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Drinking Water Pricing and Consumption. The Environmetrical Evaluation of the Situation in Poland

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Abstract

The focus of the paper is on estimation and implementation of economic model applied to municipal water economy. In the paper it was demonstrated how decrease in households' water consumption after transition to market economy leads to a significant increase of municipal water prices. Water price increase will be convergent process, what was shown in the model. Some consequences of declining water consumption, like decrease of the sewage dropped to the treatment plant, were presented.

1. Introduction

The view that water is free for exploitation is no longer tenable in a world of declining availability, increasing demand and increasing environmental damage. Establishing a reasonable price for water is very important both for the waterworks and consumers. The price should be based on the cost of supply, which means that it includes the operation, maintenance and capital costs. The proper valuation of water enables to reach a more rational its use. The price charged for water should also depend on the location of the town. The process of water production requires large capital investments and has serious health implications for the community.

Designing efficient water price is a crucial issue for water utilities and local communities. Proper valuation of water resources present a significant challenge. The first objective of a water utility pricing scheme is to generate revenues covering costs. An efficient pricing rate must also realize two other functions: a pricing rate allocates costs between users and it has to provide incentives for efficient use of water, which is public good. Applying these criteria to determine the best rate structure is rather a difficult issue. First, some of the criteria may directly conflict and require making tradeoffs among them. The balance between revenue stability and efficiency of price is an example of such a trade-off. Moreover, as water services involve high capital investments, a lot of expenses are fixed costs, which are independent on the quantity of water consumed. This makes the allocation of costs among users more difficult to achieve.

Water resources in Poland are scarce and distributed highly unevenly. They are about 1600 m^3 per inhabitant annually, similarly to Egypt. Due to not even distribution of resources and their seasonal changes, areas of water deficit are rising. Before 1990 there had been very high and unreasonable (wasteful) use of water in Poland, due to low and subsidised price. The Mnistry of Housing, Construction and Development decided in 1992 that each apartment within a block should be metered.[2] Now there is nearly universal metering, and water demand has dropped for about 50% from 1992, to almost 112 litres per person per day. Demand for water is still unstable, dropping around 2% per year. In 1990 metering was very low, even blocks of flats were not metered. Payments were based on norms. For a typical apartment the norm was 7.5 m^3 per person per month (240 litres per person and day)

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[2] The Ministry of Construction and Spatial Planning introduced the requirement to install water meters in new buildings as of January 1, 1992. (Business News From Poland, 15 March 1990, "Water and water supply system in Poland - promoting investments") Installation in existing buildings was widespread in the mid-to-late 1990s, partly under pressure from consumer organisations as well as national government.

The results of presented studies show that there is a slight possibility that the continuous increase of water price will be finished. However, as inhabitants of Polish towns still decrease their consumption, the water pricing stategies are still rather unpredictable. One of such strategies can be decreasing block prices. Unfortunately Polish law prohibits the application of fixed part of the price. Prices are derived from an accounting system that emphasizes historical rather than economic costs and they are based on artificial unit costs. The water price is in general set in such a way that the expected revenues from water sales cover the forecasted expenses. This is very close to an average-cost pricing. The price is set as proportional to water consumption.

The broadest criticism of unit cost price scheme is directed at the objective which underlies the entire process of rate-setting. There is little recognition of the role played by prices to signal resource scarcity. Consumer demands are viewed as exogenously determined and, as a result, there is no attempt to maximize the surplus from consumption through the choice of appropriate prices. Furthermore, since consumer demand is exogenous, no attempt is made to measure the market's valuation of water.

As a consequence of tariff increases and meter installations, average household consumption fall in whole country. This led water companies to financial losses. For example, in one Polish city- Gdansk (420000 inhabitants) by 15% in a single year in 1995, after falling less than 5% in the previous two years. It was the most dramatic annual fall over the period, which saw a total decline of 52% (1992-2003). No-one expected such a rapid decrease in demand from metering – which led to decreased revenue. This meant the price per unit increased, and the share of fixed costs went up. The price was increased several percent to compensate private waterworks company SAUR's losses associated with this (as an 'exceptional circumstance'). Consumption of water decreased also significantly not only in Polish town, but also in other, mainly post-communist countries (table 1).

Because the quality of water available is deteriorating and its quality is limited, there is a need to reconsider the use of different sources of water as demand of water, This has been underlined in water framework directive (2000/60/EC). It states that sustainable water resource management has to be based on principle of integrated river basin management.

Table 1:
Dynamic of water abstraction in some European countries for households purposes 1990y=100.
(Source: Eurostat data)

	Czech	Poland	Sweden	Hungary	Netherlands
1990	100,00	100,00	100,00	100,00	100,00
1991	-	96,54	99,07	-	100,00
1992	-	99,96	102,79	88,37	-
1993	-	96,56	104,47	75,13	-
1994	-	91,02	101,12	76,78	-
1995	71,64	85,72	99,44	72,74	103,10
1996	68,78	81,40	99,44	68,41	104,12
1997	66,83	78,79	97,95	65,65	101,07
1998	65,51	75,55	97,95	65,11	102,59
1999	65,01	73,11	97,95	63,65	104,69
2000	64,28	70,77	97,95	66,99	105,26
2001	62,12	68,15	97,95	64,30	101,42
2002	62,78	66,80	97,95	65,80	100,71

First, I explain various elements influencing water pricing, namely: production of water, sale of water, consumption, and next I consider a numerical example. The model of water prices illustrate the concept. Then, it is shown why the decrease in households water consumption leads to a significant increase of municipal water prices. Finally, I enlighten some consequences of declining water consumption, like decrease of the sewage dropped to the treatment plant.

2. The Model

The parameters for the formulas (1)- (4) were obtained from the data collected from the waterworks companies in Polish towns in the 90-years. The towns were inhabited by more than 50000 inhabitants. I assume that the relations between variables of the model are constant in the long run.

$$y_t = 78.829x_t - 0.59 \tag{1}$$

$$p_t = 1.133y_t + 1.884 \tag{2}$$

$$k_t = 699.3p_t - 1.2412 \tag{3}$$

$$x_{t+1} = 1.599k_t^{0.70} \tag{4}$$

Where:

y_t - sales of water as a function of price), x_t -price for the 1 m3 of water in the current period,

p_t - water production (amount of treated water),

k_t - an average cost of water production,

x_{t+1} - price for the 1 m^3 of water in the next period.

By elimination of variables: sales of water, production of water and average cost from model equations (1)-(4) the recurrent relation was obtained, (5).

$$x_{t+1} = 3.1808x_t^{0.4806}, \tag{5}$$

Let us consider the numeral x_0 belonging to the domain of function $f(x)$, that is, by assumption, water price in a current year (set on the basis of average cost of water production). By substituting this price to equation (5), I obtain price in "1" period $f(x_0) = x_1$, and similarly I get price in the period "2" $f(x_1) = x_2$, higher than price x_1[3]. Then for period $t=2$ I receive price in the next period $f(x_2) = x_3$ (water consumption is simultaneously declining), sale of water, and similarly until the price equals x^*. The sequence $x_{t+1}=f(x_t)$ is convergent to that price and its boundary is the value x^* (see Figure 1). It means that process of increasing price will stop at this point.

[3] Process (5) is an increasing process

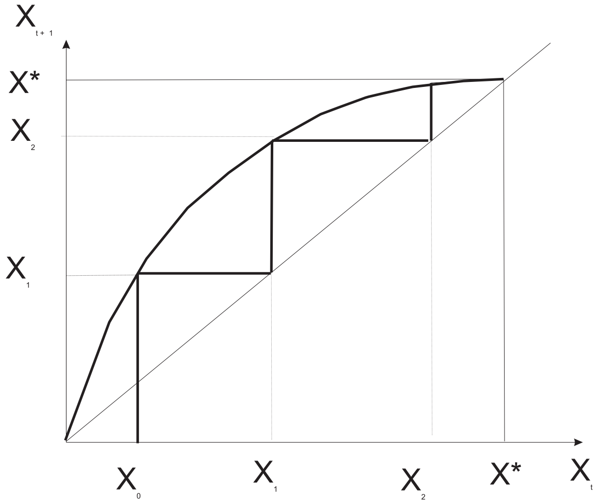

Figure 1: The convergence of water price increase. The curved line denote function $x_{t+1} = f(x_t)$, and straight line is 45 degree line,

Convergence of the sequence does not depend on the choice of the starting point x_0. By substituting for x_0 any number from the interval $(0,+\infty)$, another sequence of successive approximations could be obtained, always convergent to the boundary x^*. When $x_0 < x^*$, then the successive approximations form an increasing sequence (if $f(x)$ is ascending), so the values of this sequence are increasing till the value of a x^*

For example, we take as initial price, price in one of the towns: 1.29 euro/m^3. The recurrent process (5) with this initial price is convergent to the price x^*=2.45 euro/m^3, which is an abscissa of the point, in which the line $y=x$ cross curve $f(x)$. The number x^* is a boundary of sequence, (10). For this price we obtain the sale of water 21 milion m^3 per year, identical like in two Polish towns: Gorzow (130000 inhabitants and Kalisz (110000 inhabitants). From calculations it is clear, that decrease in water sale causes a significant increase of the water price.

Conclusions

The results of studies show a possibility that the water price increase will be finished. It is not clear if it will be the case, because inhabitants of Polish towns still decrease their consumption. Metering water consumption effectively reduces water use, but only if coupled with an incentive-oriented pricing structure such as decreasing block rate. There exist several positive and negative consequences of water consumption decrease. First of all, we use less of rare environmental resource. Second, the higher price of water and additionally the cost of processing sewage are not welcome by the households (Moll, 1995; Poss, 1991). The biggest threat to the supplies of water is secondary pollution of water due to overdimensioning of networks what leads to the increased depositing of sludge, intensifying ageing of pipes, pollution. (Bogdanowicz, 2001). The decrease of water consumption leads also to the decrease of the amount of sewage dumped to the sewage treatment plants (Suligowski 1997).

This induces higher concentration of impurities in the sewage when the load of impurities is constant. Such situation can cause big exploitation problems at the wastewater treatment plants. It can require changes in the biological part of the existing plant. Such investments can be very expensive. If there are not sufficient financial means to support the change of technology, we can even pollute the environment by incompletely cleaned wastewater. This is a paradox: an ecologically-minded activity can lead to pollution.

On the other hands the decrease of amount of water and sewage can lead to a new situation, when both new waterworks and new sewage plant can be smaller and cheaper. To assess further consequences of the decrease of water consumption, particularly with respect to the cost of sewage treatment, further studies are required.

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