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RESIDENCIAL WATER DEMAND IN A TRANSITION ECONOMY: EVIDENCE FROM POLAND.

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Abstract

This paper presents an analysis of residential water demand in Poland and its determinants including water tariffs and the income level. Information on price and income elasticities of residential water demand is crucial for effective water demand management. We carry out an empirical analysis using several panel-data models. In our survey we base on data collected from urban municipalities, where number of people connected to the water network exceeds 50.000. We focus on larger cities to obtain homogeneity of the sample in terms of access to water and waste water networks as well as income structure. We find that indicators of price and income elasticities of residential water demand in Poland are similar to results known from the surveys conducted in Western Europe. Basing on our outcomes we predict that the tendency of decreasing the individual consumption of water in Poland will stop in 5-7 years. Our research is the first one investigating the price and income elasticity of water demand in Poland and one of the first carried out in all transition economies.

Key words: residential water demand, price elasticity, income elasticity, water tariffs, panel data

1. Introduction

Problems associated with use of the natural environment in Central and Eastern European states undergoing transformation – including issues concerning water management – differ considerably from environmental problems occurring in countries of Western Europe. In the transition countries, the large water consumption resulted mainly from inefficiencies of the centrally planned economy, geared to the development of heavy industry, the large share of agriculture as well as the marginal prices for water in the municipal sector.

Significant changes in the water economy in Poland started at the end of the 1980s along with the breakdown of the communist system. Since that time, two main processes stand out that have an impact on the nation's water balance. Initially, this was accompanied with an economic breakdown in the early years of the transformation. In 1990, water consumption equalled 14 km^3, in 1992 it was 12,6 km^3. The declining trend continued through the period during which economic growth started to improve. Over the last four years, domestic demand for water has stopped declining and remains at a constant level of 11 km^3 annually. The primary portion of this consumption is associated with cooling for power plants[1].

The second trend involves significant progress in the scope of sewage treatment that was carried out over the last decade or so in Poland. The percentage of treated sewage (that required treatment) increased from 67% in 1990 to 91% in 2004. Pursuant thereto, to the extent largely inefficient mechanical technology was employed at the start of this period (53% of treated sewage) and currently most facilities employ modern biological technologies (65% of treated sewage) - increasingly with so-called enhanced removal of biogens, it should be expected that water quality will undergo ongoing improvement due to implementation of obligations from EU Directive 91/271 by Poland in the matter of municipal sewage treatment[2]. Over the next decade or so Polish municipalities equipped with sewage treatment plants will become comparable to western European ones.

The most important problem associated with water management that Poland faces is not a problem of water quality, rather the problem concerning future demand. Assuming, that water consumption for cooling purposes does not increase (increasing the availability of water for cooling needs cannot take place without a drastic intervention in the natural flow of rivers which specialists acknowledge to be a significant factor that limits development of conventional power production). Additionally, industrial consumption could undergo a marginal decline (at present, industrial consumption in Poland consumes just under 1 km3 of water annually, excluding coolant water used in power generation). Hence, the main factors impacting water consumption in Poland will be the municipal sector and agriculture[3], responsible for 19% and 10% of total consumption, respectively (GUS 2006).

This article analyses water consumption in the municipal sector, in the period of transformation in Poland. Its main goal is to estimate demand for water by households which

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[1] 64% of total consumption in 2004. In 1990-2004 it only dropped by 0.4%.

[2] According to Directive 91/271, secondary (biological) treatment is necessary for all areas, while for sensitive areas (susceptible to eutrophication process) – tertiary treatment is required (additional removal of biogenic substances). Poland is the only case in Europe, whose entire territory was acknowledged as land sensitive to eutrophication processes (Baltic drainage basin).

[3] Since the late 1980s the area under irrigation in Polish agriculture has fallen nearly fourfold, and water use for this purpose even more, although this trend may reverse itself through implementation of the EU's Common Agricultural Policy.

are the largest consumer of water from water supply systems. Household demand for water is widely and precisely analyzed in Western European countries and North America – which is reflected in numerous publications (see chapter 2). Nevertheless, these survey results cannot be transferred to countries of Central and Eastern Europe due to the specifics of the post-communist economies. According to our gathered information, to-date there is no published work concerning water demand by households in these countries[4]. This article attempts to make up for this lack.

In order to estimate demand for water by households, panel data was employed from 39 municipality districts in the period 2001-2005. The research is concentrated in mid-sized and large cities (over 50.000 residents) that covers most areas equipped with a complete water /sewerage system. Rural areas and small cities were not included due to the use of other technologies for sewage collection (transport of septic tank contents rather than through a sewerage system) as well as income structure (high share of non-monetary income). The estimation of water demand permits calculation of price and income elasticity indicators. These indicators comprise important elements in forecasting water use, hence they are necessary for proper management of its resources.

The structure of this article is the following: the first part contains an overview of literature analysing the demand for water in the municipal sector in European countries and America. The second part contains an analysis of the water /sewage sector situation and water consumption for municipal purposes in the transformation period in Poland. The third contains a description of the tariff mechanism for water and sewage. The fourth presents a demand model for water in households based on panel data. The last part features a summary and conclusions.

2. Review of literature

The first studies concerning household demand for water showed up in the 1950s (see Baumann et al. 1998). Since then dozens of papers have been published developing this subject. Most of these studies concerned the USA. Nevertheless, particularly in the last few years, there has been an increasing number of studies associated with European countries (e.g. France – Nauges C. and Thomas A., 2000, 2003; Spain – Martinez-Espineira, R., 2002; Sweden – Höglund, L. 1999; Denmark – Hansen, L. 1996; Italy – Mazzanti, M. and Montini, A., 2006, Hajispyrou, S. and Koudouri, P. 2002 – Cyprus).

The studies conducted in this area concentrated around four issues: defining the price elasticity for water demand, defining income elasticity, identification of factors that shape demand and the resolution as to whether consumers react to changes in average prices or extreme prices. The analysis most frequently employed time and time cross-section models, estimated by the least square method. In the latest works – according to general trends observed in micro-economic analyses – panel models are used.

Despite the application of very different methods and data, the estimates of price elasticity for water demand indicate in most cases, that it is rigid, though not perfect. Income elasticity, which is the subject of a lesser number of analyses, in most cases assumes a value lower than 1, but then water demand also appears to be inelastic in terms of income changes. Arbues et al. (2003), Dalhuisen et al. (2003) and Espey et al. (1997) present a precise review

[4] Dalmas and Reynaud (2004) wrote, as far as we know, an unpublished work concerning demand for water in Slovakia www.toulouse.inra.fr/lerna/cahiers2004/0407144

of literature concerning this subject. In the last two cited works, the authors use results of the analysed studies to conduct a meta-analysis[5].

Differentiation of the derived price and income elasticities is explained by many factors. Dalhuisen et al. (2003) concludes: "*… functional specification, aggregation level, data characteristics and estimation issues are responsible for significant differences among elasticity values.*" In the case of price elasticity, an important factor is the length of the analysed period. A number of studies have analysed short-run versus long-run elasticities of residential water demand, showing that the first one is smaller than the other (for example: Dandy et al., 1997; Nauges and Thomas, 2001; Martinez-Espineira, 2002). This can be explained by the fact that customers need more time to adapt or purchase water-saving devices and equipment. The result of the meta-analysis conducted by Dalhuisen et al. is interesting, indicating that price elasticities are generally smaller (water demand is more elastic) for higher income countries.

An important element in demand analysis for the researched good is the identification of substitute and complementary goods in relation thereto, since changes in their prices impact on the demand for this good. It is difficult to find a good that can be acknowledged as a close substitute for water that is used by households. The situation is simple with complementary goods. Subject literature gives two cases: sewage discharge and treatment as well as energy use needed to heat water.

Sewage services are perfectly complementary in terms of water use (at least in urban centres) – the same amount of water that was supplied to a household has to be released to the sewerage system. This is reflected in the way bills are computed – only water consumption is measured, while the charge for sewage is computed in relation to water use. In principle, households observe one price for water supply and sewage discharge. Thus, an increase in the price for sewage services has the same impact on water consumption as an increase in the price for water consumption. This means that the model should take into consideration the price for sewage services. This problem was subjected to empirical verification, inter alia, by Griffin and Chang (1990). Applying a statistical test, they showed that excluding the price for sewage services from the model leads to flawed estimates of price elasticity for water demand. In an incomplete model this elasticity is overestimated. Despite this, many studies only take water prices into consideration. This is justified by the structure of water consumption – if water is mainly designated for gardening, then there is no close complementarity and the price for sewerage services may be unimportant.

The second good whose consumption is strongly associated with water use, is energy. Hansen (1996) cites data showing that 70% of water used in households is heated (hot water in the bathroom and kitchen, the washing machine and the dishwasher, etc.). This author conducted a study in which he calculated the cross elasticity between the price for energy and demand for water. The estimated parameter equalled -0,2.

Besides, an important question concerns what elements in the demand analysis should be acknowledged as a cost of supplying water. Whether this should be extreme values or average values remains a question. From the theoretical viewpoint, consumers should react to extreme prices. Nevertheless, empirical data is not absolutely conclusive. Dalhuisen et al.

[5] The Espey et al. sample contains 124 estimated price elasticities from 24 journal articles, the Dalhuisen et al. sample comprises 225 estimates from 50 studies. In researching income elasticity Dalhuisen et al. employed the results presented in 30 publications.

(2003) presents examples of research in which the demand models employ average prices (Billings 1990, Hogarthy et al. 1975), marginal prices (Danielson 1979; Lymann 1992), both price measures (Opaluch 1982, 1984; Martin et al. 1992) and the so-called "perceived price", which is a combination of marginal prices and average prices applied, inter alia in research by Shin (1985) and Nieswiadomy (1992).

Discussion on the use of extreme or average prices is caused by the use of various schemes to define water use charges.

Three main categories of tariff systems can be distinguished:

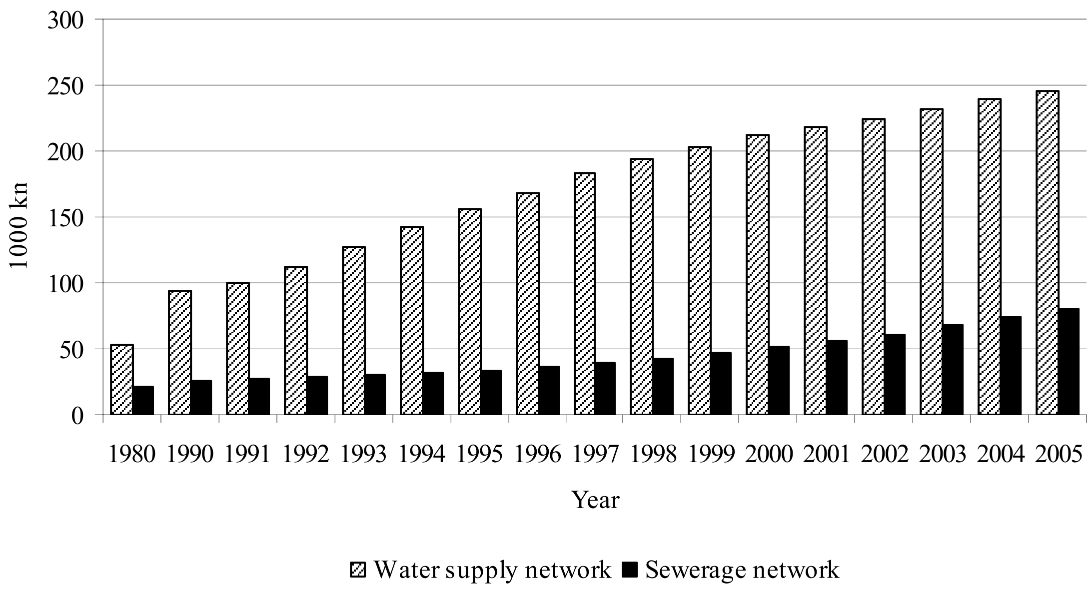
- constant unit pricing,
- increasing block rate pricing (constant within discrete intervals of use, but increasing between intervals),
- decreasing block rate pricing.

These tariffs are often applied in conjunction with a fixed fee. Olmstead and Hanemann (2005) find that households facing block prices are more sensitive to price increases than households facing constant unit prices.

3. Water-sewerage sector in Poland

When the economy was centrally planned, decisions concerning the water / sewerage sector fell to the discretion of state enterprises. Since 1990, municipal authorities are responsible for water supplies, and accessibility to water supply networks and sewerage networks. These tasks are carried out through municipal companies[6]. In the period from 1990 to 2005, 152.000 km of water supply lines and 56.00 km of sewerage lines were constructed. In 2005, 86,1% of Poles made use of water supply connections (94,9% of city residents and 84,5% of rural residents). The figure for sewerage networks was 59,1% (72,1% of city residents and 17,9% of rural residents). As can be seen in chart 1, over the last 15 years there was a significant development of the water / sewerage networks in comparison to the period before the transformation, when the sector was underinvested.

Chart 1. Length of the water supply and sewerage network in Poland from 1980-2005.



[6] Most water /sewerage firms in Poland are limited liability companies.

Source: GUS, 2006.

Accession to the EU imposed on Poland the requirement of further investments in the water / sewerage sector, especially in the expansion of the sewerage network, as well as the modernization and construction of sewage treatment plants. These investments are significant, considering that the entire territory of Poland was acknowledged as an area sensitive to the eutrophication process and according to Directive 91/271/EEC: all urban areas with a REU[7] equal or greater than 15.000 must have treatment plants in operation that ensure enhanced removal of nitrogen and phosphorous compounds. Urban areas with an REU less than 15.000 should possess sewage treatments plants ensuring complete biological treatment. Investments defined in the Accession Treaty are to end in 2015. In the period 2003-2015 planned investments include the construction of 21.000 km of sewerage network, 259 new sewage treatment plants and the reconstruction or modernization if 904 existing treatment plants. The necessary investment outlays were estimated at 35,4 billion PLN[8] (MS, 2003).

Table 1. Financial outlays to carry out the *"National program for sewage treatment"*.

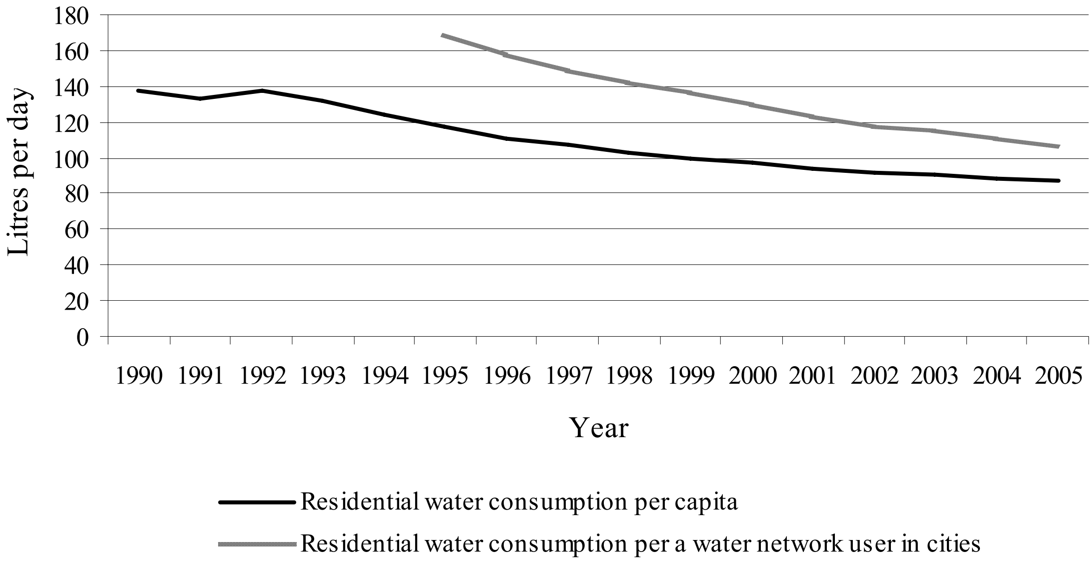
Years	Financial outlays [million PLN].		
	Sewerage network	Sewage treatment plants	Total
2003-2005	2 092	5 034	7 126
2006-2010	5 939	4 042	9 981
2011-2013	9 263	60	9 323
2014-2015	6 792	2 156	8 948
Total	24 086	11 292	35 378

Source: MS, 2003.

Despite significant investments in water /sewerage networks in Poland in the period of transformation, there was a 30% decline in water system water use (from 3 km^3 in 1990 to 2.1 km^3 in 2005). About 80% of this use goes for municipal services (GUS, 2006). This decline is tied to the significant reduction in per capita water use. In 1990 the average Pole used 138 litres per day, currently this amount is 87 (chart 2).

[7] REU – residential equivalent users.
[8] The exchange rate 4 PLN = 1 EURO

Chart 2. Water use in the municipal sector.



The decline in individual demand for water is surely tied to the increase in prices for water use and sewage discharge brought about by system changes and the start of significant investments during this period in the water /sewerage sector. From 1995 to 2004 prices for supplying cold water in the municipal sector increased nearly fourfold (GUS, 2005). Prices increased faster than the decline in individual water use. While in 1997 disbursements for cold water and sewage discharge comprised 0,9% of disposable income per person, in 2005 this share had nearly doubled and equalled 1,75%.

4. Price regulations

Before 1990, prices for water use and sewage discharge were set centrally and at a very low level. When local administration assumed tasks related to water-sewerage management in 1990, they became responsible for the shaping of prices. From 2002, when the *legal act on the collective supply of water and the collective discharge of sewage* took effect, fees were set on the basis of a detailed application prepared by the water-sewerage company[9]. This act states that individual companies set tariffs for a period of one year, based on necessary revenues. Necessary revenues should cover:

- costs to operate and maintain the water-sewerage network,
- environmental usage fees,
- repayments of capital instalments exceeding amortisation value,
- interest charges on credit and loans,
- reserves for irregular receivables,
- profit margins.

The manner of calculating fees for water conforms to guidelines of Directive 2000/60/EU.

Fees are allocated for specific tariff groups that households belong to. Current law gives rather extensive leeway for individual companies to set the manner of collecting charges for their services. In practice, the vast majority of companies charge households a constant

[9] More precisely, the Directive of the Minister of Infrastructure dated 12 March 2002 on defining tariffs and settlement conditions for the collective supply of water and the collective discharge of sewage (Dz. U. no. 26 pos. 257, which was replaced by a new directive in 2006).

rate for each m3 of water used. Additionally, about 38% of the companies apply a standing charge, although the amount is not significant (Kłoss-Trąbaczkiewicz and Osuch-Pajdzińska, 2004). Since 2002, companies can also apply block tariffs.

There are two ways of computing water use in households. Water use can be defined on the basis of water meters installed in individual apartments. Since 1994 all newly constructed buildings must be equipped with water meters[10]. Similar investments are also being conducted in older buildings. If individual water meters are not present, the quantity of water is defined on the basis of collective water meter readings in buildings. In this case, amounts due for water use are apportioned based on apartment area and the number of residents in a given apartment. It should be stated that in buildings connected to sewerage networks the amount of sewage discharged is defined according to water use (it is assumed that 100 litres of water corresponds to 95 litres of discharged sewage) and frequently the price on the bill is totalled for both services.

5. Household water demand in Polish cities

5.1. Data

The analysis is based on panel data, collected from 39 urban municipalities, where number of people connected to the water network exceeds 50.000.[11] Focus on larger cities was needed to obtain homogeneity of the sample in terms of access to water and waste water networks. In Polish cities that have above 50.000 citizens almost whole population is provided with water and sewerage services, while in smaller cities this share is much lower. In particular it applies to rural areas, where a share of households connected to the network is below 18%. Data was collected for the period 2001-2005. We used the most price-diverse household-level water demand data obtained from the Water Chamber. The length of the time series was determined by availability of this series of data.

Table 2. Tariffs and a levels of net individual income in the sample

Year	Water and waste water tariffs [PLN 2005]				Net income per head per month [PLN 2005]			
	Average	Median	Min.	Max.	Average	Median	Min.	Max.
2001	4.14	4.10	2.52	5.96	925.61	898.26	563.75	2066.10
2002	4.84	4.79	3.13	6.92	903.88	820.42	530.30	2240.34
2003	5.27	5.14	3.11	7.76	929.82	862.60	583.55	2261.35
2004	5.34	5.24	3.59	7.53	1077.13	1028.38	618.12	2885.57
2005	5.62	5.48	3.90	7.97	1120.75	1047.97	702.77	2766.12

Source: Own calculations based on GUS and Water Chamber data.

Following independent variables were included to the demand model: water and waste water tariffs, net income per capita, an average size of a household and a dummy variable describing time trend. A variable reflecting energy costs related to heating water was omitted due to lack of data. It results from the fact that in Poland there exist various ways of providing

[10] Directive of the Minister of the Spatial Economy and Building from 14 December 1994 on technical conditions for buildings and building locations. Art. 121.

[11] 62% of the population lives in cities in Poland.

hot domestic water (district heating, gas-fired boilers, electric boilers, coal-fired stoves, etc) and they are not included in national statistics in such a detailed breakdown.

The tariff is a sum of both: cold water and sewerage prices as these two services are strictly complementary in larger cities. All but one water utilities in the sample used linear pricing.[12] If a fixed component is applied, it is very small. Hence, the tariff variable (for water provision and sewage discharge) is both an average and a marginal price for a household. An income data is derived from Personal Income Tax statements for each municipality divided by a respective number of citizens. Residential water consumption and a household average size in a given municipality were obtained from GUS yearbooks.

Table 3. Residential water consumption per capita in the sample

Year	Specific water consumption per head [litres per day]			
	Average	Median	Min.	Max.
2001	122	120	86	191
2002	118	116	86	178
2003	113	108	73	192
2004	108	103	61	172
2005	103	103	30	157

Source: Own calculations.

5.2. Methodology and results of the estimation

The following general model was used to estimate the relationship between household water consumption and independent variables:

$\ln(W)=f(\ln(P), \ln(I), N, t_i)$, where:

W -- residential water consumption per capita per day [litres];
P -- household tariff for water and waste water [PLN 2005/m^3];
I -- average net income per capita [PLN 2005/m^3];
N -- average size of a household, i.e. number of people;
t_i -- year i (a dummy variable), where i = {2001, … , 2005}.

We decided to focus our analysis on static models. The analysis on static specifications allows to avoid the data losses associated with a dynamic panel specifications, what is important when the studied data came from the 5 year period.

In a micro-panel analysis, when objects were drawn from a large population, the econometric analysis based on random effects specification is usually applied. On the other hand, it cannot be taken for granted that regressors are not correlated with fixed effect dummies. In our survey, the Hausman test leads to non-rejection of the hypothesis that the fixed effect estimator is indistinguishable from the random effect estimator[13].

The next step of diagnostics was to check for an existence of groupwise heteroskedasticity, i.e. whether the variance is constant for a given object but different

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[12] In one case (Olsztyn) the municipality introduced a block tariff after a change in law in 2005. However, a linear tariff was reintroduced at the beginning of 2007.

[13] The demand model for residential water was estimated with Stata software. Detailed calculations are available from authors upon request.

between objects. Results of the corrected Wald statistics confirmed the existence of heteroskedasticity in an analysed sample. Due to shortness of the panel, the cross-sectional correlation of the random error was not studied.

Additionally, an assumption that random disturbances for each municipality are subject to a common stochastic process AR(1) with the same autocorrelation coefficient was investigated. Such correlation was check with a test based on Lagrange multipliers. Achieved results show a presence of an autocorrelation of the first degree in the model.

Based on diagnostics, constrained on technical possibility of this software, we considered application of three following models:

- (1) a random effect specification using Generalized Least Squares (GLS), accounting for autocorrelation but not for heteroskedasticity,

and two models accommodating a structure of variance of a random error (hetereskedasticity and autocorrelation) but omitting relevance of random effects:

- (2) Feasible Generalized Least Squares (FGLS),
- (3) Prais-Winsten regression with panels corrected standard errors (PCSEs)[14].

Table 4. Models of residential water demand per capita in Polish cities

Variable	**Model**								
	(1) RE GLS regression with AR(1)			**(2)** FGLS regression with AR(1), heteroskedastic panels			**(3)** Prais-Winsten regression, AR (1)		
Ln(water)	coef.	P>|z|	[95% conf. interval]	coef.	P>|z|	[95% conf. interval]	coef.	P>|z|	[95% conf. interval]
Ln(price)	**-.21656**	0.002	-.35147 -.08165	**-.22061**	0.000	-.27728 -.16393	**-.22642**	0.000	-.36749 -.08536
Ln(income)	**.11690**	0.035	.00809 .22570	**.12462**	0.000	.06079 .18844	**.15865**	0.058	-.00561 .32292
Number of people in a household	**-.34725**	0.000	-.53949 -.15502	**-.33517**	0.000	-.41948 -.25085	**-.31707**	0.001	-.50349 -.13065
2002	**.00681**	0.738	-.03316 .04679	**.01272**	0.149	-.00453 .02997	**.01007**	0.398	-.01330 .03344
2003	**-.02741**	0.311	-.08041 .025600	**-.01737**	0.129	-.03979 .00505	**-.02491**	0.161	-.05971 .00989
2004	**-.08786**	0.004	-.14727 -.02845	**-.07092**	0.000	-.09661 -.04524	**-.09123**	0.000	-.13737 -.04510
2005	**-.13221**	0.000	-.19851 -.06591	**-.09485**	0.000	-.12414 -.06557	**-.13708**	0.000	-.19370 -.08046
Const.	**5.1940**	0.000	4.14900 6.23904	**5.11155**	0.000	4.52808 5.69503	**4.84590**	0.000	3.24486 6.44693

Source: own calculations (see text for explanations).

Estimation results are similar across all three analysed models. Price and income are both highly significant in all models, with price elasticity varying from -0.22 to -0.23 and the income elasticity indicator equal to 0.12, 0.13 and 0.16, respectively, for models (1), (2) and (3). An independent variable, significant in each model at a level of $\alpha=0.001$ is an average number of people in a household. These results provide an information that any additional household member reduces individual water consumption by 32-35% what could be connected with the scale effect. A time trend, included in the model through dummy

[14] The last model applies the Prais-Winsten correction. This model is considered to be more efficient than the Cochrane-Orcutt model (no 2) in the case of low number of periods [Ciecielag, J and A. Tomaszewski, 2004].

variables, shows a substantial decrease of water consumption per capita with reference to year 2001. The rate of decrease equals 7-9% in 2004 and 9-14% in 2005 in comparison with 2001).

Goodness-of-fit measures in analysed models are as follows: R^2 within = 0.36, R^2 between = 0.45, R^2 overall = 0.45 in model (1), log-likelihood = 298.77 in model (2) and R^2 = 0.99 in model (3)[15]. The goodness-of-fit measures are not adequate to choose between alternative models, but rather to provide possible criteria for choosing between alternative specifications of the same model.

Not determining, whether an assumption of no disturbances of random errors or an assumption of randomness of estimated parameters is more relevant, it appeared that an application of all analysed models provides very similar estimates of parameters describing the relation between individual water consumption and independent variables.

6. Conclusions

Although residential water consumption in Poland per capita is much lower than in developed countries, the key parameters of a household demand model in our analysis appeared similar to those known from the Western European literature. In our model the price elasticity equals -0.22 and income elasticity 0.12. Hence, in Polish conditions, water cannot be treated as a necessity good, with an inelastic demand, when consumption is in the range of 90-110 litres per head per day[16]. It means that households still react to changes in real prices. With an increase in real tariffs caused by massive EU driven investments, we expect further decreases in household water consumption in the coming 5-7 years (2013 year is a deadline for Poland to meet the EU wastewater directive concerning cities above 15 thousand inhabitants).

Results of this survey shows also the downward trend, which has brought 5-6% reduction in the residential water consumption per annum in recent years. There is no clear explanation for the magnitude of this phenomenon. It is certainly related to dissemination of water conservation technologies. People have been moving from old communist type flats to modern apartments with individual water meters and water saving appliances. Also renovations of old flats may contribute to this trend. (There has been a governmental tax abatement scheme that has encouraged people to make such changes in their flats and houses. Part of investments facilitated by the scheme has been related to water consumption).

Another explanation of the trend may come from increased costs of a complementary service, i.e. energy required for hot domestic water. Natural gas prices, one of the most popular energy carrier used for this purpose in urban households, have increased significantly in recent years. It was not captured in the model due to the lack of data but it should be analysed in subsequent studies.

The next possible explanation of this time trend could be an overestimation of the number of people using the water network in last years due to large scale emigration observed after Poland joining the European Union. It is estimated that 5-6% of Poles have left Poland since the EU accession in 2004.

[15] In model (3) R^2 is derived from OLS that is run on variables after Prais-Winsten transformation. For raw data the PCSEs model has R^2 equal to 0.48.

[16] Probably 60-70 liters is closer to that point where households start perceiving water as a necessity.

On the other hand, Poland experiences an impressive economic growth which should result in on an improvement of the household living standard in next years. A disposable income will increase at least at the same rate as the economy, due to convergence of salaries between the New Member States and the Old Member States of the EU employees. Also the rate of unemployment has been decreasing (from 19% in 2005 to 16% in 2006). It means that the income effect captured in our model will be quite significant and will offset, at least partially, the water price effect.

The role of municipal sector in the total consumption of water in Poland depends not only on the level of individual water consumption but also on the number of users, i.e. inhabitants of cities. An analysis of demographic trends is beyond the scope of this study. However, with exception of some big cities (Warsaw, Krakow, and Wroclaw), the population is decreasing. First of all, long-term forecasts show that population in the transition countries, including Poland, will go down by 20-25% during the two coming decades. The situation will get even worse if a current rate of emigration persists. Still some cities may benefit from intra-country migration (from rural areas to cities). However, the latter applies only to big agglomerations. Hence a number of users in cities will – at best – remain constant.

Summing up, a moderate decrease in individual water consumption is expected in Poland over the coming 5-7 years. Then, water and waste water tariffs should stabilize in real terms, and the income effect will start to dominate. Individual water consumption may be rising for a number of years. The upward change will be partially outbalanced by dissemination of improved water conserving appliances.

The household sector is not expected to be a source of pressure on scarce water resources in Poland. On the contrary, the water use will go down in the next several years due to the price effect and then will recover due to the income effect. However, this upward trend will be weakened by dissemination of water-saving appliances and demographic factors. It is expected that the household sector will increase total water use neither in the short nor in the long term.

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