Local Government Control and Efficiency of the Water Industry: An Empirical Analysis of Water Suppliers in East Germany*

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Abstract

The paper deals with the effects of local governments' interference with business affairs of publicly-owned utilities. A partial model is presented to illustrate the indefinite total effect of "democratic control" on public managers' effort and the efficiency of local public production. To check the theoretical results empirically, a two-stage data envelopment analysis (DEA) is carried out for a sample of East German water suppliers using the organizational form as a measure for the degree of municipal control. The results of the OLS- and Tobit regression indicate an efficiency-enhancing effect of organizational forms with less distinctive control by local politicians.

JEL-Classification: L95, L32, D73

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I. Introduction

Many empirical studies of the water sector neglect the impact of government control or more generally speaking, the impact of institutional arrangements on the quality and the efficiency of water provision. If they take them into consideration, the analysis is often reduced to the question whether private or publicly owned water providers are more efficient. Studies such as Feigenbaum and Teples (1983) or Fox and Hofler (1986) are good examples of that kind. Dupont and Renzetti (2003) provide an overview of similar empirical studies.

But further world-wide privatization efforts will not be very likely in the future. Great Britain's privatization of its water systems seems to remain an unique and controversial event, and the stable coexistence of private and publicly owned water utilities in the USA is also not representative. Especially in Europe, the prevalent attitude towards privatization and liberalisation is negative. The Netherlands even prohibited the privatization of their water systems by law in 2000. Consequently, the European Commission seems to have retreated from its former liberalisation plans for the water market. It seems very likely that water will be provided by municipal suppliers in most countries for the next decades. Thus, instead of "plotting the overthrow" of the entire water sector it makes sense for economists to analyse institutional arrangements that increase the efficiency especially of publicly owned water utilities.

One key factor is the impact of "democratic control" exercised by the local governments on efficiency. If it was assumed that the local governments were still responsible for water provision and drinking water was produced and distributed by some municipal entity, how would different levels of public interference (excluding privatization) affect the efficiency of water provision? Especially, if municipal control was not replaced by alternative regulation systems such as cartel offices or other regulation authorities? At first glance, assuming slack-maximizing behaviour (Wyckhoff 1990) bureaucrats or public managers might enforce their shirking and rent-seeking activities. But things are not that simple because reduced municipal control might lead to increasing non-monetary benefits for managers from what is called "job enlargement" or "job enrichment" in the business administration literature (e.g. Hackman and Oldham 1980): Primarily their greater leeway for decisions might increase job satisfaction and thus manager's effort. This aspect is usually neglected by the various economic theories of bureaucracy. Furthermore, they would be able to allocate factors of production according to economic needs rather than to distributive goals set by vote-maximizing politicians. Hence, the total effect of decreasing control by local politicians on the efficiency of water provision cannot be predicted ex ante and becomes an empirical question.

To shed more light on this issue, after illustrating the effort and efficiency effects in a partial microeconomic model, a two-stage Data Envelopment Analysis (DEA) is conducted. Democratic control is operationalized by the organizational form of the municipal enterprise. One essential advantage of using this non-parametric approach is that assumptions about production technologies, profit maximization or cost minimization can be avoided. The last two points are not very realistic assumptions for public enterprises but crucial for the application of stochastic frontier analysis or other purely econometric methods. Furthermore, this two-stage approach is particularly suited to control for environmental variables, which are factors that might influence efficiency but are not under the control of the managers.

Although it has been applied to a wide range of fields the DEA approach has not received much attention yet in the water sector.[1] Aida et al. (1998) evaluate the performance of Japanese water suppliers using a range-adjusted measure but do not explicitly control for environmental variables. Most other authors (Lambert et al. 1993, Bhattacharyya et al. 1995) focus their DEA studies on efficiency differences between private and public US water suppliers. In the UK, DEA is used as a benchmarking tool for regulated water utilities. See Cubbin and Tzanidakis (1998) or Thanassoulis (2000) for this subject. Only Puwein et al. (2002) also integrate the organizational form as an environmental variable in their two-stage DEA of a sample of Austrian municipal water suppliers. But they do not find a significant effect on efficiency for this variable.

[1] For a comprehensive bibliography on DEA see Gattoufi et al. (2004).

The innovation of this paper is twofold. First, deviating from most empirical tests of the various economic theories of bureaucracy[2] including the empirical studies of the water sector mentioned above, the efficiency of private and public providers will not be compared. Instead, the impacts of different levels of municipal control on the efficiency of publicly owned water utilities will be analyzed. Second, except for Sauer's (2005) econometric cost study of rural German water suppliers no other comprehensive empirical analysis of the German water sector exists.

The paper is structured as follows. In section II some theoretical considerations about the indeterminate effect of municipal control on management effort and efficiency of production will be presented. Sections III to V will present the results of a two-stage DEA focusing on the impact of the organizational form on the efficiency of East-German water utilities. In section VI tentative conclusions will be drawn from the results.

II. Some theoretical considerations

This section deals with some theoretical considerations about the effects of municipal control on management effort and efficiency of local public enterprises. First of all, the term efficiency has to be specified further. The paper analyzes the production efficiency of single water utilities. The focus of the paper lies on technical efficiency or cost efficiency, both from an input-oriented perspective. *Technical efficiency* means providing a given output quantity by minimum input quantities. *Cost efficiency* involves varying input proportions to produce certain output quantities at minimum cost. Thus, the analysis is restricted to the production side of the water industry, whereas the demand side (households, other firms) is neglected. This input-orientated approach is well suited for the evaluation of the impact of political control on efficiency in the water sector because in most countries the output is hardly controllable for local water utilities. For example, they are obliged to provide water to every household within their service area at unit prices. Furthermore, it is difficult for them to acquire new customers because the extension of the market area is limited by legal or technical restrictions. According to the standard theory of publicly provided goods, welfare of the inhabitants would be maximized if a given output was produced with minimum input (technical efficiency) or at minimum cost (cost efficiency).

Political intervention of local governments may influence the efficiency of production in several ways. First, it may affect the costs directly. Vote-maximizing local politicians may prevent the managers from fixing the input quantities and –combinations according to economic considerations. The politicians may be reluctant to dismiss excess labour force or they may have plants or networks with excess capacities erected due to pure ignorance or for image reasons.

The basic assumption underlying all economic theories of bureaucracy are information asymmetries between politicians and bureaucrats, especially regarding minimum cost combinations. Therefore, bureaucrats or public managers may abuse their special knowledge for their own goals. These could be budget maximization (Niskanen 1971) or slack maximization (Wyckhoff 1990). The result would be either an inefficiently large output quantity or production of any output quantity at excess costs.

If slack-maximization was assumed, controlling activities by politicians might reduce for example shirking behaviour of public employees and therefore, reduce costs. But the total effect on the effort-leisure decision of public managers is not obvious ex ante: On the one hand, political intervention, especially if accompanied by disciplinary measures such as written warnings that would be included into the personnel file, public critic by the city council or the local press or even dismissal may increase effort. On the other hand, it has already been mentioned that reduced political interference and more leeway for public managers may enhance their motivation, their job would be more prestigious and they could develop better management skills, thus improving their chances to change

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[2] See Mueller (2003, 373-379) for an overview of relevant empirical studies.

into management positions in the private sector. All these non-cash benefits may boost management's effort.

It should be added that controlling by local politicians is costly. Politicians or supervisory authorities have to invest considerable amounts of resources to reduce information asymmetries. But the control effect (or the transaction costs) does not only depend on the resources dedicated to controlling but also on output characteristics (measurability), complexity of the organizational structure or institutional restrictions such as legal restrictions on the local government's right to inform and to instruct the management. Ceteris paribus, a municipal company is more difficult to control due to the aforementioned legal restrictions than a municipal department.

The next step is to illustrate the indefinite effect of municipal control in a simple partial model. The theoretical analysis will focus on cost efficiency (input-oriented) whereas for practical reasons the empirical part of the paper will refer to a mixture of physical quantities, costs and asset values to measure technical efficiency.

To analyse cost efficiency, the long-term average cost function of some representative publicly provided local service is modelled. Direct and indirect effects (via effort E) of political control on the average costs are included in the following cost function.

(1) $$c = h(\theta) \cdot c_{\min}(\mathbf{p}, T) \cdot i(n \cdot E(\theta))$$

The effective political power to control managers' activities is measured by the exogenously given θ. θ is assumed to depend mainly on the legal restrictions on politician's access to information and their right to instruct manager's. c_{min} represents the minimum cost combination per unit which depends on a vector of factor prices $\mathbf{p}$ and a technology parameter T and is at least not fully known to the local politicians. Other factors are not included in the cost function. For simplicity, factor prices and technology are taken as given. To avoid confusion with scale effects, constant returns to scale are assumed for the underlying production technology. Note that for constant returns on scale the long-term average costs are independent of output quantity.[3] The functions *h(θ)* and *i(n·E)* show how c deviates from c_{min} relative to E and θ. *i(.)* is a function of the aggregated effort of n identical managers and n shall be given exogenously.

(2) $$h'(\theta) > 0, \quad h''(\theta) < 0, \quad \lim_{\theta \to 0} h(\theta) = 1, \quad \lim_{\theta \to \infty} h(\theta) = +\infty$$

(3) $$\frac{\partial i}{\partial E} < 0, \quad \frac{\partial^2 i}{\partial E^2} > 0, \quad \lim_{E \to 0} i(n \cdot E) = +\infty, \quad \lim_{E \to +\infty} i(n \cdot E) = 1$$

The function *h(θ)* reflects the assumption that local politicians, even if they were fully informed (depending on θ) about the minimum cost combination, would be reluctant to force the managers to improve cost efficiency, for example by job reductions. The latter might lead to massive resistance of lobbyists such as unions and vote losses. According to (2) this direct cost effect is assumed to increase with increasing political interference θ, but with diminishing marginal cost effects.

The „slack function" of the public managers is represented by *i(.)*. Equation (3) states that average costs shall rise with decreasing effort of managers but the negative marginal effect is expected to diminish with decreasing E. The contradictory effects of local governments' control on manager's effort *E(θ)* can be derived from the representative manager's utility-maximizing leisure-effort decision. To this end non-cash benefits from their increasing leeway of decision and efficiency enhancing but utility reducing local government pressure are integrated in a standard income-leisure model. The former is assumed to be negatively related to and the latter positively related to the extent of municipal control. The derivations are presented in the appendix.

The total cost effect depends on the extent of the cost-increasing direct effect *h(θ)* in relation to the indefinite indirect cost effect of θ on E:

[3] This assumption is, of course, quite unrealistic for the water sector and will be skipped in section III where the variable returns approach will be applied.

(4) $$\frac{\partial c}{\partial \theta} = c_{\min} \cdot (h'(\theta) \cdot i(n \cdot E) + h(\theta) \cdot \frac{\partial i}{\partial E} \cdot \frac{\partial E}{\partial \theta}) \overset{<}{\underset{>}{=}} 0\ ?$$

$$+ \qquad\qquad - \quad ?$$

Thus, it cannot be predicted from this partial model ex ante how increasing or decreasing intervention of local governments might affect the efficiency of local public production.

Due to the indeterminate results of the theoretical analysis the effect of political control on the efficiency of the production of local public services has to be checked empirically. To this end, the following hypothesis is formulated:

Hypothesis: The efficiency of local publicly owned enterprises increases with decreasing degree of intervention by local governments and vice versa.

III. Methodology of the empirical analysis

To investigate the potential impact of political interference with management decisions in local public water utilities – and therefore to test the hypothesis put up in section II - a two-stage data envelopment analysis (DEA) approach is applied. In the first step, a technical efficiency score is calculated for every water supplier. In the second step, these scores are regressed with variables considered exogenous for the single firm, including an indicator for local government intervention.

This method has been chosen to avoid several problems with analysing cost data, especially distortions caused by mixing up efficiency gains that result mainly from an extension of output quantity (economies of scale) and efficiency gains which result from optimisation of factor quantities and –combinations.[4] Furthermore, it has been already pointed out in the introduction that the main advantage of the data envelopment analysis is to avoid problematic behavioural assumptions regarding production technology, profit maximization or cost minimization. This is very convenient for publicly owned enterprise where profit maximization or cost minimization are no plausible targets for the management.

The standard DEA approach assuming variable returns to scale in equation (5) permits to separate efficiency into technical and scale efficiency. For the subject of this paper technical efficiency is the relevant efficiency measure. To calculate the relevant technical efficiency measure ρ, the following linear programming (LP) problem has to be solved for each firm:

$$(5) \qquad \min_{\rho,\boldsymbol{\lambda}} \rho,$$

$$\text{st}$$

$$\begin{aligned} -\mathbf{y_i} + \mathbf{Y}\boldsymbol{\lambda} &\geq 0, \\ \rho\mathbf{x_i} - \mathbf{X}\boldsymbol{\lambda} &\geq 0, \\ \mathbf{I1}'\boldsymbol{\lambda} &= 1 \\ \boldsymbol{\lambda} &\geq 0 \end{aligned}$$

In case there are I water utilities, M outputs and N inputs, then the M x I output matrix $\mathbf{Y}$ and the N x I input matrix $\mathbf{X}$ contain the input and output quantities of all I water utilities. ρ is a scalar, $\boldsymbol{\lambda}$ is an Ix1 vector of constants and $\mathbf{I1}$ an Ix1 vector of ones. This formulation was suggested by Banker, Charnes

[4] There is quite a number of international empirical studies dealing with the existence or non-existence of economies of scale in the water sector including the USA, UK, the Netherlands, Japan, Korea, France or Italy. Though sample sizes and methods vary significantly, most of the studies either reject the hypothesis of increasing returns to scale or their estimated measures suggest only minor economies of scale. For an overview of this literature see for example Mizutani and Urakami (2001) or Sauer (2005). For an empirical analysis of economies of scale in the German water industry see Sauer (2005) and Haug (2006).

and Cooper (1984) and is usually referred to as the BCC-model in DEA. A derivation of this LP problem is given in Coelli et al. (2005, 160-181).[5]

In the second stage of the DEA, technical efficiency ρ as the dependent variable is regressed with some potential determinants of efficiency z. The estimation of the regression equation $\boldsymbol{\rho} = \boldsymbol{\beta}\mathbf{Z} + \boldsymbol{\varepsilon}$ by applying OLS might involve several problems. First of all, the observed values of the dependent variable vary between 0 and 1, but the disturbance ε can take any values between $+\infty$ and $-\infty$. Therefore, the additive structure of the linear regression model does not allow ρ to be confined to 1. The estimated values $\mathrm{E}(\hat{\rho}_i | \mathbf{z}) = \rho_i - \varepsilon_i$ might be higher than 1 or lower than 0.

Furthermore, in smaller samples there is some concentration of the values of the dependent variable at the upper margin. In the water sample 10 out of 37 observations have technical efficiency of one. Hence, according to the literature[6], a censored Tobit model is estimated. The standard Tobit model is defined as

$$(6) \qquad \boldsymbol{\rho}^* = \boldsymbol{\beta}'\mathbf{Z} + \boldsymbol{\varepsilon}$$

The latent variable ρ_i^* cannot be observed directly, only the technical efficiency index ρ_i and the dependent variables $\mathbf{z_i}$. But ρ is censored at the upper margin of 1, thus partly masking the true value of ρ_i^*. For $\rho_i^* \leq 1$, ρ_i and $\mathbf{z_i}$ are observed reflecting the true value of ρ_i^*. But for $\rho_i^* > 1$, the $\mathbf{z}_i$ are observed and ρ_i equals the limit value 1.

[5] For a more detailed introduction to the DEA methods see also Charnes et al. (1994).
[6] See for example De Borger and Kerstens (1996).

IV. Data

Before the process of data generation will be described, a short overview of the German water sector will be given.

Germany's water industry is highly decentralized. In 2001 about 6300 water utilities providing water to consumers (or 76 utilities per 1 million inhabitants) existed, most of them municipal suppliers. There are very few privately owned providers. Most water suppliers are organized as municipal companies, municipal departments or special purpose associations. It is important to stress that there is de facto neither an effective price regulation nor an economic performance control beyond the local level. The effectiveness of the price control by the cartel offices of the German Länder as well as by the municipal supervisory authorities seems to depend on the eagerness and frustration tolerance of the employees within this institutions. Public benchmarking is an obligatory part of the regulation process in the UK or in the Netherlands, whereas German water suppliers are benchmarked only voluntarily and without any results published.

The empirical analysis in this paper focuses on East German water utilities for several reasons. Even 15 years after the reunification significant structural differences exist. First of all, there is less continuity in the structure of public water provision in East Germany, whereas in West Germany no significant structural changes in the water sector have occurred for at least a century. Hence, some Western water utilities have been continuously providing water for 100 years or longer. In the former GDR, water provision was centralized. From at last 1964 until 1990 the former municipal tasks of providing water and sewage disposal were transferred to 16 state-owned water and sewage combines (WAB). After the German reunification, the former WABs were transformed into limited companies. Although this was discussed controversially, the re-established municipalities or associations of municipalities were granted an option of taking over the plants and networks from the former WABs. In addition, huge investments mostly funded by the federal government and the German Länder were necessary to raise the standard of public water provision to an acceptable level and to connect some remote rural areas to public water systems for the first time ever.[7] Consequently, the structure and development of the capital stock of East German water suppliers is totally different from that of their West German counterparts.

Furthermore, the East German water market is less scattered than in West Germany because only 530 of the aforementioned total 6300 German water suppliers are located in East Germany.

In the paragraphs before, some arguments were listed that give reasons for separating East and West German water suppliers for the empirical analysis. Restricting the investigation sample to East German water suppliers had more practical reasons, primarily to reduce the costs of data collection because no publicly available database for economic data on German water utilities exists.

Between October 2004 and April 2005 a standardized questionnaire was sent to 275 of the 530 water utilities in East Germany, except for Berlin. This number includes approximately all water companies and a majority of the special purpose associations Other organizational forms such as municipal departments were not included because for many of them the addresses were not available. It was also doubtful that those mostly small enterprises were able to provide the necessary data.[8] All technical and commercial data collected refer to the year 2002.

43 questionnaires were sent back including 9 municipal and mixed companies and 34 special purpose associations. The total response rate was 15.64%. The low response rate resulted partly from the insufficient willingness to cooperate of lobby groups and private water companies as well. Hence, no water suppliers with a majority of the shares held by private investors are represented in this sample. But this lack of private suppliers does not restrict the informational value of the empirical

[7] For more information about the history of the East German water sector from 1945 to the mid-nineties see Seidel (1998).

[8] With hindsight, those doubts were not justified. The good quality of the data provided by some small special purpose associations showed that the quality of accounting and other internal statistics depends on the qualification of the staff rather than on firm size.

analysis because the main issue of the paper was to investigate the effect of different levels of political control on the efficiency of publicly owned utilities.

Due to the lack of information concerning the distribution of the population of all East German water utilities it is not possible to check whether the sample is representative or not. Representativeness could only be tested for the total volume of water supplied. Although the means in table 1 do not differ too significantly, without further information about the distribution of the population the hypothesis that the IWH sample is representative can not be confirmed or rejected.

TABLE 1

Descriptive statistics referring to the firm size of East German water suppliers

Year of reference	*2001*	*2002*
Data source	Federal Statistical Office	IWH water-survey 2004
Mean (Mio. m3)	1.1	1.86
Standard deviation	?[a]	3.27
Median	?[a]	0.97
Number of observations	530[b]	42[b]

Notes: [a] Statistics cannot be calculated because only the aggregated volume of water supplied is available for East Germany and the single German Länder- [b] Only utilities providing water to end consumers are included.
Source: Statistisches Bundesamt (2003), IWH water survey 2004, author's calculations.

One of the most demanding practical problems in DEA is to specify outputs and inputs. For this analysis, only one output is used that is the volume of revenue water including the total volume of billed authorised consumption plus exported water. Water losses and consumption by water plants are not included.

Product- and service quality are also relevant output components for customers, which should be included in any proper output analysis of the water sector. But although it was part of the questionnaire, the service quality cannot be quantified. The results for the questions regarding the number of complaints on interruptions, pressure, billing and other service indicators turned out to be contradictory, fragmentary and probably downward-biased. To evaluate product quality, data has been collected for several physical, chemical and microbiological indicators. In order to compare water quality between utilities, an aggregated quality index has been calculated. Applying several methods of statistical interference including the Kruskal-Wallis test no significant differences between the quality indicators of several subgroups could be found. One potential explanation are the rigorous standards for German drinking water leaving no room for significant quality discrepancies. Hence, product quality is assumed to be homogenous on average for the sample utilities and the unmodified product volume can be used as the output measure in the following DEA.

According to the standard theory of production, labour, capital and intermediate products will be included in the DEA model. Labour is measured by the number of employees, real capital by the current book value of property, plant and equipment and intermediate goods by the expenses on material (including imported water) and purchased services. All inputs, even in multiproduct utilities, refer solely to the drinking water branch of the provider. One advantage of this model specification is that efficiency of utilities with different degrees of outsourcing can be compared. If for example a water provider decided to import all the raw water instead of abstracting it from own sources, real capital and labour would be partly substituted with higher expenses for intermediate inputs. The following table 2 shows the descriptive statistics of the inputs and the output used in the model.

TABLE 2

Descriptive statistics of variables included in the first stage of the DEA

	Output	*Inputs*		
	Volume of billed water (million m^3)	*Employees (number)*	*Property, plant and equipment (million Euro)*	*Intermediate inputs (million Euro)*
Mean	1.97847	26.973	24.39	1.8283
Standard deviation	3.46167	41.164	33.6858	3.09846
Median	0.97596	15	14.3222	1.11005
Minimum	0.084	1	0.648	0.0922
Maximum	19.3294	233	186.150	18.068
Number of observations	37	37	37	37

Source: IWH water survey 2004, author’s calculations.

Table 3 contains the descriptive statistics of the environmental variables included in the estimation for the second step of the DEA analysis. The number of observations varies due to data availability.

To measure democratic control, the organizational form of the water supplier is chosen as an indicator. This concept has also been applied in an empirical study of the impact of the organizational form on innovativeness in the German wastewater sector by Tauchmann and Clausen (2004). The data include the organizational forms “municipal company” and “special purpose association”. Special purpose associations (Zweckverbände) are associations of municipalities (in most cases) to accomplish a certain task and they form corporations of public law. Municipal companies are subject to private company law[9] and organizationally as well as legally independent from the municipality. The city councils can exercise only limited control via the supervisory board. Therefore, the effective political power θ (see section II) of local politicians to control managers' decisions is greater in special purpose associations than in the rather independently acting municipal companies.

Several indicators for the spatial distribution of customers (population density), economies of scope (multiutility firm), the quality of raw water (hardness of water supplied as approximation), alternative control mechanisms (participation in voluntary benchmarking activities), outsourcing (imported water, outsourcing dummy) and the age and quality of the network (age and portion of water pipes laid during the GDR era) are included in the regression. One potentially relevant variable, the number of service connections per square kilometer, was skipped because it correlated perfectly with population density.

[9] The preferred organizational form is the “Gesellschaft mit beschränkter Haftung” (GmbH, corporation with limited liability of shareholders) which is (roughly) similar to the Anglo-Saxon “limited company” or the French “SARL”.

TABLE 3

Descriptive statistics of the data included in the regression analysis

Variable	*Scale unit*	*Mean*	*Standard deviation*	*Mini-mum*	*Maxi-mum*	*Me-dian*	*Observat ions*
Company	Dummy variable (0,1)	0.216216	0.417342	0	1	0	37
Population density	Inhabitants per km^2 of the supplied area	191.037	237.212	25.61	1134.3	101.85	36
Imported drinking water	Ratio of imported treated water to total water input (%)	43.5627	43.5474	0	100	29.00	37
Multiutility firm	Dummy variable (0,1) 0: only drinking water supplied, 1: at least drinking water and sewage disposal	0.756757	0.434959	0	1	1	37
Hardness	°dH	13.807	8.06643	4	46	12.10	37
Bench-marking	Dummy variable (0,1), 1: water utility was benchmarked at least once during the last five years, 0 otherwise	0.228571	0.426043	0	1	0	35
Age of the distribution system	Weighted mean in years	32.4714	17.4116	6	66.3	31.63	36
Average quantity of water supplied per service connection	m^3 billed consumption per service connection	159.448	81.5055	60.67	506.01	144.44	33
Portion of distribution system 1960-1989	Percentage	31.4594	20.0292	0	74.75	27.21	36
Outsourcing	Dummy variable = 0: (partially) outsourcing of less than 5 functions; 1: (partially) outsourcing of ≥ 5 functions	0.378378	0.491672	0	1	0	37

Source: IWH water survey 2004, author's calculations.

V. Estimation results

The solution of the LP in (5) yields an average technical efficiency of 0.7336 for 37 observations in the sample. Further descriptive statistics are shown in table 4.

TABLE 4:
Technical efficiency - descriptive statistics

Variable	*Mean*	*Standard deviation*	*Minimum*	*Maximum*	*Median*	*Observations*
Technical efficiency	0.733595	0.234521	0.231	1	0.730	37

Source: IWH water survey 2004, author's calculations.

It should be stressed that no general conclusions about the extent of efficiency deficits in the German water sector can be drawn from this number. That is due to the fact that only actual stocks or costs of existing firms can be compared and not ideal standards. Hence, even enterprises with technical efficiency score 1 might have considerable leeway to increase their technical efficiency.

Table 5 gives the results of the OLS and the Tobit estimation for the variables included in the regression. Two variables listed in table 3, benchmarking and average quantity per service connection, are skipped because they have no significant effect on the dependent variable. The statistical significance of the municipal company dummy is robust for all variable combinations at least at the 95% level and at least at the 90% level for the outsourcing dummy. The signs and significance levels of the independent variables do not differ fundamentally between the OLS and the Tobit model.

It was tested if the formulation as a Tobit model is necessary or if the OLS regression is sufficient. The latter would be the case if the censoring probability went to zero. To check the model specification, two indicators are applied: the number of predicted values of the dependent variable exceeding the censoring margins of 0 or 1 and the convergence of some proposed goodness of fit measures for Tobit models with standard OLS-R^2.

The first criterion does not confirm the hypothesis of censored data because for the chosen OLS regression equation in table 5 only one case can be observed where the predicted value (1.041) of the dependent variable (1.00 observed value) exceeds the upper limit.

To verify the second criterion, two fit measures suggested by Veall and Zimmermann (1994) and Greene (2002, E21-10), R^2_{ANOVA} and $R^2_{DECOMPOSITION}$, are applied to the Tobit model. Both measures converge with the standard R^2 of a linear regression without censoring for the sample. Hence, the similarity of the three R^2 measures suggests that censoring is not really relevant for the model. Nevertheless, the results of the Tobit estimation are also presented in table 5.

TABLE 5

OLS and Tobit estimates for potential determinants of technical efficiency

	OLS			*Tobit model*		
	Coeffi-cient	*Standard error*	*t statistic*	*Coeffi-cient*	*Standard error*	*z statistic*
Constant	0.5829	0.1341	4.3477***	0.6399	0.1460	4.3819***
Company	0.4552	0.1310	3.4742***	0.8311	0.2600	3.1970***
Imported drinking water	0.0007	0.0010	0.7313	0.0007	0.0010	0.6395
Portion of distribution system 1960-1989	0.0014	0.0019	0.7437	0.0010	0.0021	0.4985
Multiutility firm	0.0411	0.0876	0.4685	0.0493	0.0930	0.5300
Hardness	-0.0029	0.0045	-0.6343	-0.0046	0.0048	-0.9696
Population density	-0.0003	0.0002	-1.2078	-0.0006	0.0004	-1.5292
Age of distribution system	-0.0006	0.0022	-0.2887	-0.0003	0.0024	-0.1361
Outsourcing	0.2024	0.0792	2.5562**	0.2231	0.0854	2.6125***
	R^2: 0.52484	Adjusted R^2: 0.37279	Akaike criterion: -0.276	Log likely-hood: 0.4416		

Notes: The number of observations included in both models is 34. *** significant at the 99% level, ** significant at the 95% level
Source: IWH water survey 2004 and author's calculations.

Due to the small sample size it is necessary to check if the disturbance term of the OLS estimation is normally distributed The hypothesis of normal distribution is confirmed by the Jarque-Bera test[10]. Therefore, the results of the t-, z- and F-tests could be considered as valid. The Breusch-Pagan-Godfrey (BPG) test statistic does not indicate heteroscedasticity and no hints for significant multicollinearity problems could be found so that the OLS method should be applicable without modifications.

The estimation results suggest that the organizational form has a significant effect on technical efficiency in the water sector. The same applies to outsourcing activities. Surprisingly enough, the effects of population density, structure of the customers and age structure of the networks are not relevant for technical efficiency. Participation in voluntary, non-public benchmarking activities, which are organized for example by the German Association of Local Public Enterprises (Verband Kommunaler Unternehmen VKU), does not seem to have any efficiency-enhancing effects in the short run. Furthermore, the existence of economies of scope cannot be confirmed. As mentioned above, the explanatory power of the regression results might have to be put into perspective because some important exogenous variables could not be included in the regression.

VI. Conclusions

The paper deals with the issue of the adequate degree of municipal control for local publicly owned firms, especially water utilities. This aspect is neglected in the efficiency literature that usually concentrates on comparisons of private and public water utilities. The hypothesis that less political interference with business activities in publicly owned utilities would increase efficiency was checked by a two-stage DEA approach for a sample of East German water suppliers. The organizational form was used as an indicator for the extent of local governments´ control in the empirical analysis.

[10] The skewness of the distribution of the disturbance term is -0.2837, the kurtosis is 2.667 and they both do not deviate significantly from the measures for normal distribution 0 and 3. The Jarque-Bera test statistic is 0.6128 and the p-value of obtaining such a value from a chi-square distribution with two degrees of freedom is 0.7361.

The empirical results confirm that a reduction of “democratic control” may increase technical efficiency. It prevents local governments from abusing their water utilities as instruments of redistribution. The greater autonomy of decision-making for public managers seems to be effort enhancing and does not necessarily boost rent-seeking activities. Therefore, organizational forms should be preferred for the local public production units that reduce the scope for municipal interventions in daily business activities. Especially for the German water sector, this might involve transforming municipal departments into municipal companies or establishing management companies for special purpose associations.

But some important aspects have to be left to future research work. First of all, the impact of private participation in the production process on efficiency could not be investigated for the German water sector because no private water providers could be included in the sample. Also differences in service quality should be integrated into future efficiency analysis of the water sector. The experiences with the IWH survey show that it would be better to collect the necessary quality data by customer survey instead of interviewing the water utilities.

This future research work, however, requires a greater spirit of openness and transparency primarily for the German water sector. Therefore, it is recommended that some national authority such as the German Federal Statistical Office should take over the collection and publication of technical and economic data for the water sector. The German water industry and their representatives are obviously unable to cope with the need for transparency in this vital industry.

Appendix: municipal control and public managers’ leisure-effort decisions

Consider a representative manager’s utility function with leisure L and non-cash benefits C_{nc}. Deviating from the usual leisure-income decision model monetary income from labour or other sources will be neglected because the manager’s labour income is usually fixed and not connected to the effective working hours (effort) or to any performance indicator of the firm.

(A) $U\ (L, C_{nc})$

The utility function shall exhibit the usual properties such as a positive elasticity of substitution, positive and diminishing marginal utility for L and C_{nc} and positive cross-derivations. Leisure can be substituted with non-cash benefits and vice versa. For simplicity, a Cobb-Douglas-type utility function is assumed:

(B) $U = L^{\alpha} C_{nc}^{\beta}$ with $0 < \alpha, \beta < 1$

Leisure L is defined as the residual of an exogenously given maximum level of effective leisure (daily, monthly, annually) $\overline{L}$ minus Effort E. For the public sector it is preferable to refer to effective leisure instead of working hours. Employees in public administration or public enterprises might have plenty of leeway to enjoy "leisure on the job" and recreate during working hours for their after-work activities.

(C) $L = \overline{L} - E \geq 0$

The non-cash consumption C_{nc} shall consist of two elements depending on the extent of intervention by the local governments θ and the effort of the public manager. Alternative control mechanisms to replace local government control such as regulation authorities are neglected. The manager chooses his utility-maximising effort level E subject to the following conditions:

(D) $C_{nc} = E \cdot w(\theta) - P(E,\theta)$

(E) $w(\theta) > 0,\ P(E,\theta) > 0$

(F) $w'(\theta) < 0, w''(\theta) > 0$

(G) $\frac{\partial P}{\partial E} < 0, \frac{\partial P}{\partial \theta} > 0, \frac{\partial^2 P}{\partial E^2} > 0, \frac{\partial^2 P}{\partial \theta^2} < 0, \frac{\partial^2 P}{\partial E \partial \theta} < 0$

(H) $\theta \geq 0$

The first term of (D) represents the benefits from “job enrichment” or “job enlargement”. The non-cash “wage” *w* per unit of effort is assumed to rise with decreasing public intervention, which raises the opportunity costs of leisure and sets incentives for the managers to increase their effort.

To describe the anti-shirking effect of increasing political intervention, the second term in (D) represents a “punishment” function $P(E,\theta)$. According to (E), *P* is assumed to increase with θ and to decrease with the manager’s effort *E*. That means, the extent of democratic control shall enhance the effectiveness of *P*, but with diminishing return. Finally, it is assumed that rising θ increases the absolute marginal reduction of *P* by effort (negative cross derivation).

Inserting (C) and (D) into (B) and taking the partial derivative with respect to *E* leads to the following first-order condition:

(I) $$\frac{\partial U}{\partial E} = -\alpha \cdot C_{nc} + \beta \cdot (\bar{L} - E) \cdot (w - \frac{\partial P}{\partial E}) = 0$$

An explicit solution of (I) for *E* to get an utility-maximizing effort function E^* is not possible without further specification of *P*. Alternatively, (I) can be interpreted as an implicit function $F(E, \theta) = 0$ and the implicit function rule of derivation can be applied to *F*. The partial derivatives of *F* with respect to θ and *E* are

(J) $$\frac{\partial F}{\partial \theta} = -\alpha \cdot (E \cdot w'(\theta) - \frac{\partial P}{\partial \theta}) + \beta \cdot (\bar{L} - E) \cdot w'(\theta) - \beta \cdot (\bar{L} - E) \cdot \frac{\partial^2 P}{\partial E \partial \theta} \cdot \begin{matrix} > \\ = \\ < \end{matrix} 0 \,?$$

(K) $$\frac{\partial F}{\partial E} = -\alpha \cdot (w(\theta) - \frac{\partial P}{\partial E}) - \beta \cdot w(\theta) \cdot + \beta \cdot \frac{\partial P}{\partial E} - \beta \cdot (\bar{L} - E) \cdot \frac{\partial^2 P}{\partial E^2} < 0$$

Therefore, the partial derivative of *E* with respect to θ is

(L) $$\frac{\partial E}{\partial \theta} = -\frac{\frac{\partial F}{\partial \theta}}{\frac{\partial F}{\partial E}} \begin{matrix} > \\ = \\ < \end{matrix} 0 \,?$$

Equations (J) to (L) illustrate that it remains unclear how managers would react to changes in political control. It is possible that the effort-enhancing additional non-cash benefits exceed the disincentives of reduced “punishment” effects.

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