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Productivity growth and price regulation of Slovenian water distribution utilities*

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Abstract

This paper aims to analyse the price regulation method and performance of the water industry in Slovenia. A stochastic cost frontier model is employed to estimate and decompose the total factor productivity (TFP) growth of water distribution utilities in the 1997-2003 period. The main goal is to find out whether the lack of proper incentives to improve performance has resulted in the low TFP growth of Slovenian water distribution utilities. The evidence suggests that cost inefficiencies are present in water utilities, which indicates considerable cost saving potential in the analysed industry. Technical change is found to have positively affected the TFP growth over time, while cost inefficiency levels remained essentially unchanged. Overall, the average annual TFP growth in the analysed period is estimated to be only slightly above zero, which is a relatively poor result. This can largely be contributed to the present institutional and regulatory setting that does not stimulate utilities to improve productivity. Therefore, the introduction of an

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independent regulatory agency and an incentive-based price regulation scheme should be seriously considered in order to enhance the performance of Slovenian water distribution utilities.

Key words: *TFP growth, SFA, cost efficiency, water distribution utilities, price regulation*

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1. Introduction

Measures of productivity and associated productivity growth are of great interest when analysing firm, sector or country performance. Measures that simultaneously take all factors of production into account are usually preferred over single or partial factor productivity measures. Total factor productivity (TFP) is an overall measure of productivity and is typically computed using an index number approach as the ratio between an output index and an input index. TFP growth is one of the most widely employed measures of overall productivity change. As productivity growth also plays an important role in incentive-based price regulation, regulatory authorities may be interested in measuring TFP growth. This information can be then used in the price regulation process to set requirements for improving utilities' performance.

Since the late 1980s it has become increasingly important to promote the performance of natural monopolies operating within network industries. In this respect, incentive-based regulation schemes appear to be superior to the traditional rate-of-return regulation. The most widely adopted incentive-based regulatory schemes involve price cap (RPI-X or CPI-X regulation)[5], revenue cap, and yardstick regulation models. The X factor reflects the cost reduction required by regulators and assures that productivity improvements are passed on and that existing above-normal profits and cost inefficiencies are removed. It assures that customers receive some price benefits as a result of price-cap regulation and that management will have to achieve some target level of efficiency improvement before stakeholders benefit from enhanced profits as a result of lower costs.

The individual X-factor is usually based on two pieces of information: the rate of productivity growth (technical change) reported in the industry in recent years and the firm's cost inefficiency, i.e. on the extent that a given firm is operating below the best practice in the industry (Coelli et al., 2003). The greater the X, the tighter is the constraint. In order to set efficiency or productivity requirements, most regulation schemes employ benchmarking. In this way, the informational asymmetry problem between the regulator and firms can be overcome. In benchmarking applications the regulator is generally interested in obtaining a measure of a firm's performance

[5] RPI and CPI denote retail and consumer price index, respectively.

relative to a predefined benchmark in order to reward (or punish) a firm accordingly. For example, benchmarking combined with a price cap is in use in the UK water and sewerage sector (OFWAT, 1999, 2004).

In Slovenia, the current price regulation of water distribution utilities resembles the traditional rate-of-return regulation. In the past this was combined with very restrictive limits on the maximum price increases allowed in order to curtail inflationary pressures. In 2004, the use of benchmarking in the price regulation of water utilities was considered but has never been implemented due to a lack of data and concerns regarding its quality.

In this paper, we consider the possibility of employing stochastic frontier benchmarking methods to analyse the performance of water distribution utilities operating in Slovenia. Stochastic frontier approach is used to estimate the cost frontier function for a sample of water distribution utilities operating between 1997 and 2003. The main objective of this paper is to obtain estimates of the TFP growth of Slovenian water distribution utilities and evaluate the outcome of the regulatory regime with respect to promoting productivity growth in the Slovenian water sector. The underlying hypothesis is that the lack of proper incentives to improve performance has resulted in the low TFP growth of Slovenian water distribution utilities. We draw on work by Filippini et al. (2008) where different stochastic frontier methods are employed to estimate the cost inefficiencies of Slovenian water utilities. While the emphasis in Filippini et al. (2008) is on comparing alternative econometric models for estimating cost efficiency using panel data, this paper extends the analysis to the measurement of productivity growth, which is a broader concept than efficiency improvement. Indeed, we use the same data set and one of the econometric models used in Filippini et al. (2008) to perform a productivity analysis and to decompose the TFP growth into its constituent parts. The goal is to identify which components, if any, made the most significant contribution to the TFP growth in Slovenian water distribution utilities.

In the academic literature we can find three types of studies on the costs of water distribution companies: (i) studies estimating economies of density, economies of scale and/or economies of scope; (ii) studies estimating cost efficiency; and (iii) studies estimating TFP growth. Most studies investigate economies of scale in the water supply industry[6], while only a few studies on cost efficiency can be found, namely in Bhattacharyya et al. (1995), Ashton (2000) and Filippini et al. (2008). Likewise, the issue of productivity growth in the water industry has been neglected in the academic literature. The only exception is the work by Saal and Parker (2001)

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[6] Relevant papers estimating economies of density, scale and/or scope in water supply companies are the following: Kim and Clark (1988), Bhattacharyya et al. (1995), Ashton (2000), Fabbri and Fraquelli (2000), Antonioli and Filippini (2001), Mizutani and Urakami (2001), Garcia and Thomas (2001), and Filippini et al. (2008).

and Saal et al. (2007) which were motivated by the privatisation of the English and Welsh water and sewerage industry in 1989. The two studies analysed productivity growth in order to assess improvements in the industry's performance under private ownership and to obtain productivity estimates that could be used in price regulation. Surprisingly, the results show that productivity growth did not improve after privatisation. Further, the decomposition of the TFP growth in Saal et al. (2007) indicates that technical change increased after privatisation, while the efficiency change and scale effects were negative. The latter implies the presence of decreasing returns to scale in the water and sewerage sector.

The remaining of the paper is organised as follows. Section 2 discusses the institutional setting, major changes and issues along with the current regulatory scheme of the Slovenian water sector. Section 3 presents the model specification employed and the methodology to decompose TFP growth. This is followed by Section 4 where a data description is briefly provided. Finally, Section 5 presents the estimation results and discusses the main findings, while Section 6 concludes the paper.

2. Institutional setting and price regulation of the Slovenian water industry

In Slovenia communal services, i.e. services related to water supply, wastewater treatment and solid waste collection and disposal, are generally managed at the local community level. They are classified as obligatory local public services since municipalities or local communities are obliged to provide these services. Public utilities have the exclusive right to provide public services in the territory of one or more local communities, which makes them local monopolists. Networks that are needed to provide communal services typically demonstrate significant economies of scale. Due to the natural monopoly characteristics of communal services introduction of competition is not feasible since new entries would only lead to duplication of fixed costs (Baldwin, Cave, 1999). Therefore, these activities need to be regulated. In Slovenia, local communities are in charge of controlling the quality of services and the prices charged. Communal services are generally provided by public enterprises, but they can also be delegated to private entities through concessions. Usually, in smaller municipalities all communal services are joined within a single company, i.e. "multi-utility", while in larger municipalities communal services are provided separately by several companies.

The post-1991 period has witnessed dramatic changes in the legal environment and institutional framework in which local communities and their respective communal utilities operate. These changes can be classified in two main groups: changes in the relationship between local communities and public utilities and changes in local communities' legislation. Both have had unfavourable impacts on the level of communal infrastructure investments (Mrak, 1997).

Under the 1993 Public Utilities Act, the ownership of communal infrastructure was transferred to local communities. They became owners of assets that were previously in the possession of public utilities. Accordingly, local communities as the new owners of communal infrastructure became responsible for the investments required to maintain and upgrade communal infrastructure. As there were no precise accounting standards for the effective implementation of legislation, the depreciation of communal infrastructure was often not accounted for. This jeopardised the long-term financial viability of communal utilities (Mrak, 1997). The solution came in 1997 with the adoption of a special accounting standard (SRS 35) to deal with accounting issues specific to the public sector.

Another development that hindered investments in communal infrastructure was the reorganisation of local communities. Under the 1993 Law on Local Self-Government the large majority of local communities was divided into two or more local communities. Between 1991 and 2008 the number of local communities in Slovenia more than tripled, from 62 municipalities in 1991 to 210 in 2008 (SORS, 2008). As the reorganised local communities were often very small, many did not have sufficient financial resources to invest in communal infrastructure. The issue of infrastructural investment was further complicated by the fact that a distribution of assets and liabilities of old local communities among the new ones had to be established. Some public utilities also faced the situation where they operated in more than one local community which exposed them to various problems as they had to deal with more than one owner of communal infrastructure, requiring a consensus on pricing and other operational issues (Mrak, 1997).

Besides these investment problems, the poor financial performance of communal utilities was another issue. Prices of communal services have been under government control since 1992. Price determination was subject to political considerations and other macroeconomic goals (e.g. reducing inflation), which caused the prices of communal services to rise slower than the inflation rate (i.e., a decrease in real terms). In this way utilities were not allowed to increase their prices to the full-cost levels (Štruc, 1997). In most cases, tariffs have only been sufficient to cover current expenditures but not to finance regular maintenance and the replacement of fixed assets (Hrovatin, 2002). Consequently, the financial soundness of communal utilities was well below the financial performance of the Slovenian economy as a whole. In fact, most communal utilities operated at a loss, which is highly unsustainable in the long run. Kavčič (2000) reported that in 1998 the average costs were on average 30 percent higher than the average price of water supplied to different customer groups.

In order to improve their poor financial position caused by the restrictive price regulation, communal utilities had to find 'creative' solutions regarding new funding sources. One of the most commonly used practices over the examined period was the introduction of environmental and/or local fees. In this way local communities tried to help their utilities overcome the most severe financial constraints on doing business.

Another interesting issue was, and still is, the striking differences in water prices across local communities. This arose from the fact that public utilities had very different price levels at the start of the price control. Some utilities charged prices close to the full-cost level, while in others prices were well below costs. Hence, the price control created different operating environments for utilities with different starting positions. Unfortunately, this issue was not recognised by the relevant authorities (Hrovatin, 2002).

As in many transition economies, Slovenia also faced significant differences in price levels for water supply between different customer groups. Prices for water supply were the lowest for households and the highest for businesses customers. Nevertheless, the range of prices paid by different customer groups has narrowed over time (Štruc, 1997). Although price discrimination between different groups of customers may sometimes be justified by differences in costs, the policy of subsidising households and thereby addressing social policy issues seems to be a more plausible explanation. Such social policy causes distorting effects of low-priced services. It enhances overconsumption and reduces incentives for efficiency since customers receive misleading signals as to the real value of services.

In 2004, there was a serious attempt to change the price setting practice whereby the primary objective of reducing inflation was to be replaced by improving the performance of public utilities. The government issued the Rules on the Price Determination of Obligatory Local Public Utilities (2004) with an attempt to introduce benchmarking methods in the regulatory scheme. In this way, utilities would have been given proper incentives for more efficient operation. This would have resembled the UK regulation practice for water and sewerage industry (OFWAT, 2004).[7] Soon after the Rules were adopted, it was realised that this objective was too ambitious for the time being due to the lack of appropriate and reliable data. Data have not been systematically collected at the national level as water utilities are under the responsibility of local communities and no regulatory agency was established at the national level. Also, an agreement on the benchmarking methodology was not reached. Therefore, the Rules never came into effect.

With minor changes each year, a very restrictive price-setting policy based on decrees on the price determination of communal services was in place until August 2009 when

[7] The EU Water Pricing Communication (COM(2000) 477 final) also facilitates benchmarking. Benchmarking of suppliers' performance is viewed as an incentive to improve their efficiency and quality of services and reduce their costs and prices.

the Decree repealing the Decree on the Formation of Prices for Basic Utility Services (2009) was issued. At present, the price regulation of Slovenian water distribution utilities resembles the traditional rate-of-return regulation. According to the Rules of the Tariff System for Obligatory Local Public Utility Services (2009) price control by the government has been abandoned which means that price-setting became the sole responsibility of respective local communities. Cost-reflective prices have been introduced, while there are no incentives for efficiency improvements. According to the IMAD (2009), the transfer of pricing responsibilities to local communities in the absence of an appropriate pricing methodology and independent regulatory body is expected to lead to greater inefficiencies which will eventually be translated into price increases. This also raises concerns regarding the competence and independence of political considerations in the governance of utilities. Local communities do not have sufficient and skilled professional staff to stimulate the efficient operation of water utilities and set up adequate price regulation schemes. Moreover, populism and other political goals may jeopardise the viability of communal utilities.

Decision-making with respect to water prices varies considerably between and within the EU member states. While water-price levels and structures can be decided at the local, regional or national level, it is rare that decisions on pricing are entirely decentralised with no supervisory power institutionalised at the national level. Municipal decision-making will inevitably lead to a greater diversity of pricing practices within a given country than centralised decisions by government ministries. Also, independent regulatory authorities may have different perspectives on price setting than respective ministries, the former being perhaps more professional and technical in their approach and the latter being more political and bureaucratic. Moreover, in the EU context there are currently considerable differences in organisation of water supply between the member states. Forms of organisation include provision of water by municipalities, private companies and quasi-autonomous non-governmental organisations, with varying degree of regulation by government departments, federal states, local communities, and independent regulatory bodies. As a result, there are wide variations between member states in relative price levels, structure of prices, costs, levels of cost recovery, investment levels, and water quality (Hrovatin and Bailey, 2001).

To address these issues, the European Commission (EC) published the EU Water Pricing Communication (COM(2000) 477 final) with recommendations for water pricing policies in the EU member states. The EC advocates an increased role for pricing in enhancing the sustainability of water resources. Efficient water pricing is believed to act as an incentive to reduce pollution and improve the efficiency of water use. The water prices should be set at the full-cost levels and in direct relation to the water consumed or pollution produced. This would additionally mobilise financial resources to ensure the financial sustainability of water infrastructure and service suppliers. Therefore, the EC recommends a harmonised approach to water pricing across the EU, using volumetric charges to reflect and recover financial, environmental and resource costs.[8] The EC also calls for the standardised accountancy practices and the adoption of common definitions for key cost variables which would facilitate the comparison between costs and prices, and benchmarking analysis. The EC recommendations are expected to have significant implications for the EU member states. However, due to the extremely diverse arrangements in the water supply between the EU member states, so far there has been a rather slow progress towards the harmonised EU water policy.

Clearly, the strategic objective of the communal sector in Slovenia should be to move towards the reliable and cost-efficient provision of communal services which will also take account of safety of the population and protection of the environment and be in compliance with the relevant EU legislation. In order to achieve these objectives, a range of co-ordinated policy measures has to be designed and put into operation. The following core elements of the communal sector reform consistent with the EU's water pricing policy recommendations can be identified (Mrak, 2000)

- the introduction of cost-reflective prices of communal infrastructure services and tariff reform;
- the introduction of competition for the market, restructuring of service providers and private sector involvement;
- a legal and institutional framework which would provide clear rules for private sector involvement in communal infrastructure investment and in the provision of communal services; and
- a regulatory framework: independent yet accountable regulatory authorities are needed to monitor the operation and performance of utilities.

3. Methodology

3.1. Model specification

The main purpose of water supply utilities is to produce drinking water with sufficient quality from a resource (groundwater or surface water) that may require preliminary treatments to make drinking water wholesome and clean, and to distribute water by continuously adapting supply to daily demand while preserving water quality during its transportation through the transmission and distribution network (Garcia and Thomas, 2001). Water supply utilities typically cover all operations from resource extraction to consumer taps. The costs of operating a water distribution system are

[8] To be noted that the harmonised approach is not expected to result in uniform prices due to the differences in costs reflecting geographical, topographical, climate, institutional and economic factors, which vary considerably not only between but also within countries.

therefore the costs of building and maintaining the water system (wells and springs, pumps, treatment facilities, storage facilities, transmission and distribution pipelines and other facilities), and of measuring and billing water. The main factors influencing the cost of water distribution companies consist of total water sold, input prices, total number of customers served, type of consumers and customer density, size and morphology of the distribution area, length of distribution pipes, water resource (underground water or surface water), water losses from the distribution system, and water treatment needed (Antonioli and Filippini, 2001).

For the specification of the cost model, we consider a water distribution company which uses three inputs, labour, capital and material, to distribute a single output to a number of customers within its service area. Therefore, the cost function can be written as:

$$C = C(P_L, P_M, P_K, Q, CU, AS, WU, t)\,, \tag{1}$$

where C represents total cost and P_L, P_M, and P_K are the price of labour, the price of material and the price of capital, respectively. Q is the output represented by the quantity of water delivered, CU stands for the number of customers served, while AS is the size of the service area. The reason for including these two variables in the model is that in the case of network industries the output typically possesses several dimensions. Therefore, besides output distributed, several output characteristics such as number of customers and size of service area can influence costs. The output characteristics are included as explanatory variables to control for the cost differences that occur merely due to the heterogeneity of output (Caves et al., 1984). WU stands for the share of underground water resources used. It is included in the model to control for the differences in production process since groundwater usually implies higher drilling and pumping costs, whereas treatment costs are usually higher with surface water. Finally, t is a time variable which captures the shift in technology.

The cost function is estimated using the translog functional form which is a locally flexible functional form widely used in the empirical literature. The translog form of the cost function in (1) is specified as follows:

$$\begin{aligned}\ln C_{it} &= \ln\alpha + \beta_{y_j}\sum_j \ln y_j + \beta_{w_l}\sum_l \ln w_l + \\ &+ \tfrac{1}{2}\beta_{y_j y_k}\sum_j\sum_k \ln y_j \ln y_k + \tfrac{1}{2}\beta_{w_l w_m}\sum_l\sum_m \ln w_l \ln w_m \\ &+ \beta_{y_j w_l}\sum_j\sum_l \ln y_j \ln w_l + \gamma_{WU} WU + \gamma_T t + \varepsilon_{it}\,,\end{aligned} \tag{2}$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T_i$, y_j ($j = 1, 2, 3$) stands for Q, CU and AS, while w_l ($l = 1, 2\ 3$) stands for P_L, P_M, and P_K, respectively. Time variable t is considered to be a neutral technical change. Interactions of the time variable with other variables are not considered since insignificant coefficients were obtained.[9] Normalisation of

[9] For example, Bauer (1990) also considered a neutral technical change.

cost and input prices by one of the input prices is used to impose linear homogeneity in input prices. Hence, the total cost, the price of labour and the price of material are divided by the price of capital. The expansion point of the translog stochastic frontier cost function is chosen to be the sample median.

Stochastic Frontier Analysis (SFA) is employed to estimate the cost function in (2). SFA was originally introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). In subsequent papers, Pitt and Lee (1981) and Schmidt and Sickles (1984) proposed stochastic frontier models for panel data. Over the years, many extensions to the originally proposed stochastic frontier models have been developed. A good review of different stochastic frontier methods is provided in Kumbhakar and Lovell (2000), while some new developments in this field can be found in Greene (2005a, b). In the stochastic frontier model the error term (ε_{it}) is composed of two parts: a stochastic error (v_{it}), capturing the effect of noise, and a one-sided non-negative disturbance capturing the effect of inefficiency ($u_{it} \geq 0$). In estimating the frontier cost function in (2) we make use of the true fixed effects (TFE) model.[10] In contrast to the conventional stochastic frontier methods, the newly proposed TFE method by Greene (2005a, b) treats firm-specific fixed effects (α_i) and cost inefficiency (u_{it}) separately and is therefore able to distinguish between the unobserved heterogeneity and inefficiency. Moreover, this relatively new method allows the inefficiency to vary over time, while the conventional SFA panel data methods assume time-invariant inefficiency.[11] The TFE model is estimated by the 'brute force' ML, i.e., by simply creating dummy variables for each firm.[12] It should also be noted that time-invariant firm characteristics cannot be included in the TFE model as explanatory variables. Nevertheless, these effects can be viewed as unobserved heterogeneity and are at least partly captured by the firm-specific time-invariant term additionally specified by this model.

3.2. TFP growth decomposition

Following the index number approach, a TFP index is generally constructed as the ratio of an output index to an input index where the weights reflect the relative importance of the various inputs and outputs (i.e., the weights equal the revenue shares and cost shares, respectively). In a single output case, TFP growth is defined as follows (Jorgenson and Griliches, 1967):

[10] Filippini et al. (2008) provide a comparison of alternative stochastic frontier models and arguments to use the TFE model.

[11] The remaining shortcoming of the TFE model is the incidental parameters problem (see Greene, 2005b).

[12] To estimate the stochastic cost frontier using the maximum likelihood (ML) method, the following distributional assumptions have to be made: $v_{it} \sim \text{iid}\, N(0, \sigma_v^2)$, $u_{it} \sim \text{iid}\, N^+(0, \sigma_u^2)$ and vit and uit are distributed independently of each other and of the regressors.

$$T\dot{F}P = \dot{y} - \dot{X} = \dot{y} - \sum_{i=1}^{K} \frac{w_i\, x_i}{C} \dot{x}_i \quad , \tag{3}$$

where a dot above a variable indicates its rate of growth over time *t*: $\dot{y} = d\ln y / dt = (1/y)(dy/dt)$. The observed output is denoted by *y*, x_i is the observed use of *i*-th input (*i* = 1, … *K*), w_i is the input price of *i*-th input, *C* is the observed cost, and *X* stands for an aggregate measure of an observed input usage, with weights equalling the observed cost shares of the inputs used.

In order to decompose TFP growth, a cost-function approach combined with a differential method is applied.[13] In addition, TFP growth is decomposed by allowing for the presence of cost inefficiency in the sample. Cost efficiency is given by the ratio of minimum (frontier) cost $C(y,\mathbf{w},t)$ to observed cost *C*:

$$CE = C(y, \mathbf{w}, t) / C \quad , \tag{4}$$

where **w** stands for the $K\times 1$ vector of input prices. Taking the natural logarithm of both sides of (4), totally differentiating with respect to time and making some minor substitutions and rearrangements after inserting this expression in (3), Bauer (1990) showed that the observed TFP growth can be written as follows:[14]

$$T\dot{F}P = C\dot{E} - \dot{C}(y, \mathbf{w}, t) + \left[1 - \varepsilon_y(y, \mathbf{w}, t)\right]\dot{y} + \sum_{i=1}^{K}\left[S_i - S_i(y, \mathbf{w}, t)\right]\dot{w}_i \quad , \tag{5}$$

where:

$\varepsilon_{\mathbf{y}}(y,\mathbf{w},t) = \partial \ln C(y,\mathbf{w},t)/\partial \ln y = \left[\partial C(y,\mathbf{w},t)/\partial y\right]\left[y / C(y,\mathbf{w},t)\right]$ is the elasticity of cost with respect to the output;

$S_i = w_i x_i / C_i$ is the observed cost share of the *i*-th input;

$S_i(y,\mathbf{x},t) = \partial \ln C(y,\mathbf{w},t)/\partial \ln w_i = w_i x_i(y,\mathbf{w},t)/C(y,\mathbf{w},t)$ is the cost-minimising cost share of *i*-th input obtained using Shephard's (1953) lemma;

$x_i(y,\mathbf{w},t)$ is the cost minimising input demand.

[13] There are two main ways to derive TFP growth decomposition, the total differential method (see, for example, Bauer, 1990, and Kumbhakar and Lovell, 2000) and the index number method (see, for example, Caves, Christensen and Diewert, 1982, and Orea, 2002). Nonetheless, the two approaches result in almost identical formulas.

[14] Bauer (1990) extended the decomposition of TFP growth proposed in Denny, Fuss and Waverman (1981) by taking efficiency change over time into account.

According to (5), the TFP growth is decomposed into terms related to: (i) cost efficiency change; (ii) technical change; (iii) scale efficiency change; and (iv) a residual price effect term. The first component captures the contribution to productivity change of a change in cost efficiency. The second component is a technical change effect that shifts the cost frontier down if technological progress is present, or up if technical change is regressing. The third component is a scale effect which makes no contribution to productivity change if either the elasticity of cost with respect to the output equals one or there is no change in the output produced. Output growth in the presence of scale economies ($\varepsilon_y(y, \mathbf{w}, t) < 1$) contributes to productivity growth, as does an output contraction in the presence of diseconomies of scale ($\varepsilon_y(y, \mathbf{w}, t) > 1$). The fourth component, the price effect term, occurs because the aggregate measure of input usage is biased when a firm is allocatively inefficient.[15] The price effect term is present because TFP growth is defined as an observable quantity and therefore relies on observed input usage which might be biased due to cost inefficiency. Alternatively, an unbiased or pure measure of TFP growth could be defined by omitting the price effect term but the link to an observable quantity would be lost (Bauer, 1990). The TFP decomposition thus provides useful conceptual and empirical tools for assigning the observed changes in TFP to various sources.

As already noted, for network industries output characteristics have an important influence on the cost of providing a certain output. Therefore, these characteristics are incorporated in the cost function and also have to be taken into the account in the TFP growth decomposition. If an increase in a given network characteristic increases (decreases) the cost given that the output remains unchanged, then increasing the level of that variable decreases (increases) TFP growth (Bauer, 1990). To allow for the effect of output characteristics on the TFP growth, (5) has to be properly modified. In our single-output case with two output characteristics, the TFP growth decomposition is obtained in the following way:

$$\dot{TFP}_{it} = \dot{CE}_{it} - \frac{\partial \ln \hat{C}_{it}}{\partial t} + (1-\varepsilon_Q)\dot{Q}_{it} - \varepsilon_{CU}\,\dot{CU}_{it} - \varepsilon_{AS}\,\dot{AS}_{it} + (LS_{it} - LS^*_{it})\dot{L} + (MS_{it} - MS^*_{it})\dot{M} + (KS_{it} - KS^*_{it})\dot{K}. \tag{6}$$

All components of the TFP growth can be obtained from the estimated cost frontier function in (2). $\hat{C}_{it}$ is the predicted frontier cost and *CE* is a cost efficiency score which is obtained from the estimated cost frontier function. Technical change is calculated by taking the derivative of estimated cost frontier function with respect to time. Further, ε_Q, ε_{CU} and ε_{AS} are elasticities of cost with respect to the output

[15] If a firm is allocatively efficient, then $S_i = S_i\,(y, w, t)$ and the price effect term is equal to zero. This term is also equal to zero when input prices change at the same rate.

delivered (*Q*), number of customers (*CU*) and area size (*AS*), respectively. *LS*, *MS* and *KS* stand for the observed cost shares of labour (*L*), material (*M*) and capital (*K*), while LS^*, MS^* and KS^* are the respective cost-minimising shares obtained by taking the derivative of the estimated cost frontier with respect to the price of labour, material and capital. Therefore, the first term on the left-hand side of (6) represents the cost efficiency change (*CEC*), the second term embodies the technical change (*TC*), the third term characterises the scale efficiency change (*SEC*), the fourth and fifth terms correspond to a change in output characteristics (*OCC*), while the last three terms capture the residual price effects (*PER*).

4. Data

The study is based on a panel data set of Slovenian water distribution utilities in the 1997-2003 period. Some utilities also provide other services like wastewater treatment, collection and disposal of waste, gas distribution etc. Since 1997 public utilities have been obliged to prepare separate accounts for each regulated activity, which enabled us to collect the data related to water supply activity only. The data were gathered via a questionnaire issued by the Ministry of the Environment and Spatial Planning in 2004. In this way data on 52 water supply utilities over the 1997-2003 period were obtained. Utilities included in the sample supply almost 80% of all Slovenian municipalities. The sample is an unbalanced panel consisting of 332 observations. As already mentioned, the data on water distribution utilities are not annually collected at the national level and since the Ministry of the Environment and Spatial Planning has not decided to repeat the survey after 2004, we were unable to collect more recent data. Nevertheless, as regulatory regime has remained basically unchanged over the years, the main conclusions also apply to the performance of water utilities up to the present date.

Descriptive statistics of the variables included in the stochastic cost frontier model are presented in Table 1, while Table 2 presents some other relevant measures for water distribution utilities. All input prices and costs were deflated to 2000 prices in Slovenian tolars (SIT) using the producers' price index.[16] The construction of input prices is described in more detail in Filippini et al. (2008). It can be noticed that utilities differ in size as well as in some environmental conditions.

[16] The average official exchange rate of the Slovenian tolar (SIT) in 2000 was EUR 1 = SIT 205.0316 (Bank of Slovenia, 2001).

Table 1: Descriptive statistics of the variables included in the model (1997-2003)

Variable description	Variable	Mean	Std. Dev.	Min	Max	N
Total annual cost (10^3 EUR)	*TOTEX*	1,486.1	2,625.9	35.2	14,619.9	332
Price of labour (EUR/ employee)	*PL*	14,864.5	1,936.8	10,397.9	20,302.7	332
Price of capital (EUR/ litre per second)	*PK*	2,191.9	2,755.2	65.8	7,237.9	332
Price of material (EUR/ km of network)	*PM*	1,521.7	1,191.5	228.8	6,886.7	332
Water supplied (1,000 m^3)	*Y*	2,298.8	3,835.5	106.6	25,507.7	332
Number of customers (nr. of connections)	*CUST*	7,402.1	7,777.4	515.0	43,272.0	332
Size of service area (km^2)	*AREA*	336.9	240.0	57.8	949.1	332
Share of underground water (%)	*WU*	60.3	42.6	0.0	100.0	332

Source: Authors' calculations

We can observe large differences in the average costs ranging from EUR 0.2 to EUR 1.4 per cubic metre of water delivered. With the exception of the share of household customers, the differences between utilities with respect to other selected measures are as well substantial.

Table 2: Selected measures of Slovenian water distribution utilities within the period 1997-2003

Variable description	Mean	Std. Dev.	Min	Max	N
Average cost (EUR/m^3)	0.544	0.218	0.211	1.395	332
Share of water losses (%)	26.7	11.0	6.5	59.1	332
Share of household customers (%)	91.8	4.0	80.0	99.6	332
Share of water delivered to households (%)	69.3	12.2	22.9	92.7	332
Customer density 1 (customers/km^2)	24.9	19.8	5.3	98.9	332
Customer density 2 (customers/km)	28.1	18.6	7.9	125.0	332
Dummy variable for heavy water treatment (1 – heavy treatment needed; 0 – otherwise)	0.121	0.326	0.000	1.000	332

Source: Authors' calculations

The share of household customers is found to be above 80 percent for all observations, while the water distributed to households varies between 23 and 93 percent. The utilities therefore significantly differ in the share of water delivered to non-household customers (i.e., industry and businesses). There are also considerable differences in customer density between the utilities. Water losses from the distribution network, which on average amount to 27 percent of total water distributed, indicate that the water systems are in quite bad shape. Most of the water delivered comes from underground sources which typically need less treatment but require higher drilling and pumping costs than surface water. Only 12 percent of utilities need to use chemical treatment which is necessary when the quality of water does not reach a predefined standard and is therefore not suitable for drinking.

5. Results

Estimation results of the translog cost frontier function of water distribution utilities in Slovenia operating between 1997 and 2003 are shown in Table 3. Using coefficient estimates in Table 3 and the decomposition in (6) enabled us to obtain components of the TFP growth (reported in Tables 4 – 6).

As expected, the results in Table 3 show that input prices, output and output characteristics are positive and highly significant. The sum of the output coefficient (b_Q) and the two coefficients associated with output characteristics (b_{CU} and b_{AS}) does not exceed 1, indicating the presence of economies of scale in the median-sized utility. Accordingly, a one-percent increase in output, number of customers and area size would lead to a 0.91-percent increase in total cost at the median point. Based on the negative and significant time coefficient (d_T) it can be concluded that the total costs of Slovenian water distribution utilities have been decreasing over time. Statistically significant parameter λ, which is a measure of the relative importance of inefficiency in the overall error variance, indicates the presence of cost inefficiencies in the model.

Table 4 provides descriptive statistics on the cost efficiency estimates of Slovenian water distribution utilities in the analysed period. The average and the median cost efficiency are estimated to be 84.4 and 84.7 percent, respectively, which indicates the presence of significant cost inefficiencies in the sample. In order to become cost efficient, water distribution utilities should cut their costs about 15 percent on average. The established low cost efficiency is largely in line with the absence of competition and with the price regulation scheme which is not designed in a way that stimulates water utilities to decrease their costs. Further, no noteworthy improvement in cost efficiency can be observed over time.

The decomposition of the productivity growth of Slovenian water distribution utilities in the 1998-2003 period is reported in Table 5. In line with the findings in Table 4, the average annual cost efficiency improvement in the analysed period amounted to just 0.04 percent and essentially did not make any contribution to the

TFP growth. Further, a positive annual technical change of 0.92 percent on average is established implying that the costs of Slovenian water distribution utilities were decreasing over the examined period. Hence, the contribution of technical change to the TFP growth is much more pronounced in comparison to the efficiency change.

Table 3: Estimation results of the cost frontier function of Slovenian water distribution utilities within the period 1997-2003

Parameter	Estimate	Parameter	Estimate
b_{PL}	0.518*** (0.035)	$b_{Q,CU}$	-0.326 (0.210)
b_{PM}	0.189*** (0.032)	$b_{Q,AS}$	-0.067 (0.109)
b_{Q}	0.273*** (0.079)	$b_{CU,AS}$	0.234** (0.109)
b_{CU}	0.483*** (0.083)	$b_{PL,Q}$	0.115 (0.100)
b_{AS}	0.156*** (0.037)	$b_{PL,CU}$	-0.078 (0.105)
$b_{PL,PL}$	-0.185*** (0.066)	$b_{PL,AS}$	-0.113** (0.055)
$b_{PM,PM}$	-0.113** (0.051)	$b_{PM,Q}$	-0.178** (0.077)
$b_{PL,PM}$	0.231*** (0.055)	$b_{PM,CU}$	0.115 (0.088)
$b_{Q,Q}$	0.660*** (0.172)	$b_{PM,AS}$	0.134*** (0.049)
$b_{CU,CU}$	-0.249 (0.288)	b_{WU}	-0.037 (0.046)
$b_{AS,AS}$	0.294*** (0.093)	b_{T}	-0.009* (0.005)
σ_v	0.1669	$\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$	0.3006***
σ_u	0.2499	$\lambda = \sigma_u / \sigma_v$	1.497*** (0.207)
logL	162.2	*N*	332

Notes: standard errors in brackets;

* – significant at 10%, ** – significant at 5%, *** – significant at 1%

Source: Authors' calculations

Table 4: Estimated cost efficiency scores by year

Efficiency score (*CE*)	1997	1998	1999	2000	2001	2002	2003	Full sample
Mean	0.847	0.837	0.846	0.845	0.839	0.844	0.846	0.844
Median	0.850	0.843	0.850	0.847	0.841	0.845	0.853	0.847
Std. Dev.	0.049	0.037	0.035	0.025	0.031	0.032	0.035	0.035
Minimum	0.673	0.729	0.720	0.769	0.764	0.730	0.752	0.673
Maximum	0.934	0.892	0.909	0.891	0.902	0.917	0.913	0.934
N	41	43	46	48	50	52	52	332

Source: Authors' calculations

Overall, an unimportant improvement in scale efficiency can be observed, which resulted in a positive annual contribution to the TFP growth of only 0.17 percent on average. However, there was a significant variation over the years. Changes in output characteristics appear to be more stable in absolute terms and with respect to the sign, where the average annual contribution to the TFP growth is estimated to be –0.76 percent. The increase in output characteristics therefore resulted in higher total costs and a negative contribution to the TFP growth. With respect to the residual price effect, the average growth rate is 0.27 percent. Similar to the scale efficiency change, there is a significant variation in residual price effects in the analysed period.

Table 5: TFP growth decomposition of Slovenian water distribution utilities within the period 1998-2003 – average annual rates

- in percent (%)

Nr.	TFP growth component	1998	1999	2000	2001	2002	2003	Full sample
1	Cost efficiency change (*CEC*)	-1.03	0.91	0.06	-0.64	0.57	0.27	0.04
2	Technical change (*TC*)	0.92	0.92	0.92	0.92	0.92	0.92	0.92
3	Scale efficiency change (*SEC*)	0.69	0.79	0.55	-2.03	-0.17	1.25	0.17
4	Change in output characteristics (*OCC*)	-0.38	-0.48	-0.99	-0.27	-1.52	-0.84	-0.76
5	Residual price effect (*PER*)	2.69	-1.40	0.04	0.43	1.79	-1.67	0.27
6	TFP growth (*TFPC*) (=1+2+3+4+5)	2.89	0.74	0.58	-1.58	1.59	-0.06	0.64
7	Pure TFP growth (without *PER*) (=6 – 5)	0.21	2.14	0.54	-2.01	-0.20	1.61	0.37

Source: Authors' calculations

Putting all the effects together, TFP growth is obtained which is found to be slightly increasing over the examined period, where average annual growth of 0.64 percent is estimated. If we observe pure TFP growth, i.e. without the residual price effects, we obtain a relatively disappointing result as the annual TFP growth is found to be very close to zero, amounting to just 0.37 percent on average. The results are not at all surprising and are consistent with the non-competitive environment in which public utilities operated and with the absence of proper regulatory incentives that would have stimulated utilities to operate in a more efficient way.

Similar studies in the case of water and sewerage companies from England and Wales reveal somewhat higher TFP growth rates. However, their performance slightly worsened, albeit not statistically significantly, after privatisation. Using an index number approach, Saal and Parker (2001) estimated a decrease in TFP growth from 2.3 percent in the 1985-1990 period to 1.6 percent in the 1990-1999 period. Further, in Saal et al. (2007) TFP growth is decomposed using stochastic frontier methods. Again, it is established that performance in terms of TFP growth in pre-transition period (1.75 percent) slightly outperformed the performance in the post-transition period (1.64 percent). The technical change did increase after privatisation, while efficiency levels slightly worsened. Scale effects also made a negative contribution to the TFP growth, implying that companies are characterised by decreasing returns to scale. The better performance of the UK water and sewerage companies compared to the Slovenian water distribution utilities can most likely be attributed to the RPI+K price cap regulation in the UK that was designed to encourage an efficiency catch up.

Table 6 presents the cumulative growth of TFP components in the Slovenian water sector in the analysed period. Efficiency improvements did not contribute to the TFP growth as the average cost efficiency levels essentially remained the same over the examined period. Technical change resulted in a 5.7 percent increase in the productivity of the water industry, which can be seen as a more promising finding. Further, positive scale and residual price effects in the analysed period are largely offset by the negative effect of a change in output characteristics. Altogether, the TFP increased by roughly 4 percent in 2003 relative to 1997, while the increase in pure TFP was only 2 percent.

Table 6: Cumulative average TFP of Slovenian water distribution utilities within the period 1997-2003

1997 = 100

TFP growth components	1997	1998	1999	2000	2001	2002	2003
Cost efficiency change (*CEC*)	100	99.0	99.9	99.9	99.3	99.9	100.1
Technical change (*TC*)	100	100.9	101.9	102.8	103.7	104.7	105.7
Scale efficiency change (*SEC*)	100	100.7	101.5	102.0	100.0	99.8	101.1
Change in output characteristics (*OCC*)	100	99.6	99.1	98.2	97.9	96.4	95.6
Residual price effect (*PER*)	100	102.7	101.3	101.3	101.7	103.6	101.8
TFP growth (*TFPC*)	100	102.9	103.7	104.3	102.6	104.2	104.2
Pure TFP growth (without *PER*)	100	100.2	102.4	102.9	100.8	100.6	102.3

Source: Authors' calculations

Based on the results it may be concluded that the productivity improvement of the Slovenian water distribution utilities over the observed period was quite poor. The main reason can be found in the regulatory framework which was very administrative in nature and primarily designed to control price increases. Productivity improvements were not the primary objective of the price regulation and no incentives were in place to promote the more efficient operation and performance of water utilities. The results could also be partly influenced by investments companies had to make in order to meet water and environmental standards. However, due to a lack of funds the investments were not substantial and were mostly postponed to the future. Therefore, the latter effect cannot be seen as the key reason for the low productivity growth of the Slovenian water industry.

6. Conclusions

In the paper we find evidence in favour of the hypothesis that the lack of proper incentives to improve performance has resulted in the low TFP growth of Slovenian water distribution utilities. Cost efficiency estimates indicate that considerable inefficiencies are present in the water distribution utilities. In addition, no improvement in cost efficiency over the observed time period is detected. Nevertheless, the costs of water utilities were slightly decreasing over time, which is a result of a positive technical change. Overall, the productivity improvement of Slovenian water distribution utilities in the analysed period is relatively disappointing. Apparently, the current institutional and regulatory setting of the Slovenian water industry does not provide sufficient incentives for water utilities to make productivity improvements. Therefore, the first step towards a good practice in regulation would be to create an autonomous and professional regulatory agency to regulate water prices. The proposed alternative would in a large part replace, rather than complement, the current regulatory practice. Higher productivity could be achieved by launching incentive-based price-cap regulation combined with benchmarking which would aim at improving the performance of water utilities. Such a scheme has already been implemented in the energy sector in many EU member states, including Slovenia. Thus, this could serve as an example of a good practice regulation for the water sector or, more broadly, the communal sector as well. A possible limitation of this study may be found in the fact that it refers to the supply of drinking water only, while some utilities also provide other services like wastewater treatment, waste collection and waste disposal. Nonetheless, since data on other activities is unavailable it was impossible to study the multi-product cost function and the presence of economies of scope. The performance of multi-utility companies is therefore left to be investigated in the future research.

References

Aigner, D.J., Lovell, C.A.K., Schmidt, P. (1977) "Formulation and Estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics*, 6(1), pp. 21-37.

Antonioli, B., Filippini, M. (2001) "The use of a variable cost function in the regulation of the Italian water industry", *Utilities Policy*, 10, pp. 181-187.

Ashton, J.K. (2000) "Cost efficiency in the UK water and sewerage industry", *Applied Economics Letters*, 7, pp. 455-458.

Baldwin, R., Cave, M. (1999) *Understanding Regulation: Theory, Strategy and Practice*, Oxford University Press, New York.

Bank of Slovenia (2001) *Monthly Bulletin*, Vol. 8, No. 1, January 2001, Ljubljana.

Bauer, P.W. (1990) "Decomposing TFP Growth in the Presence of Cost Inefficiency, Nonconstant Returns to Scale, and Technological Progress", *Journal of Productivity Analysis*, 1, pp. 287-299.

Bhattacharyya, A., Harris, T.R., Narayanan, R., Raffiee, K. (1995) "Specification and estimation of the effect of ownership on the economic efficiency of the water utilities", *Regional Science and Urban Economics*, 25, pp. 759-784.

Caves, D.W., Christensen, L.R., Diewert, W.E. (1982) "The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity", *Econometrica*, 50(6), pp. 1393-1414.

Caves, D.W., Christensen, L.R., Tretheway, J.A. (1984) "Economies of Density versus Economies of Scale: Why Trunk and Local Service Airline Costs Differ", *Rand Journal of Economics*, 15(4), pp. 471-489.

Coelli, T., Estache, A., Perelman, S., Trujillo, L. (2003) *A Primer on Efficiency Measurement for Utilities and Transport Regulators*, WBI Development Studies, Washington, D.C.: World Bank.

Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee (2000) Pricing policies for enhancing the sustainability of water resources, COM(2000) 477 final, Brussels: Commission of the European Communities

Decree repealing the decree on the Formation of Prices for Basic Public Utility Services [Uredba o prenehanju veljavnosti Uredbe o oblikovanju cen komunalnih storitev] (2009) Official Gazette of the Republic of Slovenia 61/2009, Ljubljana.

Denny, M., Fuss, M., Waverman, L. (1981) The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications. In: Cowing, T.G., Stevenson, R.E. (eds.), *Productivity Measurement in Regulated Industries*, New York: Academic Press, pp. 179-218.

Fabbri, P., Fraquelli, G. (2000) "Costs and Structure of Technology in the Italian Water Industry", *Empirica*, 27, pp. 65-82.

Filippini, M., Hrovatin, N., Zorić, J. (2008) "Cost efficiency of Slovenian water distribution utilities: an application of stochastic frontier methods", *Journal of Productivity Analysis*, 29(2), pp. 169-182.

Garcia, S., Thomas, A. (2001) "The Structure of Municipal Water Supply Costs: Application to a Panel of French Local Communities", *Journal of Productivity Analysis*, 16, pp. 5-29.

Greene, W.H. (2005a) "Reconsidering heterogeneity in panel data estimators of the stochastic frontier model", *Journal of Econometrics*, 126, pp. 269-303.

---------- (2005b) "Fixed and Random Effects in Stochastic Frontier Models", *Journal of Productivity Analysis*, 23(1), pp. 7-32.

Hrovatin, N. (ed.) (2002) *Strategy of the Local Public Utilities' Development in Slovenia* [*Strategija razvoja lokalnih gospodarskih javnih složb v Sloveniji*], Ljubljana: Svetovalni center.

Hrovatin, N., Bailey, S.J. (2001) "Implementing the European Commission's water pricing communication: cross-country perspectives", *Utilities Policy*, 10(1), pp. 13-24.

Institute of Macroeconomic Analysis and Development (IMAD) (2009) *Slovenian Economic Mirror*, Vol. 15, No. 7-8, July-August 2009, Ljubljana.

Jorgenson, D.W., Griliches, Z. (1967) "The Explanation of Productivity Change", *Review of Economic Studies*, 34(3), pp. 249-280.

Kavčič, S. (2000) *Effect of Depreciation on the Performance of Communal Utilities – Research Results* [*Vpliv amortizacije na poslovanje komunalnih podjetij – Predstavitev raziskovalne naloge*], Ljubljana: Svetovalni center.

Kim, H.Y., Clark, R.M. (1988) "Economies of Scale and Scope in Water Supply", *Regional Science and Urban Economics*, 18, pp. 479-502.

Kumbhakar, S. C., Lovell, C.A.K. (2000) *Stochastic Frontier Analysis*, Cambridge: Cambridge University Press.

Law on Local Self-Government [Zakon o lokalni samoupravi – ZLS] (1993) Official Gazette of the Republic of Slovenia 72/1993, Ljubljana.

Meeusen, W., van den Broeck, J. (1977) "Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error", *International Economic Review*, 18(2), pp. 435-444.

Mizutani, F., Urakami, T. (2001) "Identifying network density and scale economies for Japanese water supply organizations", *Papers in Regional Science*, 80, pp. 211-230.

Mrak, M. (1997) "Infrastructure Investment Needs in Slovenia", *IB Revija*, 31(12), pp. 9-23.

---------- (2000) *Communal Infrastructure in Slovenia: Survey on Investment Needs and Policies Aimed at Encouraging Private Sector Participation*, World Bank Technical Paper No. 483, Europe and Central Asia Poverty Reduction and Economic Management Series, Washington, D.C.: IBRD, World Bank.

OFWAT (1999) *Final Determinations: Future water and sewerage charges 2000-05*, *1998 Periodic Review*, Birmingham, UK.

---------- (2004) *Future water and sewerage charges 2005-10: Final determinations*, *2004 Periodic Review*, Birmingham, UK.

Orea, L. (2002) "A Parametric Decomposition of a Generalized Malmquist Productivity Index", *Journal of Productivity Analysis, 18(1)*, pp. 5-22.

Pitt, M., Lee, L.F. (1981) "The Measurement and Sources of Technical Inefficiency in the Indonesian Weaving Industry", *Journal of Development Economics*, 9, pp. 43-64.

Public Utilities Act [Zakon o gospodrskih javnih službah – ZGJS] (1993) Official Gazette of the Republic of Slovenia 32/1993, Ljubljana.

Rules on Price Determination of Obligatory Local Public Utilities [Pravilnik o oblikovanju cen storitev obveznih občinskih gospodarskih javnih služb varstva okolja] (2004) Official Gazette of the Republic of Slovenia 128/2004, Ljubljana.

Rules of the tariff system for obligatory local public utility services [Pravilnik o metodologiji za oblikovanje cen storitev obveznih občinskih gospodarskih javnih služb varstva okolja] (2009) Official Gazette of the Republic of Slovenia 63/2009, Ljubljana.

Saal, D., Parker, D. (2001) "Productivity and Price Performance in the Privatized Water and Sewerage Companies of England and Wales", *Journal of Regulatory Economics*, 20(1), pp. 61-90.

Saal, D., Parker, D., Weyman-Jones, T. (2007) "Determining the Contribution of Technical Change, Efficiency Change and Scale Change to Productivity Growth in the Privatized English and Welsh Water and Sewerage Industry: 1985-2000", *Journal of Productivity Analysis*, 28(1-2), pp. 127-139.

Schmidt, P., Sickles, R.C. (1984) "Production Frontiers and Panel Data", *Journal of Business and Economic Statistics*, 2(4), pp. 367-374.

Shephard, R.W. (1953) *Cost and Production Functions*. Princeton: Princeton University Press

Slovenian Accounting Standards [Slovenski računovodski standardi – SRS] (1997) Ljubljana: The Slovenian Institute of Auditors.

Statistical Office of the Republic of Slovenia (SORS) (2008) *Statistical Yearbook of the Republic of Slovenia 2008*, Ljubljana.

Štruc, M. (ed.) (1997) *Strategy of the Communal Sector Development in the Republic of Slovenia* [*Strategija razvoja komunalnega gospodarstva v Republiki Sloveniji*], Ljubljana: Svetovalni center.

Rast produktivnosti i cjenovna regulacija vodoopskrbnih poduzeća u Sloveniji

Massimo Filippini[1], *Nevenka Hrovatin*[2], *Jelena Zorić*[3]

Sažetak

Glavni cilj rada je analizirati metodu cjenovne regulacije i produktivnost vodoopskrbne djelatnosti u Sloveniji. Postavljena je hipoteza, da je pomanjkanje inicijativa za poboljšanje uspješnosti rezultiralo u niskom rastu ukupne faktorske produktivnosti vodoopskrbnih poduzeća u Sloveniji. Na temelju primijenjene metode stohastičke granice (SFA metode) izvedena je dekompozicija rasta ukupne faktorske produktivnosti (TFP) slovenskih poduzeća za distribuciju pitke vode u razdoblju 1997-2003. Rezultati istraživanja potvrđuju prisutnost neučinkovitosti poduzeća u vodoopskrbi, što ukazuje na potencijal za značajno sniženje troškova u analiziranoj djelatnosti. Dok se neučinkovitost u analiziranom razdoblju nije poboljšala, utvrđen je značajan i pozitivan doprinos tehničkog napretka ka rastu ukupne faktorske produktivnosti. U cjelini procijenjen rast ukupne faktorske produktivnosti je pozitivan ali blizu nule, što je prilično slab rezultat. Dobiveni rezultati mogu se pripisati sadašnjem institucionalnom i regulatornom okviru koji ne stimulira vodoopskrbna poduzeća za poboljšanje produktivnosti. Iz toga slijedi da bi bilo potrebno ozbiljno razmisliti o formiranju autonomne regulatorne agencije i uvođenju metoda regulacije koje bi imale ugrađene inicijative za poboljšanje uspješnosti vodoopskrbnih poduzeća u Sloveniji.

Ključne riječi: *rast TFP, SFA, učinkovitost, vodoopskrbna poduzeća, cjenovna regulacija*

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