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Disentangling the cost efficiency of jointly provided water and wastewater services

Nuno Ferreira da Cruz*, Pedro Carvalho, Rui Cunha Marques

CEG-IST, Technical University of Lisbon, Av. Rovisco Pais, 1049-001 Lisbon, Portugal

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ABSTRACT

Providing operators with objective incentives for cost efficiency and continuous improvement in the provision of public services are major concerns for regulators. Measuring efficiency empirically is complex and this complexity is accentuated when the same operator is responsible for delivering more than one service (e.g. in order to explore potential economies of scope). Based on a sample of operators that provide water and wastewater services, this paper uses a shared input data envelopment analysis model to measure separately the efficiency of each service. The results show that a single measure may not provide enough information for monitoring multi-utilities. Together with other indicators, the proposed model can assist decision-makers in prioritizing efforts to improve overall efficiency.

1. Introduction

Measuring the cost efficiency in the delivery of public utility services is of crucial importance. For the same level of service, higher efficiencies should lessen the burden on rate and/or taxpayers (if there is regulatory pressure). However, when the same operator delivers more than one service, performance measurement becomes more challenging (Torres and Morrison, 2006) and global efficiency measures tend to be less useful. Traditional methodologies do not always highlight in which service efficiency is lower: a key issue for both decision-makers and regulators.

In a given territory, water and wastewater services are often jointly provided by the same operator. In fact, empirical evidence supports the argument that there are economies of scope between drinking water supply and wastewater collection/treatment/disposal, especially in smaller utilities (Abbott and Cohen, 2009). Most methodologies used in the literature to evaluate the performance of water utilities only estimate overall efficiencies and do not assess the cost efficiency of each activity (e.g. see Gómez and Rubio, 2008; Romano and Guerrini, 2011 for a general overview of the literature). It could be the case that, for example, a given operator is cost efficient in drinking water supply and inefficient in the delivery of wastewater services. Using an overall efficiency score would not highlight this conclusion in a straightforward manner. Although evaluating the overall efficiency of operators in these cases still has significant value, managing to separate the efficiency of the water and wastewater services could be of further use for decision-makers and regulators.

Several methodologies have been used to assess the performance of water and wastewater services (Berg and Marques, 2011).[1] A conventional classification is the division between parametric and nonparametric methodologies, and both have their strengths and limitations (for a more detailed discussion see Fried et al., 2008). Despite being widely used in the literature, parametric methodologies require an *a priori* definition of the cost or production function and the acceptance of various assumptions derived from economic theory (which may reduce the acceptability of the results by some members of the scientific community). Nonparametric methodologies use the information 'within the data' to estimate efficiency scores and they do not require as many assumptions or constraints.[2] Among the many methodologies available, the data envelopment analysis (DEA) is the most frequently used by researchers. By means of linear programming, DEA estimates a best practice frontier using the inputs and outputs

[1] For simplicity, in this paper we use the term 'water utilities' to refer to operators that jointly provide drinking water and wastewater services in a given territory.

[2] However, nonparametric methodologies also have some drawbacks. For instance, they are very sensitive to extreme data and outliers, they suffer from the 'curse of dimensionality' problem and they are deterministic methodologies with a non-statistic nature.

* Corresponding author. Tel.: +351 21 8417729; fax: +351 21 8417979.
E-mail address: nunocruz@ist.utl.pt (N.F.da Cruz).

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of all observations and computes efficiencies using the most favorable weights for each decision-making unit (DMU).

The information asymmetries between regulators (independent agencies or local authorities) and operators (public or private) hinder the effectiveness of the regulatory framework (Berg, 2000). Frequently, the lack of transparency and sufficient detail in the annual statements of the operators do not allow the proper design and monitoring of incentives for cost efficiency. Although there are several operators that already do this explicitly in their financial statements, incurred costs (operations and capital) and staff are not typically allocated to the corresponding service (in our case, water and wastewater). To the best of our knowledge, this is the first application of a nonparametric model designed to estimate the cost efficiency of each output (i.e. each service) in the water sector, when both services are jointly provided by the same operator.[3]

The objective of this paper is to propose a model for estimating not only the overall efficiency of water utilities, but also the cost efficiency in each of the services provided. In this case, the two services under analysis are drinking water and wastewater services. Using a shared input DEA methodology (see Beasley, 1995; Cook and Green, 2004; Cook et al., 2000; Rogge and De Jaeger, 2012), the authors are also able to report estimates for the cost shares that correspond to each service. Naturally, this methodology could prove to be very useful for regulators and decision makers who wish to benchmark their services against the best practices of the sector.

This article is organized in the following manner. After this introduction, Section 2 briefly describes the importance of economic regulation in the water sector. It addresses some international experiences and the difficulties of putting in place an effective framework of incentives for cost efficiency. Section 3 presents the shared input DEA model along with the data used to assess its usefulness (consisting of 253 observations from 45 Portuguese water utilities for the period 2002–2008). Section 4 summarizes the results obtained and, finally, Section 5 provides a discussion, concluding the paper.

2. Economic regulation and incentives for cost efficiency in the water sector

The water utilities industry presents several features (market failures) that justify regulatory intervention (either implicit or explicit). Among the many concerns, the existence of economies of scale and economies of scope, the 'essential' character of the services and their impact on the well-being of society, the existence of asymmetric information, the need for very high (sunk) investments and long-lived assets, and the occurrence of negative (and positive) externalities, should be highlighted (Marques, 2010). These market failures might lead to mismanagement (lack of effort to improve efficiency) and/or misconduct (setting prices above cost recovery levels and thus earning abnormally high profits). Hence, the presence of regulation is crucial for the protection of customer as well as other stakeholder interests. Regulation intends to work as an "invisible hand" that provides the right incentives for the regulated companies to become more productive (De Witte and Marques, 2010).

Due to the asymmetric information environment and the magnitude of other market failures, performance-based or incentive regulation is gaining importance in the water sector (Marques, 2010). This regulatory process, sometimes called 'yardstick competition', is based on the use of benchmarking tools and in the scorecards obtained to make judgments for the future (Shleifer, 1985). One of the main advantages is the fact that it offers strong incentives toward efficiency and innovation by the water operators, both in their operation and capital expenses (OPEX and CAPEX, respectively). In addition, this methodology also fosters transparency and the sharing of information.

Concerning the regulation of water utilities the literature distinguishes two different benchmarking approaches (Marques, 2006). The first relies on the benchmarking used to set the operators' prices and tariffs. The types of benchmarking tools used are diverse, varying on the actors and on the features of the countries involved. The UK, Chile and Colombia are some remarkable examples of countries which apply this regulatory methodology. The second approach concerns 'sunshine regulation' which consists of the comparison and public discussion of the operators' performance. Sunshine regulation is very popular in the water sector, not only because it is easily applicable but also because it is better accepted by the water utilities. Several countries, such as Portugal, Australia, Brazil or Zambia have applied this 'name and shaming' regulatory methodology with good outcomes.

Regarding the methodologies used in the scope of the first approach, econometric and mathematical programming methodologies are dominant, particularly frontier methodologies such as stochastic frontier analysis (SFA) or DEA. These methodologies use the best practices as benchmarks and normally encompass multiple inputs and outputs. Since these methodologies estimate overall measures of efficiency, they are known as total or global methodologies (see Fried et al., 2008). The second approach uses partial methodologies such as performance indicators (see Alegre et al., 2006), for example the number of employees per thousand of connections or number of bursts per 100 km of mains length. These indices provide only a partial portrait of the issue under analysis but due to simplicity and ease of understanding they are quite popular in the water sector, mostly among engineers and managers. Hence, partial measures are widely used by the operators for managerial purposes and by the regulators to supervise the quality of service. In this article, we will focus on the first regulatory benchmarking approach and on the costs and efficiencies of water and wastewater services (regulation of multi-utilities).

Many regulators all over the world are using benchmarking and performance-based regulatory methodologies (Marques et al., 2011). In order to oversee the quality of service and/or to set prices and tariffs watchdogs are 'using and abusing' this tool (Berg, 2010). Benchmarking allows gathering insights to perform real interpretations of the way utilities work but its careless use might be perverse (Marques and De Witte, 2010). One of the major problems is the comparison of 'apples with oranges', which is particularly more serious when operators provide different services such as water, wastewater, electricity or gas (multi-utilities). This paper develops and proposes a methodology to overcome this issue by disentangling the costs and relative efficiencies per service provided.

3. Data and methodology

3.1. Background: Portuguese water sector

Currently (2012), in Portugal, as in many countries namely in continental Europe, drinking water supply and wastewater services are the responsibility of local governments. One distinctive feature of the Portuguese water sector is the significant vertical disintegration of service provision: 'wholesale' and 'retail' services are usually delivered by different operators (Cruz et al., 2012). In drinking water supply services, the 'wholesale' segment encompasses all activities from water abstraction to reservoir storage

[3] Evidently, we are referring to the use of the shared input DEA model (see Section 3.3). There are several cases where regulators use (partial) performance indicators to assess the cost efficiency of each service. See, for instance, the case of the Portuguese regulator (ERSAR, 2010).