Incentive Regulation, Efficiency Improvements and Productivity Growth in Electricity Distribution Utility: A Norwegian Case

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Overview

The electricity industry has undergone a restructuring process the last 25 years. Competition has been introduced among generators and often also among retailers. System operation, transmission and local distribution are viewed as natural monopolies and various regulatory models and schemes have been put in place. Regulation of natural monopoly in the Norwegian electricity distribution networks was introduced in 1991 when the sector was reformed. Imposing regulation is intended to ensure that distribution utilities are cost efficient so as to keep electricity prices low, ensure secure supply and good quality services to consumers. To mitigate the negative effects associated with rate-of-return regulation (Averch & Leland 1962) that was initially introduced, regulatory policies have been shifting towards incentive regulation using revenue caps or full yardstick competition (Shleifer 1985). The latest policy currently in force in Norway was introduced in 2007 and was revised in 2012. A change to incentive regulation is expected to enhance efficiency improvements and productivity growth. Studies by Miguéis et al. (2012), Edvardsen et al. (2006) and Førsum and Kittelsen (1998) have attempted to analyse the impact of regulatory policies on productivity using Data Enveloping Analysis (DEA) and nonparametric Malmquist index (MI). However, the use of parametric approaches on panel data to examine the change in productivity over time with change in regulation is less frequent. Therefore, this paper attempts to search for empirical evidence in support of the postulate that a change to incentive regulation is associated with improvements in efficiency and productivity. It investigates changes in efficiency, technical change and change in scale as sources of changes in productivity. Compared to previous studies, this study has two advantages: (1) it uses a more updated panel dataset (2004-2012) that spans two regulatory regimes allowing estimates to provide a comparison of performance before and after a change in regulation – this analysis has been lacking; and (2) it uses Stochastic Frontier Analysis (SFA), which enables to account and control for the effects of both observed and unobserved heterogeneity in the operating environment on variations in efficiency and productivity of firms.

This paper uses three output variables -amount of energy delivered, number of customers, lengths of voltage line operated, and three input variables -total operating costs, capital expenditure and system energy losses. Composite geographical variables, portion of underground cable and annual growth in the number of customers are included are included to account for variation efficiency and productivity due to differences in the operating environment.

This paper is organised as follows: After the introduction the second section gives a brief overview electricity distribution. The third section addresses the theoretical formulation of the input distance function, the parametric decomposition of MI and discusses the choice of empirical model and how it is estimated. Section four gives a discussion and justification of the input, output and environmental variables used in the study and gives their descriptive summary. The last section presents the results, their discussion and conclusions.

Methods

The paper seeks for empirical evidence in support of the change to incentive regulation. The study specifies a multi-input multi-output production technology using a parametric input distance stochastic frontier. Econometric maximum likelihood estimates of technology parameters and technical efficiency scores are made using the true fixed effects -panel data stochastic frontier techniques by Greene (2005a,b) Both observed and unobserved heterogeneity is considered and parameters for nondiscretionary variables are simultaneously estimated in one-step based on Wang and Schmidt (2002). Using estimated parameters and efficiency scores, the Malmquist productivity index is parametrically decomposed into efficiency change, technical change and changes in scale to explore changes in productivity growth and its sources (Caves et al. 1982b; Orea 2002; Saal et al. 2007). Finally, four mean comparison hypotheses on empirical estimates are developed and tested to establish the degree to which technical efficiency and productivity growth components differ before and during the current incentive regulation period.

Results

✓ Significant improvements in technical efficiency after the introduction of the current incentive regulatory regime (2007 – 2012). The latest incentive regulatory policy seems to be more effective in uplifting efficiency of lower performing firms.
Significant improvements in overall productivity growth despite no significant scale efficiency improvements. A test on returns to scale indicates that the sample average distribution operator in this industry operates no different from constant returns to scale.

Results indicate that industry has experienced significant technological change improvements with significant embodied technology effects that is both input and output augmenting.

From results of the four mean comparison hypotheses tested on empirical estimates, it is concluded that firms generally have higher efficiency and productivity after 2007. Hence incentive regulation seems to be associated with improvements in innovations and cost efficiency.

Conclusions
The Norwegian electricity distribution sector has had positive changes in efficiency and productivity growth for the period 2004-2012. Results point to a higher contribution of embodied technology to productivity relative to positive efficiency changes. This could possibly point to the fact that incentive regulation stimulates cost efficiency, innovations and adoption of input and output enhancing technology. Generally the industry seems to perform better under the new incentive regulation compared to preceding regulatory policies as expected.

References


