

# Impact of High-Powered Incentive Regulations on Improved Efficiency and Productivity Growth of Norwegian Electricity Utilities

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## Motivation and overview

This study examines the hypothesis that changes to high-powered incentive regulations has a positive efficiency and productivity growth effects in a regulated electricity distribution industry. The Norwegian electricity industry has undergone a successful reform and regulation process the last 25 years. A model wholesale market has been established among generators and competition among retailers. However, system operation, transmission, and local distribution are natural monopolies and various regulatory models have been implemented. After unbundling of the incumbent vertically integrated utilities, the management of distribution utilities was given to independent private operators. However, most of the utilities remained publicly owned, mainly by municipalities or local governments. The reform created the Norwegian Water Resources and Energy Directorate (NVE) with a mandate to create and oversee energy markets that are efficient and cost-effective. This mandate in part involves regulating electricity distributors and reviewing their regulatory policies every five years. NVE has since implemented five different regulatory regimes which in succession include cost-plus regulation, rate-of-return regulation, incentive regulation, and yardstick competition that came in force in 2007. The goal for this transitioning has been to use more high-powered incentives for reducing costs by improving cost efficiency and more effectively invest in and manage the local networks. This would consequently guarantee fair electricity prices, secure and reliable electricity supply, and good quality services to consumers. The objective of this study is to investigate whether this regulatory transition is indeed associated with improvements in efficiency and productivity growth. Thus, we hypothesize that the theoretical advantages of yardstick competition over other forms of regulation may empirically reflect into higher efficiency and productivity growth.

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## Methodology

We specify an input distance function with three outputs, two inputs, and five inefficiency determinants. The outputs include amount of energy delivered, number of customers, and lengths of voltage lines and inputs are total operating costs and value of capital inputs. The five variables we use to control for variation in efficiency and productivity growth due to observed heterogeneity in operating environment include portion of underground cables, and annual growth in customer numbers, distance to the main road, and two composite geography variables used by NVE.

We estimate technical efficiency using the true fixed effects SFA method and compute total factor productivity growth (TFPG) for 121 utilities using NVE's regulatory data covering the period 2004-2012. We investigate the sources of productivity growth by parametrically decomposing the Malmquist productivity index into technical efficiency change, technical change, and scale change. We compare estimates of efficiency and productivity growth across regulatory regimes –by testing three mean comparison hypothesis– to establish the existence of a structural break in empirical estimates as evidence of the effect of the 2007 regulatory regime change.

## Results

- We find significant efficiency improvements during the period of yardstick competition regulation and the policy seems to be more effective in uplifting technical efficiency in lower performing firms.
- Results indicate a positive productivity growth rate of 1.8 % p.a, which is mainly driven by positive efficiency change and technical change, which is growing at an annual rate of 1.0 % with significant input and output effects.
- The contribution of scale change to productivity is not significant and the sample average utility is estimated to operate not significantly different from constant returns-to-scale.
- Results for mean comparison hypotheses show a significant structural change in empirical estimates, which confirms higher efficiency and productivity for utilities after 2007. Hence, high-powered incentive regulation seems to be associated with improvements in innovations and cost efficiency.

## Conclusion

The Norwegian electricity distribution sector has had positive changes in efficiency and productivity growth for the period 2004-2012. This could possibly point to the fact that high-powered incentive regulations stimulates cost efficiency, innovations, learning, and adoption of output enhancing techniques. Generally the industry seems to perform better under yardstick competition as expected.