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Developing a nondiscretionary model of slacks-based measure in data envelopment analysis

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Abstract

Discretionary models of data envelopment analysis (DEA) assume that all inputs and outputs are discretionary, i.e., controlled by the management of each decision making unit (DMU) and varied at its discretion. In any realistic situation, however, there may exist exogenously fixed or nondiscretionary inputs or outputs that are beyond the control of a DMU's management. The objective of this paper is to present a methodology for treating nondiscretionary in slacks-based measure (SBM) formulation. A numerical example is presented. At last, concluding remarks have been mentioned.

Keywords: Data envelopment analysis; Slacks-based measure; Nondiscretionary

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1. Introduction

Discretionary models of data envelopment analysis (DEA) assume that all inputs and outputs are discretionary, i.e., controlled by the management of each decision making unit (DMU) and varied at its discretion. Thus, failure of a DMU to produce maximal output levels with minimal input consumption results in a decreased efficiency score. In any realistic situation, however, there may exist exogenously fixed or nondiscretionary inputs or outputs that are beyond the control of a DMU's management. [1] Instances from the DEA literature include snowfall or weather in evaluating the efficiency of maintenance units, soil characteristics and topography in different farms, number of competitors in the branches of a restaurant chain, age of facilities in different universities, and number of transactions (for a purely gratis service) in library performance. For example, Banker and Morey [2] illustrate the impact of exogeneously determined inputs that are not controllable in an analysis of a network of fast food restaurants. In their study, each of the 60 restaurants in the fast food chain consumes six inputs to produce three outputs. The three outputs (all controllable) correspond to breakfast, lunch, and dinner sales. Only two of the six inputs, expenditures for supplies and expenditures for labor, are discretionary. The other four inputs (age of store, advertising level, urban/rural location, and presence/absence of drive-in capability) are beyond the control of the individual restaurant manager. Their analysis clearly demonstrates the value of accounting for the nondiscretionary character of these inputs explicitly in the DEA models they employ; the result is identification of a considerably enhanced opportunity for targeted savings in the controllable inputs and targeted increases in the outputs.

Here, a literature review is presented briefly. The initial formulation is in terms of additive model. Suppose that the input and output variables may each be partitioned into subsets of discretionary (D) and nondiscretionary (N) variables. Thus,

$$I = \{1, 2, \ldots, m\} = I_{\mathrm{D}} \cup I_{\mathrm{N}}, \quad I_{\mathrm{D}} \cap I_{\mathrm{N}} = \Phi$$

and

$$O = \{1, 2, \ldots, s\} = O_{\mathrm{D}} \cup O_{\mathrm{N}}, \quad O_{\mathrm{D}} \cap O_{\mathrm{N}} = \Phi$$

The basic model formulation for the additive model (with nondiscretionary variables) is given by

[1] Ray [8] argues that technical inefficiency is simply the result of a failure to incorporate all relevant nondiscretionary variables.