

# Preface

The second edition of this book, as in the first edition, 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. The key to performance evaluation is how to conceptualize the service production in various health care settings as well as appropriately measure the variables that would define this process. The research papers published in various health care and operations research journals provide insight into 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 which 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.

Part 1 of this book has eight chapters that are designed to introduce the performance concepts and DEA models of efficiency most frequently used in health care. An example consisting of ten hospitals is used throughout these eight 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 the Malmquist Index, stochastic frontier analysis (SFA), and DEA.

Efficiency measures and efficiency evaluations using DEA are 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 Chap. 2 provide more detail on DEA techniques, including model orientation (input versus output), and various frontier models such as constant returns to scale (CRS). The hospital example and software illustration on how to run these models provide enhanced understanding to readers.

Chapter 3 further develops the returns to scale concept and introduces the variable returns to scale (VRS) model with software illustration. Weight-restricted (multiplier) 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. The second edition includes two versions of non-controllable variable models and adds categorical variable models.

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

Chapter 7 is dedicated to the effectiveness dimension of performance evaluation. This chapter 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. The second edition provides extended examples of using quality variables in DEA models and provides sensitivity testing.

Chapter 8, a new addition to this section, is where new and advanced models of DEA are discussed and illustrated. These include super-efficiency, congestion DEA, network DEA, and dynamic network DEA models. The chapter also provides discussion of two-stage DEA where researchers conduct post hoc analysis of DEA scores to evaluate determinants of efficiency. Discussion includes logistic regression and Tobit regression and it provides guidance in using these techniques in conjunction with bootstrapping to obtain bias-corrected estimates.

The aim of this book is to reduce the anxiety about 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 are purposefully placed in the appendices at the end of appropriate chapters for interested readers.

Part 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, physician practices, nursing homes, and health maintenance organizations (HMOs). The DEA models for these providers are discussed in Chaps. 9 through 12, 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, Dawson, and Maniadakis (1999) and Hollingsworth (2003) provided extensive review of nonparametric and parametric performance evaluation applications in the health care arena. In these reviews, the focus was on health care issues conducted in both the USA and abroad. Hollingsworth (2003) shows that about 50 % of the 168 DEA health care applications are for hospitals. Chapter 9 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 a standard for future hospital performance evaluations.

The scope of physician studies is varied based on different categorization methods. These different categories are workplace, diseases, and type of physician. The workplace-related studies assess physicians in independent practice association (IPA)-type HMOs, physicians in hospitals, and physicians in a general group practice. The studies based on 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 primary care provider (PCP) visits, specialist visits, emergency visits, laboratory tests, and prescriptions were usually selected to be input variables; patient episodes with different degrees of severity of disease were usually selected to be output variables. In the studies that focused on diseases and hospitals or in HMOs, the length of stay was added to the input group. The output variables were almost the same as the variables in the primary care studies. Chapter 10 provides an in-depth look at DEA-based physician evaluations. Few studies focused on dental services, but they are discussed in Chap. 14.

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 decision-making units (DMUs) as intermediate care and skilled nursing facilities. Another consistency is in the overall theme of the inputs such as staff numbers and financial issues. Chapter 11 specifies the DEA-based nursing home models.

Chapter 12 introduces a few studies on HMOs and DEA models associated with them. Chapter 13 explores home health care 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. 14.

Chapter 15 provides an insight into 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 new chapter in this section, Chap. 16, examines international-country-based applications of DEA in health care. There are 16 countries, plus OECD and multi-country studies are examined, almost half of which had significant health care reforms during the past decade, while other countries have interesting applications of DEA where often cultural and other country-specific structural factors may need attention.

A learning version of DEA Solver (DEA-Solver-LV) software written by Professor Kaoru Tone accompanies this text and can be accessed at <http://link.springer.com/10.1007/978-1-4899-7472-3>. This learning version of DEA Solver can solve up to 50 DMUs for various DEA models listed in the User's Guide at the end of the book. For the full professional version of the software, the reader is advised to visit [www.saitech-inc.com](http://www.saitech-inc.com). The reader should examine the section on "User's Guide to DEA-Solver-Learning Version," especially the 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 materials in future editions. Please e-mail your comments to [ozcan@vcu.edu](mailto:ozcan@vcu.edu).

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