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Preface¹

Socio-Economic Planning Sciences (SEPS) is emerging as a journal of choice for workers in data envelopment analysis (DEA)—a technique that allows for measurement of relative efficiency of organizational units. The methodology's main strength lies in its ability to capture the interplay between multiple inputs and outputs, a process that cannot be satisfactorily probed through traditional ratio analysis [1]. In recent years, *SEPS* has been publishing DEA content articles with increasing frequency and, in the 2002 volume-year, a DEA-based paper had the highest number of citations compared to all other such papers worldwide [2]. DEA authors representing 42 countries have contributed to the theoretical and applied bases of this widely accepted, albeit relatively young, methodology. Significantly, “applications” in the case of DEA indeed do have real-world grounding and implications, as well as high rates of implementation. DEA applications of record range, sector-wise, from banking to the not-for-profits; from welfare agencies to the military; from health services to manufacturing; from education to policing. Among the functional areas represented are: engineering, marketing, finance, policy analysis, and accounting, and the management of: human resources, pork producer farms, power plants, distribution and transportation systems, information systems, public procurements, order picking activity, etc. The objectives served are: organizational design, organizational effectiveness, credit evaluation, privatisation, insurance underwriting, benchmarking, productivity analysis, modernisation policy analysis, scale and performance measurement, physician report cards, environmental regulation, pollution prevention, facilities/equipment planning, evaluation of macroeconomic performance, leadership, ownership structure, mergers, and divestitures.

Many linkages between DEA and other methodologies have been established. Among these are: non-linear programming, simulation, multiple criteria decision analysis, multivariate and non-parametric statistics, neural networks and genetic algorithms, fuzzy sets, game theory, integer programming, goal programming, and multi-objective linear programming.

¹The Guest Editor is greatly indebted to Professors Necmi Avkiran of Queensland, Australia, William Cooper of Austin, Texas, Finn Forsund of Oslo, Norway, Nik Sarafoglu of Sundsvall, Sweden, and Zilla Sinuany-Stern and Lea Friedman of Beer Sheva, Israel, for reviewing each of the three papers in this issue and making excellent substantive suggestions—all of which were implemented. Additional thanks go to Gabriel Tavares of Piscataway, New Jersey for his contributions to this Preface. And, last but not least, the deepest of thanks go to Barnett Parker, Editor-in-Chief of *SEPS* who, like no other Editor-in-Chief, Department Editor, or Associate Editor of any of the many journals I have dealt with over the years, has personally copy-edited each of the manuscripts again and again. It is no wonder then that papers published in *SEPS* are always well formatted, grammatically correct, and readable, in addition to being contributions to knowledge, or to practice, or both.

Level-wise, in banking alone, the applications range from branch levels, to an entire bank, to cross-national analyses of entire banking systems.

There are many signs that DEA is maturing. These include textbooks being published with ever user-friendlier software for implementing this methodology, as well as the commercialization of such software.

The DEA community of scholars and practitioners is enabled in their work by a number of websites. Outstanding among these is the one run out of the University of Warwick (UK) by Professor Ali Emrouznejad on an interactive basis: <http://www.deazone.com/getpublished/index.htm>. Among its many services and databases, it offers a network of experts to any and all neophytes as indicated by [3]:

- Are you new in DEA or related topics?
- Are you a postgraduate or a Ph.D. student?
- Are you writing a dissertation, a paper, or any DEA related publication?
- Do you need help to develop your idea of using DEA in:
 - writing a paper;
 - using DEA in your organization; or
 - any other DEA related research?
- Why not contact DEA Experts?!

On the other hand, it makes requests for volunteer experts:

- Are you a DEA expert? If so, many DEA researchers are looking for your advice.
- Would you be prepared to give advice to young researchers? If so, why not join the DEA expert community?

Although two data points cannot be used to signify a trend, our finding that 1999 was the peak year for articles published in refereed journals has been corroborated by Gabriel Tavares [4], whose database includes books, chapters in books, working papers, dissertations and paper presentations in addition to journal publications. These data should be updated to see if, indeed, interest in DEA is on the decline. However, a sure sign that DEA has come of age while realizing great success in the milieu of operations research/management science (OR/MS), and in the great diversity of sectors in which it is being applied, is the fact that economists are beginning to claim inventors rights, in whole or in part, on behalf of their discipline [5,6]. In claiming such rights for economics, Forsund and Sarafoglou [6] nevertheless do acknowledge that the Charnes, Cooper and Rhodes paper [7], discussed next, is a classic.²

As is commonly known today, DEA emerged from the need to solve a real-world problem [7], for which the extant OR/MS theory did not provide a sufficiently adequate methodology. History [8] attests to the fact that Abe Charnes and Bill (William Wager) Cooper, two of the three founders of DEA, had, on at least one other occasion, faced a similar condition and ended up creating a new domain of OR/MS knowledge, viz., *Goal Programming*. Then also, theory evolved from the need to solve a real-world problem. That experience was described to this editor [26] by

² According to bibliometric standards, a paper with over 500 citations is considered a classic. This paper has 989 as of February 2003 according to the web-based SSCI (ISI web knowledge) and others in SCI [6].

one of the field's founders after he was shown an early draft of a Reisman and Kirschnick paper [9]:

This paper stimulated my thinking and also brought back many memories. One of the possibilities to be considered is the reinforcing effects which may occur when several of the strategies you describe are employed simultaneously. A case in point from my own experience is the original article which Abe Charnes and I wrote with Bob Mellon and published in the April 1952 issue of *Econometrica* (a really abstract methodology oriented journal) entitled “Blending Aviation Gasolines: A Study in Programming Interdependent Activities in an Integrated Oil Company” [10]. This was the first reported actual application of linear programming and the effect was enormous both on industrial practice in more than one industry, and theoretical-methodological research (in more than one discipline). Many things were involved—a new application, new methodologies and new substantive theory. Perhaps this was due to the mix of disciplines in our team which included chemical engineering and refinery experience (Mellon), mathematics and engineering (Charnes) and economics, management and accounting [7].

At this point, Cooper inserted a footnote that, “We only discovered at a later date that this was to be called ‘operations research’ or still later, ‘management science’”. He then continued:

These wide ranging and continuing effects, or at least the speed which these occurred, may also have been due to the times and the psychological aftermath (of euphoria) resulting from the ‘great historical divide’ we now refer to as ‘World War II’ [7].

In the above development, a *creative application*³ of linear programming followed the *structuring* of gasoline blending processes into a mathematical model. The results were *empirically* validated by industrial practice. The work involved new models, new methods, and substantive theory as a result of *bridging* linear programming with chemical engineering and bringing the results to bear on the managerial problems addressed, creating an “applications driven theory” [18].

The contents of this *Special Issue* of *SEPS* derive from an expansion of Said Gattoufi's doctoral research at the Graduate School of Management, Sabanci University, Istanbul. When this editor was asked to join the Ph.D. committee, Mr. Gattoufi was extending the DEA methodology to allow for data imprecision. He was also interested in testing the extended methodology on published banking systems' data for the 27 countries comprising the Organization for Economic Cooperation and Development (OECD). While he did complete all the above, he was persuaded to do some additional work towards his dissertation [19], while investigating this editor's ongoing interest in research (meta-research (MR) on OR/MS and its various sub-disciplines). This *Special Issue* is a major outcome of the findings of that “extra work”.

In any evolving field of knowledge, it is important to systematically review the totality of published research on some periodic basis. The history and philosophy of science literature is replete with admonitions to that effect. More specifically, MR (in OR/MS) articles are appearing with ever-greater frequency in all flagship OR/MS journals on both sides of the Atlantic.⁴ MR is

³ Italicized descriptors refer to research strategies described in [11,12] and applied in [9,13–17].

⁴ Operations Research, JORS, EJOR, IEEE Transactions on Engineering Management, Omega, Interfaces, etc.

the means to many ends. In particular, it serves many needs for the research education and professional practice communities.

The current *Special Issue* provides a panoramic view of DEA over its lifetime and across the large number (490, at last count) of refereed journals that have published articles with DEA content worldwide.

One of the papers in this *Issue* epistemologically reviews DEA over its lifespan [20]. Using hard data, it documents DEA's vitality, robustness, acceptance and diffusion. DEA's vitality is confirmed by the very high "compounding rate" representing the accumulation of its literature. This rate is shown to be much higher than that of other emerging OR/MS sub-disciplines over their respective lifetimes. DEA's diffusion to, and acceptance by, other disciplines and professions is indicated by the ever-increasing number of journals that, in turn, represent an ever-increasing diversity of mission and readership. As indicated, the paper goes on to compare the epistemology of DEA with that of other sub-disciplines of OR/MS. All this suggests that bridging DEA with other, well-established OR/MS sub-disciplines can provide hope for the latter to become the tools needed for the practice of OR/MS.

At times, MR is dedicated to consolidation of the knowledge domain. There are at least two efficient and effective ways of consolidating knowledge. One of these is to create a taxonomy and the other is to create a generalized framework (a general model or theory) that subsumes all existing models, facts, or theories within that field. The above are not mutually exclusive; in fact, they are complimentary. A taxonomy displays the subject's domain in terms that are easy to understand, communicate, teach, learn, and work with. It enables efficient and effective classification of any and all contributions/publications. In turn, this enables efficient and effective storage, recall, sorting, and/or statistical analyses. Because such classification results are meaningfully machine readable, they clearly enable further MR [12], which includes, but is not limited to, identification of voids in the literature and, therefore, directions/specifications for research to be performed [12,21]. The second of the three *Special Issue* papers thus provides a fairly detailed taxonomy for classifying works with DEA content, and delineates the many uses for such a classification scheme, including a bibliometric analysis of DEA as a field [22].

A third *Special Issue* paper provides the bibliography of all DEA-content articles that have appeared in refereed journals (over 1800 such entries) as of August 2001 [23]. This was deemed necessary as the last such effort of record was highly obsolete [24]. It preceded accumulation of the bulk of the literature ca. 2001. However, such an update was needed to do the rest of the planned MR work.

Another paper [25], not included in this *Special Issue*, provides findings of content analysis performed on the DEA literature contained in the above-mentioned bibliography. The content was judged on the basis of a two-point scale representing advancements in theory, a five-point scale indicating contributions to practice, and on seven distinguishable strategies applied by the authors in pursuing their research. As indicated, all these scales have been previously applied to several OR/MS sub-disciplines and to OR/MS as a whole. Without a doubt, the DEA literature has significantly more real-world grounding than do the corresponding literatures of other OR/MS sub-disciplines. Not surprisingly, this is, indeed, a significant finding.

Just as this issue was about to be editorially completed, Barnett Parker, the Editor-in-Chief, shared a paper with me authored by Gabriel Tavares [4] that was conditionally accepted for publication in *SEPS*. Barnett asked me to address the similarities, differences, complementarities,

and/or conflicts between that paper and the material contained in this *Special Issue*. Upon close review, I can categorically rule out any conflicts. The database on the website <http://rutcor.rutgers.edu/~gtavares/> created and maintained by Dr. Tavares was indeed one of several sources used to develop the bibliography paper in this issue [23]. The Tavares bibliography, however, only covers the period 1978–2001, whereas ours begins in 1951 and goes through August 2001. Because of the shorter coverage, the Tavares paper shows only 1278 articles published in refereed journals, or roughly 71% of those reported in our bibliography.⁵

Tavares' summary statistics are most interesting. The top authors' rankings overall are not surprising, even with the understanding that the analysis is based on 71% of the refereed journal articles comprising our basis. We did not, however, perform a by-period rankings. The statistics dealing with authors' locations, e.g. 42 countries, 214 cities, and affiliations, e.g. 306 institutions (241 being related to a university), are interesting and do not appear in any of our papers.

The Tavares section that lists all key words used with cross-indexing, each to the respective papers, is an important and useful innovation which we did not think of doing. Although Tavares did not indicate the number of refereed journals having DEA content included in his database, our work specifies the number as being 490.

Once again, most interestingly, the peak productivity year was shown to be 1999—the same as ours—for the 3235 publications (note: 3235/1278 or 2.53 times the number of refereed journal articles in the Tavares data set).

The top book year was 1992. The top book chapter year was 1993. The top Ph.D. granting year was 2000. The top event year was 1999. Finally, Table 1 of [4], shows the top journal year was 1997, vs. 1999 as found in our analysis.

In summary, there is indeed some overlap between the bibliographies in the forthcoming Tavares paper and those found in this *Special Issue*. However, as indicated earlier, in addition to papers published in refereed journals, the Tavares bibliography includes books, chapters in books, dissertations, presentations and working papers, albeit over a shorter time span.⁶ Some of his statistical analyses are unique. Importantly, those that are similar to ours support and complement our findings.

Lastly, because of the need to have the three papers in this *Special Issue* stand as an integrated whole, there is some redundancy amongst the articles. This redundancy, however, is largely restricted to the introductory paragraphs. The Guest Editor of this *Issue* (who serves as a

⁵In responding to a request for comments to a draft of this preface prior to its being finalized, Dr. Tavares offered the following observation. “The number of refereed journals in my database is 241, about 49% of your total. This means that my list of journals (which is half of yours) covers 71% of the total number of DEA publications in your bibliography.

While developing my bibliography, my main goal was to have a “large” number of DEA references covering the broadest number of scientific fields, ideas, applications and other material related to DEA. I believe that other source materials such as: conference proceedings; research papers; dissertations and books, cannot be overlooked as they are also part of the current state of the art of DEA”. It is interesting to note that there is some discrepancy between the above statistics and our findings. As shown in Fig. 2 of Gattoufi et al. [20], we found roughly 85 % of the DEA literature in 49% of the journals. This discrepancy can be explained by the fact that our 49% represents journals arrayed in descending order of DEA articles published, and/or on the basis of the differences in periods covered.

⁶Tavares presumably covers the entire 2001 whereas our coverage was terminated in August of that year.

coauthor of each article) took great pains to minimize repetitive statements. For those that remain, he asks the reader's forgiveness.

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