

NEURAL NETWORKS IN REGULATION: REVISING ELECTRICITY TARIFFS IN BRAZIL

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Overview

Regulating natural monopolies has been a tough task for regulators in any country. Comparing the performance of similar companies can be a way of minimizing ambiguities in such a task. This paper addresses the problem of defining subsets of similar companies (clustering) in the context of tariff review. For this purpose it uses as an example the clustering tool application in the sector of electric power distribution in Brazil. It discusses the importance of such a definition of subsets of companies for the proper application of benchmarking techniques to groups of companies with specific characteristics, instead of performing benchmark contrasts taking in consideration the whole universe of firms in the whole industry at once. [Parente et al. (2003)].

In this context, Kohonen Neural Networks, also known as Self-Organizing (Feature) Maps, are analyzed as a clustering tool for grouping the electricity distribution companies. The clustering process takes into consideration characteristics that may vary from company to company such as (a) the number of costumers per km²; (b) costumers per km of distribution network or (c) the percentage of rural clients with respect to the total of clients; among others. The terminology and the concepts of the neural networks field are adapted for the context being discussed.

The cluster analysis based on Kohonen Self Organizing Maps considers 60 companies of the Brazilian electric power distribution sector, which are then organized in 6 clusters. After such a clustering, a possible partial fusion of these 6 classes is shown, what results in reduced number of clusters. This fusion is done taking in consideration an important property of the Kohonen network: its intrinsic ability to organize the clusters in a map (or grid of clusters) which places the clusters with similar features close to each other. In this way, the map automatically organizes in a grid the similar prototype companies that are produced by the clustering process.

The possibility of dealing directly with a large number of variables in the characterization of each company is emphasized. It also calls attention the ability of the tool in allowing the visualization of similarities or differences among the prototype companies that are generated in the clustering process. This visualization ability is present in Kohonen method even when the dimension of the company descriptors is high, and the direct visualization through two-dimensional or three-dimensional graphs is impossible.

The issue of identifying if a company under tariff regulation is more or if it is less efficient than the average company of its group becomes facilitated through out this methodology. Also, checking out if the costs and investments of regulated companies are above or bellow the average levels of the sector through the described method, has turned out to be a more objective task.

Methods

Cluster analysis based on Kohonen Self Organizing Maps experiments applied to regulation.

Results

First, Kohonen Self Organizing Maps can be used by regulators to reduce ambiguity and discretionary power in dealing with tariff regulation.

Second, the analysis of 60 electric power concessionaires in Brazil has led to the definition of 6 subsets of grouped companies. The analysis suggests that the tools of benchmarking should be applied 6 times, considering in each time one of these subsets of companies. This procedure allows approaching each group as one of 6 small universes to be analyzed in separate.

Third, the neural network tool applied can also be used to further reducing the number of clusters by reuniting the ones with more similarities.

Conclusions

The definition of sets of similar companies through clustering techniques in the context of tariff review for electric power distribution concessionaires can be of large importance and practical use. This usefulness gains even more meaning when we realize that the definition of a single model company – even if based on the whole 60 distribution firms, as represented in the case of the Brazilian electric power distribution industry – offers a fragile tool for comparison. A better and more precise evaluation can be obtained when the benchmarking is done among a restricted number of similar companies.

This method also reveals its applicability when it is needed to take into consideration many features, or dimensions, of each company in the clustering process. The ability to deal with high dimensions allows us to indefinitely enlarge the number of features that describe each of the companies, with the inclusion of more and more variables, without any difficulty related to the visualization of similarities between clusters of companies.

We also would like to mention that the fact that the Kohonen maps allow the incremental inclusion of new company characteristics in the cluster analysis facilitate studies in which multidisciplinary specialists (engineers, economists, statisticians, finance professionals, etc.) contribute in the gradual definition of features that could, potentially, be considered in the analysis of similarities amongst concessionaires. The inclusion of several dimensions in the classification of the companies allows a more suitable approach for considering the different aspects of such a characterization. Once a suitable grouping is obtained, the task of the regulatory agency in defining a fair tariff review, with bases on the performance of manageable costs of comparable companies, gains in precision.

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