Energy Policy 102 (2017) 96–107

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

# Specification of merger gains in the Norwegian electricity distribution industry

Antti Saastamoinen[a,*], Endre Bjørndal[b], Mette Bjørndal[b]

[a] VATT Institute for Economic Research, Finland
[b] NHH Norwegian School of Economics, Norway

ARTICLE INFO

*Jel codes:*
L94
L25
L43
C6

*Keywords:*
Mergers
Efficiency estimation
Electricity distribution
Regulation

ABSTRACT

Electricity distribution often exhibits economies of scale. In Norway, a number of smaller distribution system operators exist and thus there is potential to restructure the industry, possibly through mergers. However, the revenue cap regulatory model in Norway does not incentivize firms to merge as merging leads to a stricter revenue cap for the merged company. Thus the regulator compensates the firms in order to create such incentives. The amount of compensation is based on the potential gains of the merger estimated using a data envelopment analysis (DEA) based frontier approach introduced by Bogetoft and Wang (2005). DEA is however only one of many possible frontier estimators that can be used in estimation. Furthermore, the returns to scale assumption, the operating environment of firms and the presence of stochastic noise and outlier observations are all known to affect to the estimation of production technology. In this paper we explore how varying assumptions under two alternative frontier estimators shape the distribution of merger gains within the Norwegian distribution industry. Our results reveal that the restructuring policies of the industry may be significantly altered depending how potential gains from the mergers are estimated.

## 1. Introduction

The wave of electricity distribution market liberalization in the 1990s induced competitive market type conditions upon a highly non-competitive industry. As distribution system operators (DSOs) often have significant scale economies present, indicating a natural monopoly, the liberalization was accompanied by incentive-based regulation to incentivize DSOs towards better operating efficiency (see e.g. Jamasb and Pollitt, 2001, 2007).[1] Indeed research has identified that scale economies prevail at least at the lower output levels of electricity distribution (Kwoka, 2005; Kumbhakar et al., 2015). For example in Norway, such findings were reported by the Reiten-committee in a report prepared for the Norwegian ministry of petroleum and energy (OED). The report characterized smaller utilities as being over-represented among the inefficient DSOs and suggested increasing the co-operation and coordination among DSOs (OED, 2014; see also Growitsch et al., 2009). Thus there have been pressures to restructure the Norwegian electricity distribution industry through mergers in order to exhaust the potential scale and scope economies (see footnote 1).

While the market structure in Norway has probably promoted mergers in electricity distribution, the regulation of the industry has created opposing incentives. Usually the regulation in natural monopoly industries is based on the revenue-cap (or price-cap) model which limits the revenues of the firms. Compared to the traditional rate of return or cost of service type regulation, a revenue-cap model introduces stronger incentives towards efficiency improvements (see e.g. Agrell et al., 2005; Jamasb and Pollitt, 2007). Nevertheless, even under revenue-cap regulation regulators have imperfect information about the firms' cost reduction potential (see e.g. Joskow, 2008). Thus in the spirit of the Shleifer's idea of yardstick regulation, regulators often apply benchmarking to properly set the caps (Shleifer, 1985). Frontier based methods such as *data envelopment analysis* DEA or *stochastic frontier analysis* SFA have been popular among regulators as a tool to estimate appropriate cost norms (see e.g. Bogetoft and Otto, 2011; Jamasb and Pollitt, 2001). These methods estimate an efficient cost frontier against which DSOs are compared to assess their cost efficiency. Also Norwegian regulator (NVE) uses DEA to calculate the

* Corresponding author.
*E-mail address:* antti.saastamoinen@vatt.fi (A. Saastamoinen).

[1] The existence of scale economies has been seen as a prerequisite for a natural monopoly to exist (Filippini, 1998). Baumol (1977) shows that in a multiproduct context the relevant condition for natural monopoly is *cost subadditivity* for which scale economies is a sufficient condition in the one product case. As electricity distribution is generally modelled as a multi-product industry with outputs such as distributed electricity, number of customers and network length, the incentive to merge is often dictated in terms of *economies of scope*, which implies cost subadditivity in the multiproduct case (see e.g. Bogetoft and Wang, 2005).

http://dx.doi.org/10.1016/j.enpol.2016.12.014
Received 6 April 2016; Received in revised form 11 November 2016; Accepted 6 December 2016
0301-4215/ 

cost efficiency of DSOs (see e.g. Bjørndal et al., 2010).[2] However, the application of DEA has had some unintended consequences for the incentives to merge. In the current benchmarking model the newly merged firms face stricter cost norms than the individual companies that form the mergers, creating a strong disincentive to merge. NVE has worked around this evident disparity between the restructuring needs and regulatory disincentives by applying a compensation scheme to guarantee that mergers with savings potential will take place. Obviously, to determine the appropriate level of the compensation, the regulator has to know the magnitude of the potential merger gains.

One popular framework to examine the merger gains is an approach based on standard DEA, introduced by Bogetoft and Wang (2005; abbreviated as BW hereafter). However, DEA imposes strong assumptions about the nature of the production technology. In this study, using the data on Norwegian DSOs, we examine how some of these assumptions about the production technology affect to the presence of merger gains. The Norwegian case provides an excellent illustration since the effects of mergers are explicitly accounted for in the regulatory model. Following the BW framework we compare two frontier estimation methods to examine this issue. Our results show that the estimator choice and returns to scale assumption have considerable effect to the presence of the merger gains.

The paper is organized as follows. Section 2 reviews earlier literature. In Section 3 we briefly discuss the Norwegian regulatory model. Section 4 introduces the Bogetoft and Wang framework and discusses the different frontier methods that are used to estimate the gains. Section 5 we presents the data, while Section 6 presents the results. Section 7 then concludes.

## 2. Previous literature

According to Resti (1998), the effects of mergers can be studied from two viewpoints. We can examine either the effects of mergers on the market value, financial performance, and the shareholder value of the companies, or the effects on their productive efficiency (see also Röller et al., 2000). In the financial and banking sector mergers have been widely studied from all of these viewpoints (see e.g. Akhavein et al., 1997; Bruner, 2002; Halkos and Tzeremes, 2013). In the realm of public utilities and services focus has been on productive efficiency, as maximizing financial performance rarely is the main objective of public service providers.[3] Agrell et al. (2015) examined the realized merger gains in the Norwegian electricity distribution sector during the period 1995–2004. They found rather small gains and assigned most of the improvement potential to the internal efficiency increases within the companies. Earlier Bagdadioglu et al. (2007), Kwoka and Pollitt (2010), and Çelen (2013) have analysed the potential efficiency effects of mergers for DSOs. Kwoka and Pollitt (2010) do not find significant merger gains in the US, while Bagdadioglu et al. (2007) and Çelen (2013) do find such gains within the Turkish distribution sector.

Previous literature has also highlighted the importance of modelling choices in regulatory models (see e.g. Kuosmanen et al., 2013). First, as Bogetoft and Otto (2011) point out, the results of merger analysis can vary, if different frontier estimators are used. Many of the above studies often apply only one estimator. Besides Bogetoft and Otto (2011), we are not aware of studies that would explicitly compare two different frontier estimators in the context of merger analysis.[4] Second, as we already stated, there are signs that scale inefficiencies are present in the Norwegian DSO sector (OED, 2014; Kumbhakar et al., 2015). Thus the assumption of returns to scale can alter the regulatory outcomes significantly (see e.g. Bjørndal et al., 2010). Third, it is widely acknowledged that the operating environment of firms should be taken into account when assessing the efficiency of firms (see e.g. Saastamoinen, 2013; Growitsch et al., 2012; Johnson and Kuosmanen, 2011; Wang and Schmidt, 2002). While earlier research has examined some of these specification issues, we take a more systematic approach and consider all three specification choices within one study.

## 3. The Norwegian regulatory model and merger gains

The Norwegian power market was deregulated in the early 1990s, a cornerstone being the vertical separation of (competitive) generation and (regulated) transmission/distribution. After a few years of rate of return regulation, distribution and regional transmission were subjected to incentive regulation from 1997 (Bjørndal et al., 2010). For each electricity network company, the regulator determined a maximum annual revenue, based on the company's own cost, benchmarking results, and some other adjustments of prices and increases in activity. From 2007, the benchmarking was done annually, and revenues were set according to a yardstick formula: $R = \rho C^{*} + (1 - \rho)C$, where $R$ is the annual revenue, $C$ is the actual cost, $C^{*}$ is the cost norm found by DEA, and $\rho$ is a factor determining the strength of the incentives in the regulation (presently equal to 0.6).

The current version of the benchmarking model is an input oriented DEA model, with three outputs (customers, HV-lines and network stations) and a single input (total cost; i.e. operation and maintenance, capital cost (depreciation and interest), value of lost load (VOLL) and losses), assuming a CRS technology. In a second stage, differences in operational environments are accounted for by adjusting the DEA scores with five geographical variables, or z-variables (underground cables, HV lines through forest, distance to road, and two composite variables of other environment characteristics). Finally, the cost norms are calibrated such that the sum of the cost norms equals the total sum of costs in the industry. Thus the company with average efficiency will earn the normal or regulated rate of return.

A recent addition to the regulation model is the "harmony-effect", compensating companies that merge with a part of the merger gain that is measured in the efficiency analyses. Two firms that merge (in a pure technical manner, i.e. just adding together inputs and outputs) will in most cases get an efficiency score that is lower than the weighted average of the two individual companies. If a merger results in a cost norm that takes out all the synergy effects immediately, the companies may be reluctant to merge. In order to incentivize the companies to organize optimally, part of the merger gain is kept by the companies through the harmony effect of the regulation model. Effectively the harmony effect is compensated to the firms by the regulator as a one-time lump-sum that is approximated by the discounted future gains over a period of 30 years.

Although the harmony compensation aims to fix a problem of too low incentives, it can be claimed that the compensation itself distorts the behaviour of the companies. One can argue that the regulator compensates something that it should not compensate. Intuitively savings due to merger are something that the merged firm should be able to achieve, not something that should be compensated if not achieved. It is also doubtful whether any gains in the form of price reductions are passed on to the consumers. Last, the smaller number of comparators in the benchmark regulation due to mergers might mean that DSOs face less pressure in their pricing decision from the regulator's side in the future (see e.g. Agrell and Teusch, 2016). While these are important questions to consider, we do not take explicit stance in favour or against the compensation scheme.

[2] Norges vassdrags- og energidirektorat (The Norwegian Water Resources and Energy Directorate) is referred as NVE in the text according to its Norwegian abbreviation.

[3] The merger gains have been explored in sectors such as the water sector (De Witte and Dijkgraaf, 2010; Zschille, 2014), healthcare (Kristensen et al., 2010; Peyrache, 2013; Flokou et al., 2016), and police forces (Simper and Weyman-Jones, 2008).

[4] De Witte and Dijkgraaf (2010) use both nonparametric and parametric methods. However, the parametric methods are mainly used to validate their nonparametric results rather than as an alternative.