

Determinants of Investment under Incentive Regulation: The Case of the Norwegian Electricity Distribution Networks

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Electricity networks are capital intensive and exhibit natural monopoly characteristics and are, therefore, subject to economic regulation. In recent years, the need for network expansion, integration of renewable energy resources, enabling demand side participation, and adoption of new technologies such as deployment of smart meters and smart grids has necessitated significant amount of investments in the grid. This has placed the issue of network investment at the core of recent energy policies and regulations in the power sector. The objective is to ensure sufficient investment in maintaining and modernising the grid and at the same time avoiding inefficiency in capital expenditures in order to protect end-users against high electricity prices. As a consequence, identifying the main drivers of investments can help regulators to understand the responsiveness of firms to regulatory incentives and hence, more effectively tackle the issue of investments under incentive regulation.

This study investigates the determinants of investments in the Norwegian electricity distribution companies using a Bayesian Model Averaging (BMA) approach as a coherent method of inference on regression coefficient that takes into account the uncertainties around model selection and estimation. This is particularly relevant in the context of investment in regulated industries where the companies are subject to different incentive mechanisms and hence; there is uncertainty in model selection. The estimations are based on three priors in order to avoid bias in the findings as a result of selecting a particular prior.

The results indicate that, of the 13 potential factors explored, four factors constitute the main determinants of investments in electricity distribution networks. The cost of energy not supplied is the strongest factor and repeatedly shows a high posterior

inclusion probability regardless of the choice of prior. The number of leisure homes, number of customers, and cost of network energy loss in the previous period are the other main drivers of investments. We find little evidence that the length of overhead lines drive investments though we expect network reinforcements to improve protection against severe weather conditions. One explanation can be that the environmental effects have been considered in network design to reduce the subsequent need for protective investment. Moreover, we find no investment effect from distributed generation sources connected to low voltage distribution grid. This result is likely due to the fact that Norwegian distribution grids are already well adapted to and have accommodated large numbers of small and dispersed hydroelectric resources.

The investment responsiveness of firms to the four group of factors studied in this paper provides a picture of investment behaviour of distribution companies under Norwegian regulatory framework. Two factors from the four investment drivers identified are related to the demand for electricity. The firms' investment response to demand shows the important role which direct regulation plays in ensuring sufficiency of investment.

The results indicate that the Norwegian distribution companies have generally responded to the investment incentives provided by regulatory framework. However, some of the incentives do not appear to have been effective. The quality of supply incentive embedded in the benchmarking model has motivated the firms to undertake investment to reduce service interruptions. However, the results show that these investments are more of a "corrective" nature and not of a "preventive" nature. Moreover, the relative weaker response of investment to network energy losses incentive shows that the strength and type of incentives are important in motivating the firm to reduce certain operational deficiencies. The results of this study suggests the network companies respond better to the combinatory incentives in terms of direct regulation and economic incentives compared with singular forms.