Determinants of Residential Water Demand in Germany

Joachim Schleich
Fraunhofer ISI, Karlsruhe, Germany
Virginia Tech University, Blacksburg, US

Thomas Hillenbrand
Fraunhofer ISI, Karlsruhe, Germany

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Motivation

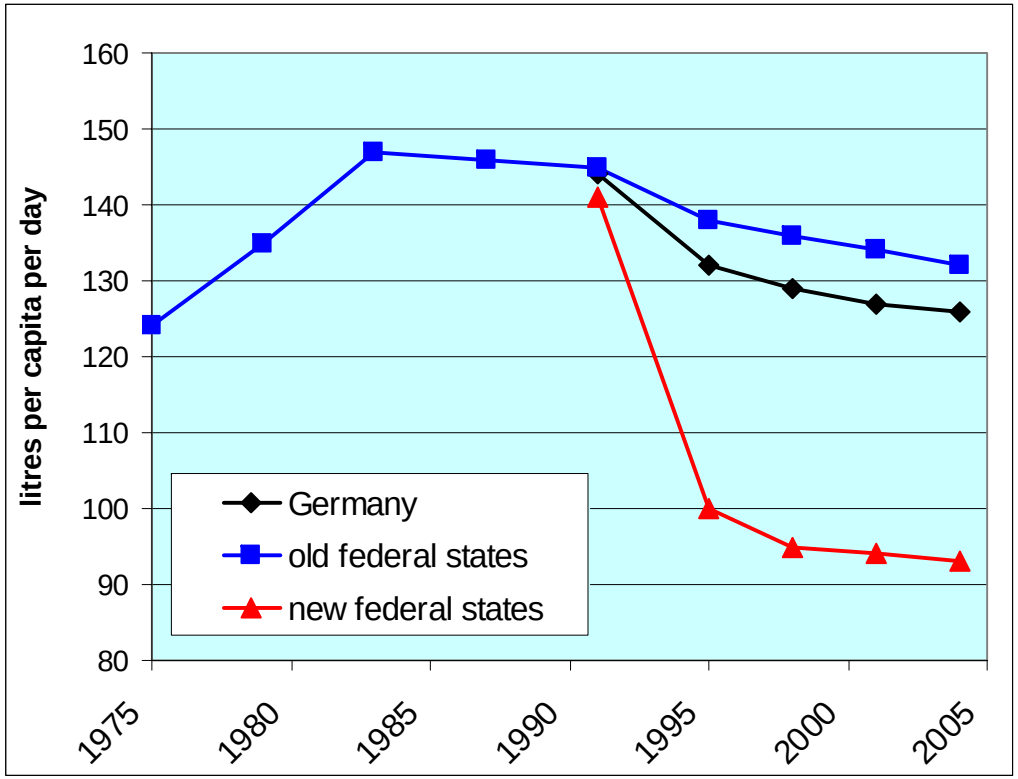
Current challenges to residential water demand market

- Economic (liberalization, income, costs from environmental regulation)
- Social (demographics; migration)
- Environmental (global warming)

Objective of paper

- Assess relevance of economic, social and environmental factors on residential water demand in Germany
- Explain difference between residential water consumption in old and new federal states

Water consumption in Germany



Per capita residential water consumption in new states is 30 % lower than in old states

Overview of German water sector

Pattern of residential water consumption

- 32 % toilet flushing
- 30 % bathing and showering
- 14 % laundry
- 6 % personal hygiene
- 6 % dishwashing
- 4 % gardening
- 3 % cooking and drinking
- 2 % car washing

Structure of supply for fresh water and sewage

- 6,383 water utilities and 9,994 sewage companies
- 50% of market is served by largest 100 water and 900 sewage utilities

Overview of data and variables

Variable	Description	Units	Mean	Std. Dev.	Min.	Max.
Q	average water use per capita per day	litres	128.23	27.26	65.70	334.20
P	price for fresh water and sewage	€ / 1000 litres	3.80	0.72	1.99	7.10
Y	average net income per capita	Euros	16509	2037	12735	21893
S	average number of household members	number of persons	2.03	0.26	1.25	3.66
A	average age of population	years	42.11	1.89	30.40	47.90
W	share of households with wells	%	1.03	2.23	0.01	20.07
R	summer rainfall	mm	305.58	71.12	166.70	629.20
T	summer temperature	Celsius	16.70	1.04	13.10	19.80

Aggregate cross section data (2003) from 600 utilities, serving 39 Mio. people (47 % of population)

Estimation issues

- Average cost pricing and endogeneity
- Single Equation and IV (TSLS) using "population size", "population density" and "vote share of Green party" as instruments (…far from perfect…)
- Wu-Hausman: fail to reject "exogeneity"
- Focus on single equation (OLS) model (lower variances)
- Weighting by population
- Log – log specification
- Allow for specific income effects in new federal states

Estimation results

	Model 1		Model 2	
	(OLS)		(IV)	
Price	-0.229	**	-0.593	**
	(0.032)		(0.161)	
Income	0.241	**	0.314	**
	(0.071)		(0.084)	
Income new states	0.444	*	0.501	*
	(0.235)		(0.261)	
Size	-0.207	**	-0.120	
	(0.061)		(0.077)	
Age	0.492	*	0.609	**
	(0.167)		(0.192)	
Wells	-0.016	**	-0.012	**
	(0.003)		(0.004)	
Rainfall	-0.052		-0.093	*
	(0.036)		(0.043)	
Temp	-0.010		-0.197	
	(0.115)		(0.151)	
constant	1.396		1.461	
	(0.975)		(1.077)	
adjusted R^2	0.6519		0.5789	
sample size	599		599	
F-value	59.95		48.30	

Statistically significant (at least at 10% level)

- Price elasticity of -0.229 at lower end of range in literature (low cost share; short run; already relatively water-efficient use compared to other countries);
- Income elasticity higher in new federal states (0.68 versus 0.24); water is normal good;
- Differences in price levels and income levels explain 54% of difference in per capita water consumption in new and old federal states;
- Household size: demographic change towards smaller households will lead to higher per capita water use;
- As population ages, water consumption per capita increases (1.5 l/year)
- More wells reduce water demand from utility;

Not statistically significant (at 10% level)

(Rainfall), temperature

Final remarks

Looking into the future

- Countervailing effects from expected trend increases in prices and per capita income of -10% and + 5% by 2020
- Demographics (household size and age) will lead to higher consumption per capita of about 1% and 3%; but decline in population likely to compensate (migration, regional differences)
- Global warming: effects on demand likely to be small; possibly indirect effects on supply from wells;

Looking for better data

- Cross sectional and panel data on temperature and rainfall patterns
- Length of droughts and heat periods;
- Disaggregate household level data on consumption patterns