

data envelope analysis

Decoding Data Envelopment Analysis (DEA): A Comprehensive Guide

Introduction:

Are you struggling to assess the relative efficiency of multiple decision-making units (DMUs) with multiple inputs and outputs? Feeling overwhelmed by traditional efficiency analysis methods? Then you've come to the right place. This comprehensive guide will unravel the mysteries of Data Envelopment Analysis (DEA), a powerful non-parametric method used to evaluate the relative efficiency of similar entities. We'll explore its core concepts, applications, advantages, limitations, and practical implications, equipping you with the knowledge to confidently apply DEA in your own analyses. Prepare to unlock the potential of DEA and gain a competitive edge in your field.

What is Data Envelopment Analysis (DEA)?

Data Envelopment Analysis (DEA) is a non-parametric method used to assess the relative efficiency of a set of decision-making units (DMUs). Unlike parametric methods that assume a specific functional form relating inputs and outputs, DEA is distribution-free, making it incredibly versatile. It constructs a "frontier" representing the best-performing DMUs, and then measures the efficiency of each DMU relative to this frontier. This frontier, often depicted graphically, showcases the optimal performance level achievable given the available inputs. DMUs on the frontier are considered efficient, while those below the frontier are deemed inefficient, with their inefficiency score indicating how far they fall short of optimal performance.

Types of DEA Models: Orientation and Returns to Scale

DEA models are categorized based on two crucial aspects: orientation and returns to scale assumptions.

Orientation: This refers to whether the model focuses on optimizing inputs or outputs.

Input-oriented DEA: This model aims to minimize inputs while maintaining the current level of outputs. It identifies the potential for reducing resource consumption while achieving the same output level. This is useful when focusing on cost reduction or resource optimization.

Output-oriented DEA: This model aims to maximize outputs given the current level of inputs. It identifies the potential for increasing production or service delivery with the same resource allocation. This is useful when focusing on productivity improvement or expansion.

Returns to Scale: This assumption deals with the relationship between input changes and output changes.

Constant Returns to Scale (CRS): This assumes that a proportional change in inputs leads to a

proportional change in outputs. It's suitable when the DMUs operate at a consistent scale.

Variable Returns to Scale (VRS): This allows for non-proportional changes in inputs and outputs, acknowledging that efficiency can vary depending on the scale of operation. This is generally more realistic for most real-world scenarios.

Increasing Returns to Scale (IRS): Larger DMUs are more efficient.

Decreasing Returns to Scale (DRS): Smaller DMUs are more efficient.

The choice of orientation and returns to scale assumption depends heavily on the specific context and the research question being addressed. Incorrect assumptions can lead to misleading efficiency scores.

Understanding Efficiency Scores in DEA

The efficiency score in DEA ranges from 0 to 1, where 1 represents full efficiency. A score less than 1 indicates inefficiency, with the magnitude of the difference from 1 representing the extent of inefficiency. DEA not only provides an efficiency score but also identifies the "targets" or benchmarks for inefficient DMUs. These benchmarks show how inefficient DMUs can improve their performance by emulating the best practices of efficient DMUs.

Advantages of Using DEA

Non-parametric: DEA doesn't require assumptions about the functional form relating inputs and outputs.

Multiple Inputs and Outputs: Handles multiple inputs and outputs simultaneously, reflecting the complexity of real-world systems.

Relative Efficiency: Provides a relative efficiency score for each DMU, allowing for comparison across entities.

Benchmarking: Identifies best practices and targets for improvement.

Easy Interpretation: The results are relatively straightforward to interpret and communicate.

Limitations of DEA

Sensitivity to Data: DEA's results are sensitive to data quality and outliers. Inaccurate or incomplete data can significantly affect the efficiency scores.

Number of DMUs: DEA requires a sufficient number of DMUs for reliable results. With too few DMUs, the frontier may not be accurately represented.

Extreme Values: Extreme values in the data can unduly influence the results.

Assumption of Constant Inputs: DEA generally assumes that inputs are fixed at a certain level which may not be the case in reality.

Lack of Statistical Inference: Standard statistical tests are not directly applicable to DEA results.

Applications of DEA

DEA has found widespread application across various fields, including:

Healthcare: Evaluating the efficiency of hospitals, clinics, and physicians.

Banking: Assessing the efficiency of banks and branches.

Education: Measuring the efficiency of schools and universities.

Manufacturing: Evaluating the efficiency of production processes.

Public Services: Assessing the efficiency of government agencies and programs.

Software for Performing DEA

Several software packages facilitate DEA analysis, including:

DEAP (Data Envelopment Analysis Program): A popular and widely used free software package.

R: The statistical programming language R offers several packages for performing DEA.

STATA: This statistical software also provides capabilities for DEA analysis.

Book Outline: "Mastering Data Envelopment Analysis"

I. Introduction to Efficiency Analysis:

What is efficiency?

Different approaches to efficiency measurement

Introduction to DEA: Non-parametric approach, advantages, and limitations

II. DEA Models and Methodology:

Input-oriented and output-oriented models

Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS)

Mathematical formulation and calculations

Interpreting efficiency scores and benchmarks

III. Advanced DEA Techniques:

Dealing with undesirable outputs

Network DEA

Stochastic DEA

Two-stage DEA

IV. Applications of DEA:

Case studies in various sectors (healthcare, banking, education)

Interpreting and presenting results effectively

Data preparation and quality control

V. Conclusion and Future Directions:

Summary of key concepts

Limitations and challenges

Future trends and research in DEA

Chapter 2: DEA Models and Methodology (Excerpt)

This chapter delves into the core mechanics of DEA, focusing on the different models and their underlying assumptions. We'll start with the fundamental concepts of input-oriented and output-oriented models, illustrating how they differ in their objective functions and interpretations. The crucial distinction between Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) will be explained with examples, demonstrating how the choice of model influences the resulting efficiency scores. We'll also provide a simplified mathematical representation of the DEA model, though avoiding overly complex mathematical notations. The chapter will culminate in a detailed explanation of how to interpret efficiency scores and the associated benchmarks, providing practical guidelines for researchers and analysts.

FAQs:

1. What is the difference between DEA and other efficiency analysis techniques like regression analysis? DEA is non-parametric and doesn't assume a specific functional relationship between inputs and outputs, unlike regression analysis which relies on specified functional forms.
1. Can DEA handle undesirable outputs? Yes, there are modified DEA models that can account for undesirable outputs, often through techniques like incorporating them as negative outputs or using a slack-based measure (SBM) model.
1. How many DMUs are needed for a reliable DEA analysis? A general rule of thumb is to have at least twice as many DMUs as the number of inputs and outputs. However, the optimal number depends on the complexity of the data and the specific research question.
1. What are the potential biases in DEA analysis? Data quality issues, outliers, and the choice of inputs and outputs can introduce biases. Careful data preparation and sensitivity analysis are crucial.
1. How can I interpret the efficiency scores and benchmarks generated by DEA? Efficiency scores range from 0 to 1, with 1 representing full efficiency. Inefficient DMUs are provided with benchmarks indicating how they can improve their performance by emulating the best practices of efficient DMUs.

1. What software packages are commonly used for DEA analysis? DEAP, R (with relevant packages), and STATA are popular choices.
1. Can DEA be used with categorical data? DEA is primarily suited for continuous data. However, there are methods to adapt DEA for categorical data, often requiring transformation or encoding.
1. What are the limitations of using DEA for performance evaluation? DEA is sensitive to data quality, requires sufficient DMUs, and lacks built-in statistical inference.
1. How can I improve the accuracy of DEA analysis? Careful data cleaning, outlier detection, appropriate model selection (CRS vs. VRS, input- vs. output-oriented), and sensitivity analysis are crucial for enhancing the accuracy and reliability of DEA results.

Related Articles:

1. Benchmarking with DEA: Explores the application of DEA for benchmarking and identifying best practices among DMUs.
2. DEA and Stochastic Frontier Analysis (SFA): A Comparison: Compares and contrasts DEA with SFA, highlighting their strengths and weaknesses.
3. Network DEA Models: Explains the application of network DEA to analyze multi-stage processes.
4. Handling Undesirable Outputs in DEA: Discusses techniques for incorporating undesirable outputs in DEA models.
5. DEA and Malmquist Productivity Indices: Explores the use of DEA to calculate Malmquist productivity indices.
6. Software for DEA Analysis: A Comparative Review: Reviews popular software packages for DEA analysis.
7. Applications of DEA in Healthcare: Provides case studies and examples of DEA applications in the healthcare sector.
8. Sensitivity Analysis in DEA: Discusses the importance of sensitivity analysis in DEA and how to perform it.
9. DEA and its Role in Strategic Decision Making: Examines the use of DEA in informing strategic

decision-making processes.

data envelope analysis: Data Envelopment Analysis: Theory, Methodology, and Applications Abraham Charnes, William W. Cooper, Arie Y. Lewin, Lawrence M. Seiford, 2013-12-01 This book represents a milestone in the progression of Data Envelopment Analysis (DEA). It is the first reference text which includes a comprehensive review and comparative discussion of the basic DEA models. The development is anchored in a unified mathematical and graphical treatment and includes the most important modeling extensions. In addition, this is the first book that addresses the actual process of conducting DEA analyses including combining DEA and 1 parametric techniques. The book has three other distinctive features. It traces the applications driven evolution and diffusion of DEA models and extensions across disciplinary boundaries. It includes a comprehensive bibliography to serve as a source of references as well as a platform for further developments. And, finally, the power of DEA analysis is demonstrated through fifteen novel applications which should serve as an inspiration for future applications and extensions of the methodology. The origin of this book was a Conference on New Uses of DEA in 2 Management and Public Policy which was held at the IC Institute of the University of Texas at Austin on September 27-29, 1989. The conference was made possible through NSF Grant #SES-8722504 (A. Charnes and 2 W. W. Cooper, co-PIs) and the support of the IC Institute.

data envelope analysis: *Handbook on Data Envelopment Analysis* William W. Cooper, Lawrence M. Seiford, Joe Zhu, 2004-03-31 This Handbook has been developed as a comprehensive reference for researchers, students and practitioners. It reflects the state-of-the-art in Data Envelopment Analysis. It also represents a milestone in the progression of a continuously advancing methodology. which has extensive utility. Written by experts - who are the major research contributors to the topics covered - the Handbook is organized in three sections. The first section is a comprehensive examination of the basic DEA models and DEA extensions. The second section consists of a collection of coverages by persons experienced in applications to the areas of banking, education, sports, retailing, health care, etc. The final section is a review of current DEA software technology.

data envelope analysis: Data Envelopment Analysis Wade D. Cook, Joe Zhu, 2014-07-08 This handbook serves as a complement to the Handbook on Data Envelopment Analysis (eds, W.W. Cooper, L.M. Seiford and J. Zhu, 2011, Springer) in an effort to extend the frontier of DEA research. It provides a comprehensive source for the state-of-the art DEA modeling on internal structures and network DEA. Chapter 1 provides a survey on two-stage network performance decomposition and modeling techniques. Chapter 2 discusses the pitfalls in network DEA modeling. Chapter 3 discusses efficiency decompositions in network DEA under three types of structures, namely series, parallel and dynamic. Chapter 4 studies the determination of the network DEA frontier. In chapter 5 additive efficiency decomposition in network DEA is discussed. An approach in scale efficiency measurement in two-stage networks is presented in chapter 6. Chapter 7 further discusses the scale efficiency decomposition in two stage networks. Chapter 8 offers a bargaining game approach to modeling two-stage networks. Chapter 9 studies shared resources and efficiency decomposition in two-stage networks. Chapter 10 introduces an approach to computing the technical efficiency scores for a dynamic production network and its sub-processes. Chapter 11 presents a slacks-based network DEA. Chapter 12 discusses a DEA modeling technique for a two-stage network process where the inputs of the second stage include both the outputs from the first stage and additional inputs to the second stage. Chapter 13 presents an efficiency measurement methodology for multi-stage production systems. Chapter 14 discusses network DEA models, both static and dynamic. The discussion also explores various useful objective functions that can be applied to the models to find

the optimal allocation of resources for processes within the black box, that are normally invisible to DEA. Chapter 15 provides a comprehensive review of various type network DEA modeling techniques. Chapter 16 presents shared resources models for deriving aggregate measures of bank-branch performance, with accompanying component measures that make up that aggregate value. Chapter 17 examines a set of manufacturing plants operating under a single umbrella, with the objective being to use the component or function measures to decide what might be considered as each plant's core business. Chapter 18 considers problem settings where there may be clusters or groups of DMUs that form a hierarchy. The specific case of a set off electric power plants is examined in this context. Chapter 19 models bad outputs in two-stage network DEA. Chapter 20 presents an application of network DEA to performance measurement of Major League Baseball (MLB) teams. Chapter 21 presents an application of a two-stage network DEA model for examining the performance of 30 U.S. airline companies. Chapter 22 then presents two distinct network efficiency models that are applied to engineering systems.

data envelope analysis: *Data Envelopment Analysis* Joe Zhu, 2015-03-18 This handbook represents a milestone in the progression of Data Envelopment Analysis (DEA). Written by experts who are often major contributors to DEA theory, it includes a collection of chapters that represent the current state-of-the-art in DEA research. Topics include distance functions and their value duals, cross-efficiency measures in DEA, integer DEA, weight restrictions and production trade-offs, facet analysis in DEA, scale elasticity, benchmarking and context-dependent DEA, fuzzy DEA, non-homogenous units, partial input-output relations, super efficiency, treatment of undesirable measures, translation invariance, stochastic nonparametric envelopment of data, and global frontier index. Focusing only on new models/approaches of DEA, the book includes contributions from Juan Aparicio, Mette Asmild, Yao Chen, Wade D. Cook, Juan Du, Rolf Färe, Julie Harrison, Raha Imanirad, Andrew Johnson, Chiang Kao, Abolfazl Keshvari, Timo Kuosmanen, Sungmook Lim, Wenbin Liu, Dimitri Margaritis, Reza Kazemi Matin, Ole B. Olesen, Jesus T. Pastor, Niels Chr. Petersen, Victor V. Podinovski, Paul Rouse, Antti Saastamoinen, Biresh K. Sahoo, Kaoru Tone, and Zhongbao Zhou.

data envelope analysis: *Data Envelopment Analysis and Effective Performance Assessment* Lotfi, Farhad Hossein Zadeh, Najafi, Seyed Esmaeil, Nozari, Hamed, 2016-09-01 For any organization, analysis of performance and effectiveness through available data allows for informed decision making. Data envelopment analysis, or DEA, is a popular, effective method that can be used to measure productive efficiency in operations management assessment. Data Envelopment Analysis and Effective Performance Assessment addresses the myriad of practical uses and innovative developments of DEA. Emphasizing the importance of analyzing productivity by measuring inputs, goals, economic growth, and performance, this book covers a wide breadth of innovative knowledge. This book is essential reading for managers, business professionals, students of business and ICT, and computer engineers.

data envelope analysis: *Data Envelopment Analysis* William W. Cooper, Lawrence M. Seiford, Kaoru Tone, 2007-01-10 This volume systematically details both the basic principles and new developments in Data Envelopment Analysis (DEA), offering a solid understanding of the methodology, its uses, and its potential. New material in this edition includes coverage of recent developments that have greatly extended the power and scope of DEA and have lead to new directions for research and DEA uses. Each chapter accompanies its developments with simple numerical examples and discussions of actual applications. The first nine chapters cover the basic principles of DEA, while the final seven chapters provide a more advanced treatment.

data envelope analysis: *An Introduction to Data Envelopment Analysis* R Ramanathan, 2003-08-18 From the Foreword: 'This book is an excellent tool for practitioners who are interested in the merits and pitfalls of the technique.... (The author's) research is an example of inventiveness, diligence and accuracy' - Freerk A. Lootsma, Delft Institute of Technology Data envelopment Analysis is a Mathematical Programme for measuring performance efficiency of organizational units. The organizational units, termed as decision-making units (DMU) can be of any kind: manufacturing units, a set of schools, banks, hospitals, power plants, police stations, prisons, a set of firms etc. DEA

has been unsuccessfully applied to measure the performance efficiency of these different kinds of DMUs which share a common characteristic - that they are non-profit organization where measurement of performance efficiency is difficult. DEA has been employed for assessing the relative performance of a set of firms that use a variety of identical inputs-say in the case of a school: quality of students, teachers, grants etc.,-to produce a variety of identical outputs-number of students who pass the final year, average grades obtained by the students in the final year etc. DEA assumes the performance of the DMUs by 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 or DMUs. The best performing DMU is given a score of 100% and the performance of other DMUs vary between 0 -100%.

data envelope analysis: Data Envelopment Analysis with R Farhad Hosseinzadeh Lotfi, Ali Ebrahimnejad, Mohsen Vaez-Ghasemi, Zohreh Moghaddas, 2019-07-23 This book introduces readers to the use of R codes for optimization problems. First, it provides the necessary background to understand data envelopment analysis (DEA), with a special emphasis on fuzzy DEA. It then describes DEA models, including fuzzy DEA models, and shows how to use them to solve optimization problems with R. Further, it discusses the main advantages of R in optimization problems, and provides R codes based on real-world data sets throughout. Offering a comprehensive review of DEA and fuzzy DEA models and the corresponding R codes, this practice-oriented reference guide is intended for masters and Ph.D. students in various disciplines, as well as practitioners and researchers.

data envelope analysis: Introduction to the Theory and Application of Data Envelopment Analysis Emmanuel Thanassoulis, 2013-06-29 1 DATA ENVELOPMENT ANALYSIS Data Envelopment Analysis (DEA) was initially developed as a method for assessing the comparative efficiencies of organisational units such as the branches of a bank, schools, hospital departments or restaurants. The key in each case is that they perform feature which makes the units comparable the same function in terms of the kinds of resource they use and the types of output they produce. For example all bank branches to be compared would typically use staff and capital assets to effect income generating activities such as advancing loans, selling financial products and carrying out banking transactions on behalf of their clients. The efficiencies assessed in this context by DEA are intended to reflect the scope for resource conservation at the unit being assessed without detriment to its outputs, or alternatively, the scope for output augmentation without additional resources. The efficiencies assessed are comparative or relative because they reflect scope for resource conservation or output augmentation at one unit relative to other comparable benchmark units rather than in some absolute sense. We resort to relative rather than absolute efficiencies because in most practical contexts we lack sufficient information to derive the superior measures of absolute efficiency. DEA was initiated by Charnes Cooper and Rhodes in 1978 in their seminal paper Charnes et al. (1978). The paper operationalised and extended by means of linear programming production economics concepts of empirical efficiency put forth some twenty years earlier by Farrell (1957).

data envelope analysis: Data Envelopment Analysis Subhash C. Ray, 2004-06-07 Using the neo-classical theory of production economics as the analytical framework, this book, first published in 2004, provides a unified and easily comprehensible, yet fairly rigorous, exposition of the core literature on data envelopment analysis (DEA) for readers based in different disciplines. The various DEA models are developed as nonparametric alternatives to the econometric models. Apart from the standard fare consisting of the basic input- and output-oriented DEA models formulated by Charnes, Cooper, and Rhodes, and Banker, Charnes, and Cooper, the book covers developments such as the directional distance function, free disposal hull (FDH) analysis, non-radial measures of efficiency, multiplier bounds, mergers and break-up of firms, and measurement of productivity change through the Malmquist total factor productivity index. The chapter on efficiency measurement using market prices provides the critical link between DEA and the neo-classical theory of a competitive firm. The book also covers several forms of stochastic DEA in detail.

data envelope analysis: Introduction to Data Envelopment Analysis and Its Uses William

W. Cooper, Lawrence M. Seiford, Kaoru Tone, 2006-03-20 Introduction to Data Envelopment Analysis and Its Uses: With DEA-Solver Software and References has been carefully designed by the authors to provide a systematic introduction to DEA and its uses as a multifaceted tool for evaluating problems in a variety of contexts. The authors have been involved in DEA's development from the beginning. William Cooper (with Abraham Charnes and Edwardo Rhodes) is a founder of DEA. Lawrence Seiford and Kaoru Tone have been actively involved as researchers and practitioners from its earliest beginnings. All have been deeply involved in uses of DEA in practical applications as well as in the development of its basic theory and methodologies. The result is a textbook grounded in authority, experience and substance.

data envelope analysis: Network Data Envelopment Analysis Chiang Kao, 2016-08-23 This book presents the underlying theory, model development, and applications of network Data Envelopment Analysis (DEA) in a systematic way. The field of network DEA extends and complements conventional DEA by considering not only inputs and outputs when measuring system efficiency, but also the internal structure of the system being analyzed. By analyzing the efficiency of individual internal components, and more particularly by studying the effects of relationships among components which are modeled and implemented by means of various network structures, the "network DEA" approach is able to help identify and manage the specific components that contribute inefficiencies into the overall systems. This relatively new approach comprises an important analytical tool based on mathematical programming techniques, with valuable implications to production and operations management. The existing models for measuring the efficiency of systems of specific network structures are also discussed, and the relationships between the system and component efficiencies are explored. This book should be able to inspire new research and new applications based on the current state of the art. Performance evaluation is an important task in management, and is needed to (i) better understand the past accomplishments of an organization and (ii) plan for its future development. However, this task becomes rather challenging when multiple performance metrics are involved. DEA is a powerful tool to cope with such issues. For systems or operations composed of interrelated processes, managers need to know how the performances of the various processes evaluated and how they are aggregated to form the overall performance of the system. This book provides an advanced exposition on performance evaluation of systems with network structures. It explores the network nature of most production and operation systems, and explains why network analyses are necessary.

data envelope analysis: Data Envelopment Analysis Joe Zhu, 2016-03-22 This handbook compiles state-of-the-art empirical studies and applications using Data Envelopment Analysis (DEA). It includes a collection of 18 chapters written by DEA experts. Chapter 1 examines the performance of CEOs of U.S. banks and thrifts. Chapter 2 describes the network operational structure of transportation organizations and the relative network data envelopment analysis model. Chapter 3 demonstrates how to use different types of DEA models to compute total-factor energy efficiency scores with an application to energy efficiency. In chapter 4, the authors explore the impact of incorporating customers' willingness to pay for service quality in benchmarking models on cost efficiency of distribution networks, and chapter 5 provides a brief review of previous applications of DEA to the professional baseball industry, followed by two detailed applications to Major League Baseball. Chapter 6 examines efficiency and productivity of U.S. property-liability (P-L) insurers using DEA, while chapter 7 presents a two-stage network DEA model that decomposes the overall efficiency of a decision-making unit into two components. Chapter 8 presents a review of the literature of DEA models for the performance assessment of mutual funds, and chapter 9 discusses the management strategies formulation of the international tourist hotel industry in Taiwan. Chapter 10 presents a novel use of the two-stage network DEA to evaluate sustainable product design performances. In chapter 11 authors highlight limitations of some DEA environmental efficiency models, and chapter 12 reviews applications of DEA in secondary and tertiary education. Chapter 13 measures the relative performance of New York State school districts in the 2011-2012 academic year. Chapter 14 provides an introductory prelude to chapters 15 and 16, which both provide

detailed applications of DEA in marketing. Chapter 17 then shows how to decompose a new total factor productivity index that satisfies all economically-relevant axioms from index theory with an application to U.S. agriculture. Finally, chapter 18 presents a unique study that conducts a DEA research front analysis, applying a network clustering method to group the DEA literature over the period 2000 to 2014.

data envelope analysis: Modeling Data Irregularities and Structural Complexities in Data Envelopment Analysis Joe Zhu, Wade D. Cook, 2007-06-08 In a relatively short period of time, data envelopment analysis (DEA) has grown into a powerful analytical tool for measuring and evaluating performance. DEA is computational at its core and this book is one of several Springer aim to publish on the subject. This work deals with the micro aspects of handling and modeling data issues in DEA problems. It is a handbook treatment dealing with specific data problems, including imprecise data and undesirable outputs.

data envelope analysis: Extension of Data Envelopment Analysis with Preference Information Tarja Joro, Pekka J. Korhonen, 2015-01-02 This book provides an introduction to incorporating preference information in Data Envelopment Analysis (DEA) with a special emphasis in Value Efficiency Analysis. In addition to theoretical considerations, numerous illustrative examples are included. Hence, the book can be used as a teaching text as well. Only a modest mathematical background is needed to understand the main principles. The only prerequisites are a) familiarity with linear algebra, especially matrix calculus; b) knowledge of the simplex method; and c) familiarity with the use of computer software. The book is organized as follows. Chapter 1 provides motivation and introduces the basic concepts. Chapter 2 provides the basic ideas and models of Data Envelopment Analysis. The efficient frontier and production possibility set concepts play an important role in all considerations. That's why these concepts are considered more closely in Chapter 3. Since the approaches introduced in this study are inspired by Multiple Objective Linear Programming, the basic concepts of this field are reviewed in Chapter 4. Chapter 5 also compares and contrasts Data Envelopment Analysis and Multiple Objective Linear Programming, providing some cornerstones for approaches presented later in the book. Chapter 6 discusses the traditional approaches to take into account preference information in DEA. In Chapter 7, Value Efficiency is introduced, and Chapter 8 discusses practical aspects. Some extensions are presented in Chapter 9, and in Chapter 10 Value Efficiency is extended to cover the case when a production possibility set is not convex. Three implemented applications are reviewed in Chapter 11.

data envelope analysis: Data Envelopment Analysis and Its Applications to Management Vincent Charles, Mukesh Kumar, 2013-02-14 Data envelopment analysis (DEA), a non-parametric technique, has emerged as a popular management tool for measuring the performance of a set of entities, known as decision making units. This book, Data Envelopment Analysis and Its Applications to Management, is a collection of contributions from DEA experts from various countries. It covers a wide range of research papers from the theoretical development of DEA to its applications in various sectors such as economy, banking, education, revenue management, sports, branch networks, cities, and live stock production systems. The book is useful for researchers as well as practitioners who intend to apply DEA to their strategic and managerial decisions.

data envelope analysis: Data Envelopment Analysis Joe Zhu, 2014-05-06 The current book introduces the methodology of data envelopment analysis (DEA) as a data-oriented operations analytics. This data analysis tool analyzes multiple performance metrics, integrates multi-dimensional data into a composite index, and recommends directions for improvement. A number of DEA books have been written for conventional and new DEA models. Yet, many of these books still require fundamental and necessary knowledge on linear mathematical optimization. This book is uniquely designed to present the DEA methodology in an applied setting where a reader is not required to have the knowledge on linear programming and linear algebra.

data envelope analysis: Dynamics of Data Envelopment Analysis Jati Sengupta, 2013-11-11 Data envelopment analysis develops a set of nonparametric and semiparametric techniques for measuring economic efficiency among firms and nonprofit organizations. Over the past decade this

technique has found most widespread applications in public sector organizations. However these applications have been mostly static. This monograph extends this static framework of efficiency analysis in several new directions. These include but are not limited to the following: (1) a dynamic view of the production and cost frontier, where capital inputs are treated differently from the current inputs, (2) a direct role of the technological progress and regress, which is so often stressed in total factor productivity discussion in modern growth theory in economics, (3) stochastic efficiency in a dynamic setting, where reliability improvement competes with technical efficiency, (4) flexible manufacturing systems, where flexibility of the production process and the economies of scope play an important role in efficiency analysis and (5) the role of economic factors such as externalities and input interdependences. Efficiency is viewed here in the framework of a general systems theory model. Such a view is intended to broaden the scope of applications of this promising new technique of data envelopment analysis. The monograph stresses the various applied aspects of the dynamic theory, so that it can be empirically implemented in different situations. As far as possible abstract mathematical treatments are avoided and emphasis placed on the statistical examples and empirical illustrations.

data envelope analysis: Data Envelopment Analysis (DEA) Methods for Maximizing Efficiency Ajibessin, Adeyemi Abel, Vajjhala, Narasimha Rao, 2024-01-16 In today's highly competitive and rapidly evolving global landscape, the quest for efficiency has become a crucial factor in determining the success of organizations across various industries. Data Envelopment Analysis (DEA) Methods for Maximizing Efficiency is a comprehensive guide that delves into the powerful mathematical tool of DEA, is designed to assess the relative efficiency of decision-making units (DMUs), and provides valuable insights for performance improvement. This book presents a systematic overview of DEA models and techniques, from fundamental concepts to advanced methods, showcasing their practical applications through real-world examples and case studies. Catering to a broad audience, this book is designed for students, researchers, consultants, decision-makers, and enthusiasts in the field of efficiency analysis and performance measurement. Consultants and practitioners will gain practical insights for applying DEA in various contexts, and decision-makers will be equipped to make informed decisions for maximizing efficiency. Additionally, individuals with a general interest in data analysis and performance measurement will find this book accessible and informative. This book covers a wide range of topics, including mathematical foundations of DEA, DEA models and variations, DEA efficiency and productivity measures, DEA applications in various industries such as healthcare, finance, supply chain management, environmental management, education management, and public sector management.

data envelope analysis: Advances In Data Envelopment Analysis Rolf Fare, Shawna Grosskopf, Dimitris Margaritis, 2015-03-26 Data Envelopment Analysis (DEA) is often overlooked in empirical work such as diagnostic tests to determine whether the data conform with technology which, in turn, is important in identifying technical change, or finding which types of DEA models allow data transformations, including dealing with ordinal data. Advances in Data Envelopment Analysis focuses on both theoretical developments and their applications into the measurement of productive efficiency and productivity growth, such as its application to the modelling of time substitution, i.e. the problem of how to allocate resources over time, and estimating the 'value' of a Decision Making Unit (DMU).

data envelope analysis: Data-Enabled Analytics Joe Zhu, Vincent Charles, 2021-12-16 This book explores the novel uses and potentials of Data Envelopment Analysis (DEA) under big data. These areas are of widespread interest to researchers and practitioners alike. Considering the vast literature on DEA, one could say that DEA has been and continues to be, a widely used technique both in performance and productivity measurement, having covered a plethora of challenges and debates within the modelling framework.

data envelope analysis: Data Envelopment Analysis: Theory, Methodology, and Applications Abraham Charnes, William W. Cooper, Arie Y. Lewin, Lawrence M. Seiford, 2011-09-01 This book represents a milestone in the progression of Data Envelopment Analysis

(DEA). It is the first reference text which includes a comprehensive review and comparative discussion of the basic DEA models. The development is anchored in a unified mathematical and graphical treatment and includes the most important modeling extensions. In addition, this is the first book that addresses the actual process of conducting DEA analyses including combining DEA and 1 parametric techniques. The book has three other distinctive features. It traces the applications driven evolution and diffusion of DEA models and extensions across disciplinary boundaries. It includes a comprehensive bibliography to serve as a source of references as well as a platform for further developments. And, finally, the power of DEA analysis is demonstrated through fifteen novel applications which should serve as an inspiration for future applications and extensions of the methodology. The origin of this book was a Conference on New Uses of DEA in Management and Public Policy which was held at the IC Institute of the University of Texas at Austin on September 27-29, 1989. The conference was made possible through NSF Grant #SES-8722504 (A. Charnes and W. W. Cooper, co-PIs) and the support of the IC Institute.

data envelope analysis: Handbook On Data Envelopment Analysis In Business, Finance, And Sustainability: Recent Trends And Developments Sabri Boubaker, Thanh Ngo, 2024-07-26 This Handbook presents recent trends and new developments in Data Envelopment Analysis (DEA) research within the realms of business, finance, and sustainability. Divided into three distinct parts, it encompasses 19 chapters that offer insightful studies conducted in diverse national environments and organizational settings. Part I focuses on DEA applications in business, including healthcare, supply chain management, and governmental organizations. Part II delves into the application of DEA in banking and finance, providing valuable insights into the efficiency and performance of financial institutions. Part III explores DEA's diverse applications in sustainability, addressing topics such as sustainability indicators, resource mobilization, food production, and farming. In essence, this Handbook stands as an invaluable reference work for stakeholders seeking to optimize organizational efficiency and performance across a variety of sectors.

data envelope analysis: Handbook of Production Economics Subhash C. Ray, Robert G. Chambers, Subal C. Kumbhakar, 2022-06-02 This three-volume handbook includes state-of-the-art surveys in different areas of neoclassical production economics. Volumes 1 and 2 cover theoretical and methodological issues only. Volume 3 includes surveys of empirical applications in different areas like manufacturing, agriculture, banking, energy and environment, and so forth.

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data envelope analysis: Big Data Mining for Climate Change Zhihua Zhang, Jianping Li, 2019-11-20 Climate change mechanisms, impacts, risks, mitigation, adaption, and governance are

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data envelope analysis: Regional Performance Measurement and Improvement Soushi Suzuki, Peter Nijkamp, 2017-03-14 This is the first book to fully introduce a newly developed distance friction minimization (DFM) model, which is one of the new efficiency improvement projection approaches in data envelopment analysis (DEA). The DFM model can produce a most effective solution in efficiency improvement projections for inefficient spatial entities (decision-making units). The book provides a set of fresh contributions to a quantitative assessment of the performance of such policy entities. First it offers a state-of-the art overview of current DEA models and approaches, followed by the operational design of various new types of DEA models, each of them addressing weaknesses in traditional DEA approaches. Then it illustrates the assessment potential of DEA — and its new variants, in particular, the DFM model and subsequent extensions — on the basis of a broadly composed collection of empirical case studies, centering mainly but not exclusively on Japan and other Asian nations.

data envelope analysis: An Introduction to Data Envelopment Analysis Ramu Ramanathan, 2003 From the Foreword: 'This book is an excellent tool for practitioners who are interested in the merits and pitfalls of the technique . (The author's) research is an example of inventiveness, diligence and accuracy' - Freerk A. Lootsma, Delft Institute of Technology Data envelopment Analysis is a Mathematical Programme for measuring performance efficiency of organizational units. The organizational units, termed as decision-making units (DMU) can be of any kind: manufacturing units, a set of schools, banks, hospitals, power plants, police stations, prisons, a set of firms etc. DEA has been unsuccessfully applied to measure the performance efficiency of these different kinds of DMUs which share a common characteristic - that they are non-profit organization where measurement of performance efficiency is difficult. DEA has been employed for assessing the relative performance of a set of firms that use a variety of identical inputs-say in the case of a school: quality of students, teachers, grants etc., -to produce a variety of identical outputs-number of students who pass the final year, average grades obtained by the students in the final year etc. DEA assumes the performance of the DMUs by 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 or DMUs. The best performing DMU is given a score of 100% and the performance of other DMUs vary between 0 -100%.

data envelope analysis: Handbook of Operations Analytics Using Data Envelopment Analysis Shih-Nan Hwang, Hsuan-Shih Lee, Joe Zhu, 2016-07-01 This handbook focuses on Data Envelopment Analysis (DEA) applications in operations analytics which are fundamental tools and techniques for improving operation functions and attaining long-term competitiveness. In fact, the handbook demonstrates that DEA can be viewed as Data Envelopment Analytics. Chapters include a review of cross-efficiency evaluation; a case study on measuring the environmental performance of

OECS countries; how to select a set of performance metrics in DEA with an application to American banks; a relational network model to take the operations of individual periods into account in measuring efficiencies; how the efficient frontier methods DEA and stochastic frontier analysis (SFA) can be used synergistically; and how to integrate DEA and multidimensional scaling. In other chapters, authors construct a dynamic three-stage network DEA model; a bootstrapping based methodology to evaluate returns to scale and convexity assumptions in DEA; hybridizing DEA and cooperative games; using DEA to represent the production technology and directional distance functions to measure bank performance; an input-specific Luenberger energy and environmental productivity indicator; and the issue of reference set by differentiating between the uniquely found reference set and the unary and maximal types of the reference set. Finally, additional chapters evaluate and compare the technological advancement observed in different hybrid electric vehicles (HEV) market segments over the past 15 years; radial measurement of efficiency for the production process possessing multi-components under different production technologies; issues around the use of accounting information in DEA; how to use DEA environmental assessment to establish corporate sustainability; a summary of research efforts on DEA environmental assessment applied to energy in the last 30 years; and an overview of DEA and how it can be utilized alone and with other techniques to investigate corporate environmental sustainability questions.

data envelope analysis: *Data Envelopment Analysis in the Service Sector* Georg Westermann, 2013-09-03 This volume emphasizes the possibilities to adjust and develop the methodology of Data Envelopment Analysis in order to meet the requirements of the service sector.

data envelope analysis: *An Introduction to Efficiency and Productivity Analysis* Timothy J. Coelli, Dodla Sai Prasada Rao, Christopher J. O'Donnell, George Edward Battese, 2005-07-22 Softcover version of the second edition Hardcover. Incorporates a new author, Dr. Chris O'Donnell, who brings considerable expertise to the project in the area of performance measurement. Numerous topics are being added and more applications using real data, as well as exercises at the end of the chapters. Data sets, computer codes and software will be available for download from the web to accompany the volume.

data envelope analysis: Productivity and Efficiency Analysis Christopher J. O'Donnell, 2018-12-12 This book provides a coherent description of the main concepts and statistical methods used to analyse economic performance. The focus is on measures of performance that are of practical relevance to policy makers. Most, if not all, of these measures can be viewed as measures of productivity and/or efficiency. Linking fields as diverse as index number theory, data envelopment analysis and stochastic frontier analysis, the book explains how to compute measures of input and output quantity change that are consistent with measurement theory. It then discusses ways in which meaningful measures of productivity change can be decomposed into measures of technical progress, environmental change, and different types of efficiency change. The book is aimed at graduate students, researchers, statisticians, accountants and economists working in universities, regulatory authorities, government departments and private firms. The book contains many numerical examples. Computer codes and datasets are available on a companion website.

data envelope analysis: *Basic Methods of Policy Analysis and Planning* Carl Patton, David Sawicki, Jennifer Clark, 2015-08-26 Updated in its 3rd edition, *Basic Methods of Policy Analysis and Planning* presents quickly applied methods for analyzing and resolving planning and policy issues at state, regional, and urban levels. Divided into two parts, *Methods* which presents quick methods in nine chapters and is organized around the steps in the policy analysis process, and *Cases* which presents seven policy cases, ranging in degree of complexity, the text provides readers with the resources they need for effective policy planning and analysis. Quantitative and qualitative methods are systematically combined to address policy dilemmas and urban planning problems. Readers and analysts utilizing this text gain comprehensive skills and background needed to impact public policy.

data envelope analysis: Data Envelopment Analysis Michael A. Norman, 1991

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Data Envelopment Analysis (DEA), a powerful data analysis tool that can be used in performance evaluation and benchmarking. This book is based upon the author's years of research and teaching experiences. It is difficult to evaluate an organization's performance when multiple performance metrics are present. The difficulties are further enhanced when the relationships among the performance metrics are complex and involve unknown tradeoffs. This book introduces Data Envelopment Analysis (DEA) as a multiple-measure performance evaluation and benchmarking tool. The focus of performance evaluation and benchmarking is shifted from characterizing performance in terms of single measures to evaluating performance as a multidimensional systems perspective. Conventional and new DEA approaches are presented and discussed using Excel spreadsheets — one of the most effective ways to analyze and evaluate decision alternatives. The user can easily develop and customize new DEA models based upon these spreadsheets. DEA models and approaches are presented to deal with performance evaluation problems in a variety of contexts. For example, a context-dependent DEA measures the relative attractiveness of similar operations/processes/products. Sensitivity analysis techniques can be easily applied, and used to identify critical performance measures. Two-stage network efficiency models can be utilized to study performance of supply chain. DEA benchmarking models extend DEA's ability in performance evaluation. Various cross efficiency approaches are presented to provide peer evaluation scores. This book also provides an easy-to-use DEA software — DEA Frontier. This DEA Frontier is an Add-In for Microsoft® Excel and provides a custom menu of DEA approaches. This version of DEA Frontier is for use with Excel 97-2013 under Windows and can solve up to 50 DMUs, subject to the capacity of Excel Solver. It is an extremely powerful tool that can assist decision-makers in benchmarking and analyzing complex operational performance issues in manufacturing organizations as well as evaluating processes in banking, retail, franchising, health care, public services and many other industries.

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Jingzheng Ren, Sara Toniolo, 2019-11-19 Life Cycle Sustainability Assessment for Decision-Making: Methodologies and Case Studies gives readers a comprehensive introduction to life cycle sustainability assessment (LCSA) methodology for sustainability measurement of industrial systems, proposing an efficiency methodology for stakeholders and decision-makers. Featuring the latest methods and case studies, the book will assist researchers in environmental sciences and energy to develop the best methods for LCA, as well as aiding those practitioners who are responsible for making decisions for promoting sustainable development. The past, current status and future of LCSA, Life Cycle Assessment method (LCA), Life Cycle Costing (LCC), Social Life Cycle Assessment (SLCA), the methodology of LCSA, typical LCSA case studies, limitations of LCSA, and life cycle aggregated sustainability index methods are all covered in this multidisciplinary book. - Includes models for assessing sustainability in environmental, energy engineering and economic scenarios - Features case studies that help define the advantages and obstacles of real world applications - Presents a complete view, from theory to practice, of a life cycle approach by exploring the methods and tools of sustainability assessment, analysis and design of sustainability assessment

data envelope analysis: Spatial Point Patterns Adrian Baddeley, Ege Rubak, Rolf Turner, 2015-11-11 Modern Statistical Methodology and Software for Analyzing Spatial Point Patterns Spatial Point Patterns: Methodology and Applications with R shows scientific researchers and applied statisticians from a wide range of fields how to analyze their spatial point pattern data. Making the techniques accessible to non-mathematicians, the authors draw on th

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open source software environment for statistical computing and graphics. This enables the reader to solve not only standard problems, but also many other problem variants. Using R, one can focus on understanding the context and developing a good model. One is not restricted to predefined model variants and to a one-size-fits-all approach. To facilitate the use of R, the authors have developed an R package called Benchmarking, which implements the main methods within both DEA and SFA. The book uses mathematical formulations of models and assumptions, but it de-emphasizes the formal proofs - in part by placing them in appendices -- or by referring to the original sources. Moreover, the book emphasizes the usage of the theories and the interpretations of the mathematical formulations. It includes a series of small examples, graphical illustrations, simple extensions and questions to think about. Also, it combines the formal models with less formal economic and organizational thinking. Last but not least it discusses some larger applications with significant practical impacts, including the design of benchmarking-based regulations of energy companies in different European countries, and the development of merger control programs for competition authorities.

data envelope analysis: *Uncertain Data Envelopment Analysis* Meilin Wen, 2014-07-24 This book is intended to present the milestones in the progression of uncertain Data envelopment analysis (DEA). Chapter 1 gives some basic introduction to uncertain theories, including probability theory, credibility theory, uncertainty theory and chance theory. Chapter 2 presents a comprehensive review and discussion of basic DEA models. The stochastic DEA is introduced in Chapter 3, in which the inputs and outputs are assumed to be random variables. To obtain the probability distribution of a random variable, a lot of samples are needed to apply the statistics inference approach. Chapter 4 and 5 provide two uncertain DEA methods to evaluate the DMUs with limited or insufficient statistical data, named fuzzy DEA and uncertain DEA. In order to evaluate the DMUs in which uncertainty and randomness appear simultaneously, the hybrid DEA based on chance theory is presented in Chapter 6.

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