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An overall profit Malmquist productivity index with fuzzy and interval data

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ABSTRACT

Although crisp data are fundamentally indispensable for determining the profit Malmquist productivity index (MPI), the observed values in real-world problems are often imprecise or vague. These imprecise or vague data can be suitably characterized with fuzzy and interval methods. In this paper, we reformulate the conventional profit MPI problem as an imprecise data envelopment analysis (DEA) problem, and propose two novel methods for measuring the overall profit MPI when the inputs, outputs, and price vectors are fuzzy or vary in intervals. We develop a fuzzy version of the conventional MPI model by using a ranking method, and solve the model with a commercial off-the-shelf DEA software package. In addition, we define an interval for the overall profit MPI of each decision-making unit (DMU) and divide the DMUs into six groups according to the intervals obtained for their overall profit efficiency and MPIs. We also present two numerical examples to demonstrate the applicability of the two proposed models and exhibit the efficacy of the procedures and algorithms.

1. Introduction

Efficiency and productivity measurement in organizations has enjoyed a great deal of interest among researchers studying performance analysis. Data envelopment analysis (DEA) is a popular method for comparing the inputs and outputs of a set of homogenous decision-making units (DMUs) by evaluating their relative efficiency. Charnes et al. [1] originally proposed the first DEA model, known as the CCR model (see also [2]). DEA is non-parametric, and it utilizes linear programming (LP) to measure the relative efficiency of the DMUs without a priori specification of input and output weights (or multipliers). A score of 1 is assigned to the frontier (efficient) units. The frontier units in DEA are those with maximum output levels for given input levels or with minimum input levels for given output levels. While DEA does not provide

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