A Forgotten Point in Technology Selection

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Abstract

The assumption of classical technology selection models is based on complete homogeneity of technologies. In spite of this assumption in many applications some technologies do not comprehensively consume common inputs to comprehensively supply common outputs. The objective of this paper is to propose a Data Envelopment Analysis (DEA) model for selecting slightly non-homogeneous technologies. A numerical example demonstrates the application of the proposed method.

Keywords: Technology selection, Slightly non-homogeneous technologies, Data envelopment analysis, Interval data, Missing values

1. Introduction

The assumption of classical technology selection models is based on the principle that technologies consume common inputs to produce common outputs. In spite of this assumption in many applications some technologies do not comprehensively consume common inputs to comprehensively produce common outputs. For instance, to select a power plant there are different technologies. Most of inputs and outputs of power plants are common, but there are a few input(s) and/or output(s) for some power plants that may not be common to all. A power plant may consume natural gas, coal, oil, nuclear fuel, falling water, geothermal steam, wind power, solar energy, and biomass. A power plant uses natural gas whereas an input of such kind for the power plant that uses nuclear fuel may be meaningless. It is clear that zero value allocation for this type of input, causes relative efficiency of the power plant that uses nuclear fuel, to increase unrealistically. In other words, to evaluate the relative efficiency of power plants, all the power plants may not have identical functions. In this case, it is not acceptable saying that the power plants which use natural gas, are not comparable with the power plants which do not. Meanwhile, allocating zero value to power plants that do not use natural gas, is not fair. Generally, zero allocation to outputs and inputs of some technologies, makes the efficiency evaluation unfair. That is zero allocation to output, may make a technology inefficient, on the other hand, zero allocation to input, may make a technology efficient, unrealistically.

Some mathematical programming approaches have been used for technology selection in the past. Archer and Ghasemzadeh (1999) suggested an integrated framework to provide decision support for project portfolio selection. Ghasemzadeh and Archer (2000) discussed the implementation of an organized framework for project portfolio selection through a decision support system. Lee and Kim (2000) presented a methodology using Analytic Network Process (ANP) and Zero-One Goal Programming (ZOGP) for information system projects selection problems that have multiple criteria and interdependence property. Lee and Kim (2001) described an integrated approach of interdependent information system project selection using Delphi method, ANP, and Goal Programming (GP). Kim and Emery (2000) addressed the quantitative methodology for determining possible implementable solutions to project selection problems. Also, they presented an application of GP as an aid in project selection. Mohamed and McCowan (2001) addressed the issue of combining both monetary and non-monetary aspects of an investment option. They proposed a method capable of modeling and ranking various investment options, specifically developed for construction projects. The proposed method utilizes interval mathematics and possibility theory to handle the inherent uncertainty associated with investment parameters. Badri et al. (2001) attempted to present a comprehensive model that includes all the suggested factors that appeared in separate studies. Their model is based on GP. Malladi and Min (2005) showed how an Analytic Hierarchy Process (AHP) model could be utilized to select the optimal access technology for a rural community under a multiple number of criteria. Then, they formulated a mixed integer programming problem that would provide the optimal access technologies for a multiple number of homogeneous communities that were pooling resources such as budgets for fixed and variable costs. Finally, they showed how the problem could be extended to the case of heterogeneous communities