Human Resources

Efficiency in Turkish State Libraries a Data Envelopment Analysis Application

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This paper investigates the relative efficiency of public (state) libraries of major cities in Turkey by applying a data envelopment analysis. Scale, technical, and overall efficiency scores are calculated. It is found that there is a negative correlation between economic and social development index of the cities and efficiency scores of state libraries of same cities. In order to understand the sources of technical inefficiencies, the slack analysis is employed. Book collection and library staff are turned out to be the most problematic inputs and library members and lending of the books the most problematic outputs.

Introduction

Efficiency problems in public sector have been at the center of economic and political debates in Turkey for a long time. It has been argued that many public/government institutions are using government funds and resources ineffectively. However, empirical studies addressing the issue are very rare. Therefore, the motivation of this paper is to investigate empirically a hotly debated subject and initiate research about efficiency evaluation of public sector institutions using the example of public libraries. It is hoped that our results help policy makers in their decisions in allocating public resources to different services and administrative units and in making the services better.

Studies of efficiency in different fields of the public sector have been reported in the literature (Fox, 2002; Ganley and Cubbin, 1992). This study, however, is one very few analyzing the efficiency in public sector service production in Turkey. It may well be the first one to assess the relative efficiency of public libraries in Turkey by examining the relationship between library inputs and library outputs.

The recent article of Moore (2004) is a good descriptive summary about the importance of libraries and new trends about them. In it, widespread network of public libraries and their functions and services are descriptively analyzed. Another recent study about the importance of public libraries or willingness to pay (WTP) is that of Aabø (2005), which uses the contingent valuation method to analyze demand for library services.

Efficiency analysis of libraries has been reported before in the literature as well (Chen, 1997; Vitaliano, 1998; Hammond, 1999 and 2002; Worthington, 1999), to name just a few. Almost all of the studies except Hammond (1999) use data envelopment analysis (DEA). The DEA method, which is not explained in detail here, was first developed by Charnes et al. (1978) who employed a mathematical linear programming (CCR) model to create efficiency frontier. Then Banker et al. (1984) derived a revised model (BCC model) to measure technical and scale efficiency. The basic idea of DEA is to identify the most efficient decision making unit(s) (DMUs) among all the DMUs. All the papers mentioned above investigate the efficiency of libraries in developed countries. The contribution of the present paper is the fact that it analyzes a diverse cross section of public libraries in developmentally different regions of Turkey, which is an emerging country. It is usually assumed that less developed regions of a country use the public resources less effectively. This assumption or hypothesis will be tested in this paper in the context of public libraries of different cities.

Therefore, this study investigates relative efficiency of public libraries of different provinces in Turkey by using DEA. It derives overall, technical, and scale efficiency scores for a sample of 81 provincial state libraries. The required input values implied by the analysis also enable one to identify which of the inputs are most strongly associated with inefficiency. Section 2 describes the public library services in Turkey. The next section analyzes library inputs and outputs used in this study along with the data resources and DEA efficiency scores of individual libraries. Section 4 gives the empirical results and the last section provides a brief conclusion.

Public Library Services in Turkey

Public libraries in Turkey are owned and governed by the state and there is a high degree of centralization in managing libraries, as with many other public services in Turkey; the correct term is state libraries instead of public libraries. Even though some local governments (municipalities) own and operate libraries independently of the state, these are only a small percent of the population of libraries in Turkey, and their size in terms of number of books, is very small. University libraries are not used by the general public; and therefore, they are excluded from this paper. Only state owned libraries of main provinces are investigated. All state libraries are governed by the state; all employees are appointed by the central government which also determines policy as to how to manage or direct the library. Therefore, there is little autonomy in terms of employing and firing staff, moving a location or buying new books and materials for the library.

The only services a typical Turkish public library provides to the public are space for reading periodicals at certain times of the day, and lending books to members. Becoming a member

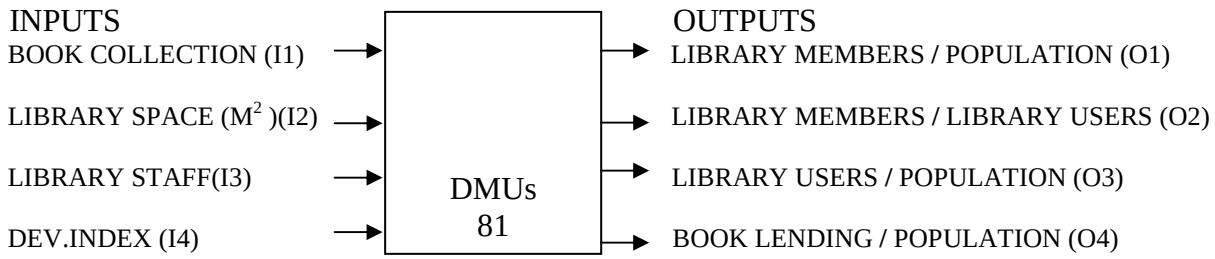
of a library requires some minor paperwork. One has to bring an official paper which shows where the prospective member lives in terms of the neighborhood, two pictures for library ID card, and a small fee for membership. This paperwork can probably explain the difference between number of library members and number of library users; the later is a lot larger than the former for every library in the sample. Especially evidence of residence is big deterrent for membership since one might not get official paper easily because local authority to issue that paper might not be available at the time one needs it. In short, this requirement can delay or totally terminate the membership desire of people. In a personal interview with the manager of a provincial library in Turkey, we learn that this requirement can be waived by the manager of the library if the person has certain qualifications like having a regular job, or having a government job or being a teacher, professor, officer or soldier. In smaller provinces, people usually know about each other and the first requirement can be waived most of the time if wanted.

Data Envelopment Analysis and Library Inputs and Outputs

In this section, a DEA is proposed to evaluate relative efficiency of state libraries in Turkey. The sample constitutes 81 main state libraries as the decision making units (DMUs) of 81 different major cities (provinces) in Turkey. Metropolitan and developed cities like Istanbul, Ankara, and Izmir have more than one library; libraries of universities, libraries of some civil society organizations like libraries of chambers of commerce, libraries of different public institutions like those of municipal authorities, etc. In fact, there are 16 metropolitan municipal authorities (MMA) in Turkey and they are administratively, economically and socially more developed than rest of the cities. These 16 cities have more than one library even though state has only one branch. Other libraries in these 16 cities belong to other institutions mentioned above. Other cities usually have only one library, which is owned by the state and only one branch in a given city.

Library inputs and outputs are to be identified to apply DEA. Measuring Academic Library Performance (MALP), a comprehensive manual of performance evaluation, is recommended by the American Library Association (ALA). The MALP manual provides many output measures for university library performance evaluation. The evaluation in this paper as in Chen (1997) is based on the MALP manual published by ALA and availability of data. Based on the manual, the output measures are conducted using the following items: attendance or reader visits (library users), book circulation (number of borrowed or checked out books). Number of library members and the ratio of library members to reader visits (library users) are also used as output measures. All the output items except for the ratio of library members to library users are normalized by the population of the city.

The input measures are based on the items listed in the Standard of University Libraries provided by the American University Library Association. Even though this current paper is not about university libraries, we follow the Standards for University Libraries as in the case of Chen (1997). Our evaluation selects the following inputs: library staff, book collection (number of books), and area of library space. Economic and social development index (ESDI) of the cities, which is calculated by State Planning Organization (SPO), is also used as one of the inputs since this index can be used as a proxy for the environment in which a particular library operate. This environment can be quality of employees, or can be a proxy for rental values of library building since in developed cities property is more expensive, etc. The basic framework to employ DEA is as follows.



The time span of the analysis is the average values of 2003 and 2004. Unfortunately data for previous years for big city libraries are not organized by the Ministry of Culture. All data, except ESDI and population values, are taken from the Ministry of Culture in Turkey. Population values are taken from the State Institute of Statistics (SIS) in Ankara.

Descriptive statistics about library variables is given in Table 1.

Table 1 Descriptive Statistics

	Book Collection	Library Users	Library Members	Book circulation	Library Staff	Library Space	Dev. Index	Pop.
max	1076135	721410	14162	164278	41	5500	4.81	8831805
min	21940	10868	171	2339	4	100	-3.49	17274
mean	160306.06	257677.16	5279.185	53588.48	11.25	942.494	0.001	369334.1
Std. dev	156674.78	175233.66	3533.121	40380.44	7.03	830.789	1.08	1058051

Now the idea of calculating DEA scores can be formulated as a linear programming problem. Y_{rk} denotes as the *r*th output of the *k*th decision making units (DMUs) and X_{ik} as the *i*th input of the *k*th DMU. If a DMU employs *m* inputs and *s* outputs, the overall efficiency score of the *k*th DMU, ϕ_K, is a solution to the linear programming problem (CCR model).

CCR MODEL

MAX $\phi_K = \sum_{r=1}^{s} \mu_{rk} Y_{rk}$

S.T.

$$\sum_{i=1}^{m} v_{ik} X_{ik} = 1$$

$$\sum_{r=1}^{s} \mu_{rk} Y_{rk} - \sum_{i=1}^{m} v_{ik} X_{ik} \le 0 \qquad i=1,.....,m \quad r=1,.....,s \quad j=1,.....,N$$

$$\mu_{rk} \ge 0 \ , \ v_{ik} \ge 0$$

where μ_r and v_i give the weights associated with each output and input, respectively. The objective function of the above problem seeks to maximize the efficiency score of a DMU, ϕ_K, by choosing a set of weights for all inputs and outputs. A DMU is considered to be efficient if the objective function of the associated problem results in an efficiency score of 1, otherwise it is considered to be inefficient. CCR model calculates the overall efficiency scores.

Overall efficiency (OE) can be decomposed into (pure) technical efficiency (TE) and scale efficiency (SE) since OE is equal to the product of TE and SE. The BCC model, mentioned in the introduction, is used to decompose OE into TE and SE. The BCC model is the revised version of CCR model. The former model can be reformulated by adding $\sum_{j=1}^{N} \lambda_{jk} = 1$ to the dual problem of the CCR model, which serves very important purpose to decompose OE. The BCC model is as follows

BCC MODEL

MIN θ_k

S.T.

$$\sum_{j=1}^{N} Y_{rj} \lambda_{jk} \ge Y_{rk}$$

$$\theta_k X_{ik} - \sum_{j=1}^{N} X_{rj} \lambda_{jk} \ge 0 \quad i=1,.....,m \quad r=1,.....,s \quad j=1,.....,N$$

$$\sum_{j=1}^{N} \lambda_{jk} = 1$$

$$\lambda_{jk} \geq 0$$

Empirical Results

CCR model produces the overall efficiency scores of DMUs and BCC technical efficiency scores. Scale efficiency of a DMU is calculated as the ratio of CCR efficiency to BCC efficiency. All the libraries in the sample except for those of Bolu and Afyon have exactly the same BCC efficiency scores as CCRs. Therefore, overall efficiency scores, except for those two cities, are also technical efficiency scores, which are generalized in Table 2

Table 2 Overall Efficiency Frequency

OVERALL EFFICIENCY RANGE	FREQUENCY
≤ 0.4999	36
0.5000-0.5999	10
0.6000-0.6999	7
0.7000-0.7999	6
0.8000-0.8999	1
0.9000-0.9999	4
1	17
TOTAL	81

Afyon has overall efficiency and technical efficiencies as 0.38 and 0.28 respectively Bolu's values are 0.12 and 0.40. Therefore, these two cities are scale inefficient as well. Since BCC model allows for variable returns to scale, the source of scale inefficiency can be identified by calculating the BCC model above one more time with replacing $\sum_{j=1}^{N} \lambda_{jk} = 1$ by the $\sum_{j=1}^{N} \lambda_{jk} \leq 1$ constraint for these two cities. It is found that new efficiency values are exactly the same as technical efficiency values for both cities; this is the evidence that both cities have decreasing returns to scale (DRS). That is, reducing the scale or capacity of libraries in these two cites would increase the scale efficiency. All other city libraries are scale efficient since their scale efficiency scores are 1. This result is not surprising since state libraries in every city in the sample were established in 1960s. Over the last 45 years one would expect that libraries would find their optimal size and scale. Therefore, the source of overall inefficiency is the technical inefficiency for almost every library.

17 out of 81 city libraries are efficient as shown in Table 2. Efficiency scores are regressed on a dummy variable, west, taking the value of 1 for the Western cities, and 0 for the Eastern cities. This division of all cities is used by public administration discipline in Turkey. A strait line from Samsun in the North to Adana in the South divides Turkey into two main regions. Cities on the left side of the line are the Western cities, and cities on the right are Eastern ones. It is found that efficiency scores of libraries are not statistically significantly different between the East and the West regions of Turkey. This finding is actually contrary to common belief in Turkey since it was expected that less developed regions have less efficiency of resource use in any activity. Economic and Social Development Index (ESDI) is also regressed on the same dummy variable, west, and it is found that Western cities on average have higher development index than Eastern cities. This is confirming the common belief that Western cities on average are more developed. The relationship between efficiency scores and Economic and Social Development Index is also examined by Pearson correlation test for all cities. It is found that there is a significant negative relationship between efficiency scores of city libraries and ESDIs of cities (r=-0.28 , p=0.01). A stronger relationship is found in only Eastern cities (r=-0.39, p=0.01), while no relationship in the Western cities. These findings imply that less developed cities have more efficient libraries, especially in the Eastern cities.

In the less developed cities, there are no alternatives to get information and knowledge, most schools don't have big libraries and many less developed cities don't have major universities, especially in the Eastern region. Some developed cities of the Eastern region have major universities and public libraries of those cities have relatively lower efficiency scores since universities have much bigger libraries and university students don't use public libraries. In these cities there are more movie theaters and in some of them there are established state theaters. Therefore for socialization public libraries are not necessarily best places for students. In these more developed cities of Eastern region, public libraries have lower efficiency. Most libraries in the less developed cities are places not only for school work and school related information, but also for socialization of students and readers since library is an acceptable place to let their school children, both girls and boys alike, go out for many families in these very traditional cities in Turkey. Also, there are no major theater groups and state theaters, not many movie theaters in the less developed cities of the Eastern region. Therefore, city library is one of the attraction places of the city in those cities and therefore relatively has higher efficiency scores. Another observation is that all 16 metropolitan cities except Istanbul have lower efficiency values than average efficiency of inefficient libraries. Only three out of 16 metropolitan cities are in the Eastern region. In these metropolitan cities, there are many alternatives for both socialization and acquiring information about school work or only reading.

There is one city that breaks the pattern or paradigm laid out here, Istanbul. Istanbul is not a typical big or metropolitan city. It is a cosmopolitan city. It has the highest social and economic development index. There are many major public and private universities in Istanbul and many socialization places, movies, theaters, museums, many other institutions' libraries. It would not be surprising if its efficiency score would have been lower than the average of inefficient libraries. However, it has an efficiency score of 0.98. This is not 1, but it is not a lower efficiency score. A considerable portion of population in Istanbul is not registered to any school or university, looking for jobs constantly, preparing for the university entrance exam, and not economically well off. These people mostly use public library of Istanbul and the library has a higher efficiency score.

Now, the sources of technical inefficiency are investigated by the slack analysis in Table 3.

Table 3 Slack Analysis

Efficiency Range	Ave. Eff.[1]		I1	I2	I3	I4	O1	O2	O3	O4
≤ 0.4999	0.334	REQ	3.35	9.23	4.27	15.96	22.17	24.81	16.49	20.21
		ACT	18.99	36.52	22.50	44.96	10.84	25.49	17.86	13.36
0.5000-0.5999	0.556	REQ	4.54	11.89	5.94	26.82	33.82	38.53	26.09	35.37
		ACT	9.45	21.71	16.33	40.42	21.41	37.00	24.06	24.11
0.6000-0.6999	0.651	REQ	5.74	12.16	6.15	28.17	36.80	38.26	29.34	38.35
		ACT	12.02	19.16	19.15	41.15	27.00	37.88	29.02	29.89
0.7000-0.7999	0.759	REQ	4.39	9.84	3.89	23.90	23.33	23.34	24.64	29.50
		ACT	9.98	15.86	6.25	37.29	15.62	20.48	29.25	24.74
0.8000-0.8999	0.813	REQ	2.19	11.89	4.32	36.81	21.82	62.34	10.73	18.05
		ACT	8.36	14.63	21.82	40.84	17.79	62.34	10.73	12.21
0.9000-0.9999	0.984	REQ	2.28	10.22	4.11	24.57	18.94	37.16	14.23	17.67
		ACT	27.14	26.83	13.78	47.20	11.59	31.90	15.29	13.79

REQ. and ACT mean required and actual values, respectively. These values are all in percentage terms.

[1] Average Efficiency

As is shown in Table 3, in all ranges of inefficiencies, all inputs are used more than required since actual values are larger than required ones. If the ratio of actual to required inputs is 1 or close to 1 from below for a particular input, then it means that that particular input is used efficiently. These actual and required values are coming from the slack analysis. In none of the efficiency ranges, for no inputs, that ratio is 1, that is, all of them are greater than 1. This means that all the inputs are used inefficiently in all inefficient libraries. However, some inputs are used more inefficiently than others, meaning priorities should be placed on more urgent inefficiencies. First priority should be placed on the input with highest actual/required ratio; the second priority should be placed on the second higher ratio, and so on. The same priority analysis is used for outputs as well. If the ratio of actual to required outputs is 1 or close to 1 from above, then output production is efficient. In our case here, most ratios are less than 1; it means that productions of those outputs with less than 1 actual to required ratio should be improved. That is, first priority should be given to output type with smallest less than 1 ratio; the second priority should be placed on output type with second smaller less than 1 ratio, and so on. If the ratio is higher than or equal to 1, then there is no problem with that output type, no priorities need to be placed on that output type. Table 4 gives the priorities that need to be placed on both different input and output types.

Table 4 Priorities to eliminate inefficiencies

	Input Priorities				Output Priorities			
Range	1st Priority	2nd Priority	3rd Priority	4th Priority	1st Priority	2nd Priority	3rd Priority	4th Priority
≤0.4999	I1	I3	I2	I4	O1	O4	----	---
0.50-0.59	I3	I1	I2	I4	O1	O4	O3	O2
0.60-0.69	I3	I1	I2	I4	O1	O4	O2	O3
0.70-0.79	I1	I2	I3	I4	O1	O4	O2	---
0.80-0.89	I3	I1	I2	I4	O4	O1	O2	O3
0.90-0.99	I1	I3	I2	I4	O1	O4	O2	----

Table 4 shows the priorities to be considered to reduce and increase the actual to required for inputs and outputs, respectively. In terms of inputs, there is a pattern that for all inefficiency ranges, input type 1 and input type 3, book collection and library staff, respectively, have highest inefficient use of resources. In terms of output, there is pattern that for all inefficient ranges, output type 1 and output type 4, library members to population and book lending to population, respectively, have highest inefficient production of those outputs.

As policy implications, in order to reach the efficient level, library members to population and book lending to population should be increased. Such slack values must be interpreted carefully because the analysis takes the output to be exogenously determined; input oriented CCR model is used to calculate the overall efficiency scores. Given the centralized and bureaucratic structure of Turkish library system, the logical implication is that the elimination of output slacks can not be regarded as the obligation of local library managers. Nevertheless, differences in relative magnitude of output slacks maybe indicative of the weights attached to the member of the output vector, in planning library provision for the service area. Therefore, if the library provision is to be planned by the state, then some policies should be proposed to increase the membership and book lending. The way to increase the library members is to eliminate the bureaucratic structure of membership process and update the book collection frequently. This in turn increases book lending to population which is the fourth output in our model.

In terms of inputs, book collection should be updated or renewed. According to our slack analysis, book collection is more than required for given efficiency scores. Existing book collection

is not up to date and has limited variety. The most important thing here is not quantity of the book collection, but quality and variety of the books. This in turn increases the number of library members and book lending, which were problematic output types. According to our data and analysis, library users are much higher than library members and book lending is not at the required levels. This implies that people who come to library do not become members of the library and neither do they check out the books. This can be in line with bureaucratic cumbersome procedure of membership and the non diverse and not updated nature of book collection. It is the common fact that book collection is not updated in city libraries very frequently and also there is no data about the circulation of periodicals. Another problematic input type is the number of library staff; actual number of library staff is a lot larger than required number. Labor market for government employment in Turkey is also highly centralized. Staff in any library is appointed by the central government in Ankara. Employment policies don't always follow the line of economic and operational reasoning. That is, in many times very populist employment policies have been employed in many public services in Turkey. Therefore, it is quite often the case that a library staff is appointed into a library in which there is no need for a new staff. In addition, only very small percentage of library staff is librarians, which in turn affects the quality of the service and in turn affects the number of library users, library members, and lending of the books, which were our critical problematic outputs. In order to improve the efficiency, highly centralized structure of employment and other policies of public libraries (budgeting, updating books, making library more relevant to local people's most urgent needs, promotion activities, etc) should be relaxed, and more power should be granted to local public authorities since local public authorities are the best to know about the local peoples needs, wants, and service demands.

Conclusion

This paper investigates the relative efficiency of public (state) libraries of major cities in Turkey by applying a data envelopment analysis. All the libraries except for Bolu and Afyon have been found scale efficient. Technical efficiency scores are calculated. It is found that there is a negative correlation between economic and social development index of the cities and efficiency scores of state libraries of same cities. This negative relationship is significant and very prevalent especially in the Eastern region, where development index is smaller than that for Western cities. It is explained in the text that in more developed cities there are alternatives to reach information and to socialize. In order to understand the sources of technical inefficiencies, the slack analysis is employed. Book collection and library staff are turned out to be the most problematic inputs and library members and lending of the books the most problematic outputs. Library users as output type are not a problematic output. This implies that people use libraries, but for some reasons are having problems of becoming members. This might be because of cumbersome membership process. Book collection is very old, not up to date as it is the well known fact of libraries in Turkey. Even if there is more than enough number of books in the libraries, variety and updated books are not enough. This is also proved by smaller number of book check outs and low percentage of library membership. In terms of employment in the libraries, too many non-librarians have been employed in the libraries. This might be because of highly centralized structure of the public labor market and state library management.

As policy implications, this paper suggests that book collection should be updated and diversified. Membership procedure and level of bureaucracy related to the membership process should be shortened and simplified. High centralized structure of state libraries should be relaxed, and local authorities should take more responsibility to design the public services in terms of public libraries.

Finally, it is suggested that government institutions should employ this kind of efficiency analyses into many different areas of public service productions.

Appendix I: Population of City libraries in the analysis according to efficiency range.

≤ 0.4999 : Kirsehir, Balikesir, Aksaray, Batman, Adiyaman, Bingol, Erzincan, Manisa, Sanliurfa, Diyarbakir, Kocaeli, Kirikkale, Denizli, Sakarya, İsparta, Eskisehir, Trabzon, Hatay, Afyon, Tokat, Sivas, Erzurum, Mersin, Kars, Samsun, Malatya, Elazig, Antalya, Adana, Kayseri, Konya, Izmir, Ankara, Gaziantep, Bolu, Bursa.

0.5000-0.5999 : Usak, Siirt, Osmaniye, Agri, Canakkale, Kutahya, Corum, Tekirdag, Zonguldak, Van

0.6000-0.6999 : Rize, Ordu, Yozgat, Edirne, Amasya, Burdur, Duzce

0.7000-0.7999 : Aydin, Bayburt, Sirnak, Nigde, Gumushane, Kilis

0.8000-0.8999 : Karaman

0.9000-0.9999 : Hakkari, Igdir, Istanbul, Ardahan

1 : Artvin, Bartin, Bilecik, Bitlis, Cankiri, Giresun, Karabuk, Kastamonu, Kirklareli, K.Maras, Mardin, Mugla, Mus, Nevsehir, Sinop, Tunceli, Yalova

References

Aabø, Svanhild, (2005), "Valuing the benefits of public libraries", *Information Economics and Policy*, 17, 175-198.

Banker, R.D., A. Charnes and W.W.Cooper, (1984), "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis." *Management Science*, 30(9), 1078-1092.

Charnes, Abraham, W.W. Cooper and E.Rhodes, (1978), "Measuring the Efficiency of Decision Making Units", *European Journal of Operations Research*, 2(6), 429-444.

Chen, Tser.-Yieth, (1997), "A Measurement of the Resource Utilization Efficiency of University Libraries", *International Journal of Production Economics*, 53, 71-80.

Fox, Kevin, J., (2002), *Efficiency in the Public Sector*, Kluwer Academic Publishers, Norwell Massachusetts, USA.

Ganley, J.A. and Cubbin, J. S., (1992), *Public Sector Efficiency Measurement: Applications of Data Envelopment Analysis*, London, North-Holland.

Hammond, Christopher, J., (1999), "The Technology of Library Service Provision: A Cost Function Analysis of Public Library Systems in the United Kingdom." *Information Economics and Policy*, 11, 271-295.

Hammond, Christopher, J., (2002), "Efficiency in the Provision of Public Services: A Data Envelopment Analysis of UK Public Library Systems", *Applied Economics*, 34, 649-657.

Moore, Nick., (2004). "Public Library Trends", *Cultural Trends*, vol. 13(1), 49, 27-57.

Vitaliano, Donald, F., (1998), "Assessing Public Library Efficiency Using Data Envelopment Analysis", *Annals of Public and Cooperative Economics*, 69:1, 107-122.

Worthington, Andrew, (1999), "Performance Indicators and Efficiency Measurement in Public Libraries", *The Australian Economic Review*, 32:1, 31-42.