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Dynamic Efficiency Analysis of Polish Electricity Distribution Utilities – Is Transition Efficiency Enhancing?

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Overview

This paper provides a dynamic comparative efficiency analysis of all 33 Polish electricity distribution companies. As the European Union is extending eastwards, all East European countries having joined the EU recently now have to apply recent directives, in particular the Electricity Directive 2003/54 ("Acceleration Directive") as the key European legislation establishing the internal market of electricity. This involves an increased need to integrate the new member states' industry in European-wide competitiveness and performance measurement. Consequently there is an increasing need for efficiency analysis also in the new EU member states.

Our current paper can be seen as an extension and amplification of the work carried out by Apfelbeck, Cullmann and Hirschhausen (2005) who provide a cross country efficiency analysis of electricity distribution in Central Europe pointing out that Polish distribution companies, in comparison to their East European neighbors feature high scale inefficiencies. By means of a more detailed dynamic approach, including as a further extension also monetized cost data, we verify the obtained results to get more reliable conclusions. For our analysis we consider a panel of 33 distribution utilities operating over a seven-year period (1997-2003).

Methods

The technical efficiency analysis is mainly based on a model including technical data, especially number of customers, total power sales, grid length, and labor. Structural and geographical differences between the companies are captured by means of structural variables. We extend the approach of technical efficiency taking account of cost and factor price data in order to derive allocative efficiency and provide an overall economic efficiency measurement by means of specific cost efficiency models.

To reflect a significant and detailed image of the economic operations also for further regulatory purposes we discuss, apply and compare a wide variety of common benchmarking methodologies. Before using any frontier estimation we apply in a first step the method by Wilson (1993) as exploratory data analysis for detecting outliers in our production data. Our empirical approaches are differentiated between nonparametric and parametric as well as deterministic and stochastic approaches. Within the nonparametric approaches we apply the deterministic Data Envelopment Analysis (DEA), the deterministic Free Disposal Hull (FDH), developed by Deprins et al. (1984) as well as the stochastic order-m estimator proposed by Cazals et al. (2002). Sensitivity analysis for the nonparametric deterministic efficiency estimates is conducted by means of the bootstrap method described by Simar and Wilson (1998, 2000).

The parametric efficiency measurement using Stochastic Frontiers (SFA) presents an alternative approach to the estimation of frontier functions operating with econometric techniques, and assuming explicitly a functional form for the technical production process of the firms. We mainly refer to two model specifications proposed by Battese and Coelli (1992, 1995): The Error Component Model as well as the Technical Efficiency Effects Model. We specify a translog functional form for the production process as well as distance functions

which are frequently applied due to the advantage of allowing to deal with multiple-outputs multiple-inputs.

In addition, this paper discusses and applies alternative approaches and specifications explicitly for panel data models including technical and geographical as well as monetized cost data. Following e.g. Greene (2005) we apply econometric frontier models to distinguish unobserved firm-specific heterogeneity from inefficiency. Further we measure and decompose productivity change with Malmquist indices.

Results

First results indicate that there are significant differences between the companies in each period, both within the technical efficiency models as well as within the cost efficiency models. This difference can be due on the one hand to the different structure of the distribution area in which the companies are operating. The inclusion of the structural variable, the inverse density, account for the differences, compensating small utilities which are operating in less densely settled areas. First results also indicate that Polish companies feature scale inefficiencies due to increasing returns to scale. This seems to be constant over time, since excluding the last two years there were no significant changes with regard to the individual firm sizes. The Malmquist indices point out that the change of the technical efficiency as well as the technical change over the years is very small. Within the cost efficiency analysis, the results indicate that the Polish distribution companies feature a low cost efficiency level, approximately around 68% on average, but that the level increases slightly over the observation period. This can be seen in Figure 1, where the decomposition of the cost efficiency into allocative and technical efficiency is represented. The results indicate that the modest cost efficiency change is only due to an increase of the technical efficiency whereas the allocative efficiency decreases. The Bootstrap analysis suggests robust results within the nonparametric technical efficiency models. The results can be confirmed by the stochastic frontier analysis.

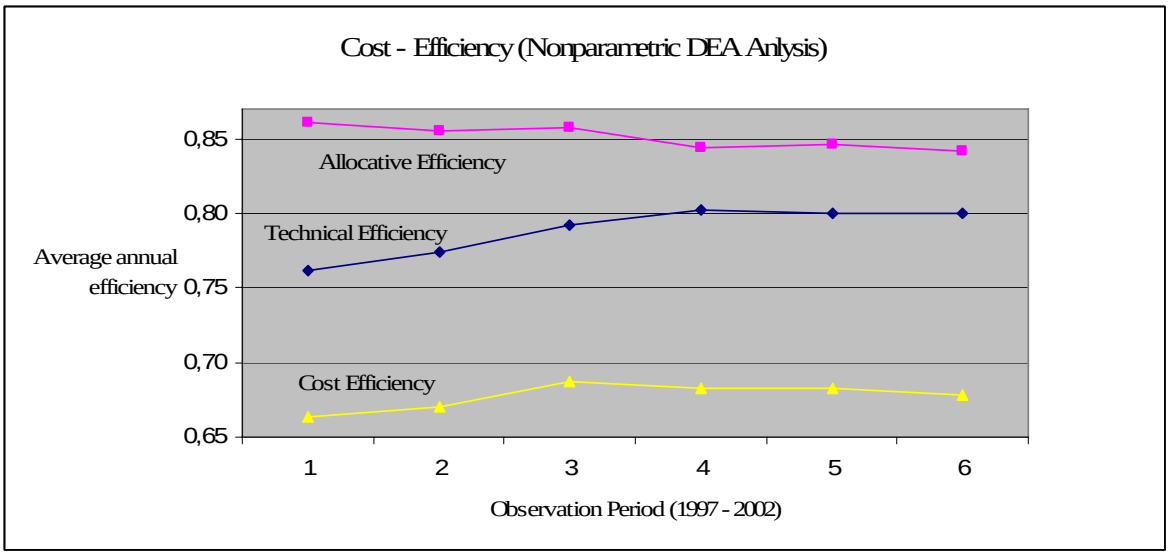

Figure 1: Cost – Efficiency (Nonparametric DEA Analysis)

Conclusions

The results show the relevance of appropriate and adequate structural and environmental variables in quantitative efficiency studies for the regulation process of electricity distribution utilities. The presence of increasing returns to scale indicates that the regulatory authority should consider inducing the merger process of small electricity distribution companies into larger units. The slight progress of technical efficiency and technical progress over time reveal the importance of further restructuring in the Polish electricity distribution.