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DEA-type models for designing optimal systems and determining optimal budgets

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ABSTRACT

This study intends to develop easy-to-implement and effective approaches to help decision makers cope with the challenges of designing their optimal systems, and determine the corresponding optimal budgets. The approaches are realized by constructing optimal system design (OSD) data envelopment analysis (DEA) models that build on the concepts and techniques of DEA, de novo programming and parametric linear programming with a parametric right-hand side. The proposed models explicitly take the important issue of congestion in system design into account. Therefore, the OSD DEA models can help decision makers not only optimally design their systems, but also determine their optimal budgets. Numerical examples are used to evaluate the strengths of the proposed models.

1. Introduction

In practice, decision makers in various industries quite often face the challenge of designing an optimal system given only a known available budget. However, to our knowledge, there do not exist both effective and easy-to-implement approaches to help the decision makers cope with the task. Therefore, one main goal of this study is to develop such approaches; the proposed method is a data envelopment analysis (DEA)-type approach. It is well known that conventional DEA models originating from linear programs are used to evaluate DMUs' performances given their known amounts of inputs and outputs. That is, the DEA models (and thus the LP models) consider given pre-configured systems (DMUs) (i.e., the resource allocation is given a priori and fixed); we refer the reader to Zeleny [1] for the detailed description of the distinction between designing an optimal system and optimizing a pre-configured system. This research, however, shows that we can actually modify and extend conventional DEA models to construct a both effective and easy-to-implement approach for dealing with the task of optimally designing DMUs' systems by simply relaxing the assumption of fixed and given a priori resource allocation and adding the budget constraint. The new models are referred to as optimal system design (OSD) DEA models for the following two reasons: (1) the models use the inputs and outputs of all reference DMUs as benchmarks of the target DMU by way of constructing a corresponding production possibility set, and thus the models are intrinsically models of DEA types; and (2) the function of the models is not to "evaluate" DMUs, but rather to "optimally design" DMUs. It is noted that the resource allocation models in the literature (e.g., [2,3]) actually deal with given pre-configured DMUs.

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