TECHNISCHE UNIVERSITÄT DRESDEN

The Impact of Governance Choice on Performance – An Application to the German Water Distribution Sector

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Agenda

Introduction

- **Intensive discussion about the optimal level of private involvement in the provision of traditional public services**
- **We would expect higher overall performance and lower consumer prices where a private partner is involved in service provision**

In the German water production and distribution sector we observe:

- **Widely varying retail prices**
- **A broad range of governance structures, among them private sector participation and public-private partnerships**

- **There exists a huge body of theoretical literature discussing advantages and disadvantages of PPPs**

Introduction II

- **Existing literature evaluating the performance of water utilities is mainly based on efficiency analysis** (e.g. Bhattacharyya et al. 1995; Estache and Kouassi 2002)
- **Only a very limited number of studies accounts for the “self-selection” of managers into a strategy** (see e.g. Chong et al. 2006; Carpentier et al. 2006)

Our contribution to the literature:

- **Empirical analysis investigating the impact of governance choice on firm performance using a database of 765 German water suppliers correcting for potential self-selection (Heckman model)**

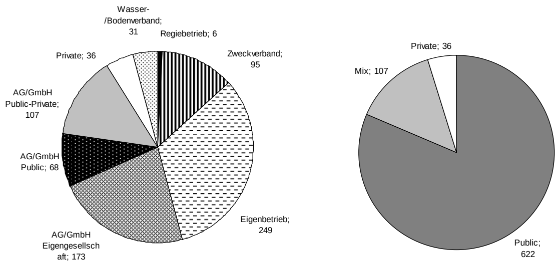
Main findings:

- **Consumer prices are higher under PSP**
- **Technical and structural characteristics cannot explain the whole variation**
- **There seems to be self-selection only into one strategy**

Industry Context

- **Local public authorities traditionally are responsible for water supply**
- **Regulation differs by federal state; decentralized decision making**
- **Various governance structures (26% PSP, 74% public service provision)**

Governance structures observed in our dataset:



- **~ 6,500 utilities supply water to 81.6 million inhabitants in > 13,000 municipalities**
- **TPA not enforceable under current legislation**

Working Hypotheses

Organizational form:

- *Proposition 1:* The participation of private companies in the operation of water supply should lead to an increase in overall performance due to the realization of economizing potential under competitive pressure; hence, we expect lower retail prices under PSP.

Scale economies:

- *Proposition 2:* Scale economies should lead to higher firm performance values which should mirror in lower retail prices.

Technological and structural characteristics:

- *Proposition 3a:* The higher the share of underground water in the supply portfolio of the company, the lower should be the retail price.
- *Proposition 3b:* The higher the quality of the network, the lower should be the retail price.
- *Proposition 3c:* The higher the dependence on imports, the higher should be the retail price.

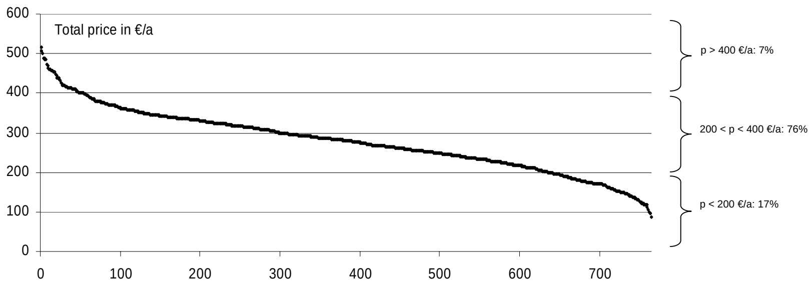
Dataset

Unit of analysis:

- **Water supply company in 2003, 765 observations**

Endogenous variables:

- **Governance structure: DPRIVATE (1 under PSP and zero otherwise)**
- **Consumer price for a representative household: PRICE (excluding taxes)**



Variables

Characteristic	Denotation	Unit	Mean	Min	Max	N

Variables

Characteristic	Denotation	Unit	Mean	Min	Max	N
Retail price for a representative household consuming 150 m³/a	PRICE	€/a	279.13	88.20	517.20	765
Governance form: dummy equaling one for private sector participation	DPRIVATE	Dummy	0.180	0	1	765
Percentage of water sales to household customers (versus industry)	SALESHH	%	0.831	0	1	765
Population supplied	POP	In 1000	53.72	1	3416	765
Dummy equaling one for cities with more than 500,000 inhabitants	DCITY	Dummy	0.013	0	1	765
Network density: ratio of population supplied over network length	DENSITY	POP/km	159.47	17.09	478.01	765
Percentage of water production from underground sources	UNDERGROUND	%	0.593	0	1	765
Count index for the number of treatment steps before distribution	TREAT	Ordinal	1.083	0	4	654
Leak ratio: (total input – total sales) / total input	LEAK	%	0.114	0	0.429	765
Import dependence: percentage of water imports from third producers	IMPORTDEP	%	0.276	0	1	765
Dummy for suppliers in the Eastern part of Germany	DEAST	Dummy	0.148	0	1	765
Dummy for suppliers only supplying water (i.e. no sanitation or other services)	DWATER	Dummy	0.225	0	1	765

Methodology

- **First regression: Simple OLS**

$$PRICE_i = \alpha G_i + \beta X_i + \varepsilon_i$$

- **If there is self-selection, the governance form is an endogenous variable**
- **Second regression: Switching regression model (Heckman model)**

$$G_i^* = \delta X_i + \gamma Z_i + v_i$$ with $G_i = 1$ if $G_i^* > 0$ and zero otherwise

$$\lambda_i^1 = \phi[\delta X_i + \gamma Z_i] / \Phi[\delta X_i + \gamma Z_i]$$
$$\lambda_i^0 = \phi[\delta X_i + \gamma Z_i] / (1 - \Phi[\delta X_i + \gamma Z_i])$$

$$PRICE_i^1 = \beta^1 X_i - \sigma_u^1 \phi\left[\hat{\delta} X_i + \hat{\gamma} Z_i\right] / \Phi\left[\hat{\delta} X_i + \hat{\gamma} Z_i\right] + e_i^1$$
$$PRICE_i^0 = \beta^0 X_i + \sigma_u^0 \phi\left[\hat{\delta} X_i + \hat{\gamma} Z_i\right] / \left(1 - \Phi\left[\hat{\delta} X_i + \hat{\gamma} Z_i\right]\right) + e_i^0$$

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Estimation Model

- **First regression: Simple OLS**

$$PRICE_i = \beta_0 + \alpha DPRIVATE_i + \beta_1 SALESHH_i + \beta_2 POP_i + \beta_3 POP_i^2 + \beta_4 DCITY_i + \beta_5 DENSITY_i$$
$$+ \beta_6 UNDERGROUND_i + \beta_7 TREAT_i + \beta_8 LEAK_i + \beta_9 IMPORTDEP_i + \beta_{10} DEAST_i + \varepsilon_i$$

- **Second regression: Switching regression model (Heckman model)**

$$DPRIVATE_i = \delta_0 + \delta_1 SALESHH_i + \delta_2 POP_i + \delta_3 POP_i^2 + \delta_4 DCITY_i + \delta_5 DENSITY_i +$$
$$\delta_6 UNDERGROUND_i + \delta_7 TREAT_i + \delta_8 LEAK_i + \delta_9 IMPORTDEP_i + \delta_{10} DEAST_i + \gamma DWATER_i + v_i$$

$$PRICE_i^1 = \beta_0^1 + \beta_1^1 SALESHH_i + \beta_2^1 POP_i + \beta_3^1 POP_i^2 + \beta_4^1 DCITY_i + \beta_5^1 DENSITY_i$$
$$+ \beta_6^1 UNDERGROUND_i + \beta_7^1 TREAT_i + \beta_8^1 LEAK_i + \beta_9^1 IMPORTDEP_i + \beta_{10}^1 DEAST_i - \sigma_u^1 \lambda^1 + e_i^1$$

$$PRICE_i^0 = \beta_0^0 + \beta_1^0 SALESHH_i + \beta_2^0 POP_i + \beta_3^0 POP_i^2 + \beta_4^0 DCITY_i + \beta_5^0 DENSITY_i$$
$$+ \beta_6^0 UNDERGROUND_i + \beta_7^0 TREAT_i + \beta_8^0 LEAK_i + \beta_9^0 IMPORTDEP_i + \beta_{10}^0 DEAST_i + \sigma_u^0 \lambda^0 + e_i^0$$

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Specification	OLS Dep. var.: PRICE		
	Model 1	Model 2	Model 3
CONSTANTE	273.39 *** (3.09)	219.56 *** (16.83)	221.47 *** (19.50)
DPRIVATE	31.77 *** (7.28)	22.79 *** (7.31)	18.40 *** (6.68)
SALESHH		33.71 * (18.77)	31.93 * (16.85)
POP		0.19 *** (0.06)	0.15 *** (0.06)
POP squared		-0.00 *** (0.00)	-0.00 ** (0.00)
DCITY		-42.89 (39.10)	-62.57 * (35.47)
DENSITY		0.12 *** (0.04)	0.09 ** (0.04)
UNDERGROUND			-64.57 *** (10.97)
TREAT			10.93 ** (4.45)
LEAK			155.29 *** (38.69)
IMPORTDEP			20.33 (12.89)
DEAST			55.53 *** (7.57)
DWATER			
Adjusted R^2	0.02	0.07	0.35
Pseudo R^2			
p-value F.-stat.	0.000	0.000	0.000
p-value Chi sqrt.			
N	765	765	654

Simple OLS Model

- **PSP results in higher consumer prices for all specifications:** Controlling for potential scale economies, technical and structural characteristics etc. we find that consumers pay 18.40 €/a more under PSP
- **Scale economies** (SALESHH, DCITY) **result in lower prices**
- **Market size** (POP) **has a positive and decreasing, but negligible effect on price**
- **Counterintuitive result for DENSITY**
- **Cost advantages** (UNDERGROUND) **as well as cost disadvantages** (LEAK, TREAT) **are mirrored in consumer prices**
- **Dependence on imports no significant impact**
- **Water prices in the Eastern countries** (DEAST) **are significantly higher than in the Western part of Germany**

Specification	Probit Governance Choice Dep. var.: DPRIVATE		
	Model 1	Model 2	Model 3
CONSTANTE	-0.798 *** (0.058)	-1.262 *** (0.344)	-1.260 *** (0.467)
DPRIVATE			
SALESHH		-0.179 (0.386)	-0.098 (0.417)
POP		0.003 * (0.001)	0.003 (0.002)
POP squared		-0.000 (0.000)	-0.000 (0.000)
DCITY		0.004 (0.825)	-0.259 (0.869)
DENSITY		0.003 *** (0.001)	0.003 *** (0.001)
UNDERGROUND			-0.251 - (0.254)
TREAT			0.111 + (0.100)
LEAK			-0.141 (0.952)
IMPORTDEP			0.032 (0.291)
DEAST			0.015 (0.179)
DWATER	-0.680 *** (0.156)	-0.544 *** (0.161)	-0.526 *** (0.180)
Adjusted R^2			
Pseudo R^2	0.03	0.07	0.08
p-value F.-stat.			
p-value Chi sqrt.	0.000	0.000	0.000
N	765	765	654

Switching Regression Model

1st stage:

Probit model explaining governance choice

- **Instrumental variable** (DWATER) **indicates that pure water companies typically remain under public control**
- **Need for further efforts to improve this model**
  - Very low explanatory power of the model
  - Asymmetric predictive power:

	Subsample (654 observations including TREAT)
$D\_hat_i = k$ and $D_i = k$	534 (82%)
$D\_hat_i = 1$ and $D_i = 1$	6 (5%)
$D\_hat_i = 0$ and $D_i = 0$	528 (99%)
	Subsample (654 observations including TREAT)
$D\_hat_i = k$ and $D_i = k$	534 (82%)
$D\_hat_i = 1$ and $D_i = 1$	6 (5%)
$D\_hat_i = 0$ and $D_i = 0$	528 (99%)

Specification	Switching Regression A Dep. var.: PRICE (DPRIVATE = 1)		Switching Regression B Dep. var.: PRICE (DPRIVATE = 0)	
	Model 3	Model 3b (without TREAT)	Model 3	Model 3b (without TREAT)
CONSTANTE	592.86 *** (218.26)	561.89 *** (195.17)	57.76 (72.64)	45.31 (66.18)
SALESHH	-20.92 (39.13)	9.35 (37.14)	54.18 *** (18.98)	64.80 *** (18.04)
POP	0.16 (0.25)	0.20 (0.23)	0.11 (0.07)	0.12 * (0.07)
POP squared	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
DCITY	48.03 (81.01)	35.35 (75.98)	-34.07 (49.22)	-45.33 (46.95)
DENSITY	-0.14 (0.16)	-0.11 (0.15)	-0.01 (0.07)	-0.04 (0.06)
UNDERGROUND	-49.56 * (28.08)	-58.09 ** (24.56)	-53.32 *** (12.83)	-61.41 *** (10.84)
TREAT	8.34 (10.66)		5.31 (5.31)	
LEAK	203.21 * (102.56)	184.32 * (98.44)	158.51 *** (42.39)	138.31 *** (39.10)
IMPORTDEP	22.48 (29.48)	6.85 (23.43)	18.70 (14.47)	5.18 (11.79)
DEAST	35.65 ** (16.71)	34.96 ** (15.42)	56.61 *** (8.63)	58.99 *** (7.92)
LAMBDA	-413.79 (286.67)	-380.65 (265.22)	176.96 ** (81.83)	205.83 *** (72.66)
Adjusted R^2	0.36	0.32	0.33	0.32
p-value F.-stat.	0.000	0.000	0.000	0.000
N	119	138	535	627

Switching Regression Model

2nd stage

- **Inverse Mills ratio indicates a positive selection only in strategy "public"** (i.e. DPRIVATE = 0)
- **Estimation results loose in statistical significance as compared to the simple OLS model**

→ There seems to be no endogeneity problem

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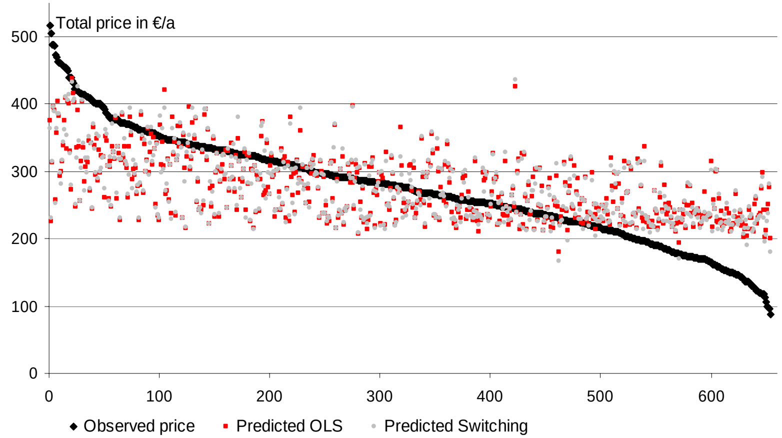
Predicted versus Observed Prices



- **The models predict mainly prices in the middle range; peak values cannot be explained by structural and/or technical characteristics**

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Conclusions

- **This paper investigates the impact of governance structure on firm performance (i.e. consumer prices)**
- **Simple OLS model as well as a switching regression model accounting for the possible endogeneity of governance choice**
- **Controlling for scale economies as well as technical and structural characteristics of the suppliers we find that consumer prices are significantly higher under private sector participation**
- **Is there functioning competition for the market?**

Need for further research

- **Improvement of the econometric analysis**
- **Similar analysis with alternative performance measures (such as revenues or technical efficiency scores)**

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Thank you very much for your attention!
Any questions or comments?

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Backup – Switching Regression Model

- **Assume that strategic decisions are endogenous to their expected performance outcomes**

Model setup:

- **Binary set of strategies** *S = (S⁰, S¹)* **resulting in a binary set of performance outcomes** $\pi = (\pi^0, \pi^1)$
- **What would have been the performance level if the alternative governance form had been chosen (= "strategy effect")?**
- **We do not observe neither** $E(\pi^0 | S^1)$ **nor** $E(\pi^1 | S^0)$

Heckman Model

- **Organizational choice is modeled as a continuous latent variable** *S** **and depends i) on the expected performance difference, ii) on exogenous variables** ***Z*** **affecting organizational choice but not the performance outcome, and iii) on some unobserved factors:**

$S_i^* = \gamma(\pi_i^1 - \pi_i^0) + \delta Z_i + \vartheta_i$ with $S_i = 1$ if $S_i^* > 0$ and zero otherwise

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Backup – Switching Regression Model II

- **Since we only observe the performance outcome under the chosen alternative, we substitute the performance levels described above and get the reduced form model:**

$S_i^* = X_i \beta + Z_i \delta + \vartheta_i$ with $\vartheta_i = \gamma(e_i^1 - e_i^0) + \vartheta_i$ and $\beta = \gamma(\beta^1 - \beta^0)$

- **Under the assumption of** ε_i^1, ε_i^0 **and** ϑ_i **being jointly normally distributed Heckman showed that**

$$E(e_i^1 | S^1) = E(e_i^1 | S^* > 0) = -\sigma_u^1 \phi[X_i \beta + Z_i \delta] / \Phi[X_i \beta + Z_i \delta] = -\sigma_u^1 \lambda_i^1$$
$$E(e_i^0 | S^0) = E(e_i^0 | S^* \le 0) = \sigma_u^0 \phi[X_i \beta + Z_i \delta] / (1 - \Phi[X_i \beta + Z_i \delta]) = \sigma_u^0 \lambda_i^0$$

- **Estimation procedure:**
  - Estimation of the reduced form model;
  - Calculation of the inverse Mills ratios;
  - Estimation of the sample-selection corrected performance equations (standard OLS)

$$\pi_i^1 = \beta^1 X_i - \sigma_u^1 \phi[X_i \hat{\beta} + Z_i \hat{\delta}] / \Phi[X_i \hat{\beta} + Z_i \hat{\delta}] + e_i^1$$
$$\pi_i^0 = \beta^0 X_i + \sigma_u^0 \phi[X_i \hat{\beta} + Z_i \hat{\delta}] / (1 - \Phi[X_i \hat{\beta} + Z_i \hat{\delta}]) + e_i^0$$