Preface

Data envelopment analysis (DEA) is a linear programming based approach for measuring relative efficiencies or performances of peer decision making units (DMUs). The performance or efficiency of a DMU is expressed in terms of a set of measures which are classified or coined as DEA inputs and outputs. In conventional DEA, each DMU is treated as a black-box and its internal structures and operations are ignored.

With the publication of the 2nd edition of *Handbook on Data Envelopment Analysis* (eds, Cooper et al. 2011), DEA models for treating DMUs that have internal or network structures have been identified as being on the research frontier (see, for example, Cook and Seiford 2009, and Liu et al. 2013). In fact, there already exists a significant amount of research on both the theory and applications of the network DEA approach. A significant number of researchers and scholars have started to look into the internal structures of DMUs.

Färe and Grosskopf (1996) are the first to propose DEA models when inputs and outputs of DMUs form a network structure. Castelli et al. (2004) study several types of DMU internal structures and develop DEA-type models to measure the overall and component efficiencies. In a different line of research, Kao and Hwang (2008) and Liang et al. (2008) model a specific type of internal structure where DMUs are composed of a two-stage process, namely the output measures from the first stage become input measures to the second stage. Tone and Tsutsui (2009) develop slacks-based network DEA model. There are other variations or extensions to the above earlier work on network DEA models, depending on the particular DMU network structures. Some are based upon the DEA envelopment form and some on the DEA multiplier form.

The current handbook serves as a complement to the *Handbook on Data Envelopment Analysis* (eds, Cooper et al. 2011) in an effort to extend the frontier of DEA research. It provides a comprehensive source for the state-of-the art DEA modeling on internal structures and network DEA.

Chapter 1 by Cook and Zhu provides a survey on two-stage network performance decomposition and modeling techniques. Chapter 2 by Chen et al. discusses the pitfalls in network DEA modeling. The authors point out that caution should be paid when models are developed based upon the envelopment or multiplier forms, because the usual duality (or equivalence) between the DEA envelopment and multiplier linear models is no longer true. Chapter 3 by Kao discusses efficiency decompositions in network DEA under three types of structures, namely series, parallel, and dynamic.

Chapter 4 by Chen, Cook and Zhu studies the determination of the network DEA frontier. In Chap. 5 the same authors then discuss additive efficiency decomposition in network DEA. Kao and Hwang present an approach in scale efficiency measurement in two-stage networks in Chap. 6. Sahoo, Zhu and Tone further discuss the scale efficiency decomposition in two stage networks in Chap. 7.

Chapter 8 by Du et al. offers a bargaining game approach to modeling two-stage networks. Chen et al. in Chap. 9 study shared resources and efficiency decomposition in two-stage networks. Chapter 10 by Chen introduces an approach to computing the technical efficiency scores for a dynamic production network and its sub-processes.

In Chap. 11 Tone and Tsutsui present a slacks-based network DEA. Chapter 12 by Li et al. discusses a DEA modeling technique for a two-stage network process where the inputs of the second stage include both the outputs from the first stage and additional inputs to the second stage.

Chapter 13 by Golany, Hackman and Passy presents an efficiency measurement methodology for multi-stage production systems. Färe' Grosskopf, and Whittaker in Chap. 14 discuss network DEA models, both static and dynamic. The discussion also explores various useful objective functions that can be applied to the models to find the optimal allocation of resources for processes within the black box that are normally invisible to DEA. Chapter 15 by Castelli and Pesenti provides a comprehensive review of various types of network DEA modeling techniques.

In Chap. 16, Cook et al. present shared resources models for deriving aggregate measures of bank-branch performance, with accompanying component measures that make up that aggregate value.

In Chap. 17, Cook et al. examine a set of manufacturing plants operating under a single umbrella, with the objective being to use the component or function measures to decide what might be considered as each plant's core business.

Chapter 18 by Cook et al. considers problem settings where there may be clusters or groups of DMUs that form a hierarchy. The specific case of a set of electric power plants is examined in this context.

Chapter 19 by Fukuyama and Weber models bad outputs in two-stage network DEA. Chapter 20 by Lewis presents an application of network DEA to performance measurement of Major League Baseball (MLB) teams. Lu et al. in Chap. 21 present an application of a two-stage network DEA model for examining the performance of 30 U.S. airline companies. Chapter 22 by Triantis presents two distinct network efficiency models that are applied to engineering systems.

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