Chapter 1

DATA ENVELOPMENT ANALYSIS
History, Models and Interpretations

William W. Cooper[1], Lawrence M. Seiford[2] and Joe Zhu[3]

*[1] Red McCombs School of Business, University of Texas at Austin, Austin, TX 78712 USA
email: cooperw@mail. utexas. edu*

*[2] Department of Industrial and Operations Engineering, University of Michigan at Ann Arbor,
Ann Arbor, MI 48102 USA   email: seiford@umich.edu*

*[3] Department of Management, Worcester Polytechnic Institute, Worcester, MA 01609 USA
email: jzhu@wpi. edu*

Abstract: 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. This chapter discusses the fundamental DEA models and
some of their extensions.

Key words: Data envelopment analysis (DEA); Efficiency; Performance

1.   INTRODUCTION

Data Envelopment Analysis (DEA) is a relatively new "data oriented" approach for evaluating the performance of a set of peer entities called Decision Making Units (DMUs) which convert multiple inputs into multiple outputs. 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 (2000), 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 – and this 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. "mutual" insurance companies have shown that previous studies have fallen short in their attempts to evaluate the potentials of these different forms of organizations. 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 in its present form was first introduced in 1978, 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 (2002) provides a number of DEA spreadsheet models that can be used in performance evaluation and benchmarking. DEA's empirical orientation and the absence of a need for the numerous *a priori* assumptions that accompany other approaches (such as standard forms of statistical regression analysis) have resulted in its use in a number of studies involving efficient frontier estimation in the governmental and nonprofit sector, in the regulated sector, and in the private sector. See, for instance, the use of DEA to guide removal of the Diet and other government agencies from Tokyo to locate a new capital in Japan, as described in Takamura and Tone (2003).

In their originating study, Charnes, Cooper, and Rhodes (1978) described DEA as a 'mathematical programming model applied to observational data [that] provides a new way of obtaining empirical estimates of relations - such as the production functions and/or efficient production possibility surfaces – that are cornerstones of modern economies'.

Formally, DEA is a methodology directed to frontiers rather than central tendencies. Instead of trying to fit a regression plane through the *center* of