Energy Economics 45 (2014) 412–418

Contents lists available at ScienceDirect

Energy Economics

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

The impact of ownership unbundling on cost efficiency: Empirical evidence from the New Zealand electricity distribution sector

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ARTICLE INFO

Article history:
Received 13 March 2013
Received in revised form 8 July 2014
Accepted 2 August 2014
Available online 12 August 2014

JEL classification:
L15
L94
D24

Keywords:
Electricity distribution
Ownership separation
Cost efficiency
Total cost function
Variable cost function
Stochastic frontier analysis

ABSTRACT

Several countries around the world have introduced reforms to the electric power sector. One important element of these reforms is the introduction of an unbundling process, i.e., the separation of the competitive activities of supply and production from the monopole activity of transmission and distribution of electricity. There are several forms of unbundling: functional, legal and ownership. New Zealand, for instance, adopted an ownership unbundling in 1998. As discussed in the literature, ownership unbundling produces benefits and costs. One of the benefits may be an improvement in the level of the productive efficiency of the companies due to the use of the inputs in just one activity and a greater level of transparency for the regulator. This paper analyzes the cost efficiency of 28 electricity distribution companies in New Zealand for the period between 1996 and 2011. Using a stochastic frontier panel data model, a total cost function and a variable cost function are estimated in order to evaluate the impact of ownership unbundling on the level of cost efficiency. The results indicate that ownership separation of electricity generation and retail operations from the distribution network has a positive effect on the cost efficiency of distribution companies in New Zealand. The estimated effect of ownership separation suggests a positive average one-off shift in the level of cost efficiency by 0.242 in the short-run and 0.144 in the long-run.

1. Introduction

Historically, electricity sectors all around the world were characterized by vertically integrated, mainly state-owned monopolies. Beginning with the early 1980s, many countries started to liberalize their electricity markets with the aim to introduce more competition and to improve efficiency. A major element of all reforms was the unbundling of the competitive generation and retail segments from the non-competitive network segments (i.e., transmission and distribution). Up to now, many countries have implemented some kind of functional or legal unbundling, while the strictest form of unbundling, i.e., ownership separation, has only been adopted by New Zealand in 1998 and the Netherlands in 2011 (Shen and Yang, 2012).

As discussed in de Nooij and Baarsma (2009), the introduction of ownership unbundling, i.e. a situation in which transmission and distribution networks are operated under different ownership than generation/production and supply, can result in various costs and benefits. The main argument in favor of ownership separation is that, via a more transparent regulated third party access to network, it is possible to increase the level of competition on the electricity market as well as the level of cost efficiency in the distribution sector. Furthermore, ownership separation would eliminate the possibility of cross subsidization, force the companies to use the inputs in just one activity, and decrease the asymmetric information problem for the regulation authority and thereby create incentives for the network owners to operate more cost-efficiently. On the other hand, we should consider that the separation of ownership may imply the loss of economies of vertical integration and, therefore, an increase in the level of cost.[1]

There are few studies that analyze the costs and benefits of ownership unbundling in the electricity sector. Most of these studies analyze the introduction of ownership unbundling to transmission networks (e.g. Pielow et al., 2009; Pollitt, 2008), whereas only two studies analyze the effects of ownership unbundling on electricity distribution companies.

In the first study, de Nooij and Baarsma (2009) propose an ex ante cost–benefit analysis of the ownership unbundling of distribution companies in the Dutch electricity sector. The results of the analysis show that ownership unbundling would decrease welfare. In their analysis, de Nooij and Baarsma (2009) mention explicitly that ownership

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[1] For a discussion of empirical works on the economies of vertical integration, see Fetz and Filippini (2010).

http://dx.doi.org/10.1016/j.eneco.2014.08.002
0140-9883/

unbundling has a positive impact on the level of productive efficiency of the companies. However, due to a lack of data, they were not able to approximate the impact of ownership unbundling on the productive efficiency using an econometric approach.

The second study by Nillesen and Pollitt (2011) analyzes the impact of the introduction of ownership unbundling on electricity prices, quality of service and costs using a sample of electricity distribution companies operating in New Zealand. For this purpose, they propose a relatively simple empirical method based on the estimation of a Cobb–Douglas variable cost function, using data from 1995 to 2007 for 28 electricity distribution companies, and applying a fixed effects as well as a random effects model. The variable cost model specification used by Nillesen and Pollitt (2011) includes the explanatory variables: output, a variable on the customer density, a variable on the quality of the service, a time trend and a dummy variable related to the introduction of the ownership unbundling. The results of this study show that ownership unbundling has an impact on unit operational costs of electricity companies operating in New Zealand.[2] This is an interesting study, however with some limitations. First, the variable cost model specification used by Nillesen and Pollitt (2011) does not include in the explanatory variables, contrary to what is suggested in microeconomic theory of production, a variable representing the capital. Second, a relatively rigid functional form of the Cobb–Douglas is used. Finally, this study analyzes the impact of ownership unbundling on the level of the cost and not on the level of cost efficiency. Of course, we are aware that these two types of analyses are related. However, due to the fact that regulation authorities use benchmarking analyses of the cost, an analysis on the impact of this type of unbundling on the level of cost efficiency is more interesting from a regulation point of view.

The aim of this paper is, therefore, to analyze the impact of ownership separation on the level of cost efficiency of the electricity distribution companies in New Zealand. For this purpose, we estimate several stochastic cost frontier functions utilizing a panel data set of 28 electricity distribution companies for the period between 1996 and 2011. To obtain robust results, we estimate both a total cost function and a variable cost function. The total cost function expresses the long-term cost performance assuming that firms are in static equilibrium and use all their inputs at an optimal level. However, this is a strong assumption because electricity distribution utilities cannot easily adjust their stock of capital. The variable cost function takes this into account. It reflects the short-term cost performance accounting for the quasi-fixed character of the distribution network.

Our approach differs from the approach used by Nillesen and Pollitt (2011) in several aspects. First, we use a more flexible functional form. Second, we investigate the impact of ownership separation on cost efficiency. Finally, our results are based on a greater amount of actual data with observations available up to the year 2011. Therefore, our study may be interpreted as an in-depth analysis of the study by Nillesen and Pollitt (2011).

The results of our study are relevant for practitioners and theorists. Politicians and regulators in many countries still debate about the economic advantages and disadvantages of ownership separation, not only in the electricity markets but also in other network industries such as rail transport or natural gas distribution. Within this discussion, the question as to whether ownership separation increases or decreases cost efficiency is one important issue.

The remainder of the paper is organized as follows: Section 2 briefly discusses ownership separation in New Zealand's electricity sector. The estimation methodology is introduced in Section 3, while Sector 4 describes the data. The estimation results are presented in Section 5. Section 6 summarizes and concludes.

[2] Note that Bertram and Twaddle (2005) provide an interesting analysis using accounting data on the impact of deregulation and corporatization of the New Zealand electricity sector on the price–cost margins of the electricity companies.

2. Ownership unbundling in the New Zealand electricity sector

Prior to the electricity market reforms in the mid-1980s, almost 100% of the electricity generation capacity and the transmission grid in New Zealand's electricity sector were controlled by the government, namely the New Zealand Electricity Department (NZED). Retail and distribution were provided by 61 publicly-owned local franchise monopolies, the so-called Electrical Supply Authorities (ESAs). In April 1987, the government converted NZED into a state-owned enterprise, the Electricity Corporation of New Zealand (ECNZ). A couple of years later in 1992, the ESAs were corporatized and in 1994, the publicly-owned transmission grid company Transpower was formed. In 1996, parts of ECNZ's generation assets were transferred to the newly founded and publicly-owned generation company Contact Energy (Bertram, 2006).

However, all these reforms did not meet the objective of the liberalization process: To improve efficiency and consumer welfare by increasing competition in generation and retail and by eliminating cross subsidization of the potentially competitive generation and retail segment from the non-competitive distribution segment (Shen and Yang, 2012).

Given this unsatisfactory development, New Zealand's government enacted the Electricity Industry Reform Act (EIRA) in 1998. The two main elements of the EIRA were the splitting of ECNZ into three competing publicly-owned companies and the ownership separation of distribution from retailers. Between July 1998 and April 1999, the vast majority of distribution companies sold their retail operations. In the following years, several acquisitions and mergers gradually reduced the number of electricity distribution businesses in New Zealand to 28 in 2008. In 2009, the number increased back to 29 utilities as Vector sold its Wellington network (Shen and Yang, 2012).

As of now, the final act of ownership separation in New Zealand's electricity sector took place in 2010, when New Zealand's government introduced the Electricity Industry Act (EIA). The EIA partly relaxes the strict ownership separation of distribution and generation from retail by allowing a re-bundling up to a maximum threshold (Shen and Yang, 2012).

3. Cost model specifications and estimation methods

Previous studies on the cost structure of electricity distribution companies are numerous.[3] Generally, these studies consider the estimation of a total or variable cost function using a flexible functional form. Moreover, the most used explanatory variables in these studies include: the electricity supplied measured in kilowatt-hours, the number of customers and the factor prices, as well as some output characteristic variables such as the customer density, the network size, the service area and the load factor.

In our analysis, we estimate both variable and total cost functions. For this purpose, we specify a total cost function with two outputs and three output characteristic variables. Unfortunately, due to a lack of data, we are not able to introduce the input prices in the cost model specification. Therefore, following Nillesen and Pollitt (2011), we assume that all firms in New Zealand's electricity distribution sector are subject to the same input prices.

If it is assumed that the firm minimizes cost and that the isoquants are convex, a total cost function can be written as

$$TC = C(QE, QC, LF, SAIDI, CD, DT), \tag{1}$$

where TC represents total cost; QE is the electricity supplied in kilowatt-hours; QC is the number of final consumers; LF denotes load factor; $SAIDI$ is an index on the average interruption duration of the system; CD is consumer density; and DT represents time dummies which capture changes over time. A detailed description of these variables

[3] For a discussion on the estimation of cost functions in the energy sector and a review of previous studies, see Ramos-Real (2005) and Farsi and Filippini (2009).