# Epistemology of data envelopment analysis and comparison with other fields of OR/MS for relevance to applications

Said Gattoufi[a], Muhittin Oral[a], Ashok Kumar[b], Arnold Reisman[a,c,*]

[a] *Graduate School of Management, Sabanci University, Istanbul, Turkey*
[b] *Grand Valley State University, Grand Rapids, MI, USA*
[c] *Reisman and Associates, Shaker Heights, OH, USA*

## Abstract

Periodically, professionals in a given field must reflect and assess where the field has been, where it is heading, and what if anything, should be done to change that field's course. This article discusses statistical trends within the data envelopment analysis (DEA) literature. The number of articles published per year in refereed journals over the entire lifespan of the field, authorship and publishing outlets-of-choice statistics are used to indicate DEA's *vitality*, *relevance*, *diffusion* to other disciplines/professions and its worldwide *acceptance*. Lastly, based on published meta reviews, comparisons are made with other OR/MS sub-disciplines.

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## 1. Introduction

There is agreement in the corresponding, economic as well as OR/MS, literature that modern measurement of economic efficiency was introduced by Farrell [1] who drew upon the work of Debreu [2] and Koopmans [3] to define a simple measure of a firm's efficiency. Farrell pointed out that "[a]lthough there are many possibilities [for efficiency measures] two at once suggest themselves—a theoretical function specified by engineers and an empirical function based on the best results observed in practice" [1].

Charnes and Cooper [4] gave this concept more precision and suggested a way of dealing with efficiency in practice. They defined efficiency and justified the necessity for a "*relative*" rather than

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an "*absolute*" measure thereof: more than 20 years later, the CCR model remains central in the DEA literature.

> [The] distinction between effectiveness and efficiency need not be emphasized in evaluating private enterprise activities…. We lay aside the more difficult problem of effectiveness and assume that this has been decided in the choice of inputs (resources) to be used and outputs (benefits) to be achieved, as well as the way in which the inputs and outputs are to be measured:

> 100% of efficiency is attained for any Decision Making Unit (DMU) only when:

>  (a) None of its outputs can be increased without either

>   i. increasing one or more of its inputs or
>   ii. decreasing some of its other outputs
>  (b) None of its inputs can be decreased without either

>   i. decreasing some of its outputs or
>   ii. increasing some of its other inputs.

Publication of the Charnes, Cooper and Rhodes (CCR) model [5] is widely recognized as the birth of *data envelopment analysis* (*DEA*)[1]. That paper formulated the evaluation of a firm's efficiency "in a stringent mathematical form more readily understood and absorbed by the research community" [7]. To date, more than 20 years later, the CCR model remains central within the DEA literature.

In 1996, Seiford [8], traced DEA's evolution from the early articles by Koopmans [3], Debreu [2], Farrell [1], and CCR [5] up to the "*state-of-the-art*" (SOA) in DEA, circa 1995 and summarized the SOA circa 1980, 1985, 1990 and 1995. His paper discusses the main issues typically addressed during each 5-year period followed by a ranking of the most influential papers. With some exceptions these rankings were confirmed by citation analysis in [9]. Additionally, Seiford discusses novel applications and advances in the theory. Finally, he claims that "stochastic DEA is the most critical and difficult future issue in DEA" [10].

Although stochasticity was not new to the DEA literature, the period 1996–2001 recorded a quantum jump in the number of articles attempting to introduce it into DEA. One can question if this was a natural trend or a "bias" in the trend due to an "influential paper" produced by the "influential Seiford." Was DEA in need of developing in that direction or was this due to a "natural drift"? How successful were these developments in real-world implementation? To be sure, the gap between "parametric methods" and DEA was significantly reduced, but was that the right direction? More debate and more insights are needed. A panoramic view through a more systematic analysis of the literature should help in this debate.

At the last mile-stone year of Seiford's analysis, e.g. 1995, the literature recorded roughly 700 papers published in refereed journals [9] and that literature has grown to more than 1800 such

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[1] Beside the Farrell [1] paper, largely recognized as providing the seminal ideas for DEA, subsequent developments leading to the CCR model were forgotten until Forsund and Sarafoglou's [6] historical explorations into the matter.