From simple price comparisons to rigorous benchmarking methods - An application to electricity distribution networks

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Abstract--**This paper aims at explaining how, in the real world, efficiency comparison efforts in electricity distribution networks may lead to practical difficulties, and how these difficulties may be overcome by moving from simple, price-based comparisons to more complex and analytical activity-based benchmarks that use cost and input-output analysis, amongst other procedures. The paper was presented at the Balkan Power Conference in 2003.**

Index Terms—**Price comparisons, benchmarking, electricity networks' regulation.**

I. Introduction

Price comparisons across different electricity networks can be a useful exercise to assess and understand absolute differences amongst countries and operators that may be driven by either underlying costs, market power, regulatory environments, or environmental conditions. However, simple price comparisons by themselves do not provide means to identify and quantify the driving factors of observed price differences. From simple price comparisons we should therefore move towards bottoms-up analysis that takes into account production, as well as environmental, factors and - when needed for regulatory purposes - underlying costs as well. In doing so, the researcher digs deeper into the actual drivers of efficiency and is able to separate, in the absence of data constraints, the different components of productive efficiency from mark-ups and other elements determined by market power and external conditions.

The main problem associated with bottoms-up techniques for rigorous benchmarking - as opposed to simple price analysis - is given by stringent data requirements that are not always met in the real regulatory world. Extreme forms of cost-based benchmarking assume equal conditions (post-adjustment for environmental factors) and move therefore towards yardstick regulation. This requires absolutely transparent and homogeneous cost information across the industry. As this is not available today in practice - and will not be in the foreseeable future, even if regulators work more closely together - the analytical work needs to be accompanied by practical assessments. This requires the consideration of relevant and common planning and operating practices in the benchmarking process. This paper provides an overview of the state-of-the-art benchmark methodologies, the practical difficulties associated with these methods, and possible ways to consider practical experience to lead to meaningful and relevant results. Practical experience from international regulatory agencies is described.

II. Mere Price Comparisons?

Benchmarking network operations is a separate task from the mainstream issue of economic benchmarking. Traditionally, "economic" benchmarking refers to variables and issues that are internal to, and at least partially controllable by, decision-making units. Merely comparing prices is therefore a different matter. Obviously, network charges do not necessarily depend upon decisions taken by network managers to enhance efficiency and, even if they do, they will not be left free from external regulation (regulated access). Cost-reflective network charges depend on a number of accounting conventions (usually imposed by regulators or general accounting laws) that would have a significant impact on their level without any relationship to bear with efficiency/inefficiency considerations. Examples for such differences are the treatment of depreciation and the return on assets. The specification of the regulatory assets base, asset valuation (historic cost, replacement cost, deprival value), depreciation (economic versus accounting depreciation, straight-line versus accelerated, technical versus economic life etc.), rate of return (real or nominal, pre-tax or post-tax, risk adjustment premia, working capital treatment, capital contribution treatment) could result in substantial differences in the outcomes. To accomplish successful benchmarking analysis, such differences will need to be identified and adjusted for properly [1]. In our view, a mere comparison of charges – rather than costs or efficiency levels – does not provide enough information to set adequate price regulation. There are three main reasons for this.

Firstly, the level as well as the structure of charges may substantially differ. Even if it is feasible to some extent (using simple correction factors), the complete "removal" of such elements would be eventually impossible. Recalculation of network charges for price comparison reasons would require complete history of demand data, network development, detailed elements of price control frameworks in the respective country etc.

Secondly, basing the parameters of the price control on the charges observed in other countries ignores the differences that may exist in the regulatory framework between countries. In the end, the charges that a regulated company is allowed to impose are made up of two components: costs (which could also be split up into efficient and inefficient costs or "slack") and allowed profits. Profits in turn result from regulatory decisions that can significantly differ from country to country. For example, some regulators do not allow cost-reflective charges for various social and political reasons whilst others do. Also, differences in price-control regimes may drive, at least partially, the level of charges, e.g. tighter price controls will be likely to lead to lower charges – but only after some time (the regulatory lag). Undertaking a benchmarking analysis based on charges to the purpose of setting the price control, therefore, is not a very practical choice.

Thirdly, in many cases the charges will exhibit different scope. Here, in particular, we refer to cases where network service is provided within integrated utilities and the charges cover not only the cost of networks, but also generation and supply. It is unlikely that detailed information on each type of service will be in the public domain. Moreover, our experience from European countries shows that even in restructured industries where at least accounting separation is required, cost data per unbundled service (e.g. distribution and supply) is frequently not available or, when available, it is not reliable. Rules-of-thumb could be used in order to disaggregate costs for network service provision, based for instance on cost allocation methods.

Mere price comparisons provide a valuable "rough" guess. However, it is our view that such an analysis in isolation cannot be applied to set price targets for the regulated industry. To assure the professional quality and economic integrity of the whole effort, more rigorous techniques than simple price comparisons are required.

III. From Price Comparisons to Rigorous Benchmarking

Electricity networks use inputs (capital, labour) to provide services to customers. While all network service providers use broadly the same inputs, some providers may use proportionately more of some inputs and less of others. The mix of inputs used depends upon, among other things, management practices and the operating environment. Similarly, the nature of services provided by networks varies according to the nature of customer demands. For example, some network service providers may need to maintain significant network capacity to transport power to a small number of customers while others may serve a large number of customers with limited and highly variable demand. The benchmarking technique must be able to accommodate these different supply and demand conditions. Further, the technique must recognize that it is possible to operate at equal efficiency while substituting between input and output sets.

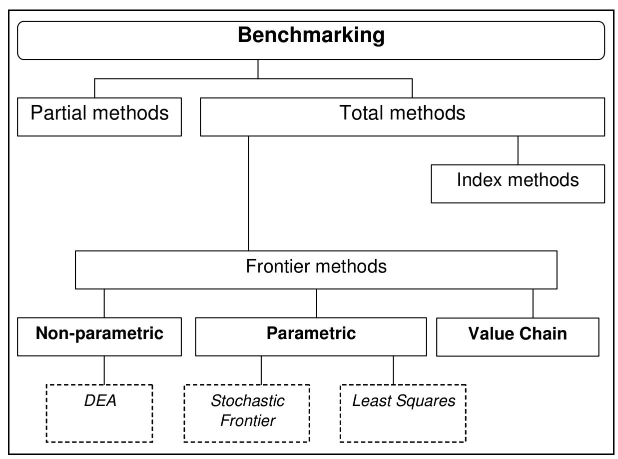

Figure 1: Benchmarking Methods

A wide range of benchmarking methodologies is available (see Figure 1). The common feature of these methods is that they all involve setting targets for cost reduction that are independent of the actual cost reduction achieved by the company over the regulatory review period. The methodologies differ in the mathematical techniques, and consequently in their data requirements. Below we briefly describe different measures used in structured benchmarking analysis.

A. *Partial methods*

Partial (uni-dimensional) measures of performance (performance indicators), such as MWh distributed per employee or minutes lost per customer, are the simplest way to perform comparisons between different companies. Clearly, these can provide important indicative information on relative performance which give rise to the suggestion that a given network service provider could improve its performance in a particular way, e.g. by reducing staff numbers. Such measures appear in annual reports of companies and are commonly used by market analysts because they are easy to calculate and (only apparently) interpret. The main drawback of uni-dimensional measures is that they fail to account for the relationships between different input and output factors.

B. *Index methods*

Index Methods use index-based techniques to aggregate input and output variables of the company. Total Factor Productivity (TFP) is an index of the ratio of all output quantities (weighted by revenue shares) and all input quantities (weighted by cost shares). Calculating TFP requires the aggregation of diverse inputs and output quantities of network service providers into measures for total output and input. Index number theory is used to overcome the different nature of variables.

C. *Non-Parametric Frontier methods*

Frontier methods are based on the concept that, given a certain sample, all companies should be able to operate at an optimal efficiency level that is determined by other efficient companies in the same sample. These efficient companies are usually referred to as the "peer firms" and determine the "efficiency frontier". The "efficiency frontier" is formed from the observed performance of the companies in the analyzed sample, as determined by the relationships between the inputs and outputs of the sampled units. The companies that form the efficiency frontier use the minimum quantity of inputs to produce the same quantity of outputs. The "efficiency frontier" is used as a yardstick against which the comparative performance of all other companies (that do not lie on the frontier) is measured. The distance to the efficiency frontier provides a measure for the (in)efficiency. Frontier methods can be divided into non-parametric and parametric methods. Non-parametric methods do not impose any functional form on the relationship between inputs and outputs. The most used non-parametric approach is Data Envelopment Analysis (DEA). Under this methodology, the frontier is made up of linear combinations of the best-performing companies in the sample.

D. *Parametric Frontier methods*

Parametric methods impose a functional form on the frontier using estimation for production or cost functions. They require more knowledge about the production or cost functions and also about the distribution of errors. However, to test for the validity of the assumptions and to fine-tune the weight assigned to each variable, a large number of networks are required. Parametric frontiers could be estimated by some variant of Ordinary Least Squares (OLS) or by Corrected Ordinary Least Squares (COLS). Under OLS, the frontier is based on the average cost function while COLS tightens the criterion and shifts the frontier towards the best performing company. Stochastic Frontier Analysis (SFA) attempts to estimate an efficient cost frontier that does incorporate the possibility of measurement error or chance factors in the estimation of the efficient frontier. This method first allows for the adjustment of individual costs for stochastic factors and then calculates efficiency scores in a way similar to COLS. The efficiency scores are usually higher than under the COLS method precisely because the most efficient company under COLS will be assumed to be subject to some negative stochastic factor affecting its actual costs. While this method incorporates stochastic factors, it still requires the specification of a functional form for the efficient frontier. It further requires the specification of a probability function according to which stochastic errors are distributed.

E. *Value Chain*

The "Value Chain" Method is a special form of frontier benchmarking. Under this method, the regulator undertakes a detailed analysis of the several processes of the regulated company and compares these with some yardstick – usually, a similar network company. For each particular process (e.g. maintenance, dispatch, repair, etc.), an efficiency score is derived by computing an appropriate "cost/cost driver" ratio. In the comparisons, one may adjust costs to reflect differences in geographical or historical circumstances, etc. The overall efficiency of the company is derived by weighting each individual process's efficiency scores into an overall score. An example of where the value chain method was applied is the price control for the Norwegian TSO (Statnett) which was based on a comparison with the Swedish TSO (SVK). The value chain method is particularly useful when one wants to avoid a "high-level" analysis (e.g. to the purpose of industry acceptance) or if the number of suitable comparators is very restricted (as is usually the case in TSO benchmarks). A major disadvantage of this method is, on the other hand, represented by the detailed data requirements and labour-intensive character of the analysis. Also, this analysis requires the availability of a suitable "yardstick" company, i.e. one which is both similar to, and arguably more efficient than, the company being assessed.

IV. The Importance of Cross-Methodological Checks

Uni-dimensional ratios and frontier efficiency scores can only provide information on the past dispersion of relative inefficiency. First, they do not give much guidance as to the absolute level of inefficiency. Secondly, a view has to be taken about the rate of cost reduction that is feasible for the most efficient firm in the sample, and hence for each regulated firm in addition to the elimination of relative efficiency differences. The DEA, COLS, and SFA methodologies have been widely used by regulators around the world to measure the relative inefficiency of regulated firms. Each method has something to recommend it: COLS is straightforward to understand and implement; SFA attempts to incorporate stochastic factors; and DEA makes no assumptions about the functional form of the production/cost function. The data requirements are broadly similar, but not exactly identical, in each case.

Ideally, benchmarking should use total controllable costs (costs that the company can control) as an input. In this case, the regulator will remain indifferent to the mix of inputs provided by each company, provided that each company is able to deliver its required outputs at the lowest total cost. In many practical cases, conducting such a kind of total cost-based benchmarking is hardly possible because of data limitations, different accounting practices in the treatment of capital costs etc. Therefore, under such information constraints, benchmarking exercises are conducted on the basis of physical data and/or data for operational and maintenance cost only.

One regulatory approach is to set the productivity improvement targets equal to the long-term rate of total factor productivity growth of the electricity sector (or even better, only the networks' subset), under the assumption that efficient companies should be able to reduce their cost at this rate in the future (cost-unlinked approach). These measures have the effect of completely de-linking the setting of productivity improvement targets from the behavior of individual regulated service providers, and of giving the set of regulated companies the same productivity improvement factor over time.

The "unlinked" form does not take into account any company-specific information on initial inefficiency levels, and hence the actual scope for cost reduction. An inefficient company would by definition be able to easily outperform the benchmarking targets while an efficient company with little scope for cost reduction would find it difficult to fulfill the efficiency improvement target. Therefore, in some liberalized European electricity markets (UK, Norway, the Netherlands), regulators have tended towards cost-linked benchmarking which uses other electricity firms as the comparators against which actual firms' costs are compared. In the linked approach, productivity improvement factors for individual firms are therefore set with reference to the measured inefficiency of the given firm vis-à-vis a sample of utilities from the same sector and from comparable backgrounds.

Methodological cross-checking is used because of robustness problems that may be encountered when calculating projected efficiency scores via different benchmarking techniques. Statistical tests of both a parametric and non-parametric nature exist in order to test the robustness of benchmarking results from different techniques and their degree of accordance in statistical (average) terms. It is sometimes useful to consider statistical testing in order to ascertain whether results from different methodologies are actually consistent and can be jointly reported and defended by the regulator [2].

Benchmarking can also usefully be applied to service quality. Quality standards, such as the number of customer complaints per 1,000 customers, can be usefully benchmarked. Quality incentive schemes which penalize/reward firms for poor/good performance can be based on the relative performance of a regulated utility. To the extent that regulation seeks to improve quality standards, this could be relevant and becomes matter for further analysis [3].

V. International Experience of Rigorous Benchmarking

There are a number of countries that have embarked upon ambitious benchmarking processes to regulate their network utilities. We briefly report the experience of the Dutch and Australian regulators, and the Central European experience of Slovenia and Hungary.

A. The Netherlands

The Dutch regulator DTe undertook in 2000 a fully-fledged efficiency benchmarking exercise of both transmission and distribution companies. The technique used was DEA (in common with previous experience from Scandinavia) and the X-factor process was heavily informed – if not influenced straight away – by the naked results of efficiency analysis. The Dutch experience with benchmarking has been mixed for a number of reasons. Misinterpretation of data, use of non-comparable data combined with unfamiliarity with the specifics of the electricity industry led to some faulty benchmark results, especially in the TSO benchmark. In the end, this led to the abandonment of initial X factors and to the setting of price controls based upon reviewed X factors to take into account counter-analyses put forward by the regulatees (distribution). For transmission, the initial price control - based upon international benchmarking - was abandoned altogether and subject to changes.

B. New South Wales (Australia)

The Independent Pricing and Regulatory Tribunal of New South Wales, Australia, has heavily relied over the years upon the usage of economic benchmarking techniques, and of DEA in particular. Extensive cost benchmarking was undertaken by

IPART during the latest distribution price determination, using cross-checked data from a number of different jurisdictions. However, differently from DTe, IPART has not used the benchmarking results as a straight determinant of X factors. On the contrary, the IPART approach was one of composite information gathering whereby benchmarking outcomes were only part of the overall information used to come to a price control scheme. This is part of the relatively complex approach taken in Australian regulatory accounting, which is also known as the "building blocks" approach, and which considers benchmarking only as one if its many inputs.

C. Two Central European Countries

Recently, countries from Central Europe have started considering the use of economic benchmarking as part of network price controls. Rightly enough, none of these countries is apparently looking at economic benchmarking as the only and one method to arrive at sensible price controls. Vice versa, they are considering the usage of benchmarking techniques to inform their choices based on other, also financial, methodologies to encompass cost of capital problems and past under-investment issues. The Republic of Slovenia has used a number of benchmarking techniques in setting the price levels for its five distribution utilities. Methods were compared and contrasted from the list we provided above of statistical and linear programming techniques. The Hungarian Republic is now considering a similar effort in the economic benchmarking of its six distribution utilities vis-à-vis a sample of international comparators.

KEMA Consulting has been involved in the regulatory process of both countries and, with special respect to Hungary, is still actively involved in it, as the benchmarking process has not been completed yet.

VI. Conclusions

Price comparison is a useful exercise to assess and understand absolute differences amongst countries and operators. However, to explain and understand the prevailing price differences, more rigorous techniques such as benchmarking are needed. There is a wide set of techniques available to the regulator. These range from simple ratio analysis to more sophisticated methods that are able to encompass multiple input and output factors. International experience shows that the analysis need not be limited to one technique only. Cross-checking the outcomes from different techniques strengthens the confidence in the results, and ensures that subsequent regulatory policy – e.g. the setting of productivity and/or quality targets – is fair and robust.

VII. References

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VIII. Biographies

Virendra Ajodhia (1975) studied Electrical Engineering at Delft University of Technology, Netherlands. In 1999 he joined KEMA Consulting where he is currently active as a consultant in electricity network benchmarking and regulation. Mr. Ajodhia is also a PhD candidate at Delft University of Technology on the topic of Integrated Price and Quality Regulation for Electricity Networks. He is a member of the International Association for Energy Economics (IAEE) and a member of the IEEE Power Engineering Society (Delft University of Technology, Delft, the Netherlands, P.O. Box 5015, 2600 GA, Email: v.ajodhia@tbm.tudelft.nl

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Gian Carlo Scarsi (1971) is an expert in Energy Economics. His project expertise ranges from economic efficiency benchmarking to the valuation of stranded costs in electricity, utility market design, media rights, and the restructuring of electricity and gas markets throughout Western Europe. He holds a D.Phil. in Economics from Oxford University, specializing in comparative efficiency analysis and benchmarking of electric utilities, and has obtained a Research Doctorate in Economics and Public Policy in Milan. He has written a number of publications on comparative efficiency analysis in electricity distribution and the reform of public utility industries throughout the European Union.
Amongst Gian Carlo's energy-related projects, he was involved in studies to both private clients and public regulatory agencies on distribution price control reviews (UK, the Netherlands, and Slovenia). Other projects carried out by Gian Carlo include the evaluation of privatisation strategies in Italy, the analysis of efficiency/effectiveness of UK Train Operating Companies in the new franchising regime, and various non-utility related projects in the fields of media and anti-trust policy. In 2001/ 2002, Dr Scarsi advised the Energy Agency of Slovenia in the establishment of economic regulation (price cap regulation) for networks and in the performance of a benchmarking study. Recently ha managed a price comparison study for transmission and distribution network in Singapore.