

# Weight restrictions in the DEA benchmarking model for Norwegian electricity distribution companies

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The electricity sector is a natural monopoly in most regions and the role of regulatory authorities is to supervise the distribution business and assure the reasonableness of the distribution pricing. However, it is also important to maintain the attractiveness of the industry to investors whilst securing efficiency improvements over time. The characteristics of appropriate regulatory models have been extensively studied and as a result these have moved away from traditional rate of return regulation to benchmarking models based on frontier techniques (Agrell et al, 2005; Jamasb and Pollitt, 2003).

The models used by the Norwegian regulator are considered to be among the most sophisticated approaches for regulation. Norwegian network companies are regulated by means of a yardstick model in which the cost norms are calculated based on relative efficiency scores found by Data Envelopment Analysis (DEA). There are separate DEA models for distribution and transmission, respectively. The model currently used for the distribution activity has one input (total cost) and several outputs representing direct measures of the production activity (transported energy and customers), as well as variables representing structural conditions and geographic variables (forest, snow and coast). In the unrestricted DEA model, large differences in shadow prices of outputs between companies have been noticed, and the geographic variables are often given extreme weights, especially for small companies. Moreover, it seems to be a tendency that companies with a large weight on geographic variables and/or a low weight on transported energy and customers are considered more efficient than other companies. This seems unreasonable, and so the objective of this paper is to restrict the weights (shadow prices) of the DEA model for individual outputs or combinations of outputs.

This paper discusses alternative approaches for the incorporation of weight restrictions (Allen et al, 1997) for geography variables in the DEA model: absolute, relative and virtual weight restrictions. Restrictions with respect to absolute shadow prices do not seem natural in the case of the geography variables, so we focus on the comparison of the effects of the virtual versus relative weight restrictions. It was noticed that the relative weight restrictions affected more companies, but the efficiency estimate changed by a lesser extent. An important task when introducing weight restrictions in the DEA analyses is to determine the specific limits on the weights. Finding reasonable limits depends on the type of weight restrictions under consideration, and should be based on knowledge of the industry cost and technology. An advantage of the virtual weight restrictions is that they are defined on a more aggregated level than the relative ones. It may be easier to establish limits on the overall effects on the total cost norm for a subset of outputs rather than reasonable pair-wise comparisons of outputs weights.

This paper presents the results of the application of the DEA models proposed, with virtual weight restrictions, to the Norwegian companies with data from 2006.

## References

- Agrell P., Bogetoft P., Tind, J. 2005. DEA and Dynamic Yardstick Competition in Scandinavian Electricity Distribution. *Journal of Productivity Analysis*. 23, 173-201.
- Jamasb, T., Pollitt, M. 2003. International Benchmarking and regulation: an application to European electricity distribution utilities. *Energy policy*, 31, 1609-1622.

Allen, R., Athanassopoulos, A.D., Dyson, R.G., Thanassoulis E. 1997. Weights restrictions and value judgements in data envelopment analysis: Evolution, development and future directions. *Annals of Operations Research*, 73, 13-34.

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