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Chapter 1 : Data envelopment analysis

In about 30 years, Data Envelopment Analysis (DEA) has grown into a powerful quantitative, analytical tool for measuring and evaluating the performance. DEA has been successfully applied to a host of many different types of entities engaged in a wide variety of activities in many contexts worldwide.

By definition this figure of 1. You can see Reigate plotted on it. It can be shown that any branch with a ratio personal transactions per staff member: You can see that line below. If you are geometrically minded then the slope gradient of this line is 1. Hence if Reigate were to retain the same business mix i. For example were Reigate to operate the same level of output with 9 staff we would have: It might seem reasonable to suggest therefore that the best possible performance that Reigate could be expected to achieve is given by the point labelled Best in the diagram above. This is the point where the line from the origin through Reigate meets the efficient frontier. Then in DEA we numerically measure the relative efficiency of Reigate by the ratio: The logic here is to compare the current performance of Reigate the length of the line from the origin to Reigate to the best possible performance that Reigate could reasonably be expected to achieve the length of the line from the origin through Reigate to the efficient frontier. Recall the list of ratios with extra branches added given before. Plainly we could easily find their efficiencies from the diagram. There are a couple of points to note here: Many mangers without any technical expertise are happy with ratios. Showing them that their ratios can be viewed differently and used to obtain new information is often an eye-opener to them. On a technical issue note that the scale used for the x-axis and the y-axis in plotting positions for each branch is irrelevant. Had we used a different scale above we would have had a different picture, but the efficiencies of each branch would be exactly the same. If you need convincing of this note that if we rescale the x-axis by a factor of k1, and the y-axis by a factor of k2, then the coordinates of any point x,y change to k1x,k2y. Achieving the efficient frontier The point labelled Best on the efficient frontier is considered to represent the best possible performance that Reigate can reasonably be expected to achieve. Whilst we have talked above of Reigate varying the number of staff to achieve Best in fact there are a number of ways by which Reigate can move towards that point. In fact the same diagram as we used to calculate the efficient of Reigate can be used to set targets in a graphical manner. Use of the efficiencies It is important to be clear about the appropriate use of the relative efficiencies we have calculated. Rather the efficiencies here would usually be taken as indicative of the fact that other branches are adopting practices and procedures which, if Reigate were to adopt them, would enable it to improve its performance. This naturally invokes issues of highlighting and disseminating examples of best practice. Equally there are issues relating to the identification of poor practice. In DEA the concept of the reference set can be used to identify best performing branches with which to compare a poorly performing branch. The Best point associated with Reigate lies on the efficient frontier. A branch at this point would be the best possible branch to compare Reigate with as it would have the same business mix. No such branch exists however so we go to the two efficient branches either side of this Best point. These branches, Croydon and Redhill, are the reference set for Reigate. Broadly put this means that the branches in the reference set have a "similar" mix of inputs and output. Question What other reasons can you think of for the apparently low relative efficiency score for Reigate? Exercise Consider the diagram above with branches A to E included. What would be the efficiencies and reference sets for branches A to E? What changes as a result of this extra branch being included in the analysis? The effect of this can be seen below Note that the efficient frontier now excludes Redhill. We do not draw that efficient frontier from Croydon to Redhill and from Redhill to F for two reasons: The example below, where we have added a branch G, illustrates that a branch can be efficient even if it is not a top performer. In the diagram below G is efficient since under DEA it is judged to have "strength with respect to both ratios", even though it is not the top performer in either. Recap Let us recap what we have done here - we have shown how a simple graphical analysis of data on inputs and outputs can be used to calculate efficiencies. Once such an analysis has been carried out then we can begin to tackle, with a

clearer degree of insight than we had before, issues such as:

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Chapter 2 : DATA ENVELOPMENT ANALYSIS History, Models and Interpretations | shoaib nasir - calendr

In about 30 years, Data Envelopment Analysis (DEA) has grown into a powerful quantitative, analytical tool for measuring and evaluating the performance.

Data Envelopment Analysis is a "balanced benchmarking" Read our article Vol. According to Cook, Tone and Zhu , Data envelopment analysis: Specifically, DEA is used to identify best-practices when multiple performance metrics or measures are present for organizations. Based upon Cook, Tone and Zhu , although DEA has a strong link to production theory in economics, the tool is also used for benchmarking in operations management, where a set of measures is selected to benchmark the performance of manufacturing and service operations. In the circumstance of benchmarking, the efficient DMUs, as defined by DEA, may not necessarily form a "production frontier", but rather lead to a "best-practice frontier". For example, if one benchmarks the performance of computers, it is natural to consider different features screen size and resolution, memory size, process speed, hard disk size, and others. However, these features may not actually represent inputs and outputs at all, in the standard notion of production. The issue now becomes one of how to classify these performance measures into inputs and outputs, for use in DEA. This can then be a rule for classifying factors under these two headings. There are, however, exceptions to this; for example, pollutants from a production process are outputs, yet higher levels of these indicate worse performance. There are DEA models that deal with such undesirable outputs. In certain circumstances, a factor can play a dual role of input and output simultaneously. For example, when evaluating the efficiencies of a set of universities, if one considers the numbers of Ph. At the same time, however, Ph. In such cases, the user must clearly define the purpose of benchmarking so that such performance measures can be classified as inputs or outputs. In some situations, the DMUs may have internal structures, e. For example, banks generate deposits as an output in the first stage, and then the deposits are used as an input to generate profit in the second stage. DEA can be viewed as a multiple-criteria evaluation methodology where DMUs are alternatives, and DEA inputs and outputs are two sets of performance criteria where one set inputs is to be minimized and the other outputs is to be maximized. It is meaningless to apply a sample size requirement to DEA, which should be viewed as a benchmarking tool focusing on individual performance. According to Cooper, L. Zhu , "Data Envelopement Analysis: The definition of a DMU is generic and flexible. Recent years have seen a great variety of applications of DEA for use in evaluating the performances of many different kinds of entities engaged in many different activities in many different contexts in many different countries. These DEA applications have used DMUs of various forms to evaluate the performance of entities, such as hospitals, US Air Force wings, universities, cities, courts, business firms, and others, including the performance of countries, regions, etc. Because it requires very few assumptions, DEA has also opened up possibilities for use in cases which have been resistant to other approaches because of the complex often unknown nature of the relations between the multiple inputs and multiple outputs involved in DMUs. As pointed out in Cooper, Seiford and Tone , DEA has also been used to supply new insights into activities and entities that have previously been evaluated by other methods. For instance, studies of benchmarking practices with DEA have identified numerous sources of inefficiency in some of the most profitable firms firms that had served as benchmarks by reference to this profitability criterion â€" but DEA has provided a vehicle for identifying better benchmarks in many applied studies. Because of these possibilities, DEA studies of the efficiency of different legal organization forms such as "stock" vs. Similarly, a use of DEA has suggested reconsideration of previous studies of the efficiency with which pre- and post-merger activities have been conducted in banks that were studied by DEA. Since DEA was first introduced in in its present form, researchers in a number of fields have quickly recognized that it is an excellent and easily used methodology for modeling operational processes for performance evaluations. This has been accompanied by other developments. For instance, Zhu , provides a number of DEA spreadsheet models that can be used in performance evaluation and benchmarking. See, for instance, the use of DEA to

guide removal of the Diet and other government agencies from Tokyo as described in Takamura and Tone Formally, DEA is a methodology directed to frontiers rather than central tendencies. Because of this perspective, DEA proves particularly adept at uncovering relationships that would remain hidden from other methodologies. This is accomplished in a straightforward manner by DEA without requiring explicitly formulated assumptions and variations with various types of models such as in linear and nonlinear regression models. Rhodes, , Measuring the efficiency of decision making units, European Journal of Operational Research 2,

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Chapter 3 : Data envelopment analysis - Wikipedia

Chapter 1 DATA ENVELOPMENT ANALYSIS History, Models and Interpretations William W. Cooper1, Lawrence M. Seiford2 and Joe Zhu3 1 Red McCombs School of Business, University of Texas at Austin.

Since then, there have been a large number of books and journal articles written on DEA or applying DEA on various sets of problems. Other than comparing efficiency across DMUs within an organization, DEA has also been used to compare efficiency across firms. No cleanup reason has been specified. Please help improve this section if you can. July Learn how and when to remove this template message Data envelopment analysis DEA is a linear programming methodology to measure the efficiency of multiple decision-making units DMUs when the production process presents a structure of multiple inputs and outputs. Utilizing the selected variables, such as unit cost and output, DEA software searches for the points with the lowest unit cost for any given output, connecting those points to form the efficiency frontier. Any company not on the frontier is considered inefficient. A numerical coefficient is given to each firm, defining its relative efficiency. Different variables that could be used to establish the efficiency frontier are: An early survey of studies of electricity distribution companies identified more than thirty DEA analysesâ€”indicating widespread application of this technique to that network industry. A number of studies using this technique have been published for water utilities. The main advantage to this method is its ability to accommodate a multiplicity of inputs and outputs. It is also useful because it takes into consideration returns to scale in calculating efficiency, allowing for the concept of increasing or decreasing efficiency based on size and output levels. However, these features may not actually represent inputs and outputs at all, in the standard notion of production. The issue now becomes one of how to classify these performance measures into inputs and outputs, for use in DEA. A desire to Improve upon DEA, by reducing its disadvantages or strengthening its advantages has been a major cause for many discoveries in the recent literature. The currently most often DEA-based method to obtain unique efficiency rankings is called cross-efficiency. Originally developed by Sexton et al. For instance a government authority can choose data envelopment analysis as their measuring tool to design an individualized regulatory rate for each firm based on their comparative efficiency. The input components would include man-hours, losses, capital lines and transformers only , and goods and services. The output variables would include number of customers, energy delivered, length of lines, and degree of coastal exposure. Berg DEA is also regularly used to assess the efficiency of public and not-for-profit organizations, e. Examples[edit] In the DEA methodology, formally developed by Charnes, Cooper and Rhodes , efficiency is defined as a ratio of weighted sum of outputs to a weighted sum of inputs, where the weights structure is calculated by means of mathematical programming and constant returns to scale CRS are assumed. Assume that we have the following data: Unit 1 produces items per day, and the inputs per item are 10 dollars for materials and 2 labour-hours Unit 2 produces 80 items per day, and the inputs are 8 dollars for materials and 4 labour-hours Unit 3 produces items per day, and the inputs are 12 dollars for materials and 1. But since linear programming cannot handle fraction, we need to transform the formulation, such that we limit the denominator of the objective function and only allow the linear programming to maximize the numerator. So the new formulation would be: Inefficiency measuring[edit] Data Envelopment Analysis DEA has been recognized as a valuable analytical research instrument and a practical decision support tool. DEA has been credited for not requiring a complete specification for the functional form of the production frontier nor the distribution of inefficient deviations from the frontier. Rather, DEA requires general production and distribution assumptions only. However, if those assumptions are too weak, inefficiency levels may be systematically underestimated in small samples. In addition, erroneous assumptions may cause inconsistency with a bias over the frontier. Therefore, the ability to alter, test and select production assumptions is essential in conducting DEA-based research. However, the DEA models currently available offer a limited variety of alternative production assumptions only. Journal of Productivity Analysis. Also see many references therein. New Directions for

Program Evaluation. Derivations, Meanings and Uses". Journal of the Operational Research Society. European Journal of Operational Research. References[edit] Banker R. Measurement, Methodology, and Performance Incentives. Journal of the Royal Statistical Society. Health Services Management Research. European Journal of Health Economics. Applications of Modern Production Theory: Efficiency and Productivity, Kluwer: A tool for Performance Measurement, Sage Publishing. Health Care Management Review.

Chapter 4 : Chapter 1 DATA ENVELOPMENT ANALYSIS History, Models and Interpretations - CORE

Zhu, J. , Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets and DEA Excel Solver, Kluwer Academic Publishers, Boston. Part of the material in this chapter is adapted from the Journal of Econometrics, Vol. 46, Seiford, L.M. and Thrall, R.M.

Show Context Citation Context The most common method is the assurance regions AR model, and AR is to impose restrictions on the upper bound and lower bound of a ratio of the weights of two variables [43]. Sun [45] applied pairwise comparison to col Seiford, Joe Zhu, Key Words " In a relatively short period of time Data Envelopment Analysis DEA has grown into a powerful quantitative, analytical tool for measuring and evaluating performance. DEA has been successfully applied to a host of different types of entities engaged in a wide variety of activities in many contexts w DEA has been successfully applied to a host of different types of entities engaged in a wide variety of activities in many contexts worldwide. This chapter discusses the fundamental DEA models and some of their extensions. Major criteria weights are analyzed using the analytic hierarchy process AHP and sensitivity analysis. Analysis results indicate that the proposed selection model enables the manager to select the supply chain management of NB more objectively by allowing them to deploy effectively. The proposed model can also be applied to other high technology factories, thus enhancing Taiwanese competitive advantage. Location selection is one of the most important aspects of business success. In fuel industry, gas station site selection problem involves several quantitative and qualitative factors such as the number of other stations in the area, traffic directions, social composition of surrounding residential In fuel industry, gas station site selection problem involves several quantitative and qualitative factors such as the number of other stations in the area, traffic directions, social composition of surrounding residential area, and curb appeal of the station structure. The purpose of this study is to present a comprehensive hierarchy of factors for selecting the best gas station site. In the study, Analytic Hierarchy Process AHP methodology was also used to calculate the relative importance of criteria and the sub-criteria in accordance with the aggregate opinions of experts. AHP is a commonly used mathematical tool especially where subjectivity may affect on overall result of the decision making process. The study demonstrated that the access to station from both directions, road barricades in direction of station, to be located on a local or state road, and the speed limit on the front road have been the major factors for the gas station site selection. Abstract- Proposed in this study is a hybrid model for supporting the performance of a department within Amir Kabir University in Iran. The proposal is a two-stage model designed to fully rank the organizational departments where each faculty has multiple inputs and outputs. First, the Data Envelopm In the second stage, the pair-wise evaluation matrix generated in the first stage is utilized to fully rank the units via the Analytical Network Process ANP. Nevertheless, one hybrid model combines the best techniques of the two models. The DEA-ANP hybrid algorithm ranking does not replace the DEA classification model; rather, it extends the analysis by providing full ranking in the DEA context for all departments, whether they are efficient or inefficient. Some of these examples include. DEA is adopted for evaluating the efficiency of transportation infrastructure systems of nineteen cities and towns in Japan. The cities can be divided into two groups, which are big cities from the whole Japan and small cities and towns in Hokkaido. The decision-making unit here is not a s The decision-making unit here is not a single infrastructure unit, but the whole transportation infrastructure systems in the city which include the road networks and the railway systems. Transportation modes, which serve people mobility, consist of road-using modes cars and buses and rail-using modes JR, private trains, streetcars, subways, monorails, etc. For comparison purpose, evaluations using various input-output combinations were performed. This study provides a benchmark for cities to improve their infrastructure system management by identifying weak points of each city and suggesting the way to improve efficiency. It is well known that the discrimination power of DEA models will be diminishing if too many inputs or outputs are used. It is a dilemma if the decision makers want to select comprehensive indicators to present a relatively

holistic evaluation using DEA. In this work we show that by utiliz In this work we show that by utilizing hierarchical structures of input-output data DEA can handle quite large numbers of inputs and outputs. We present two approaches in a pilot evaluation of 15 institutes for basic research in Chinese Academy of Sciences using DEA models.

Chapter 5 : CiteSeerX â€" DATA ENVELOPMENT ANALYSIS -- History, Models and Interpretations

In a relatively short period of time Data Envelopment Analysis (DEA) has grown into a powerful quantitative, analytical tool for measuring and evaluating performance. DEA has been successfully applied to a host of different types of entities engaged in a wide variety of activities in many contexts worldwide.

Chapter 6 : Handbook on Data Envelopment Analysis - Google Books

Chapter 1 Data Envelopment Analysis: History, Models, and Interpretations William W. Cooper, Lawrence M. Seiford, and Joe Zhu Abstract In about 30 years, Data Envelopment Analysis (DEA) has grown into.*

Chapter 7 : History of DEA from its developer William W Cooper â€" Ali Emrouznejad's Data Envelopment

Data Envelopment Analysis is an Operations Research Tool that uses Linear Programming formulation to find the relative efficiency between different Decision Making Units (DMU) in a service or manufacturing setup.

Chapter 8 : Tutorial â€" Ali Emrouznejad's Data Envelopment Analysis

In a relatively short period of time Data Envelopment Analysis (DEA) has grown into a powerful quantitative, analytical tool for measuring and evaluating performance. DEA has been successfully applied to a host of different types of entities engaged in a wide variety of activities in many contexts.