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FACTORS INFLUENCING QUALITY OF SERVICE AMONG ELECTRICAL DISTRIBUTION UTILITIES – AN ANALYSIS BASED ON PANEL DATA

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Overview

After the restructuring of the Norwegian electricity industry in early 1990s, distribution utilities have reduced both investments and maintenance activities in distribution networks. At the same time, the quality of service in terms of continuity of supply has increased. An interesting question is therefore if this development is because of previous over-investment due to cost-of-service regulation, or is the incentive for investment in the present revenue cap mechanism too low? In addition, will the quality of service remain at today's level with the present investment level? Continuity of supply is important for at least two reasons. Firstly, a reliable network structure is a necessary condition for achieving a competitive electricity market (Newbery 2002) and (Green 2005). Secondly, reliability is important due to society's high dependency of electricity, e.g. in hospitals, firms, as well as households.

In 1997, when incentive regulation was introduced in the form of revenue caps, the regulator did not apply any quality standards, but such standards were introduced from 2001. The quality dependent revenue caps (the CENS arrangement) increased or decreased the revenue caps if the realized level of electricity not supplied (ENS) was lower or higher than expected. (Langset, Trengereid et al. 2001). Variables that the utilities may influence in the short run, e.g. maintenance, and in the long run, e.g. investments, are not included in this model.

Continuity of supply depends upon several factors like climate, topography, network characteristics, and economical decisions by the company, e.g. when to invest, level of maintenance and investment activities, level of quality and capacity in investment decisions. In addition, utility specific characteristics like quality of management and employees, size of the company, organization etc. may influence continuity of supply as well.

In this paper, we will present and discuss factors that influence quality of service among distribution utilities, and test the model empirically with a panel data set.

Methods

The empirical analysis is based on a secondary data set received from the regulatory agency. The data set contains economical and technical figures for 128 distribution utilities in the period 2001 to 2004. Cross-sectional regression for each year, as well as a pooled OLS for all years has been performed. Due to limitations in the data set, panel data regression models are not used. In the model, the dependent variable ENS is as described above. A high value of ENS indicates lower quality of service than a low value of ENS, all other variables equal. The independent variables are a measure of capital intensity (booked value of distribution assets divided by electricity supplied each year), operational intensity (wages divided by length of air wires), dummy variables for climate/region, utility size, and eventual mergers. These variables hexplain more than half of the variation in ENS (R-square statistic), and all the models show overall significance at the 0,001 level (F-statistic).

Results

The results from the pooled OLS show that for the capital intensity variable, with a one per cent increase in this variable, the quantity of ENS will be reduced with 0,59 per cent. For the variable operational intensity, "proactive" maintenance dominates "reactive" repair because a one percent increase in the operational intensity variable reduces the quantity of ENS with 0,28 per cent. The effect of proactive maintenance may be reduced by reactive repair, which “pulls” the coefficient in the opposite direction. A utility that reduces the level of proactive maintenance will in most cases realize a higher level of electricity not supplied, which in turn forces the utility to spend more man-hours on repair. In the data set, it is not possible to make a distinction between the ratios of resources spent on maintenance to the resources spent on repair, but the negative sign of the coefficient for the operational intensity variable indicates that the utilities seem to prioritize proactive maintenance. The implication of this result is that if the utilities succeed to increase the values of the capital intensity and operational intensity variables, their quality of service in terms of continuity of supply will increase as well (ENS will decrease). To increase the capital intensity variable with no changes in the network structure or demand, the utility has to reinvest (upgrade existing components). If only the demand for electricity among existing customers increases, the utility has to invest in extra capacity if for instance the load factor in the network is getting close to the capacity limits in peak hours. If demand increases due to new customers (increased in demand as well as increase in network structure), the capital intensity variable is most likely to increase as the booked value of the new distribution assets is high. In order to increase the operational intensity variable, the utility has to put more effort into maintenance, and/or reduce the length of air wires. Therefore, an increase in these two variables reduces the quantity of ENS, i.e. the quality of supply increases.

Utilities located in the more extreme climatic regions realize higher levels of ENS than the other utilities. We also see that larger utilities seem to realize more ENS than smaller utilities. Finally, utilities that have merged also realize more ENS than the “unchanged” utilities. The implications of these findings will be presented in the next section.

So far, we have commented the results from the pooled OLS. The results from the cross-sectional analyses show some variation from year to year, but a lot of factors seem to be almost unchanged over the time span. However, some variation is natural since a lot of factors influence continuity of supply, and their impact may vary from year to year. For example, very extreme weather does not occur every year. The price of electricity varies as well, and to a certain degree, high prices reduce demand, and this again reduces ENS during an interruption in supply. Another factor that may influence the coefficients is the quality of the reports from the utilities, if this quality varies; it explains some of the variation. Due to the problem of information asymmetry, it is hard to measure the quality of the reports. In order to come across this problem, the pooled model used on a time-series with cross-sectional data may balance this effect over time.

Conclusions

In the overview, we described the paradox that the investments and maintenance in distribution networks have been reduced, and at the same time, the quality of service in terms of continuity of supply has increased. In this analysis we have shown that investments (which influence capital intensity) and maintenance are important factors that explain differences in quality of service. With a more detailed specification of wage costs, an opportunity for the regulator is to consider including these variables in the quality dependent revenue cap mechanism. This is especially important if utilities that focus on continuity of supply get “punished” and considered inefficient in the revenue cap calculation, i.e. the value of the lower than expected level of ENS that is added to the revenue cap has to be equal to or greater than the “inefficiency” reduction in the revenue cap the utility may get when it becomes compared with other utilities that do not focus on continuity of supply. According to Vickerman (2004), an important lesson in studies of maintenance incentives in transportation infrastructure is the need to improve the quality indicators for infrastructure condition. It is not the volume of investment or maintenance that is important, but it is the quality of maintenance and investment that is important. In our view, this supports the view to link maintenance and investment to the quality indicator ENS.

Another important policy implication is the effect of the binary variables climate, utility size, and mergers. Climate is already a factor the CENS arrangement, and this analysis asserts that it is a highly relevant factor. However, for the other to variables there seems to be a conflict between quality of service and cost efficiency. In several contexts, the regulator expresses the view that in order to utilize economics of scale, distribution utilities have to merge in order to exploit these effects. This analysis shows that one effect of such a policy is likely to be lower quality of service. Therefore, the gains from more efficient utilities have to be compared by the loss in quality of service. However, this is a problem that needs further research.

To determine the optimal level of investment and maintenance in distribution networks is a nearly impossible task due to difficulties in measurement and valuation. In addition, dynamics over time will provide additional uncertainty. For the regulator, this implies that all the possible effects of the regulatory mechanisms have to be considered carefully. In the short history of incentive regulation, the use of the revenue cap mechanism seems to have set off a more efficient operation of distribution networks (Kinnunen 2003), and the CENS arrangement has increased the quality of service. But will this be the case in the future? Socially efficient regulation of investment level is more difficult, as this among other things depends on the utilities profit motive in the long run. In the light of this development, it is necessary with more research on incentives for investment and maintenance in the long run, better measures of service quality, and more accurate data.