# LITERATURE OVERVIEW OF UTILITY REGULATION: WATER PRICING MODELS IN EUROPE

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## Abstract

Water issues are drawing major attention concentrating on water scarcity and water regulation. Water pricing regulation may serve as a one-of-a-kind multi-dimensional tool to achieve an effective demand-supply equilibrium in the context of natural monopoly while incorporating the water scarcity and water stress factors and motivating the innovative approach to water management. Thus, the aim of the paper is to provide a comprehensive literature overview of water pricing models and their rationales and to establish their ordered systematisation. Besides, the aim is extended to classify and to qualitatively assess (with respect to the rationales) water pricing regulation approaches of the selected member states of the European Union and the United Kingdom (England and Wales). Three common elements of the applied approaches/models were identified in the selected states: (1st) the hybrid model application, (2nd) the cost recovery principle and (3rd) the importance of water affordability. Extensive heterogeneity of models defends the general conclusion about the assessment of the model suitability in the context of the individual country environment. Still, the obsolescence of traditional cost-of-service regulation is detected as well as the importance of national characteristics to water pricing model success.

## Keywords

Cap Regulation, Cost-of-Service, Rationales, Water Pricing, Water Regulation

## I. Introduction

Water is an essential and vital commodity. According to Rios et al. (2018), water is a finite and vulnerable resource that has an economic value and social importance. People should be entitled to a minimal quantity and quality of safe water (United Nations, 2010). Thus, its price is a subject of both public and academic discussion which aims to influence and create a socially acceptable model of its regulation (e.g. Maxwell, 2010; Tsur and Zemel, 2018; Tsur, 2020). Water pricing models are undergoing a constant dynamic development just as the goals that the regulation is intended to achieve. The starting point for the regulation is the fact that water utilities are natural monopolies, so the marginal costs are usually lower than average costs. Simple solutions of the natural monopoly problem in the context of the water sector, such as to leave the natural monopoly alone, or to reach and maintain perfect competition, may not achieve required efficiency (Clark and Mondello, 2002). Hence, the regulation of prices and produced quantities may take place to provide both consumers and the general society interests with benefits while balancing the interests of water companies' stakeholders.

The water pricing regulation should reflect many factors which may be summarised to six major recommendations presented by OECD (2016). The following recommendations should be taken into account in the process of water price setting:

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1) Setting abstraction charges for surface water and groundwater that reflect water scarcity and cover administrative costs of managing the system.
2) Setting water pollution charges for surface water and groundwater pollution and charges for wastewater discharge at a sufficient level to have a significant incentive effect of preventing and controlling water pollution.
3) Setting consumers' payments for water services that cover the operation, maintenance and renewal costs of infrastructure and an increasing proportion of capital costs.
4) Accounting for redistributive consequences and priority water uses for vulnerable social groups and providing them with the right to safe drinking water and sanitation.
5) Phasing out price-distorting policy measures and general subsidies that affect water availability, quality, and demand.
6) Considering transaction costs, including administrative costs, when designing pricing instruments and revenue management schemes.

Previous studies have focused on case studies of water pricing models in the context of specific countries, e.g. Zhong and Mol (2009) in China, Crew and Kahlon (2014) in California, Urdiales and García-Valinas (2014) in Spain or Brea-Solis et al. (2017) in England and Wales. Theoretical views on water pricing models are mainly focused on specific approaches (e.g. Kim and Horn, 1999; Newbery, 2002) or do not reflect contemporary movements in society perspectives, e.g. Leland (1974), Liston (1993) or Kearney and Favotto (1994). Despite the authors' interest, a comprehensive overview of the current water pricing models that could be used by policy-setters in the process of policy formulation is not specified in the European region. Therefore, the aim of this paper is to provide a comprehensive literature overview of existing water pricing models (in terms of natural monopoly regulation) and their rationales and to establish their ordered systematisation. Besides, to find out whether and how the models are applied in the European states, the aim is extended to classify and to qualitatively assess (with respect to the rationales) water pricing regulation approaches of the selected member states of the European Union (the Czech Republic, Austria, Germany, France, Portugal, and Hungary) and the United Kingdom (England and Wales). These states were selected based on economic (the most economically powerful states and states less powerful, demographically comparable with the Czech Republic), geopolitical (connection to the European Union – founding states, accession before and after 2004 and secession), topographical and geographical criteria (water stress level and water exploitation index).

## II. Water pricing models background and criteria of their assessment

The water sector is a typical example of a natural monopoly, making a single company the most efficient producer due to substantial economies of scale, and thus lowering unit costs (Sherer, 1980). Huge investment costs and network supply characteristics inevitably lead to the diminishing of competitiveness and in the end, the survivorship of only one company that may independently determine the price of its goods (Yarrow, 1994). Hence, the market failed to allocate resources efficiently. Moreover, the natural monopoly situation in the water sector is intertwined with the issue of public goods, positive and negative externalities or information asymmetry.

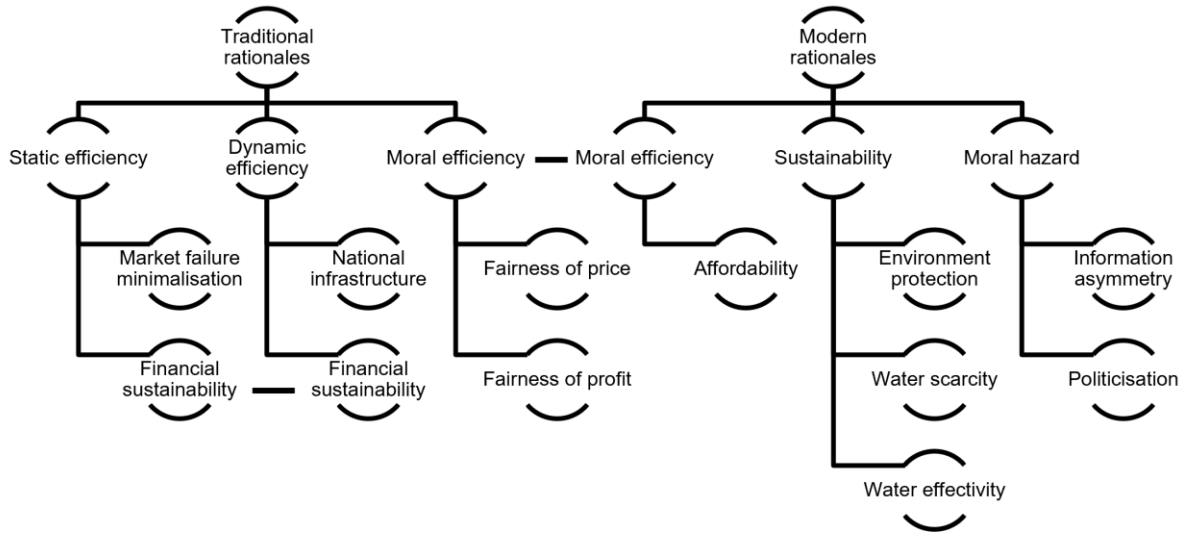
Regulation and nationalisation are logical solutions. The primary goal of natural monopoly regulation in the water sector is to find the equilibrium between the efficient prices (meaning negative profit) and monopolist prices (meaning the Pareto inefficiency) and minimise the market failure (Kim and Horn, 1999). The market failure is commonly considered as a static efficiency problem. However, the regulation motivation may also be caused by the dynamic

efficiency considerations, i.e. the investment necessary to offer the quality of service appropriate to the country's changing needs over time (Bradbur, 1992). Hence, the second goal of natural monopoly regulation in the water sector is to ensure sufficient investments into the monopolies' services to promote the overall country's growth. Both these goals may be reflected to guarantee financial sustainability, through the ability to cost recovery and economic and technology effectivity. The third regulation consideration is based on "moral" assumptions (moral efficiency) and points to such criteria as the fairness of prices and profits (Kim and Horn, 1999).

Shifting perspectives, technology development and current environmental concerns (water scarcity, climatic changes or sustainability) incorporated social and environmental dimensions into considerations and defined the modern goals of water regulations. The moral efficiency was extended by social issues represented by affordability (Hart et al., 2017), the right to water and sanitation was introduced (United Nations, 2010) and the environment and ecosystems protection, water efficiency and sustainability assessment are nowadays taking into account (Hart et al., 2017; European Commission, 2020). The moral hazard is seen in both information asymmetry and the vulnerability of water sector regulation to changes in the political environment, pointing to the possible politicisation of the regulation model choice (Estache et al., 2016).

Figure 1 shows a schematic overview of traditional and modern rationales forming the regulation approaches and model application.

**Figure 1 Schematic overview of water regulation models rationales**




*Source: authors' own processing*

## III. Overview and systematisation of models

Theoretical approaches to the water pricing regulation materialised into different regulation models. Over the years of application, the original view on water pricing regulation changed as well as the academic capture, and the definitions and systematisation experienced periodical variations. Current knowledge and development require revision of the standard way of the presentation of the models. Thus, a literature review of standard approaches to water pricing models and their brief description is followed by the authors' comprehensive systematisation.

The basic framework for model systematisation may be found in Breyer and MacAvoy (1991) dividing regulation approaches into four categories: government ownership, issuing permits, rate-of-return, and price cap. Even though this structure was the basis for many studies (e.g.

Kearney and Favotto, 1994), government ownership and issuing permits cannot be considered as a standard water pricing regulation. This conclusion is consistent with Newbery (2002) recognising only two branches (cost-of-service regulation and price/incentives regulation), Liston (1993) also recognising two branches (cost-of-service regulation and price-cap regulation), or with Sappington (1994) presenting cost-of-service regulation and performance-based regulation. The difference between cap regulation and performance-based regulation is not clear, as some authors class cap regulation as performance-based regulation and some authors consider cap regulation to be an independent category (i.e. Machek and Hnilica, 2010, who in addition recognise the yardstick competition). Sappington (1994) recognises two branches, rate-of-return regulation and incentives-based regulation which the author further divides into earning sharing regulation, revenue sharing regulation, rate case moratoria, price cap regulation, partial deregulation, yardstick regulation and options (Sappington, 2000). Sappington's (1994) two branches are also proposed by Joskow (2007) who adds the category of alternative regulation represented by franchise regulation. On the other hand, Berg (1997) and the Australian Treasury (1999) divide models into five branches, cost-of-service regulation (consisting of direct price setting and rate-of-return), price cap regulation (avoiding return cap regulation), performance-based regulation, franchise regulation and yardstick regulation. Performance-based regulation may be divided into sliding scale regulation, profit sharing regulation and output floor scheme (Australian Treasury, 1999), or can be an equivalent to earnings sharing regulation (Hauge and Sappington, 2010). Besides, according to the Australian Treasury (1999), the hybrid scheme may be recognised.

The category of *cost-of-service regulation* covers two traditional approaches. The model known as the *direct price setting* is characterised by the government full control of the prices setting. It consists of utilities operated by either the government department or agency/commission. Formerly common price regulation is sharply criticised mainly due to the lack of clear objectives and the principal-agent problem (Australian Treasury, 1999). The political and social context, as well as the lack of transparency, information asymmetry and conflict of interests, determine the failure of the model as an efficient regulation. The second cost-of-service model *rate-of-return* is the most established water pricing model, which can be described using equation (1) derived from Jamison (2007) as follows:

$$\frac{p(y)\cdot y-(E+d+T)}{B} \leq r \tag{1}$$

where:

- $p$ is the price;
- $y$ is the quantity expected to be sold;
- $E$ is operating expenses, i.e. the costs;
- $d$ is the annual depreciation costs;
- $T$ are all taxes not counted as operating expenses and not directly charged to customers;
- $B$ is the designated rate base, which is the amount of capital or assets the utility dedicates to providing its regulated service;
- $r$ is the allowed rate of return which is the cost the utility incurs to finance its rate base, including both debt and equity.

Its foundation lies in costs recognition and fair rate of return limitation, which are both its strengths and weaknesses. While the proponents argue for the ability to control the maximum return on investment, the opponents identify several significant problems, e.g. determination of allowable costs, depreciation expenses, lack of incentives to efficiency maximisation and to

minimise costs for the certainty of passing them on consumers while maximising the profit, the rate base and allowed return, Averch-Johnson effect (Averch and Johnson, 1962; Petersen, 1975), regulatory capture and politicisation.

While *cost-of-service regulation* may provide a standard and well-established way of price regulation, its difficulties and constraints force regulatory authorities to leave it gradually. The successor introduced in the 1980s is *price-based regulation* (also known as *cap regulation*), which may be further divided into *price-cap* and *return-cap models*, both trying to ensure the incentives to cost minimising and efficiency promoting. The *price cap model* is based on a maximum allowed inter-temporal path for the price depending on factors that are beyond the control of the regulated company. Factors may consist of exogenous variables such as price index or another benchmark, or endogenous variables such as expected efficiency growth or technology development, expressed by parameter X (reflects expected price reductions or increase). According to Littlechild (1983), the approach does not require arbitral determination and valuation of capital base or fair rate of return, and at the same time, eliminates the need to allocate only pre-defined costs. Thus, the maximisation of the equation (2) defines the model:

$$p(y) \leq \bar{p} \tag{2}$$

where:

- $\bar{p}$ is the allowed price, price cap.

Hence, the function RPI-X defining the price is introduced, which corresponds to the expected changes in the specified time interval on the market of the given sector. An alternative is to add an adjustment to inflation-permitted yields depending on consumption (Machek and Hnilica, 2010). Most authors consider this regulation to be more successful than the original rate-of-return, other previous forms of regulation or complete liberalisation. The motivation to increase efficiency is based on the simple principle: profits can be increased by reducing costs and increased by increasing consumption. However, some papers proposed that imperfect determination of the price cap, which is based on similar information as used for the rate-of-return model, also causes the Averch-Johnson effect. Other problems may be the determination of parameter X, the determination of the primary price base and ensuring the quality of water and infrastructure. *Revenue-cap model* is based on the determination of maximal allowed intertemporal path for the revenue similarly determined as the price in the price-cap model. Thus, the maximisation of the equation (3) defines the model:

$$p(y) \cdot y \leq \bar{R} \tag{3}$$

where:

- $\bar{R}$ is the allowed revenue, revenue cap.

The substitution of the price for revenue enables the regulator to change parameters without model deformation flexibly. A company can determine its tariff structure or differentiate consumer groups, such as households and industry (Kuosmanen and Nguyen, 2018). The motivation to increase efficiency is assessed as high: profits can be increased by reducing costs, and in case of reducing the consumption prices can be increased (loss reduction). The model should include in the calculation the factor of expected efficiency growth (Sappington, 1994).

*Performance-based regulation* may be considered the next generation of incentives-based models promoting the efficiency maximisation by linking the profit (or directly the employee reward) with the performance measuring unit. The *sliding scale model* is characterised by the

inverse relationship between price and dividends; the *revenue sharing model* distributes unexpected changes in revenue between shareholders and employees and in some cases to customers also. Similarly, the *earnings sharing model* distributes unexpected changes in earnings. In the case of setting the redistribution at a low level (i.e. profit stays in the company), the model is close to the cap regulation (high incentives), while in the case of a significant redistribution, it is close to the classic rate-of-return model. Problematic parts of the implementation are the determination of a suitable performance indicator and the insufficient control of cost growth, which can be passed on to customers.

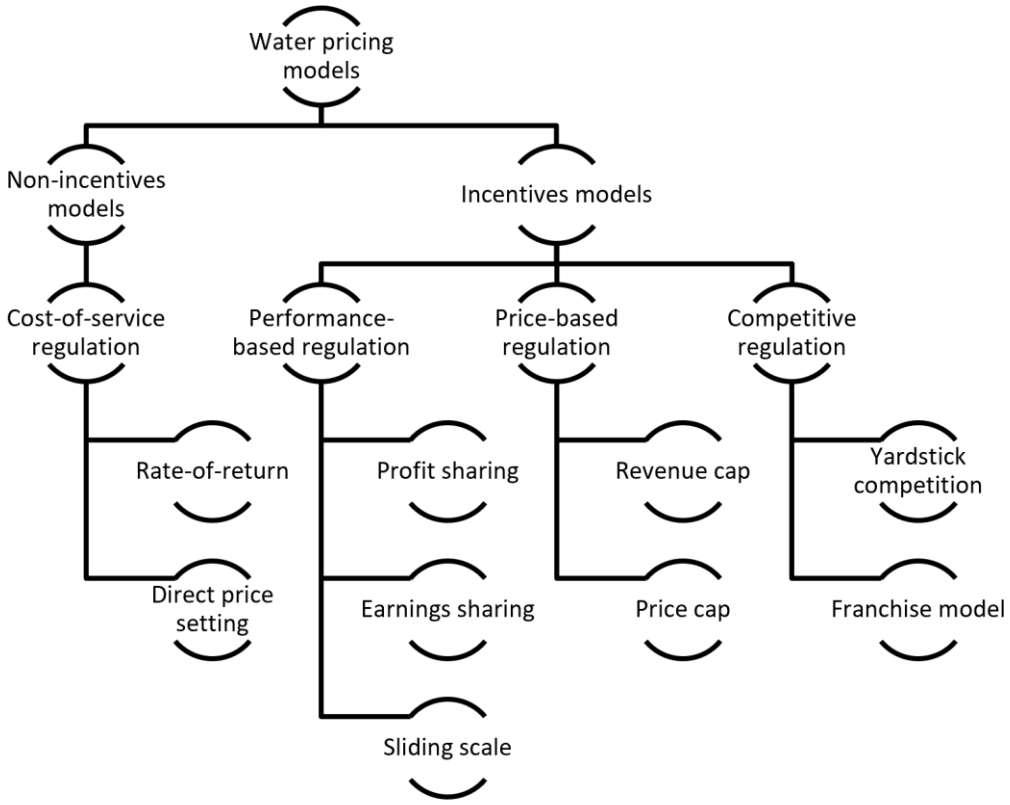
The *competitive regulation* may be understood as a slightly different approach to water pricing models as it incorporates the element of competition into pricing decision both directly and indirectly. The direct competition introduction is in the *franchise regulation model* (also known as the *auction, tender* or *contractual model*). The contract determines the quality and scope of services provided, as well as the responsibility for investments and the method of negotiations with the owner. The contract also specifies the conditions under which it is possible to change the price. This regulation model is discussed due to its requirement on auction complexity, determination of the contractual length and attraction of a sufficient number of bidders. A successful example is an application in Buenos Aires (Argentina), where it resulted in a 27% reduction in the price of water and a tenfold increase in investment compared to the previous situation when water supply was run by the state (Klein, 1999).

The indirect competition is introduced by the *yardstick regulation* (or *yardstick competition*), which is a regulatory tool to compare the performance or costs of the selected company with that of companies in other regions of the country or with international norms to enable the regulator to set strict performance targets or tariff adjustments at the time of regulatory review (Foster 1992; Carrington et al. 2002). The first step is to determine performance indicators (financial or non-financial). These indicators must be comprehensible, identifiable, useful and lasting over time, while in small numbers, they should provide a sufficient picture of the functioning of the company as a whole. This method is facing considerable criticism from regulated companies arguing for the uniqueness of each of them and the specific circumstances that shape their performance and thus, make valid comparisons impossible. Other problems are also the possible collusion of the monitored companies. However, it is considered a suitable tool as a complement to another model for ensuring efficiency and effectiveness in the regional, national or international comparison.

All the above mentioned are, to some extent, intertwined and may be further connected, what is called the *hybrid model*. It is very popular to add the yardstick competition or performance-based regulation to the initially used mechanism (Australian Treasury, 1999). Besides, a variant of the hybrid model is the incorporation of specific tools targeting designated goals such as environment protection and water efficiency.

Based on the literature review, the water pricing models might be divided into two groups, i.e. *non-incentive models* represented by cost-of-service regulation, which are to some extent based on the sum of costs, and *incentive models* introducing different types of incentives to reach requested efficiency, cost minimalisation or environment protection. Competitive models incorporating specific efficiency incentives can be considered incentive models as well. The systematisation of the models established by the authors is shown in Figure 2.

**Figure 2 An overview of theoretical water pricing regulation models**

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## IV. Methodology

To fulfil the extended aim of the paper, seven European states based on the following criteria were selected:

- economic criterion: the most economically powerful countries (Germany, France and the United Kingdom) and states less powerful, demographically comparable with the Czech Republic (Hungary, Portugal, Austria and the Czech Republic);
- geopolitical criterion: membership in the European Union, i.e. founding states (France, Germany), accession before 2004 (Portugal, Austria), after 2004 (Hungary, the Czech Republic), and secession in 2020 (United Kingdom);
- topographical and geographical criteria: prevailing water stress level (European Environment Agency, 2016a) with respect to the water exploitation index (European Environment Agency, 2016b), i.e. low (Hungary, Austria), medium (the Czech Republic, France, Portugal), and high values (Germany, England and Wales from the United Kingdom).

The applied water pricing approach (a model or the combination of the models) in the selected states was identified and further analysed based on information provided by regulation authorities. Specific criteria reflecting the rationales are introduced to assess applied water pricing models in the selected countries. Given the possibility to measure and compare the data, only *moral efficiency*, *sustainability*, and *moral hazard* were chosen for the analysis.

*Moral efficiency* representing both traditional and modern rationales is connected to fairness and social availability. Its characteristics are expressed by the average price of water per cubic metre (EUR/$m^3$) and gross operating margin (in %). Gross operating rate is an indicator of profitability that corresponds to the share of gross operating surplus in turnover. The gross operating surplus is the surplus generated by operating activities after the labour factor input has been recompensed and turnover represents the total of all sales (excluding VAT) of goods and services carried out by the company (Eurostat, 2017). *Sustainability* is represented by average leakage per capita (in %) and average consumption per capita in cubic metre to illustrate the ability to promote water efficiency while reflecting the water scarcity. *Moral hazard* is in a simplified way assesses by prevailing ownership of water supply infrastructure in the selected states.

The data was obtained particularly from the open-access database of Eurostat (2020), reports published by regulatory authorities of the selected states and OECD (2020). The gross operating rate and average consumption per capita are presented as a mean value for the period 2015-2017. Other variables are due to unavailability of data stated only for the year 2017. Microsoft Excel was used to perform the calculations.

## V. Water pricing models in the selected states and their assessment

Table 1 presents applied water pricing models in the selected states. The results show that the approach of the selected countries to the water regulation shows considerable heterogeneity, which could be caused by specific historical, geographical, geopolitical and topographic characteristics. The performed analysis indicates that examined countries might be divided into two groups with similar water regulation characteristics, except for Portugal representing a particular case.

**Table 1 Applied water pricing models in selected countries**

| State | Rate of return | Direct price setting | Performance-based regulation | Price cap | Revenue cap | Franchise regulation | Yardstick competition |
|---|---|---|---|---|---|---|---|
| Czech Republic | X | | X | | | | |
| Austria | | | | | X | | |
| Germany | | | | X | | X | X |
| France | X | | | | | X | |
| Portugal | X | | | X | X | | |
| Hungary | | X | | | | | X |
| England and Wales | | | | X | | | X |

*Source: authors' own processing*

The *first group of countries* consisting of the Czech Republic, Hungary and France still apply the cost-of-service regulation, even though in the hybrid form. Despite being recognised as a member of the same group, all these countries apply unique price regulation approach. The Czech Republic still adheres to the rate-of-return regulation since the transformation of its economy in the 1990s. However, it has tried to introduce some incentive tools in the regulation, but these attempts have been limited by considerable heterogeneity in size, ownership, infrastructure quality and foreign investment influence on the water supply companies. Thus, the discussion about the model innovation is still in progress. On the other hand, Hungary revolutionary changed the water sector environment in 2012 to achieve higher economies of scales. The Hungarian Water Utility Supply Act from the year 2011 set the minimal requirement

of 150,000 customers per company to operate in the water industry. Hence, from 400 original companies operating in Hungary in 2011 remained only 41 after the Act came into effect (Kisvardai, 2015). Concurrently, it accepted to some extent to *direct price setting* on the government level to maintain the water affordability (the maximal price is set by the law and oscillates around 90% of the price in 2013, HEA, 2015). France traditionally tends to *franchise regulation*. From the perspective of contractual price determination, this approach is in many cases based on the same mechanism as cost-of-service regulation but directly incorporates into the model a competitive element. Despite the long history, the data from the year 2002 show that the average number of tender participants is only 2.2 and 28% of tenders attracts only one participant (Prasad, 2008). Only in the marginal case of municipality water supply self-management in France, the standard cost-of-service regulation is commonly used (Salvetti and Canneva, 2017).

The *second group* represented by Austria, Germany, England and Wales left the traditional way and decided to apply the incentive-based models. Austria has such a plentiful supply of quality groundwater that there is no need to treat it specially and 10% of the population can supply itself, which significantly reduces costs (The European Federation of National Associations of Water Services, 2018). Applied *revenue cap model* constraint expected revenue to a maximum of twice the annual financial needs of water suppliers. Authorities are entirely in charge of the rate of return (i.e. municipal bodies, associations, etc.). Germany gives its municipalities a significant level of autonomy –each municipality may decide the water pricing model and water regulation itself. However, the *combination* of price cap model with benchmarking (yardstick competition) and the franchise regulation (sufficient competition is necessary) prevails. Regulation approaches in Austria and Germany are similar mainly due to historical, cultural and geographical proximity. Both countries emphasise the autonomous and liberal municipal water management and municipal ownership of water infrastructure. England and Wales underwent rapid privatisation in the 1980s and 1990s to restore the superannuated infrastructure and to reach financial sustainability of newly established publicly traded companies. The water sector in England and Wales is regulated and supervised by the independent state authority OFWAT, which controls the application of *price cap regulation* while incorporating the *yardstick regulation* (OFWAT, 2020). As the number of water companies is relatively low (32), their business plans are regularly analysed in detail. This fact enables OFWAT to take specifics of each company into account individually and set price cap, performance-based incentives or investment support for each company.

Portugal is a specific example of the country currently passing through a transitional phase in the water industry. Therefore, it might be considered a bridge between the first and the second group of counties. The *price cap regulation* is gradually replacing the traditional *rate of return* model, and pilot application of the *revenue cap model* is planned soon. Heterogeneity in the management and regulation causes significant price differences, and in some areas, the price exceeds the level of social affordability. Portugal has been prosecuted for failing to meet the framework conditions for water quality; in many cities, the standard for polluted water treatment is not met. However, according to da Cunha (2018), the situation is rapidly improving. A national fund is planned to balance uneven costs in some areas, redistributing revenues to regions with higher water abstraction and treatment costs, which would at least partially unify the currently highly differentiated prices.

To sum up, based on the analysis of water pricing applied approaches, three common elements were identified in the selected states: (1$^{st}$) the hybrid model application, (2$^{nd}$) the cost recovery principle and (3$^{rd}$) the importance of water affordability. It should be stated that the pure cost-of-service regulation (in case of both the direct price setting and the rate of return models) is not capable of meeting the rationales, which led either (i) to the addition of an original model with some incentive tools or its combination with an incentive model to obtain the benefits of

a hybrid mechanism, or (ii) directly to switch the cost-of-service regulation with the price-based regulation (as the results show in Austria, Germany, Portugal, England and Wales).

Further, the selected criteria in these countries, reflecting some of the identified regulation rationales, were compared (see Table 2). Although some specific characteristics might be pointed out for the countries, it is not possible to divide the countries into the same groups as above. Taking into account the average wage in individual countries (see Eurostat, 2020), it can be stated that the price of water in selected countries is affordable for the population, which is consistent for instance with Hutton (2012).

**Table 2 Comparison of chosen criteria representing the regulation rationales in the selected states**

| State | Moral efficiency | | Sustainability | | Moral hazard |
|---|---|---|---|---|---|
| | Average price in EUR/$m^3$ (2017) | Gross operating rate in % (avrg. 2015-2017) | Average leakage per capita in % (2017) | Average consumption per capita in $m^3$ (avrg. 2015-2017) | Prevailing ownership of infrastructure |
| **Czech Republic** | 3.27 | 13.80 | 18% | 30.45 | private |
| **Austria** | 3.67 | 18.47 | 16% | 43.6 | municipality |
| **Germany** | 1.69 | 22.37 | 6% | 44.56 | municipality |
| **France** | 3.92 | 7.93 | 20% | 54.02 | municipality |
| **Portugal** | 1.82 | 26.10 | 22% | 55.48 | state/municipality |
| **Hungary** | 2.65 | 10.40 | 21% | 34.3 | state |
| **England and Wales** | 3.54 | 36.77 | 24% | 51.1 | private |

*Source: authors' own processing based on Eurostat (2020); National Infrastructure Commission (2019); CIEAU (2018); The European Federation of National Associations of Water Services (2018); OECD (2020)*

*Moral efficiency* and *sustainability* are assessed together due to their connectedness. Despite the lowest average price in Germany and Portugal, both developed western countries with incentive-based water pricing models, the proximity of current state of the water sector cannot be confirmed as the average leakage per capita significantly differs. In terms of leakage, Germany could be pointed out as an example of efficient state (only 6% leakage per capita) while Portugal and England and Wales as a significantly inefficient (22% leakage, 24% respectively). The reason for this fact consists of long-term and well-managed investments and introducing innovative technologies in the water infrastructure in Germany led by experienced severe water stress in the country (European Environment Agency, 2016a). Low price in Portugal does not point to transport efficiency (the water efficiency and environment protection as well) but to a high level of average consumption which pushes the prices down. This may be changed in the near future as Portugal experiments with different price settings to fight the projected water stress level in 2050 (European Environment Agency, 2016a).

The Czech Republic represents the opposite of Portuguese high consumption. Its average water price, average leakage and average consumption per capita are rather low, which could be caused by society attitude to water scarcity and environment protection. The similar situation might be seen in Hungary sharing a similar history with the Czech Republic. Austria can be considered a bridge among the countries mentioned above with relatively low average consumption and leakage but higher average consumption per capita. The last region, England and Wales, shows the highest leakage and also one of the highest average consumption per capita. Concurrently, this region has the highest level of the gross operating rate which may be explained by the catastrophic state of the water supply infrastructure in the 1990s forcing the companies into huge investments in infrastructure, which may deform the current gross

operating rate (turnover has to be higher to cover depreciation), but as the average leakage still remains high further investments are expected. This fact is also supported by the severe water stress experienced by these regions of the United Kingdom. On the other hand, France has a significantly lower gross operating rate than other countries. This could be explained by the particular properties of the *franchise regulation* concerning various approaches to participation in investment financing set by the law.

The *moral hazard rationale* is discussed with ownership criteria results showing the Czech Republic and England and Wales as the only countries where the ownership of infrastructure is allowed to be private. Both countries decided to privatise the infrastructure but ended up with different results. England and Wales thanks to establishing of publicly traded companies managing relatively large regions are under systematic public and regulatory supervision. On the other hand, the Czech Republic privatisation ended up in a huge amount of heterogeneous companies, both in size and performance, preventing their easy supervision. Moral hazard connected to the ownership of the infrastructure consists of the possibility to apply public interest in the process of the price-setting – municipalities and states are often more willing to generate losses than private companies. On the other hand, the most discussed problem of privately-owned infrastructure is the neglecting of investments in order to generate higher profit.

To sum up, the analysed water pricing models applied in the selected countries are not easy to assess in the context of the fulfilment of the rationales illustrated by the selected criteria. Even though some states show the features of a functional model for all examined criteria (Germany, Austria), these results cannot be generalised because of the influence of unique characteristics of the states, such as availability of water sources or cultural and historical specifics. In the light of the national characteristics, selected criteria may provide only limited explanatory power and serve as an outline for future research. Hence, the general conclusion about the water pricing models ability to effectively accomplished their economic rationales cannot be stated. Nevertheless, it can be concluded that cost-of-service regulation cannot meet the expectations on the ideal regulating model, but incorporating some incentive tools, affecting the society attitude to water efficiency and environmental protection or even experimenting with a pilot of price-based regulation may provide a feasible way to get closer to the ideal model.

## VI. Conclusion

Water represents final and vulnerable economic good that should be accessible and price affordable to all people. Due to the existence of natural monopolies typical in the water utility industry, the regulation precedes market failure. Despite considerable academic interest in water pricing models, comprehensive overview, and their systematisation reflecting current social requirements are not clearly stated. Therefore, this paper aimed to provide a comprehensive literature overview of existing water pricing models (in terms of natural monopoly regulation) and their rationales and to establish their ordered systematisation. Besides, to find out whether and how the models are applied in the European states, the aim was extended to classify and to qualitatively assess (with respect to the rationales) water pricing regulation approaches of the selected member states of the European Union (the Czech Republic, Austria, Germany, France, Portugal, and Hungary) and the United Kingdom (England and Wales only).

Based on the literature review, traditional and modern rationales forming the water pricing regulation were identified. While the traditional rationales proceed from the classic economic theory (static, dynamic, and moral efficiency problem), modern rationales reflect current changes in technology, society and environment (sustainability, affordability and moral hazard). Water pricing models were systemised into non-incentive models (cost-of-service

regulation) and incentives models (price-based regulation, performance-based regulation and competitive regulation). The analysis of the applied water pricing approaches/models showed three common elements in all selected states: (1st) the hybrid model application, (2nd) the cost recovery principle and (3rd) the importance of water affordability. On the other hand, selected criteria reflecting the rationales do not provide enough certainty to formulate a general conclusion, which specific model is able to meet the rationales most efficiently. However, the cost-of-service regulation models (direct price setting and rate-of-return model) cannot succeed in comparison to incentive models. Still, some states rely on these models as the standard process of a water pricing model selection depends mainly on national, political, and historical particularities, while disregarding water scarcity indicators, such as water stress level. In general, Germany, facing severe water stress with projected further deterioration, may serve as an inspiration for authorities of other states to achieve the efficient water pricing model.

The paper provided the literature review devoted to water pricing models (their rationales and systematisation) and their qualitative analysis in the selected European countries. An overview of existing models could make it possible to assess possible ways of regulating the water price in their complexity. Future studies should extend the literature review presented in the paper by mathematical-statistical analysis of the models and their effects on the national economy, including the national characteristics of both European and non-European countries. Combination of a qualitative and quantitative approach could create a comprehensive basis for policy-setters to meet recommendations formulated by OECD (2016) which should be taken into account in the process of water price setting.

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