Do Organizational Forms matter?

An Econometric Analysis of organizational Innovativeness in the German Wastewater sector

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Abstract

In the German wastewater sector, innovations are often regarded to be the key to better service provision. Our focus is on the question of whether less direct control by the authorities does improve the innovativeness of providers of wastewater services. On basis of data from a survey among German service providers a structural model explaining firms' innovativeness is estimated. Estimation results suggest that firm size improves innovativeness; however, the organizational arrangement, i.e. the legal dependency on municipalities does not. We conclude that reforms directed towards increased legal autonomy have only limited effects on innovations if not accompanied by market liberalization.

1. Introduction

The German wastewater market has some characteristics which seem to be inconsistent with one another. On the one hand, German wastewater services meet high technical standards. Such standards are set by working groups of the professional association DWA (German Association for Water, Wastewater and Waste). Although these norms do not pass automatically into law, they obtain a status similar to legal force in practice. On the other hand, the sector is perceived to be inefficient. This criticism was first raised by Briscoe (1995), and has been picked up regularly ever since.[1] According to Oelmann (2007) the potential to increase efficiency in the German wastewater sector should be around 4 % per annum in real terms. In addition to this productive inefficiency the sector is very fragmented and therefore might also be technically inefficient. According to Scheele (2000) around 8,000 wastewater companies currently exist.[2] Taking into account publications on the optimal size of a wastewater utility this seems to be far too much.[3]

Despite this situation there is neither a tendency to open up the wastewater market nor to materially privatize utilities. In addition, utilities only fear limited threat to actually loose part of their business to private companies, because different value added tax rates for utilities under private and public law apply. Whereas a public undertaking pays no value added taxes a private service provider currently faces 19 %.[4]

This raises the question whether there are any alternative options to improve the performance of the sector. Irrespective of the specific market form, innovations are often considered as a possible means to solve the sector's problems. However, such kind of innovations have to develop out of the

[1] E.g. Ewers et al. (2001), Hirschhausen (2009).

[2] German wastewater associations do not provide more recent data on the number of wastewater companies. See e.g. BGW & DWA (2005).

[3] E.g. SMC (2002) or SWC (2004).

[4] The European Commission has yet to reach a decision about the BDE's (Federal Association of the German Waste Management Industry) complaint submitted to the EU concerning the different manner in which public and private sector wastewater management businesses are taxed.

companies themselves. Yet, it is not clear what factors drive the generation and diffusion of innovations, and how innovativeness can be fostered by policy measures.

This paper therefore attempts to empirically assess these external factors that determine the innovativeness of firms operating wastewater services. We focus on organizational innovations, like the implementation of performance indicator systems, rather than technical ones. Hereby we want to answer two major research questions: Firstly, we are interested in whether firms which are less directly controlled by municipalities are more innovative than those directly controlled by the authorities. We assume that the innovative performance of privately run firms as opposed to those run by municipalities is higher, since allowing for more commitment of private firms on the one hand, and reducing the municipalities' influence on the other, might improve the sector's performance. However, we have also emphasized that there is no competitive threat to wastewater utilities in Germany. Therefore it seems possible that the organizational form does not play a significant role to explain the innovative performance of a firm; cf. Wu (2006) who identifies only limited effects of privatization on firms' efficiency if privatization is not accompanied by market liberalization. Secondly, we will scrutinize if bigger companies are more innovative than others. Our hypothesis is that the bigger the companies are the more specific know-how they employ to actually improve innovative performance. In a way, our paper on the German wastewater sector can be regarded in close relationship to Haug (2008), where similar questions are empirically answered for the German water sector. This paper reveals that the more independent the utilities are of municipal influence the more efficient they perform. However, the German water supply market incorporates more competitive elements than the German wastewater market.

The following section describes the role of municipalities in the German wastewater sector. The main focus is on organizational arrangements between the service provider and the municipality. Section 3 outlines the concept of innovativeness. Section 4 discusses the econometric model. Section 5 introduces the survey data used to estimate the econometric model, presents descriptive

analyses and discusses our estimation results. Finally, Section 6 offers conclusions and policy advice that are based on our empirical results.

2. Organizational Arrangements and the Role of Municipalities

According to German law, wastewater services belong to the duties of the municipalities, although these services do not necessarily have to be provided by the municipality itself. In fact, the municipality may even transfer the task, but always remains responsible for proper sewage disposal (Boscheck 2002).[5] In effect, municipalities are able to determine the degree of control they exercise on the provision of wastewater services, by choosing the organizational arrangement for the public utility.[6]

Possible arrangements range from 'municipal departments' that is complete integration of wastewater service provision into the local government, to firms held by private owners. Between these extremes, several organizational forms such as 'semi-autonomous municipal agencies', 'public law incorporations', 'inter-municipal agencies', and formally privatized but municipal held 'municipal enterprises' reflect gradual differences of the direct influence local governments have on the provision of wastewater services. Appendix A provides a brief description of these organizational arrangements.[7]

Wastewater services are still protected from direct competition in Germany. Therefore, there is no way to directly measure the effects that liberalization and exposure to market forces would have on firm's innovative activities. In addition, the share of private firms is still very small. Nevertheless,

[5] Even though the Federal Water Act has allowed the delegation of responsibility, most of the federal states have not yet adopted the corresponding legislation.

[6] This right was strengthened by the European Court of Justice on 9th of June 2009 (Case C-480/06). The Court argued, first, that Community law does not require public authorities to use any particular legal form in order to carry out jointly their public service tasks. Secondly, such cooperation between public authorities does not undermine the principal objective of the Community rules on public procurement, that is, the free movement of services and the opening-up of undistorted competition in all the Member States.

[7] Several legal terms – such as organizational form – that appear in this paper are specific to the German case. For this reason, the English translations that are used here often are not unique. For clarification, Appendix A lists the original German expressions along with the English translations.

numerous changes in organizational arrangements have been observed in recent years, leading to a substantially reduced share of municipal departments (cf. BGW & ATV-DVWK, 2003; BGW & DWA, 2005). This development might suggest that local governments increasingly regard the provision of wastewater services an entrepreneurial rather than administrative task. Such a reduction in municipal influence might be the first step towards opening the sector to private commitment and market forces. However, on the other hand it might as well be argued that a simple change in organizational arrangement is not at all a substitute to liberalization or material privatization. Our empirical assessment will reveal which of the two hypotheses holds true.

3. Innovations and Innovativeness

According to the OECD (1997) Oslo Manual, innovation stands for technical improvements of products and processes, as well as organizational innovations. Since technical innovations, such as new products, have to be judged as rather exceptional in the wastewater sector, and because information about new processes is weak in the data, our focus is on organizational rather than technical innovations. Organizational innovations include measures to improve the organizational structures of the firm and the work flow within firms as well as the implementation of advanced management techniques, such as Total Quality Management, and new or substantially changed corporate strategic orientations (OECD, 1997).

Typical innovation surveys provide information on both the input for a firm's innovative activities and on the resulting output, as well as on the modalities of these activities (Mairesse & Mohnen, 2001). The input side of innovative activities encompasses, for example, R&D expenditures, the share of staff that has a tertiary degree, expenditures on new technologies, and the information whether or not the firm is engaged in R&D. Our analysis solely focuses on the *output* of innovative activities, that is, the implementation of certain novelties.

We define innovativeness as a firm's general affinity and capability to carry out innovative activities whose explanation is the ultimate aim of this paper. Obviously, innovativeness represents a theoretical concept that lacks an observable counterpart. Nevertheless, firms reveal their innovativeness through the generation of specific innovations. In order to operationalize the concept of innovativeness in our empirical application, we now employ a structural econometric model that incorporates the firms' unobservable innovativeness as a latent variable, while the observable occurrence of several specific organizational innovations serve as dependent variables.

4. An Econometric Model of Innovativeness

The structural econometric model we employ for explaining firms' general innovativeness was originally designed by Fertig & Schmidt (2002) and modified by Brenner & Fertig (2006). Although the research question of these papers is completely different compared to the present one, strong methodical links exist as any of these analyses aim at identifying the determinants of a latent variable from a wide range of answers to survey questions that are more or less loosely related to the latent variable of interest.

4.1 The Structural Model

It is assumed that firm i's propensity X^*_{li} to implement a certain innovation l is determined by a vector of exogenous firm-specific variables $z_i \equiv [z_{1i} \dots z_{Ki}]'$ and the unobservable variable "innovativeness" Y^*_i:

$$\begin{aligned} X^*_{1i} &= \alpha_1 + \delta_1 Y^*_i + \beta_{11} z_{1i} + \dots + \beta_{1K} z_{Ki} + \varepsilon_{1i} \\ &\vdots \qquad\qquad \vdots \\ X^*_{Li} &= \alpha_L + \delta_L Y^*_i + \beta_{L1} z_{1i} + \dots + \beta_{LK} z_{Ki} + \varepsilon_{Li}. \end{aligned} \tag{1}$$

Here, $i = 1,\ldots,N$ indexes the firms. $l = 1,\ldots,L$ indexes those L organizational innovations that the firms were asked if they had implemented any of them. Finally, $\varepsilon_{1i},\ldots,\varepsilon_{Li}$ represent normally distributed mean-zero error terms that may be correlated across equations.

For the latent variable Y^*_i, we assume that it is determined by the same firm-specific characteristics z_i that enter (1):

$$Y^*_i = \gamma_1 z_{1i} + \ldots + \gamma_K z_{Ki} + \eta_i . \qquad (2)$$

The additional random variable η_i is assumed to be mean-zero normally distributed, too. Again, it may be correlated with any of the equation-specific errors $\varepsilon_{1i},\ldots,\varepsilon_{Li}$. By measuring $z_{1i},\ldots,z_{Ki}$ in terms of deviations from sample means, we normalize innovativeness so that Y^*_i takes the expected value zero for firms that displays average characteristics.

We proceed by replacing Y^*_i in equation (1) by equation (2) in order to get a reduced-form representation:

$$\begin{aligned} X^*_{1i} &= \alpha_1 + \theta_{11} z_{1i} + \ldots + \theta_{1K} z_{Ki} + \upsilon_{1i} \\ &\vdots \qquad\qquad\qquad \vdots \\ X^*_{Li} &= \alpha_L + \theta_{L1} z_{1i} + \ldots + \theta_{LK} z_{Ki} + \upsilon_{Li}, \end{aligned} \qquad (3)$$

where

$$\theta_{lk} = \delta_l \gamma_k + \beta_{lk} \quad for \quad l = 1,\ldots,L \quad and \quad k = 1,\ldots,K, \qquad (4)$$

and

$$\upsilon_{li} = \delta_l \eta_i + \varepsilon_{li} \quad for \quad l = 1,\ldots,L. \qquad (5)$$

4.2 Identification of the Structural Parameters

Our interest is on the structural model parameters $\gamma \equiv [\gamma_1 \cdots \gamma_K]'$, which capture the effects the exogenous variables have on a firm's innovativeness. However, without further restrictions, estimating the coefficients θ_{lk} of the reduced-form model (3) does not allow for the identification of γ. In order to obtain the necessary identifying restrictions, we follow Fertig & Schmidt (2002). Firstly, we assume that the cross-equations averages of the structural coefficients β_{lk} take the value zero:

$$\frac{1}{L}\sum_{l=1}^{L}\beta_{lk} = 0 \quad for \quad k = 1,\ldots,K\,. \tag{6}$$

That is, although we allow for direct effects of the explanatory variables z_i on the propensity to implement that do not operate through the latent variable "innovativeness", we rule out that the variables in z_i can systematically influence the attitude towards all single innovations in any other way than by influencing the firms' innovativeness. This restriction allows for a separate identification of direct and indirect effects of the explanatory variables.

Secondly, a restriction is required that disentangles the effects of the exogenous variables on Y^*_i from the effect Y^*_i has on the dependent variables, i.e. a high estimate of θ_{lk} may reflect a high value of δ_l as well as a high value of γ_k. We follow Fertig & Schmidt (2002) and assume

$$\frac{1}{L}\sum_{l=1}^{L}\delta_l = 1\,. \tag{7}$$

That is, we normalize the average effect of innovativeness on the propensity to innovate to take the value one.[8] Since there is no obvious way to metrically measure the propensity to innovate, and since the absolute size of the coefficients, therefore, has no obvious interpretation, this

[8] This choice does not result in any loss of generality. Any other positive value could be chosen just as well.

normalization is less restrictive than one might think at first. On basis of (6) and (7), and with estimated reduced-form coefficients θ_{lk} in hand, one can calculate estimates for the structural parameters γ_k:

$$\frac{1}{L}\sum_{l=1}^{L}\theta_{lk} = \gamma_k \underbrace{\frac{1}{L}\sum_{l=1}^{L}\delta_l}_{=1} + \underbrace{\frac{1}{L}\sum_{l=1}^{L}\beta_{lk}}_{=0} = \gamma_k \quad for \quad k = 1,\ldots,K\,. \tag{8}$$

Equation (8) states that the effect of a variable z_{ki} on firms' innovativeness can be expressed as the average effect this variable has on the propensity to implement any innovation. This result has quite an intuitive interpretation: Since we cannot observe innovativeness, we focus our attention to certain innovations and estimate how exogenous variables influence the likelihood for implementing them. However, we then face the problem of how to aggregate this set of estimated effects to a single effect on overall innovativeness. Equation (8) simply suggests taking the average.[9]

4.3 Estimation

The reduced form model (3) cannot be directly estimated, since $X^*_{1i},\ldots,X^*_{Li}$ – the propensities to implement the L single innovations – are latent variables. However, the answer to the question of whether a certain organizational innovation has been implemented can be interpreted as an observable counterpart to the latent variable "propensity to implement". More specifically, it is assumed that the possible answer categories ("not implemented", "implementation planned ", and "already implemented" – coded $x_{li} = 0$, 1, or 2) correspond to certain levels of the latent variable. That is, if the "propensity to implement" is low, a firm does not implement an innovation; if its propensity is high, the firm does implement; and finally, if its propensity is somewhere in between,

[9] Indeed, if the coefficients are estimated by discrete choice models, e.g. by probit, taking the average is subject to an implicit whiting scheme. I.e. equations with high explanatory power receive more weight in the calculation of the aggregate effect on innovativeness, see Fertig & Schmidt (2002) for technical details.

a firm may consider the implementation of an innovation for the future. Hence, the reduced-form coefficients θ_{lk} can be estimated using conventional ordered probit models.

In order to reduce the estimation procedure's computational complexity, ordered probit estimation is carried out individually for each equation rather than simultaneously. While this does not affect the consistency of the estimation, conventionally derived analytical standard errors might result in misleading inference as – by construction of the model - the reduced-form error-terms exhibit cross-equation correlation. Hence, bootstrapped rather than analytically determined standard errors are calculated for the structural parameters. The reported standard errors are based on 250 bootstrap iterations.

5. Data and Empirical Results

Our empirical analysis rests on a survey among German firms that provide wastewater services which was conducted in 2003 (cf. Clausen et al., 2003 for a comprehensive descriptive analysis). The members of the "German Association for Water, Waste-Water and Waste Services" (ATV-DVWK) – today called the “German Association for Water, Wastewater and Waste” (DWA) - were used as the data base for this survey. These approximately 2,000 organized firms represent about one fourth of all 8,000 assumed suppliers in the sector (cf. Clausen & Rothgang, 2004). Out of the ATV-DVWK members, 683 firms were randomly drawn. The sample was stratified by location and firm size, whereas large firms were systematically over-sampled. 237 firms returned completed questionnaires.

5.1 Organizational Innovations

In addition to firm-specific characteristics, several innovation-related questions are addressed in the survey. Firms were first examined on their subjective perception of different factors encouraging or impeding innovations. Here, we are more interested in behavioral facts than in stated perceptions,

so we focus on questions referring to innovation-related behavior. While the questionnaire did not directly address specific technical novelties, firms were asked about organizational innovations. In addition to a few sector-specific novelties, we especially focus on those organizational novelties that are widespread in the private industry. With particular respect to a specific set of eight organizational innovations, firms were asked if they had already implemented them, plan to implement them, or whether they are not considering implementing them at all.

Only firms that responded to the full set of questions concerning the eight organizational innovations are used for estimating the model. Because of 'item non-response', the sample effectively used consists of only 161 observations. Table 1 displays the distribution of answers in the sample. Appendix B provides a brief description of organizational innovations considered. None of the organizational novelties considered is already used on a regular basis. Only "service and operation directions" and, to a smaller extent, "cost and activity accounting", as well as "split wastewater charges" are widespread among the firms in our sample, whereas , "management systems", "incentive wages", and "success-related fees" still seem to be rather exceptional in the sector.

Table 1: Distribution of the dependent variables

Organizational innovation	**neither planned nor implemented**	**implementation planned**	**already implemented**
split wastewater charges	93	24	44
success-related fees	133	21	7
service and operation directions	50	33	78
cost and activity accounting	80	30	51
internal performance indicators	105	24	32
benchmarking	117	16	28
management systems	128	20	13
incentive wages	137	13	11

5.2 The Explanatory Variables

The key concern of this paper is to assess whether direct municipal influence, measured by a firm's organizational form, has an effect on firms' innovativeness.[10] The relevance of this question is underpinned by the fact that in the survey many firms report that political interventions from municipalities are regarded as major obstacles for implementing new technologies and organizational reforms (cf. Clausen et al. 2003). Organizational arrangements are captured by a set of dummy variables. Here, "municipal department" serves as the base category. Table 2 displays – along with descriptive statistics for other explanatory variables – the distribution of organizational forms among those observations that are used for estimating the model. We regard organizational arrangements as the result of political decisions: the organizational form is a matter of local policy and, therefore, is determined independently from the innovation-related behavior of the firm that actually operates wastewater services. Hence, in the regression analysis we can treat the organizational arrangement as an exogenous variable.

In addition to its organizational environment, our second key concern is whether the size of a firm might determine if or if not innovations are successfully implemented. Contradictory arguments are circulating of firms being either too small or too large to innovate. Small firms are often assumed to lack the necessary human and financial resources, while large firms may lack the flexibility to implement innovations. Because firm size is typically endogenous in standard markets, it might be a rather problematic regressor. This problem does not apply to wastewater services, where firm size is exogenous, because the disposal areas are fixed, and each firm's size can be measured in terms of the number of customers. That is, we equate firm size and population size and employ the population size of the corresponding disposal area as a regressor.

[10] This corresponds to the theoretical literature concerned with innovations in other industries, e.g. Arrow (1962) or Aghion et al. (2002), which often regards market conditions and, in particular, the degree of competition – in addition to the regulatory framework – to be the key determinants for innovations.

Since disposal areas are exogenously determined, regional characteristics are able to serve as regressors. We include the population density in our model, since draining wastewater from highly populated areas appears to be a rather different task than providing the same service in rural areas that possibly even lack comprehensive common grid-type networks for draining sewage.

Table 2: Descriptive statistics for the explanatory variables in the sample

Explanatory Variable	**Mean**	**Std. Dev.**	**Measuring Unit**
municipal department	0.273	0.447	indicator
semi-autonomous municipal agency	0.360	0.482	indicator
inter-municipal agency	0.236	0.426	indicator
public law incorporation	0.062	0.242	indicator
private law	0.068	0.253	indicator
population	0.120	0.403	10^6 people
population density	0.049	0.067	10^4 people/km^2

Finally, environmental policy regulations, such as water quality or technical standards, are generally considered as key driving forces for innovations. However, although environmental policy regulations typically vary across time, they do not within cross-sections. For this reason, our data are ill-suited for identifying such effects on innovations and this aspect has to be excluded from the analysis.

5.3 Discussion and Interpretation of Estimation Results

Table 3 displays estimates for the structural model parameters.[11] Other variants of the model besides the specification presented in table 3 were also estimated. None of the explanatory variables additionally included proved to be significant. Therefore, results for a rather small model serve as the basis for our discussion.

[11] Results for the corresponding reduced-form coefficients are available from the authors upon request.

None of the individual coefficients attached to dummies indicating organizational arrangement significantly deviates from zero. Therefore, municipal departments cannot be judged to be more or less innovative than any other organizational form. However, since we are not interested in the base category "municipal department" in its own right, this result may be of secondary interest. More importantly, these coefficients are also jointly insignificant, with the p-value of the corresponding Wald-test being as high as 0.880. That is, we cannot find any evidence in the data to support the hypothesis that innovativeness systematically differs for different organizational forms.

Table 3: Estimated structural model coefficients

Explanatory Variable	**Estimated Coefficient**	**Standard Error**
semi-autonomous agency	0.269	0.555
inter-municipal agency	0.216	0.564
public law incorporation	-0.126	0.834
private law	0.739	0.822
population	1.475*	0.709
population density	4.251**	1.286

Notes: ** and * indicate significance at the 0.01- and 0.05-level, respectively.

Since many firms regard interference from municipalities to be a major obstacle to the introduction of novelties, in our first hypothesis we expected firms less directly controlled by them to be more innovative. Our preferred explanation for this unexpected result is that organizational arrangements do require some form of competitive threat and/or material privatization to actually work. Comparing our results with the ones of Haug (2008) actually supports this view. Haug (2008) has performed a similar analysis for German water suppliers, but reached very different results. Here, the organizational arrangement mattered. The more independent the utilities were able to act, the more efficient they were. Thus, we may argue, that the German wastewater market would as well profit from more competition and material privatization. Even though the German water supply market is also not really competitively organized, this market at least incorporates more competitive

elements and private involvement than the German wastewater market. Interestingly, this argument corresponds with the empirical results Wu (2006) finds for the case of privatization in Taiwan.

In contrast to the dummies indicating organizational forms, the coefficients attached to the population within the disposal area, i.e. the size of the firm, and the population density are both positive and significant. That is, larger firms and those operating in highly populated areas are significantly more innovative than smaller ones and those operating in rural areas. In fact, the density of population in the disposal area turned out to be the most highly significant regressor in any specification of the model that was estimated.

Since the German wastewater sector is characterized by a huge number of, mostly, very small service providers, which are likely to lack the recourses for being innovative, the result that large firms are more innovative than small ones may not come as a surprise. To explain, however, why innovativeness is so strongly determined by the density of population requires some discussion. The main reason to include population density is to account for differences in physical environment in which firms operate, but the coefficient might also capture another effect. Areas of high population densities are typically found in large cities. Cities, however, may provide not just a natural but also a social environment that enhances innovativeness. Research facilities, firms that already have experienced technical or organizational novelties, and other institutions that can provide information about innovations, are typically located in large cities. Therefore, population density might be a rough proxy for a firm's integration into innovation-enhancing networks.[12]

5.4 Alternative Count-Data Specification

In order to check for the robustness of our previous results, we also report estimates for a conventional count-data analysis. That is in this model, the number of organizational innovations

[12] This interpretation is supported by results obtained from slightly modified models, where population density is replaced by a closely related, but purely technical, variable e.g. "length of grid per inhabitant" that turn out to be insignificant.

serves as a single dependent variable. We distinguish two variants, one where only implemented innovations are counted and another that considers both planned and already implemented ones. Statistical test favor the zero-inflated Poisson (ZIP) model to alternative specifications. Estimation results, see table 4, largely confirm our previous ones. For the variant that considers implemented and planned innovations, the organizational from still does not exert any effect what so ever. If only implemented innovations are considered, the indicator for private utility is individually significant, i.e. compared to the category of reference. However, jointly, organizational arrangements still do not exert a significant effect on utilities' innovativeness. Moreover, as in our earlier model, population density exerts a significant effect in innovative activities. In contrast, population is insignificant for any count-data model.

Table 4: Results for the alternative ZIP models

Explanatory Variable	**only implemented**		**implemented & planned**	
	Est.	**S. E.**	**Est.**	**S. E.**
semi-autonomous agency	0.179	0.125	0.198	0.115
inter-municipal agency	0.068	0.141	0.132	0.133
public law incorporation	0.059	0.236	0.157	0.285
private law	0.603*	0.227	0.333	0.176
population	0.152	0.172	0.020	0.188
population density	3.754**	1.404	3.312**	1.274

Notes: ** and * indicate significance at the 0.01- and 0.05-level, respectively.

6. Conclusions and Policy Implications

We emphasized that currently German wastewater companies do not face any competitive threat at all. In spite of this situation we tried to identify other determinants which influence the innovativeness of German firms that provide wastewater services. Our first determinant, the organizational form, i.e. legal dependency from municipalities, cannot explain firms' innovativeness: Our estimation results, therefore, do not support the hypothesis that a change in

organizational arrangement and, in particular, a reduced influence of municipal councils will improve the innovation-related performance of service providers. Thus, reforms directed towards increased legal autonomy do not seem to be the first policy choice to foster innovativeness.

Haug (2008) has performed a similar analysis for the German water supply market. His results show that the organizational form does matter and that the more independent the utilities are of political interference the more efficient they are. This outcome might come as a surprise. An important explanation could be that the German water supply and the German wastewater market are organized differently. Whereas the German wastewater market is structured in such a way that companies do not face any competitive threat to improve performance, the German water suppliers are facing at least some form of pressure. In addition private companies are far more engaged in the German water supply than in the German wastewater market.[13] Therefore our results suggest that reforms directed towards increased legal autonomy are not a substitute to introduce more competition or privatization. They might rather be complements. Hence, policy makers should not rely on organizational reforms alone in order to improve the performance of the German wastewater industry. Rather, the relevant regulation of this industry should allow for more competition among service providers.

We also analyzed the outcome of a second explanatory variable: firm size. The hypothesis has been that the bigger a company is – at least in such a fragmented market like the German wastewater market – the more innovativeness we can expect. Our result is, that large firms proved to be more innovative than small ones suggesting that even a moderate restructuring within the existing legal framework that leads to larger units may help to foster innovations and improve the efficiency of the German wastewater sector. From this point of view, a process of mergers and acquisitions – which has already started in drinking water supply services – could be potentially beneficial for the wastewater sector as well.

[13] The German wastewater sector displays only the early signs of privatization. Correspondingly, our sample is comprised of just a few private firms that often do not even exhibit actual private ownership.

Besides the size of the company, the density of population within the firms' areas of supply also determines firms' innovativeness. This might be a "big city effect" rather than a genuine population-density effect, resting upon integration into innovation-enhancing networks and access to human capital, which is rather located in city centers. Therefore, besides fostering bigger units in general, this finding might offer an additional starting-point for pushing innovativeness: Firms apparently benefit from a socio-economic environment that offers access to sources of innovations. Therefore, general investments in research and education are at least likely to have positive effects on wastewater services, too.

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Appendix A: Organizational Arrangements

A **municipal department** (*Regiebetrieb*) is legally and organizationally a dependent part of the municipality. Its finances are integrated in the general community budget, and it often does not have an accounting system to call its own. All decisions are made by the municipal council.

The **semi-autonomous municipal agency** (*Eigenbetrieb*) is also a legally dependent part of the municipality. In contrast to municipal departments, however, it is a separate municipal entity that operates clearly defined budgetary allotments on its own. (Holzwarth & Ewens, 2001).

The **public law incorporation** (*Anstalt des öffentlichen Rechts*) concerns a firm under public law with its own legal status that can be set up by a state body only on the basis of a specific law. Public law incorporation arrangements are exempted from any tax (Hansen et al., 2000).

Inter-municipal agencies (*Zweckverband*) and **water and soil management associations** (*Wasser- und Bodenverband*) are mainly associations of municipalities. This way, several municipalities can accomplish their tasks jointly. Both organizational arrangements have their own legal status, making them less dependent from single responsible municipalities than municipal

departments are. Additionally, they can use a semi-autonomous agency for fulfilling the wastewater services (Holzwarth & Ewens, 2001).

In contrast to these five types of organizational forms, wastewater services can also be arranged under private law. "Private", however, does not necessarily mean that the entire firm or even shares are held by private owners (material privatization); it also labels firms that are still entirely publicly owned while operated under private law (formal privatization). Three general types of private arrangements can be distinguished:

A **municipal enterprise** (*kommunale Eigengesellschaft)* is usually organized as a limited liability company (GmbH) or as an incorporated company (AG). The entire shares are held by the municipality. The firm is independent of the municipality in terms of its organization, management, and its accountancy; however, the municipality has influence through the supervisory board.

In the case of **a management and services enterprise (***Betriebsführungsgesellschaft***)**, the ownership of the assets and the corresponding responsibility for investments both remain with the municipality, whereas the private firm runs the wastewater treatment plants, etc.

Joint ventures and **co-operating enterprise** (*Kooperationsgesellschaft*) represent public utilities, in which a private firm holds a (typically minor) share in the firm's capital. Other types of organizational arrangements involving private firms may occasionally occur, whereas completely private wastewater firms are extremely rare in Germany.

Appendix B: Description of Organizational Innovations

Split wastewater charges (*gesplitteter Gebührenmaßstab*): In principle, wastewater charges can be calculated in two different ways. The common method exclusively takes the amount of freshwater used by the consumer as the basis of the charges. In contrast, "split wastewater charges" combine

two criteria. The first charge is for sewage that results from freshwater consumption. The second one is for rain run-off and depends on, among other things, the size of the sealed surface. Thus, the polluter-pays-principle is realized by using a "split wastewater charge" rather than an exclusively freshwater-based measure. Nevertheless, about three out of four German municipalities use the latter one (Rahmeyer, 2002).

Success-related fees (*Erfolgshonorarvereinbarung*) refers to fees that architects and engineers receive. These fees are traditionally calculated wholly on basis of production costs. Since 1996, a revised ordinance has allowed for the agent's fee to be partly dependent on cost-reduction effects of so-called technical-scientific solutions; i.e. a municipality that orders, for example, the renewal of a sewage plant is allowed to pay the architect an extra fee of up to 20 percent of the cost saved by an innovation. In our survey, a mere four percent of the firms already use this instrument, and further 14.4 percent intend to use it.

Service and operation directions (*Dienst- und Betriebsanweisungen*) are special legally defined bureaucratic means to systematically concretize a firm's tasks, regulate the duties of the staff, and create norms for dealing with the facilities. Their implementation is regarded as an organizational innovation. In detail, "service directions" explain what the task "wastewater disposal" is comprised of, and which single tasks have to be fulfilled. They name the legally responsible persons and assign duties. "Operation directions" describe the facilities (e.g. sewage networks or sewage plants) and list the corresponding duties to operate and maintain the facilities. Beyond these two types, more detailed instructions about specific parts of the technical facilities can also be used.

Cost and activity accounting (*Kosten- und Leistungsrechnung*) deals with the coverage and assignment of costs to cost units (i.e. a product) and cost centers (i.e. a department) in order to determine how cost-intensive the different parts and outputs of a firm are. While cost and activity accounting is part of double entry-bookkeeping and therefore standard for private enterprises, it is not mandatory for public institutions, and therefore not for public utilities, either.

Internal performance indicator systems (*interne Kennzahlensysteme*): Although closely related to "cost and activity accounting", "internal performance indicator systems" represent a wider approach. This instrument can deal with all kinds of performance categories, such as quality, reliability, customer service, sustainability, and economic efficiency, and can, therefore, look at monetary as well as non-monetary indicators.

Benchmarking is related to "performance indicators systems". In contrast to these, benchmarking restricts the analysis not only to indicators concerning the own firm, but also compares them with those of its peers. If done properly, benchmarking can help to reveal any hidden potential to catch up with the most efficient firm. In Germany, benchmarking is performed by utilities on a voluntary basis, and in most cases, the information remains confidential (WRc & Ecologic, 2002). Besides, benchmarking initiatives are often comprised of only one or a few processes. As a contrast to this, it is used for *ex ante* regulation of the English and Welsh water sector.

Management systems (*Managementsysteme*) seek to improve the quality of processes and products, as well the management of environmental and health risks of drinking water and wastewater services. Certain management systems can be certified according to the standards defined in ISO 9000 pp. or ISO 14001; by doing so, a firm signals that its processes have reached a good and generally accepted quality.

Incentive wages (*Entlohnungs- und Anreizsysteme*) reward the staff for good working results, special achievements, etc. This organizational innovation is considered because traditional payment systems used in the public sector are often considered to be inflexible.