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Performance of the Tunisian Water Utility: An input-distance function approach

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ABSTRACT

The main objective of this paper is to analyse the performance pattern in the Tunisian drinking water industry. The industry is a state monopoly, administered by the Tunisian Water Utility (TWU) since 1968. We apply the stochastic distance frontier method to TWU data over a period of 11 years, from 1999 to 2009. This approach is used to estimate water production technology, to measure technical efficiency levels and total factor productivity growth, and to investigate the factors influencing efficiency levels and those driving productivity growth. The results suggest that performance-based regulation can improve efficiency and enhance productivity in the Tunisian water industry.

1. Introduction

Water supply is always a public service and water is usually provided by the public sector. Since 1968, SONEDE, which is the Tunisian Water Utility (henceforth TWU), has held the monopoly on drinking water supply over the entire country. TWU is a state-owned company and vertically integrated provider of drinking water. The drinking water industry is organized in three stages: resources and facilities development, production and treatment, and transmission and distribution.

The Ministry of Agriculture supervises TWU and a board of directors is appointed to oversee its activities. TWU operates through central operating departments, regional departments, and district water agencies. The district water agencies, operating essentially at the transmission and distribution stage, are in charge of commercial and operational functions, while the legal, financial, and human resources management tasks are centrally monitored.

Tunisia has made significant progress in terms of securing access to drinking water for most citizens.[1] However, in 2012, repeated disruption in supply service in some regions of the country put the TWU under fire. Meanwhile, the new socio-political context increased the pressure on the company (Morin, 2013). As a result, TWU faces a growing challenge as it is called upon to enhance its performance in order to ensure the reliability of water supply service. However, regulation has a substantial impact on TWU's productivity and efficiency. The Tunisian government plays the key regulatory role. It has practiced "rate-of-return" regulation, entirely controlling the price level of water service and setting TWU's recruitment schemes. Since 1992, a contract program has been used to govern TWU and government mutual obligations. For each block of five years, the government approves TWU's investment plan and social, operational, and financial goals.

[1] In 2013, 99.5% of the urban population, which accounts for 66.46% of the total population, has a property connection with 24 out of 24 h service supply. 93.9% of the population in rural areas has access to an improved water source; however, only 46.1% has a property connection. Overall, 83.1% of the total population benefits from TWU property supply service. For these customers, the annual cost of 40 L per day per capita as a share of per capita GDP is 0.116% and connection fees, as a share of per capita GDP, are 6.75%.

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The government also has to approve every TWU tariff-adjustment request (Baietti et al., 2006).

Most information on the performance of the Tunisian drinking water industry is available in the TWU annual activity report. This report presents the achievements that have been realised and the corresponding resources used during each year's activities, as well as the TWU financial statement. It also serves as TWU's report to the government on its performance in the application of the contract program. The report displays 24 technical, financial and social indicators related to the objectives set in the contract program. The target achievement level and annual change of each indicator are also presented. It appears, however, that analysis of the Tunisian drinking water industry's performance is confined to a single measure-based gap analysis, and it is restricted to assessing TWU efficacy. But TWU efficiency, which constitutes the other part of overall performance, has remained unmeasured.

To our knowledge, there are no empirical studies to date to help managers and policy-makers understand the performance pattern in the Tunisian water industry. The objective of this paper is twofold: first, we measure the technical efficiency levels of TWU's district water agencies over an 11-year period. Second, we analyse TWU's productivity growth and quantify all sources of total-factor productivity change.

Abbott and Cohen (2009), Berg and Marques (2011), Walter et al. (2009), and Worthington (2011) have conducted comparative literature reviews of efficiency analyses and productivity measurements in urban water utilities. Their studies present a comprehensive account on the issue from the earliest paper of Ford and Warford (1969) up to studies published in 2010. Their work also describes the various approaches adopted and summarises the key structural research findings.

In this study we use an empirical technique that can accommodate the multi-input, multi-output nature of the industry to estimate the relative efficiency and productivity growth of each district water agency and the Tunisian water industry overall.

This paper makes three contributions. First, it demonstrates the advantage of the stochastic parametric input distance function to characterise Tunisian drinking water technology. Second, it measures technical efficiency of district water agencies while taking into account the influence of contextual factors. Third, it identifies the drivers and constraints of productivity growth in the Tunisian water industry.

The results of the analysis should provide decision-makers with useful information to improve drinking water governance in Tunisia, and perhaps elsewhere. In particular, the benchmarking results could serve the design and implementation of alternative regulatory arrangements.

This analysis follows the conventional step-by-step empirical procedure appropriate for this kind of research. We select, first, the frontier-efficiency measurement approach and present the method used to explain efficiency differences and productivity growth; second, we specify the variables used (Section 2); and finally, we present and interpret the results of our estimation and calculations (Section 3).

2. Methods: stochastic frontier and technical inefficiency effects model

In this study we adopt the measurement of efficiency introduced by Farrell (1957). For that purpose, we assess the technical efficiency of the 21 decision-making units (DMUs) encompassing Tunisia's 27 to 37 district water agencies over the study period by estimating the production technology of "fully efficient" agencies.

Efficiency measurement can use either a parametric or non-parametric approach; each can also be either deterministic or stochastic. The non-parametric approach is based on mathematical programming techniques, while the parametric approach is based on econometric techniques. The alternative approaches and underlying concepts were reviewed in Försund et al. (1980). The choice of any particular approach is motivated by theoretical and empirical considerations; Coelli et al. (2003) and Worthington (2011) present a useful comparison detailing the merits and drawbacks of the different approaches. In this study, we look for a suitable method that enables us to take into account the noisiness of the data. Therefore, a parametric stochastic frontier analysis method, independently proposed by Meeusen and van den Broeck (1977) and Aigner et al. (1977), is used. This approach accommodates random error and lends itself to a standard statistical test, but it requires the selection of a functional form for the production technology and specification of the error distribution.

TWU deals with multi-output, multi-input processes; therefore we represent the production technology by a stochastic distance function. This approach addresses a single output restriction implicit in the standard production function. Furthermore, it requires neither a behavioural objective specification nor information on output prices. The distance-function estimates allow us to compute and to evaluate technical efficiency as well as a range of measures reflecting firm economic performance, such as output–input relationships and productivity growth.

The distance function has either an input or an output orientation. In the water industry, the level of service is generally considered mandatory and the utility management focus is to reduce inputs while maintaining a measure of output. Furthermore, since Tunisian water resources are scarce, TWU is subject to demand-side management policies, and increases in output are generally impractical.[2] For this reason, an input-oriented measure is most appropriate for water utility management.

2.1. Input-distance function

The input distance function (Shephard, 1953, 1970), measures the largest scalar by which the input vector X may be proportionally contracted in order to produce a given output vector Y with the technology existing at a particular time t (i.e., catch up to the productivity frontier). The input distance function may be defined on the input set as: $d_{Input}(X,Y) = \sup\{\omega : (X/\omega) \in L(Y)\}$ where ω is the scalar, or distance, by which the input vector can be deflated, and the input set $L(Y)$ represents the set of all input vectors, $X \in R_+^K$, which can produce the output vector, $Y \in R_+^M$.

We assume that the standard Färe and Primont (1995) axioms hold and the input distance function has the following properties: $d_{Input}(X,Y)$ is non-decreasing, positively linearly homogenous and concave in X, and non-increasing and quasi-concave in Y. X belongs to the input set of Y if and only if $d_{Input}(X,Y) \geq 1$. When a DMU operates on the frontier of the period t technology, isoquant L(Y), then $d_{Input}(X,Y) = 1$ and DMU achieves technical efficiency. Moreover, the input distance function is the dual of the cost function.

2.1.1. Translog approximation

We employ a translog form to estimate in a parametric setting the input distance function. This functional form has the desirable property of flexibility; that is, it can be used as a second-order approximation to a true but unknown technology. This characteristic is of particular interest because it reduces estimation bias resulting from an improper assumption about functional form.

[2] Nevertheless, the utility may seek to maximise some output, such as service quality, and this likely reflects discretionary actions taken by management.