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Scale economies and optimal size in the Swiss gas distribution sector

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HIGHLIGHTS

- Presence of unexploited scale economies for small and medium sized companies.
- Scale economies vary considerably with customer density.
- Higher density or greater complexity is associated with lower optimal size.
- Optimal size varies across the companies through unobserved heterogeneity.
- Firms with low density can gain more from expanding firm size.

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ABSTRACT

This paper studies the cost structure of Swiss gas distribution utilities. Several econometric models are applied to a panel of 26 companies over 1996–2000. Our main objective is to estimate the optimal size and scale economies of the industry and to study their possible variation with respect to network characteristics. The results indicate the presence of unexploited scale economies. However, very large companies in the sample and companies with a disproportionate mixture of output and density present an exception. Furthermore, the estimated optimal size for majority of companies in the sample has shown a value far greater than the actual size, suggesting remarkable efficiency gains by reorganization of the industry. The results also highlight the effect of customer density on optimal size. Networks with higher density or greater complexity have a lower optimal size.

1. Introduction

During past two decades, many industrial countries have started to reform their gas markets in order to lower costs and improve service quality and expand access to utility services. The EU gas directive, 1998/30/EC started a process of industry and market reform designed to produce a single, open and competitive market for natural gas across Europe (Thomas, 2005). The directive aimed to achieve this goal through the opening of third party access (TPA) for transport and storage of natural gas and by separating control of the main gas infrastructure from vertically integrated national and regional monopoly companies (Harris, 2008). The general idea is to introduce competition in the wholesale and retail markets, and to have a regulated natural monopoly in the transmission and distribution sectors. In the latter sectors we anticipate an increasing use of incentive schemes such as price-cap regulation, which is currently being used in UK and Argentina (Green, 1997).

Along with growing concerns about the performance of gas distribution companies, the productive efficiency of the sector can be questioned regarding economies of scale and the optimal size of local distributors. This issue is of particular importance in cases such as Switzerland, where the sector is characterized by relatively small operators. In fact, the natural gas distribution sector in Switzerland differs from most EU countries in its scale of operation. In many EU countries, gas distribution is either dominated by a few state-owned companies (e.g., France), or, in cases with a relatively large number of companies (e.g., Germany), the distributors are typically much larger than those operating in Switzerland, see Asche et al. (2001).

The Swiss gas distribution industry includes more than a 100 local small monopolists operating in relatively small to medium-size service areas with a strongly segmented structure. The size of a typical Swiss gas distributor is about 100th of that of a major

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Table 1
An overview of previous studies (gas distribution).

	Guldmann (1983)	Kim and Lee (1996)	Kim et al. (1999)	Fabbri et al. (2000)	Farsi et al. (2007)
Data	1979 (cross-section) U.S.	1987–1992 (panel data) Korea	1987–1995 (panel data) of 28 companies	1991–1992 (panel data) Italy	1996–2000 (panel data) Switzerland
Functional form (estimation)	Log linear OLS	Translog OLS, SUR	Translog OLS, FGLS SUR	Translog SUR	SFC-Cobb–Douglas GLS, GLS and Mundlack
Output	Residential and non-residential sales	Volume of gas delivered	Flow of natural gas	Volume of gas delivered	Volume of gas delivered
Output characteristics	Number of customers and population density	Customer density, average customer size and supply rate	–	Customer density, concentricity ratio and average altitude	Load factor, area size, customer density and terminal block
Factor prices	Omitted (considered to be constant)	Labor price, unit price of pipeline	Labor and administration price	Material and services, labor and capital price	Labor, capital and energy price
Economies of scale	Weak economies of scale	Weakly positive	Significant economies of scale	Very low	Weak
Economies of density	Significant economies of density	–	–	High	Strong

European company.[1] Considering the typical cases of EU countries with large dominant utilities, one can argue that the potential efficiency gains from the economies of scale are not considerable, so these are overlooked by the EU policy directives. However, given the relatively small size of Swiss gas distributors, such an approach does not apply to Switzerland's case. In Switzerland, and perhaps in other countries with similar market structures, an important policy question is to what extent the sector's productive efficiency can be improved through economies of scale. In these cases it can be argued that, for historical reasons related to the political organization of the economy,[2] the public utilities are organized in small units that are occasionally far from the optimal size. With globalization and the increasing integration of European natural gas markets, such historical grounds for small utilities appear to have lost relevance. In these circumstances, considerable efficiency gains may be achieved by reorganizing the industry in a more consolidated structure. Given this situation, economies of scale and optimal size are important policy issues especially for the case of Swiss natural gas distribution. In this study we focus on the issue of scale economies and its variation with output. Our main objective is to estimate the optimal size of the gas distribution companies and to study its possible variation with respect to network characteristics such as customer density.

This study estimates a total cost function via different panel data models using a panel of 26 gas distribution utilities in Switzerland over five years (1996–2000). As these utilities operate in environments characterized by strong heterogeneity, the omitted variables may have an important effect that can be better accounted for in panel data models. Due to the small size of the data set; statistical efficiency considered as a main issue to elaborate econometric specifications. Therefore, several econometric models, such as random effects and a system of equations with input share equations, are considered.

Finally, because of the strong heterogeneity of gas networks in both observed and unobserved characteristics, it is important to consider the variation of the economies of scale and optimal size across individual companies. For this reason two different approaches are considered in studying the variation of scale economies. In the first approach, economies of scale are studied for three hypothetical companies and in the second approach the economies of scale are estimated for four groups of companies based on the actual levels rather than on hypothetical values.

[1] See Harris (2008) for statistics regarding major European companies.
[2] Federalism and the self-determination of relatively small communities.

The rest of the study is organized as follows. In Section 2 we summarize the methodologies used in previous studies. The model specification and the concept of economies of scale are presented in Section 3. In Section 4 the estimation methods adopted here are discussed. Section 5 describes the data sets. The estimation results are presented in Section 6. The study ends with a summary of main results and policy conclusions.

2. Review of literature

Empirical contributions regarding cost and technology of gas distribution sector are not widely available in the literature. This can be partly explained by the lack of suitable data. In this section, some relevant studies are reviewed, focusing on the model specifications and econometric approaches suggested by different authors. A summary of these studies and their main results has been presented in Table 1. A special attention was given to the choice of flexible functional form and the necessity to account for unobserved heterogeneity in panel data set.

Guldmann (1983) proposed a multi-output cost function to model the structure of urban gas distribution. The cost of the system depends not only on the number of customers and the quantity sold to each but also on the population density. The results show the presence of weak economies of scale but significant economies of density. Guldmann's (1983) findings indicate that the economies of scale vary with the market size and territorial concentration of the customers. Hollas and Stansell (1988) analyzed the technical and allocative efficiencies of 64 US private gas distributors using a translog profit function. They include fuel and labor prices, customer density[3] and the fixed capital input[4] in the model. Hollas (1990), using the same data set, found that increasing the customer density has a statistically significant and negative effect on the cost of gas distribution.

Kim and Lee (1996) used a translog cost function to model the distribution technology of seven Korean gas distribution companies over the period 1987–1992. The explanatory variables include labor price, unit price of pipeline, customer density, customer size and supply rate.[5] Their results indicate that all the firms included in the sample are located in the increasing returns to scale region

[3] Defined as number of customers per mile of network.
[4] Measured in daily throughput capacity.
[5] These variables are defined as number of total customers/total pipe length, average consumption (total supply quantity/number of metering devices) and the number of total customer relative/number of total potential customers respectively.