0.040						
North Carolina	1.000	North Carolina	1.000										
North Dakota	1.000	North Dakota	1.000										
Ohio	1.000	Ohio	1.000										
Oklahoma	0.950	Kentucky	0.253	Montana	0.345	Nevada	0.234	North Carolina	0.131	Utah	0.038		
Oregon	1.000	Oregon	1.000										
Pennsylvania	0.925	Kentucky	0.427	North Carolina	0.251	Ohio	0.233	Texas	0.089				
Rhode Island	0.886	Kentucky	0.070	Montana	0.278	Nevada	0.224	North Dakota	0.428				
South Carolina	0.902	Kentucky	0.259	Louisiana	0.054	North Carolina	0.293	North Dakota	0.394				
South Dakota	0.978	Kentucky	0.010	Montana	0.648	North Dakota	0.343						
Tennessee	1.000	Tennessee	1.000										
Texas	1.000	Texas	1.000										
Utah	1.000	Utah	1.000										
Vermont	0.936	Montana	0.518	North Dakota	0.465	Utah	0.016						
Virginia	0.935	Kentucky	0.095	North Carolina	0.307	Ohio	0.230	Utah	0.369				
Washington	0.995	California	0.118	Nevada	0.239	Ohio	0.112	Oregon	0.531				
West Virginia	0.994	Kentucky	0.058	Mississippi	0.230	Montana	0.006	North Dakota	0.653	Tennessee	0.054		
Wisconsin	0.927	California	0.013	Kentucky	0.082	North Carolina	0.209	Ohio	0.140	Utah	0.555		
Wyoming	0.871	Kentucky	0.085	Nevada	0.041	North Dakota	0.874						

Among all the states in USA, Alaska, Arizona, California, Delaware, District of Columbia, Florida, Illinois, Kentucky, Louisiana, Minnesota, Mississippi, Montana, Nevada, North Carolina, North Dakota, Ohio, Oregon, Tennessee, Texas, Utah lie on the best practice frontier. That is, public library services in these twenty states operate efficiently.

The worst performers include public libraries in Connecticut, Kansas, Maine, Maryland, Massachusetts, New Hampshire, Rhode Island, and Wyoming. One of the most useful benefits derived from a DEA analysis is the set of target values for improvement for DMUs that DEA found inefficient. For example, to operate their services efficiently, public libraries in New York State could use 6% less resources to obtain the same service level. In details, these libraries can consume $X_{California}*0.60 + X_{Illinois}*0.36 + X_{Ohio}*0.04$ (X_i is the input vector for DMU i) amount of input to generate its observed output level.

6.1. Alternative Path to the Frontier

There are many different ways in DEA methodology to evaluate DMUs' efficiency. The adopted input-oriented model is a natural choice in this study to evaluate how efficient each state in USA operates its public libraries. However, if each state wants to keep the current level of the labour and total expenditure, the output-oriented model can provide the guidance on how each state should grow its public library services in order to become efficient using the current level of inputs. Table 4 provides the details.

Table 4: Output-Oriented DEA Results

	Output oriented BCC model
Average Score	0.96
Standard Deviation	0.05
Maximum Efficiency Score	1
Minimum Efficiency Score	0.83
Number (and %) of Efficient DMUs	20 (39%)
# Efficient DMUs exhibiting IRS	6
# Efficient DMUs exhibiting CRS	10
# Efficient DMUs exhibiting DRS	4

Table 4 shows a highly identical result as the input-oriented model.

7. Discussion

This is one of the first efforts to assess the overall public library performance efficiency at state level via DEA technique. The analysis results provide an overall picture of public library performance efficiency in United States by state. They also tell the target values for those comparatively less efficient states to improve. Nationally speaking public library services operate very efficiently. The space for improvement for most states is quite small.

On the other hand, the value of libraries to their communities and library usage across the country increased while national economy declined. Yet public funding did not keep pace with this increase and many states experienced budget cuts and anticipated even further cuts ("Report: library funding lags", 2009). What can be done to satisfy the needs of patrons with limited and decreasing funding has been a challenge to public libraries in general. For this purpose, our research results highlight the need for future research directions and practical implications as discussed below.

First of all, DEA analysis needs to be performed at individual public library level to figure out whether and to what extent individual public library performance efficiency can be improved. For this type of research, researchers should plan well for the sources of data for analysis and should carefully consider the inputs and outputs of their analysis, especially in the present digital information environment.

Based on the performance efficiency analysis results at individual public library level, researchers should do further research on the factors that may impact public library service performance efficiency. Even though the general space for improvement is small for public libraries, individual libraries may be able to find ways to improve their efficiency by looking into factors that may positively or negatively impact library performance efficiency.

Since the space for efficiency improvement is generally small, public libraries should consider ways to find more fund revenues. As pointed out by Coffman (2004), “most public libraries depend almost entirely on local and state tax dollars for operating budgets” (p. 37).

So to resolve the difficulties brought about by budget cuts, public libraries should campaign for alternatives to traditional sources of funding, (non-tax sources such as donations, fines, fees, etc.). They should initiative marketing campaign to increase people’s awareness of the value of public libraries and the need for support. Researchers should investigate feasible alternative funding models for libraries (Coffman, 2004).

One other future research direction is the investigation of the impact of policies and politics on public libraries’ performance. As explained by Jaeger, Bertot, and Gorham (2013), “Public libraries are entities strongly affected by political discourse and policy making at all levels of government, … The interrelationship between policy, politics, and public libraries is evident in the current recession” (p.61). Among various areas in which politics and policies have been impacting public libraries is the effect brought by economic policies at local, state, and federal levels. “The fact that library activities and contributions to their communities cannot be easily translated into monetary terms makes them easy targets for budget cuts, which has been all too apparent throughout the prolonged economic downturn that began in 2008” (Jaeger et al., 2013, pp. 64-65). Public libraries now face the challenge of advocating their perspectives in the present policy environment. They should be able to quantify the value of their services to their customers and those who fund them. For researchers, the investigation of policy and politics related issues (including economical ones) should have the significance of increasing the awareness of the impacts of policy and political choices related to public libraries among people in general and governments of all levels.

8. Conclusion

Library performance assessment has attracted significant research attention since the libraries have been facing serious budget cuts. The traditionally-used single productivity measures can only provide the information about a certain perspective of the library performance, which motivates a more complex research method in the library industry. This paper adopts DEA to evaluate how efficient each state in USA operates their public library services making use of the available staff and operating expenditure. The DEA results indicate that public library services in all states operate fairly efficiently on the whole although there is still a little room for improvement. In addition, the DEA analysis provides the set of target values for improvement for those states that DEA found inefficient so that the inefficient states can reach the best practice frontier. To the best of our knowledge, it is the first time to introduce DEA to measure the public library performance at the state level in USA. The results provide the guidance for government budgeting process. For those states that do not perform efficiently in terms of public library service, our results give the strong indication on how to use the minimum budget and manpower to maintain the same level of public library services.

Future research is needed to analyze public library performance efficiency at individual level, to examine how each public library, especially in the inefficient states, should improve its individual performance with the identification of the impacting factors. With the ongoing economic downturn, public libraries and researchers should also explore alternative funding models as well as the impact of policy and politics on public library performance. They should advocate their perspectives in the present policy environment to governments of all levels and people in general.

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