Research Methodology on Data Envelopment Analysis (DEA)

Research Methodology on Data Envelopment Analysis (DEA)

Jibendu Kumar Mantri

Universal-Publishers
Boca Raton

Research Methodology on Data Envelopment Analysis (DEA)

Universal-Publishers
Boca Raton, Florida • USA
2008

ISBN-10: 1-59942-950-0 (*paper*)
ISBN-13: 978-1-59942-950-2 (*paper*)

ISBN-10: 1-59942-940-3 (*ebook*)
ISBN-13: 978-1-59942-940-3 (*ebook*)

www.universal-publishers.com

Library of Congress Cataloging-in-Publication Data

Mantri, Jibendu Kumar, 1965-
Research methodology on data envelopment analysis (DEA) / Jibendu Kumar Mantri.
p. cm.
Includes bibliographical references.
ISBN-13: 978-1-59942-950-2 (pbk. : alk. paper)
ISBN-10: 1-59942-950-0 (pbk. : alk. paper)
1. Data envelopment analysis--Case studies. 2. Benchmarking (Management)--Case studies. I. Title.
HA31.38.M36 2008
519.7'2--dc22

2008043586

DEDICATION

In Bhagavad-Gita, Lord KRISHNA tells…

"Your right is to work only,
But never to its fruits;
Let not the fruits of action be thy motive,
Nor let thy attachment be to inaction."

• • •

Affectionately dedicated to my father,

Mr. Jugal Kishore Mantri

… But for whom nothing could have been possible.

My special thanks & gratitude to

the publisher, Mr. Jeff Young,
who has directly or indirectly helped and extended his support in bringing the book to the present shape.

• • •

My affections to

my daughter Lipsa
for her inspirations and suggestion

CONTENTS

	Preface	*ix*
1	Measuring the Efficiency of University Libraries using Data Envelopment Analysis	**13**
2	Measuring and Comparing the (In) Efficiency of German and Swiss Hospitals	**23**
3	The Economic Impact of Academic Centers and Institutes on State-Level GRP	**47**
4	Analysis of the Benchmarking Results of the Electricity Distribution Companies in Finland.	**63**
5	Merging Decision Making Units in DEA	**77**
6	Data Envelopment Analysis in the Benchmarking of Electricity Distribution Companies	**95**
7	An Evaluation of Advertising Media Spending Efficiency using Data Envelopment Analysis.	**109**
8	Power Quality Factors in Efficiency Benchmarking	**125**
9	The Effect of Scale on Productivity: An Application of Data Envelopment Analysis	**141**
10	A Data Envelopment Analysis Model for Risk Ranking of Rigid Subsea Pipes	**157**
11	Efficiency and Quality in the Current Higher Education Context in Europe	**165**
12	End-of Life Processing via Data Envelopment Analysis	**197**
13	Performance Measurement by means of Data Envelopment Analysis: A New Perspective for Undesirable Outputs	**217**
14	Using DEA to Structure Product–Markets	**227**

15	Assessing and Managing Product Efficiency- A Super Efficiency Model	**251**
16	A Data Envelopment Analysis Study of Airline Efficiency	**269**
17	Productive Efficiency Evaluation of Agricultural Sector of Municipal Districts of Amusep	**281**
18	Productivity Performance of Regional Electric Cooperatives in the Philippines	**293**
19	Temporal Aggregation in Data Envelopment Analysis	**307**
20	An Evaluation of Association between Firms' Financial and Productivity Performances	**329**
21	Benchmarking Indonesian State Universities: A Data Envelopment Analysis	**353**
22	An Optimization Methodology (DEA Analysis)	**365**
	Acknowledgements	*377*

PREFACE

Now-a-days DEA represents a milestone in the progression of a continuously advancing methodology for data analysis, which finds extensive use in industry, society and even in education.

This book is a handy encyclopedia of comprehensive references from expert to reflect the state-of-the-art in Data Envelopment Analysis (DEA) for researchers, students and practitioners. This author has undertaken significant efforts in selections of papers of application of DEA in different fields so that this book can also be used as a reference book to many.

The bibliography of DEA (1978-2001) by Gabreil Tavers states that: DEA is a mathematical programme for measuring performance efficiency of organizations popularly named as decision-making units (DMU). The DMU can be of any kind such as manufacturing units, a number of schools, banks, hospitals, police stations, firms etc. DEA measures the performance efficiency of these kinds of DMUs, which share a common characteristic that they share non-profit organization where the measurement is difficult.

DEA assumes the performance of the DMU using the concepts of efficiency or productivity, which is measured as the ratio of total outputs to total inputs. Also the efficiencies estimated are relative to the best performing DMU is given a score of 100% and the performance of other DMUs vary between 0-100%.

The twenty-two numbers of researched papers included here cover-interesting areas of application and finding as:

Naveena and Vyara apply DEA analysis in order to measure the efficiency of University libraries. In their paper the panel data of five University libraries for years 2002 and 2003 has been estimated. They find that three libraries from the efficiency frontier and the other two are inefficiency for 2002 and 2003 and they recommend a benchmark model for inefficient units.

Lukas, Gunnar, Alexander and Peter use DEA in the hospitals in the federal state of Saxony (Germany) and in Switzerland. Their solution continues to be that hospitals of Saxony have higher efficiency scores than their Swiss counterparts.

Julie, Tim, Necati and Deokro describe to measure the impact of public post secondary centers and institutes (C & Is) on the employment and economic output on Florida's economy. They have used REMI model to forecast both direct and indirect economic impacts for which economic benefits extend to job creation, generation of GRP, personal income and state taxes.

Jukka, Satu and Jarmo have described the present efficiency benchmarking method of the electrifying distribution business in Finland. In their paper the results of the sensitivity analysis performed to all distribution companies are presented and the prices for outages are determined.

Esfahani, Memariani and Saati suggest how to estimate the efficiency scores of DMUs in DEA when they are merged.

Lassila, Viljainen, Honkapuro and Partanen describe the efficiency benchmarking method of the Fanish electricity distribution companies. Especially the developments of the benchmarking method using internal weight restrictions in DEA model are studied in this paper.

Yunjae Cheong evolutes the advertising practices of top U.S. advertisers using DEA. His results reveal inefficiencies in area print, broadcast and Internet relative to the money spent by the advertisers, and also reveals the efficiency of statement advertising for these advertisers is less than that for print on broadcast expenditures.

Lassila, Honkapuro, Vilijainen, Tahavaninen and Partanen describe the power quality factors in efficiency benchmarking as outage costs. In there paper the effects of outage costs in efficiency benchmarking are evaluated by means of sensitivity analysis, effects and kind of regulation models in actual network planning task.

Nurgul and Atilla apply DEA for measuring relative performance of DMUs taking example of Turkish Banks. In their paper they conclude that Turkish Banking has "U shaped scale Efficiecncy" on selected profitability ratios.

Matos, Lessa, Melo, Netto and Qassim describe the application of DEA model for Risk Ranking of rigid pipes in sub-sea systems of petroleum off shore.

Emilio Martin applies DEA methodology to assess the performance of the departments of the University of Zaragoza (Spain) and finally discusses the existence of differences in strengths and weakness among departments of different area as and when European countries faced the principal challenges improving the efficiency and transparency of the system of higher studies.

Elif and Surendra investigate a product recovery facility where the end-of-life (EOL) products are taken back from the Last users/ owners and are brought into a disassembly facility for processing. Specially using DEA they determine the number and types of the EOL products that will be required to fulfill the demand.

Mauro, Eugenia and Agnese try to provide a new DEA model that includes the presence of undesirable outputs and to show its usage in some examples with respect to the variable that represent the strategies and objectives in place in different units.

Maik and Matthias provide a method to structure product markets by criterion of customer value using DEA.

Maik and Matthias also introduce another concept of product performance from customer's prospective in 2nd paper. They also suggested that using a supper efficiency model it is possible to differentiate the efficient products that are left with a score of 100% by standard efficiency models.

Eugenia and Agnese describe the new applications of DEA in examining the relative efficiency of Air One routes. They also suggest that DEA can be a valuable benchmarking tool for management.

Marcelo describes a methodology based on DEA and partial indicators for Brazilian agricultural sector, which has experienced important process of modernization since 1970.

His results reveal that the agricultural activity, which does not depend on the type of soil, has influenced the productivity levels as well as the productivity efficiency levels.

Ramon and Emilyn examine the productivity performance of private electric co-operatives in Philippines using DEA models. Their result in this paper gives a new empirical contribution to the electricity productivity literature emphasizing that the productivity is given more by technological innovations in the industry than managerial efficiency.

Lozano, Villa, Guerrero and Calle examine the issue of the effects of temporal aggregation of the input and output data used by DEA taking two approaches. The first approach consists in aggregating inputs and outputs using different time bucket sizes, which can be performed, in a siding window fashion and for each window, a time aggregated DEA model can be used. The second approach is to use a conventional DEA model but on exponentially smoothed input and output data.

Viverita describes a link between the accounting-cum-financial performance and production efficiency performance of matched sample of 141 public and private sector firms in Indonesia. His study employs two performance measures – DEA- Malmquist and the traditional financial ratios.

Viverita and Sigit investigate the productivity in forty state universities over the period 2001 to 2005 using a non-parametric frontiers approach DEA Malmquist methodology. They conclude that twenty out of forty universities experienced productivity growth; eighteen universities operated in declaring productivity, the rest of the universities had a constant productivity performance and also they find that total factor productivity (TFP) change was not related to the size and age of the universities.

Mantri, Panigrahi, Tripathy and Gahan explain the interrelationship of funds with the trend of tiger population using economic model for Similipal forest in Orissa, India. They also examine the level of efficiency of fund utilization for eight financial years taking the help of DEA.

All possible care has been taken in reproducing the content. However, errors and criticisms shall be highly solicited.

CHAPTER 1

MEASURING THE EFFICIENCY OF UNIVERSITY LIBRARIES USING DATA ENVELOPMENT ANALYSIS

Measuring the Efficiency of University Libraries Using Data Envelopment Analysis

Nevena Stancheva[1] **& Vyara Angelova**[2]
University of Economics - Varna, Bulgaria

Abstract

Data envelopment analysis is a non-parametric linear programming-based technique used for measuring the relative performance of organizational units where the presence of multiple inputs and outputs makes comparisons difficult. The aim of this paper is to apply Data envelopment analysis in order to measure the efficiency of University Libraries. The panel data of five University Libraries for years 2002 and 2003 has been estimated. We identified six inputs and three outputs. The input variables are staff, print edition expenses, electronic edition expenses, building space, wages, library technical equipment. As output variables we estimated: number of registered readers, number of customers served, number of borrowed items. We found that three libraries form the efficiency frontier and the other two are inefficient for 2002 and 2003. A benchmark model is recommended for inefficient units.

INFORUM 2004: 10th Conference on
Professional Information Resources
Prague, May 25-27, 2004 (Reprint)

---

[1]Assistant Professor, Department of International Economic Relations, University of Economics-Varna e-mail: nevenasisi@abv.bg

[2] Bibliographer in Information Bibliographic Sector, University of Economics, Varna, e-mail: veripa@abv.bg

1. Introduction

Because of their specific organization, University Libraries present certain difficulties in their efficiency evaluation. One recent approach to the evaluation of library efficiency is Data envelopment analysis (DEA). There have been a number of studies that applied DEA technique in order to assess the efficiency of different types of libraries. The most recent and accomplished is the paper of Shim[3], where a comparison of DEA applications in libraries is put forward. Chen, Vitaliano and Shim examine academic libraries and Hammond, Sharma et al., and Worthington study the efficiency of public libraries. Easun is one of the firsts to apply DEA approach to evaluate school libraries. The aim of the present paper is to apply DEA to measure the efficiency of University Libraries, in the town of Varna, Bulgaria.

2. Background of Data envelopment analysis (DEA)

Data envelopment analysis (DEA), occasionally called frontier analysis, was first put forward by Charnes, Cooper and Rhodes in 1978. It is a linear programming-based technique for evaluating the performance of administrative units. Examples of such decision-making units (DMUs) to which DEA has been applied are: banks, mutual found, police stations, hospitals, tax offices, defense bases, insurance companies, schools, libraries and university departments. The method can successfully be applied to profit and non-profit making organizations, as well. DEA can handle multiple inputs and multiple outputs as opposed to other techniques such as ratio analysis or regression. The performance of a unit is evaluated by comparing its performance with the best performing units of the sample. Best performing units form the efficiency frontier. If the unit is not on the efficiency frontier it is considered to be inefficient. Hence, DEA is called frontier analysis. The aim of DEA is to quantify the distance to the efficient frontier for every DMU. The measure of performance is expressed in the form of efficiency score. After the evaluation of the relative efficiency of the present set of units, the analysis shows how inputs and outputs have to be changed in order to maximize the efficiency of the target DMU. DEA suggest the benchmark for each inefficient DMU at the level of its individual mix of inputs and outputs. The basic mathematical formulation of DEA has the following form:

---

[3] Shim, W., Applying DEA Technique to Library Evaluation in Academic Research Libraries, Library Trends, Vol. 51, No 3,2003, p312-332

Maximize

$$E_B = \left\{ \sum_{r-1}^{R} u_{rb} y_{rb} \right\} / \left\{ \sum_{i-1}^{I} v_{rb} x_{rb} \right\}$$

Subject to:

$$\left\{ \sum_{r-1}^{R} u_{rb} y_{rj} \right\} / \left\{ \sum_{i-1}^{I} v_{ib} x_{ij} \right\} \leq 1, \forall i, j = 1, 2, ..., N$$

And u_{rb}, v_{ib} >=e for all r, i (where r = 1,2,….,R and i = 1,2,…,N)
Where
Eb is the efficiency of any unit b;
y_{rj} is observed quantity of output r produced by unit j = 1,2,…,N
x_{ij} is observed quantity of input I used by unit j = 1,2,…..,N
u_{rb} is the weight (to be determined) given to output r by base unit b
v_{ib} is the weight (to be determined) given to input i by base unit b
e is a very small positive number.

The u's and v's are the variables of the problem and are constrained to be greater than or equal to some small positive quantity e in order to avoid any input or output being totally ignored in determining efficiency. Charnes, Cooper and Rhodes proposed that each unit should be allowed to adopt the most favorable set of weights. The linear program solution technique will attempt to make the efficiency of the unit as large as possible. This search procedure will terminate when some of the efficiencies hit 1.

DEA gives the weights of inputs and outputs leading to the calculated efficiency. The unit is efficient if the efficiency is equal to 1 and inefficient if it is less than 1. If represented graphically, for a given set of units, the efficient DMUs form the frontier that encloses the inefficient ones (the whole data set). Hence the name of analysis - data envelopment analysis. So, the efficient units use its mix of inputs better than inefficient ones or the efficient units manage to produce more outputs using a given mix of inputs. An input-oriented measure quantifies the input reduction, which is necessary for a DMU to become efficient, holding the output constant. Similarly, an output-oriented measure quantifies the necessary output expansion, holding the input constant. A non-oriented measure quantifies the improvements when both inputs and outputs can be modified simultaneously. DEA suggest the creation of virtual unit B' for the inefficient unit B. B' lies on the efficient frontier and is the best practice for unit B, if it aims to be efficient. The outputs and inputs of such a virtual unit are linear combinations of corresponding outputs and inputs of all other units. Thus DEA gives inputs/outputs

targets for inefficient units – a benchmarks. The benchmark represents the peer group for the inefficient DMU.

Since the technique was first proposed much theoretical and empirical work has been done. Many studies have been published dealing with applying DEA in real-world situations. The most important task is to determine the proper set of inputs and outputs for the observed units. Having reviewed literature on economics of hospitals, we concluded that the authors use tree categories of inputs: labour, supplies and capital. Labour is number of physicians, surgeons, nurses, technical staff; the suppliers are pharmaceutical and others; capital includes equipment, vehicles and building space. There are four types of outputs: inpatient days, outpatient visits, surgical operations, and live births. When DEA is undertook to evaluate bank branch efficiency inputs are: staff, interest costs, non-interest costs – expenses for rent, electricity, printing, advertising, post and telephone, repair and maintenance, etc. and the outputs are: number of transactions – deposits, loans, advances, mortgages etc. One of the strengths of DEA is the fact that inputs and outputs can be measured in different units for example dollars, square meters, number of staff, etc. The analysis can be run using one input and several outputs or vice versa estimating one output produced by multiple inputs. DEA can be run with a very small data set, as is the case in this paper.

The first and probably most difficult step in efficiency evaluation is to decide which inputs and outputs data should be included.

The literature on applying the DEA technique to library evaluation shows various schemes of inputs and outputs sets. The inputs usually are library staff (Chen 1997; Sharma, Leung and Zane 1999), weekly hours (Vitaliano 1998), volumes held (Shim 2000), book collection (Sharma, Leung and Zane 1999), material resources (Easun 1992). The most frequently used outputs are total circulation, reference transactions, library visits, interlibrary lending, online search and provision of information. The inputs or outputs that can be controlled by the DMUs are called "standard" or "discretionary" variables. "Nondiscretionary" variables are beyond the control of library administration, like population density, area size, resident population, nonresidential borrowers, and socioeconomic indices.

3. Research Frameworks and Data Set

We have estimated the following six inputs: number of staff (Staff), printed edition expenses (ExPrIss), expenses on electronic databases and software (ExDB), building space (Scale), wages (Wages), technical equipment (MTB). We have defined three outputs: registered readers (Reg), customers served (Serv), books borrowed (Borr). Nondiscretionary inputs and outputs are not included, because the Libraries are situated in the same town. Number of staff includes director, bibliographers and technical personnel of the library. Printed edition expenses are textbooks, dictionaries, periodicals (newspapers and journals) purchased by the University plus all printed edi-

tions given as a grant by foundations or projects; expenses on electronic databases and software include electronic editions, software packages and all Internet resources paid for by the University. Building space is the area used for reading-rooms, checking out service and the information sector. Wages are the gross sum for twelve months. Technical equipment includes computers, furniture, electric devices etc. The wages, technical equipment and expenses are measured in Bulgarian leva (1BGL=0,5EUR approximately). The building space is measured in square meters. All outputs are measured in numbers. DEA can handle inputs and outputs measured in different units.

The data was analyzed using a program called EMS - Efficiency Measurement System version 1.3. The type of analysis is input oriented, with radial distance and constant returns of scale.

We have collected the data by conducting an inquiry into five University Libraries in Varna, Bulgaria. As mentioned this fact minimizes the deviations caused by the environmental factors if the analysis is undertaken for DMUs located in different places. The estimated units are the Libraries in F1-Naval Academy, F2-Medical Academy, F3-Technical University, F4-University of Economics and F5-Free University. It is important to notice that the Universities are different types, but the Libraries' reports have similar structure.

Data for 2002

DMU	Staff{I}	ExPriss{I}	ExDB{I}	Scale{I}	Wages{I}	MTB{I}	Serv{O}	Reg{O}	Borr{O}
F1naval	4	13170	2700	2000	17900	14052	14120	1700	25520
F2med	8	73520	12656	1700	29700	94682	14600	2850	30260
F3techn	11	20883	2700	2000	41367	15404	83065	5638	142250
F4ec	14	102009	2228	2000	77280	84568	82250	6533	304584
F5free	8	6450	1700	800	46080	17200	33818	5202	48701

Results for 2002

DMU	Score	Benchmarks		Ex Prlss-	ExDB-	MTB-	Wages-	Borr+	Serv+
F1naval	75,66%	3 (0,18) 5 (0,14)		5399,74	1335,56	5582,86	0	6214,79	5138,22
F2med	70,41%	3 (0,51)		41207,09	7545,9	58876,3	0	41647,15	27389,22
F3techn	100,00%	2							
F4ec	100,00%	0							
F5free	100,00%	1							

Data for 2003

DMU	Staff{I}	ExPrIss{I}	ExDB{I}	Scale{I}	Wages{I}	MTB{I}	Serv{O}	Reg{O}	Borr{O}
F1naval	4	39511	2440	2000	18480	16702	12170	1406	35217
F2med	8	77788	9520	1700	30791	94682	14930	2395	38690
F3techn	10	23165	3500	2000	42917	45942	73250	5139	131005
F4ec	13	76444	2837	2000	74234	121859	86474	6702	308276
F5free	8	70230	2225	2000	46900	120400		5612	50147

Results for 2003

DMU	Score	Benchmarks		ExPrIss-	ExDB-	MTB-	Wages-	Borr+	Serv+
F1naval	75,26%	3 (0,27)		23397,07	878,7	0	2165,7	625,19	7870,77
F2med	64,96%	3 (0,47)		39733,59	4552,85	40092,5	0	22364,08	19207,72
F3techn	100,00%	2							
F4ec	100,00%	0							
F5free	100,00%	0							

4. Results

As can be seen from the table above, the Libraries in the Technical University, in the University of Economics and in the Free University form the efficiency frontier for the two observed periods. The Libraries in the Medical Academy and in the Naval Academy work less efficiently during the period. The Library in Naval Academy efficiency is 75,66% in year 2002 and 75,26% in year 2003. The efficiency of the Library in the Medical Academy decreases from 70,41% in year 2002 to 64,96% in year 2003. DEA recommend benchmarks for the inefficient Libraries. For the Library in Naval Academy it is advisable to follow the model of DMU F3 - the Technical University or that of F5 - the Free University in the year 2002. Numbers in brackets show the corresponding intensities. The Library in Technical University is pointed as a benchmark twice – for the Library in the Naval Academy and for the Library in the Medical Academy. The Library in the Free University is referenced once – in 2002 to be an additional benchmark for the Library in the Naval Academy.

In order to improve their efficiency, the Libraries in the Naval Academy and in the Medical Academy can choose from the following variants or some mix of those:

1. Year 2002 the Library in the Naval Academy could reduce its expenses on printed editions by 5399,74 BGL, or reduce its electronic edition expenses by 1335,56 BGL.
2. The Library in the Naval Academy could make some efforts to increase its outputs – the borrowed literature approximately by 6214 or customers served by 5138.

3. The Library in the Naval Academy uses technical equipment, which could be decreased by 5582,85 BGL.
4. For year 2003 the Library in the Medical Academy could decrease its expenses on printed books and journals by 39733,59 BGL or it could reduce its expenses, made for electronic issues by 4552,85 BGL.
5. The expenses on technical equipment of the Library in the Medical Academy exceed with 40092,5 BGL.
6. If the Library in the Medical Academy aims to improve its relative efficiency, it has to increase the borrowed items by 22364 or to increase the number of served readers by approximately 19207.

The analyses of 2002 for the Library in the Medical Academy and of 2003 for the Library in the Naval Academy are made in the same way.

5. Conclusions

Data envelopment analysis seems to be a useful tool for small data sets estimation. When the DEA was undertaken in a group of University Libraries in the same town, the problem with population density, area size, resident population and others environment details was overcome. The method identifies best practices for the purpose of benchmarking. The analysis provides the precise corrective figure for every output and input in order to improve the efficiency of an inefficient University Library. The library administration might choose a new strategy, based on the results of DEA, in order to operate in a more efficient mode. However, this does not mean that the results are directly transformed into attainable recommendations. In our case we apply Data envelopment analysis, using nine variables, which are not related to internal service quality. This analysis estimates the relative operating efficiency of University Libraries irrespective of quality comparisons. The Libraries of the Medical Academy and the Naval Academy tend to have lower efficiency score due to special features and resources needed. Further research - focusing on quality and specific characteristics of the different Libraries - might provide interesting insights.

References

[1] Shim, W. (2003), Applying DEA technique to Library Evaluation in Academic Research Libraries, Library Trends, Vol. 51 (3), pp 312-332

[2] Dyson, R. G., Thanassoulis, E. & Boussofiane, A. (1990). A DEA (Data Envelopment Analysis) tutorial [Online]. Available from http://www.warwick.ac.uk /∼bsrlu

[3] Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units European Journal of Operations Research, 2, pp 429 444.

[4] Easun, M. S. (1992). Identifying efficiencies in resource management: An application of data envelopment analysis to selected school libraries in California. Ph.D. Diss., University of California, Berkeley.

[5] Emrouznejad, A. (2001). An extensive bibliography of Data Envelopment Analysis (DEA), Volume I: Working Papers. Business School, University of Warwick, Coventry CV4 7AL, England. [Online]. Available from http://www.deazone.com/bibliography/index.htm.

[6] Hammond, C. J. (2002). Efficiency in the provision of public services: A Data Envelopment Analysis of UK public library systems. Applied Economics, 34 (5), pp 649 - 657.

[7] Sharma, K. R., Leung, P., & Zane L. (1999). Performance measurement of Hawaii state public libraries: An application of Data Envelopment Analysis (DEA). Agricultural and Resource Economics Review, 28 (2), pp 190-198

[8] Vitaliano, D. F. (1998). Assessing public library efficiency using Data Envelopment Analysis. Annals of Public and Cooperative Economics, 69 (1), pp 107-122.

[9] Chen, T. Y. (1997). An evaluation of the relative performance of university libraries in Taipei. Library Review, 46 (3), pp 190 - 201.

CHAPTER II

MEASURING AND COMPARING THE (IN) EFFICIENCY OF GERMAN AND SWISS HOSPITALS

Measuring and Comparing the (In) Efficiency of German and Swiss Hospitals

Lukas Steinmann†, Gunnar Dittrich‡, Alexander Karmann‡, & Peter Zweifel†

Abstract

A nonparametric Data Envelopment Analysis (DEA) is performed on hospitals in the federal state of Saxony (Germany) and in Switzerland. This study is of interest from three points of view. First, contrary to most existing work, patient days are not treated as an output but as an input. Second, the usual DEA assumption of a homogeneous sample is tested and rejected for a large part of the observations. The proposed solution is to restrict DEA to comparable observations in the two countries. The finding continues to be that hospitals of Saxony have higher efficiency scores than their Swiss counterparts. It proves robust with regard to modifications of DEA that are motivated by differences in hospital planning in Germany and Switzerland.

JEL codes: I11, I18, C61

Keywords: International efficiency comparison, Hospitals, Data Envelopment Analysis

* Comments and criticism from participants (in particular Vivian Valdmanis) of the 4th World Congress of the International Health Economics Association in San Francisco, 15-18 June 2003, and two anonymous referees, are gratefully acknowledged.
† University of Zurich (Switzerland)
‡ Technical University of Dresden (Germany)

1. Introduction

There is an increasing interest in comparing the efficiency of national health care systems rather than just health care expenditure. The present work purports to provide such a comparison with regard to the hospitals of two neighboring countries, Germany and Switzerland. It seeks to answer the question of whether a given bundle of hospital services can be provided with less resources in the German land of Saxony compared to Switzerland and whether findings are robust when attempts are made to take institutional differences into account. The method used to assess relative performance is DEA (Data Envelopment Analysis). First, the institutional background of the two hospital sectors is described, followed by a characterization of the DEA applied and the two data sets used. The fourth section contains a preliminary test for efficiency by juxtaposing each country's decision-making units (observations) to a joint reference set. It continues by restricting the sample to those units that can be projected on the other country's efficiency frontier. Also, a test of robustness is performed at this stage. In the fifth section, differences between the countries with respect to the stringency and payment for hospital services are tested by modifying the DEA. The final section presents concluding remarks.

The analysis of hospital efficiency in a given country has a certain tradition. One of the first applications was presented by Banker et al. (1986), who compared estimated efficiency using DEA and a parametric translog cost function. Färe et al. (1994) not only addressed efficiency of Swedish hospitals but also measured changes in productivity by adapting the Malmquist index to DEA. A vast number of studies have been presented for the US hospital sector [e.g. cf. Burgess and Wilson (1996), Ferrier and Valdmanis (1996) for extensive citations]. Dalmau-Matarrodona and Puig-Junoy (1998) analyzed the effects of market structure on hospital efficiency in Spain using data from Catalonia; Linna and Hakkinen (1998), Linna (1998) estimated efficiency of Finnish hospitals, comparing DEA with a wide range of parametric alternatives. Linna (2000) used similar methodology to test for the productivity effects of a reform of Finnish health care finance. Bjørn et al. (2002) analyze the effect of a change of financing regime on efficiency of Norwegian hospitals. Steinmann and Zweifel (2000, 2003) relate efficiency of Swiss hospitals to regional differences in hospital financing and ownership.

By way of contrast international comparisons of hospital efficiency are rare. On the output side, one reason are differences in patient and treatment classification systems that impede comparability of outputs. In addition, the absence of quality measurement, constituting already a problem in within-country comparisons, detracts even more from international comparisons of hospital outputs [cf. Reinhard et al. (2002)]. On the input side, differences in labor law, e.g. weekly working hours, and the question of how to transform national currencies and price levels, complicate the analysis. However, Mobley and Magnussen (1998) and Magnussen and Mobley (1999) compared and analyzed the relative efficiency of regulated public Norwegian and Californian