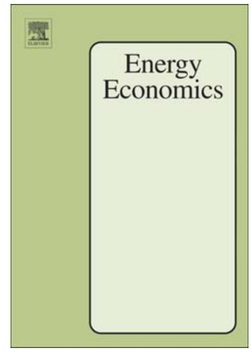

Spatial statistical methods applied to the 2015 Brazilian energy distribution benchmarking model: Accounting for unobserved determinants of inefficiencies

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Spatial statistical methods applied to the 2015 Brazilian energy distribution benchmarking model: accounting for unobserved determinants of inefficiencies

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Abstract

In 2015 the Brazilian regulator presented a DEA benchmarking model to set the regulatory operational cost goals, to be reached in four years for 61 electricity distribution utilities. The DEA model uses: adjusted operational cost as the input variable, seven output variables and weight restrictions. Although non-discretionary variables or environmental variables are available in the dataset, the regulator argued that no statistically significant correlation was found between the DEA efficiency scores and the non-discretionary variables. This study evaluates the statistical correlation between the DEA efficiency scores and the available environmental variables. Spatial statistic methods are used to show that the efficiency scores are geographically correlated. Furthermore, due to Brazil's environmental diversity and large territory it is unlikely that only one environmental component is sufficient to adjust inefficiencies across the Brazilian territory. Thus, a new combined environmental variable is proposed. Finally, a second stage model using the proposed environmental variable and accounting for a spatial latent structure is presented. Results show major differences between original and corrected efficiency scores, mainly for utilities located in harsh environments and which originally achieved lower efficiency scores.

Keywords: *Data Envelopment Analysis, second stage analysis, spatial statistics, Bayesian analysis*.

Introduction

The most commonly used benchmarking models in electricity distribution regulation are: Data Envelopment Analysis (DEA; Charnes et al., 1978), Stochastic Frontier Analysis (SFA; Aigner et al., 1977; Meeusen and van den Broeck, 1977), Corrected Ordinary Least Squares (COLS) (Richmond, 1974) and Stochastic Semi-nonparametric Envelopment of Data (StoNED; Kuosmanen, 2006; Kuosmanen and Kortelainen, 2012). Briefly, DEA is a non-parametric linear programming model proposed by Charnes, Cooper and Rhodes (1978) which creates the efficiency frontier using a convex linear combination of inputs and outputs of decision making units (DMUs). SFA requires a parametric equation of the efficiency frontier and assumes a compound error, which represents deviations from the frontier. The compound error is the sum of stochastic inefficiencies and stochastic noise. StoNED is similar to SFA and DEA, with a compound stochastic error and with a non-parametric, piece-wise linear frontier. Lopes and Mesquita (2015) have shown that these models are very popular among the European electricity distribution regulators.