

HEALTH CARE BENCHMARKING AND PERFORMANCE EVALUATION

**An Assessment using
Data Envelopment Analysis (DEA)**

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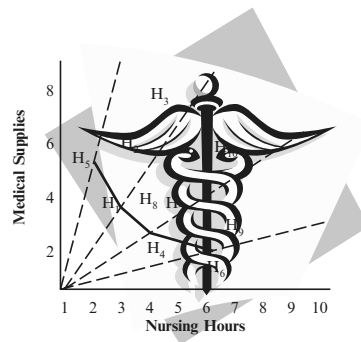
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HEALTH CARE BENCHMARKING AND PERFORMANCE EVALUATION

An Assessment using
Data Envelopment Analysis (DEA)

Yasar A. Ozcan



DEA Frontier Software Included

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Yasar A. Ozcan
Virginia Commonwealth University
Richmond, VA, USA

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Stanford University
Stanford, CA, USA

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To my wife Gulperi Ozcan

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Yasar A. Ozcan
Richmond, VA

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Foreword

Improving the efficiency of health care, the primary focus of this book, is one of the most important management challenges of this century. US health care spending exceeded \$2 trillion in 2005 and credible estimates suggest this amount will double by 2016. Over one of every seven dollars (16%) of gross domestic product is devoted to health care. In addition to spending more on health care than other countries by some measure, this weakens US based business' global competitiveness. Globally, on average, over 10% of gross domestic product is spent on health care, and the national health systems are feeling the stress of high costs and seeking ways to improve efficiency, contain costs, and maintain quality of care. The value and relevance of this book are significant and can benefit government policy makers, health care managers, and students of management, public health, and medicine; and of course the value and relevance applies around the globe to wherever there are organized health care systems.

Professor Yasar Ozcan is literally one of a handful of academics that has the background, experience, and acumen to develop this book focusing on improving health care productivity using of data envelopment analysis (DEA) and related methods. He has been actively researching and publishing on issues of health care management, use of operations research methods in health care to improve delivery and quality of care, and specifically DEA for over 20 years. A study in *Socio-Economic Planning Sciences* (by Gattoufi, Oral, Kumar and Reisman – vol. 38 – 2004) notes that Prof. Ozcan is one of the 15 most prolific DEA contributors as of 2001, measured in volume of academic journal publications. More importantly, I believe Prof. Ozcan is distinguished as the only one of these major DEA contributors that is a widely recognized expert in health care management. In addition to his significant body of work in health care operations research and DEA, Prof. Ozcan is the founder and editor of *Health Care Management Science*. Professor Ozcan's work on health systems in several countries around the globe makes the perspective of his writing sensitive to and applicable to health system issues throughout the globe.

While Professor Ozcan's volume of work is substantial and impressive, the element that makes this book particularly valuable is that Prof. Ozcan's work focuses on applications to a broad set of health care fields and organizations. The focus

on field studies and the quality of that work will allow managers and policy makers to gain new insights into ways to enhance the productivity of their health care services or to understand the way alternative initiatives will impact efficiency and cost of care. After offering a perspective on health care productivity management, a primer on DEA, and alternative models, this book provides field examples that speak directly to every significant facet of health care services that I can think of. Included are major providers: hospitals, managed care (health maintenance – HMO) organizations, nursing homes, home health agencies, dialysis center, mental health centers, dental clinics, aging program, and others specialized activities. The focus also extends both to managing the organization and its method of delivering health services as well as the providers practice patterns (physicians, nurses) in their delivery of general care and in specialized disease treatments.

This book offers a perspective on the unique strengths of DEA in addressing the types of service management issues common to most health care services. Specifically, DEA is particularly powerful in managing services where there are multiple outputs (types of patients, diverse severity of patients, etc.) and multiple inputs used to provide these services. At the same time, Prof. Ozcan identifies the boundaries of DEA and also describes related methods that are used for health care productivity analysis such as regression analysis and total factor productivity. The result is that the reader is encouraged, challenged, and energized to apply these concepts to their research or directly to their organization, as has occurred with many students that have worked with Prof. Ozcan over the years.

Managers, government policy makers, consultants, students, and academics can all gain new insights in the quest to improve productivity of health care services, manage costs of care, and develop methods to tackle related problems from this book. *HealthCare Benchmarking and Performance Evaluation: An Assessment Using Data Envelopment Analysis* is, in my view, a welcome and needed addition to the DEA literature and health care management literature.

Boston, MA

H. David Sherman

Preface

This book places emphasis on the application of contemporary performance and efficiency evaluation methods, using data envelopment analysis (DEA), to create optimization-based benchmarks including, but not limited to hospitals, physician group practices, health maintenance organizations, nursing homes, and other health care delivery organizations. Hence, this book will not only be useful for graduate students to learn DEA applications in health care, but will also be an excellent reference and “how to book” for practicing administrators.

There are various evaluation methods to assess performance in health care. Each method comes with its strengths and weaknesses. Key to performance evaluation is how to conceptualize the service production in various health care settings, as well as appropriately measuring the variables that would define this process. The research papers published in various health care and operations research journals provide insight to conceptualization of service production processes in various health care organizations. Also many research papers delineate methods that can be used for this purpose. Depending upon when and where the research was conducted, and the availability of the measures for inputs and outputs or their proxies, researchers can determine what variables they should employ in conceptualization of the health service production process. The nature of data availability further implies that some research findings on performance may produce sensitive results, thus a comparison of the results using different variables, if possible, is prudent.

Section 1 of this book has seven chapters that are designed to introduce performance concepts and DEA models of efficiency most frequently used in health care. An example consisting of ten hospitals is used throughout these seven chapters to illustrate the various DEA models. This example includes only two output and two input variables. The intent for the example is to create understanding of the methodology with a small number of variables and observations. In practice, measurement of efficiency in hospitals or in other health care organizations using DEA goes beyond the presented example and requires appropriate conceptualization of service production in these organizations. The extensive health care provider applications are left to the second section of this book, where DEA models with appropriate output and input variables for various health care providers and the like are presented.

In this first section of the book, Chap. 1 provides a brief survey of performance evaluation methods for health care and discusses their strengths and weaknesses for performance evaluation. These methods include ratio analysis, the least-square regression analysis, total factor productivity (TFP) including Malmquist index, stochastic frontier analysis (SFA), and DEA.

Efficiency measures and efficiency evaluations using DEA is the subject of Chap. 2. This chapter explains the most commonly used concepts of efficiency, such as technical, scale, price, and allocative efficiency. Other sections of the Chap. 2 provide more detail on DEA techniques, including model orientation (input vs. output), and various frontier models such as constant returns to scale (CRS). The hospital example and software illustration on how to run these models provides enhanced understanding to readers.

Chapter 3 further develops the returns to scale concept and introduces variable returns to scale (VRS) model with software illustration. Multiplier or weight restricted models (cone ratio or assurance region models) are presented and illustrated in Chap. 4. Chapter 5 discusses non-oriented or slack-based models and shows how and under what circumstances they can be used.

Longitudinal (panel) evaluations are illustrated in Chap. 6 using Malmquist Index. This chapter illustrates not only an efficiency change between two time periods, but also accounts for technological changes.

The last chapter of this section, Chap. 7, introduces effectiveness in a performance model and shows the potential misuse of quality variables in DEA models. Furthermore, it suggests a procedure to evaluate both efficiency and effectiveness. Finally, other less frequently used DEA-based methods are discussed.

The aim of this book is to reduce the anxiety for complex mathematics, and promote the use of DEA for health care managers and researchers. Thus, the mathematical formulations of various DEA models used in this book purposefully placed in the appendices at the end of appropriate chapter for interested readers.

Section 2 includes the health care applications. In this section, DEA is applied to health care organizational settings to determine which providers are functioning efficiently when compared to a homogenous group of providers in their respective services. The most frequently evaluated health care providers are hospitals, nursing homes, physician practices, and health care maintenance organization (HMOs). The DEA models for these providers are discussed in Chaps. 8–11, respectively.

Many DEA studies defined hospital service production and delineated the variations in hospital production by suggesting models that provide conceptualization of inputs and outputs in this process. Hollingsworth et al. (1999) and Hollingsworth (2003) provided extensive review of non-parametric and parametric performance evaluation applications in the health care arena. In these reviews, the focus was on health care issues conducted in both the US and abroad. Hollingsworth (2003, p. 205) shows that about 50% of the 168 DEA health care applications are for hospitals. Chapter 8 develops a robust hospital DEA model based on these previous studies, where we also provide a synopsis of some of these studies and suggest a model that can serve as standard for future hospital performance evaluations.

The scope of physician studies is varied based on different categorization methods. These different categories are working place, diseases, and type of physician. The working place related studies assess physicians in IPA type HMOs, physicians in hospitals, and physicians in a general group practice. The studies based on the disease encompass heart failure and shock, otitis media, sinusitis, stroke, and so on. Other studies focused on generalists or specialists.

Due to different scopes of these studies, the inputs and outputs selected to assess efficiency via DEA are not consistent. In those studies that focused on diseases and primary care, the variables of PCP visits, specialist visits, emergency visits, test, and description were usually selected to be input variables; and patient episodes with different degrees of severity of disease are usually selected to be output variables. The studies that focused on diseases and hospitals or in HMOs, the length of stay was added to the input group. The output variables are almost the same as the variables in the primary care studies. Chapter 8 provides an in-depth look to DEA based physician evaluations. Few studies focused on dental services, but they are discussed in Chap. 13.

The nursing home studies are more consistent and provide a more focused scope. Common observations for nursing homes are the type of outputs used, and definition of the DMUs as intermediate care and skilled nursing facilities. The second consistency is in the overall theme of the inputs such as staff numbers and financial issues. Chapter 10 specifies the DEA-based nursing home models.

Chapter 11 introduces a few studies on health maintenance organizations and DEA models associated with them. Chapter 12 explores home health, and introduces DEA models for home health agencies.

Other types of health care providers covered include dialysis centers, community mental health centers, community-based youth services, organ procurement organizations, aging agencies, and dental providers. DEA models for these providers are shown in Chap. 13.

Chapter 14 provides an insight to other DEA models designed to evaluate health care provider performance for specific treatments including stroke, mechanical ventilation, and perioperative services. This chapter also includes DEA models for physicians at hospital settings, hospital mergers, hospital closures, hospital labor markets, hospital services in local markets, and sensitivity analysis for hospital service production.

A CD-ROM containing limited version of DEAFrontier software written by Professor Joe Zhu accompanies this text. This limited version of DEAFrontier can solve up to four-input and four-output DEA models for 100 DMUs. For Malmquist evaluations, it can solve approximately 50 DMUs. For full version of the software, reader is advised to check www.deafrontier.com. Reader should examine the section on "Running the DEAFrontier Software," especially data format for the Excel worksheet.

Developing examples for the techniques explained in each chapter has been a consuming task. Any errors and oversights in that process are solely mine. I will appreciate reader comments to improve or correct the mistakes, as well as suggestions for incorporating additional material in future editions. Please email your comments to ozcan@vcu.edu. Yasar A. Ozcan.

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