# Chapter 15
# Stochastic Data Envelopment Analysis in Measuring the Efficiency of Electricity Distribution Companies

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## ABSTRACT

*Performance benchmarking of electricity distribution markets is essential for improving industry performance parameters. In a benchmarking study, the most important problem is that regulators often do not have accurate, specific, and sufficient information to determine current input use to achieve expected amount of output. The study combines statistical symmetric error structure with stochastic chance constrained DEA models and compares deterministic data envelopment analysis (DEA) models with stochastic chance-constrained DEA models within random input and output variables. The proposed models were applied on Turkey's electricity distribution units for assessment of energy efficiency. Study revealed that the results obtained with random data softened efficiency frontier. This study contains symmetric error structure and random inputs and outputs for performance benchmarking of electricity distribution markets by stochastic data envelopment analysis within a symmetric error structure in Turkey.*

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## INTRODUCTION

Benchmarking the efficiency of electricity distributions is an important case within the energy field and DEA is a widely used optimization method for measuring the relative efficiency of decision-making units (DMUs) (Azadeh et al., 2015).

Since energy is one of the basic concerns of the industrial revolution, improving the efficiency of electricity distribution units is an important issue. The electricity industry plays an important role in the development of countries. Therefore, assessment of the electricity distribution industry plays an important role in improving performance parameters. For these reasons, in the paper, a new approach was applied for assessment of Turkey's distribution units over the period 2011–2016 to evaluate the performance. In this regard, 21 of Turkey's electricity distribution units were considered as the decision-making units in the study. The main objective of the study was efficiency measuring of electricity distribution units with respect to five important indicators, including peak load, transformer capacity, operating cost based on productivity, number of customers and total electricity sales using classical DEA and stochastic chance-constrained data envelopment analysis (CCDEA) approach by using the symmetric error structure. The results were obtained from General Algebraic Modeling System (GAMS) mathematical programming and optimization system.

In this paper, due to the lack of information about some parameters, a stochastic DEA model was applied for evaluating the shaping factor for performance assessment of electricity distribution units. Through the study, the indicators peak load, transformer capacity, operating cost based on productivity, number of customers and total electricity sales were determined as random, and they were frequently applied for the assessment of electricity distribution units in the literature. These indicators were frequently applied for the assessment of electricity distribution (Jamasb et al., 2001).

The aim of the study is to show the deterministic and stochastic approaches on electricity distribution units where uncertainty has a technological structure, especially in the electricity markets. Decision-making problems in electricity markets are debated with uncertainty, which has affected prices, demand, production, equipment availability and similar things. Stochastic programming provides an adequate modelling framework in which problems of decision making under uncertainty are properly formulated (Birge et al., 1997).

This study extended output-oriented deterministic CCR and output-oriented stochastic CCR DEA models within the symmetric error structure to consider the stochastic variations in the input/output data.

To the best of our knowledge, this is the first study on the performance benchmarking of electricity distribution units by using symmetric error structure within output oriented stochastic data envelopment analysis in Turkey. With this

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