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The Water Tariff Structure in the New Convergence Regulatory Scheme

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Abstract The most recent innovation in the regulation of the Italian Urban Water Management is the introduction of the Convergence Regulatory Scheme. The new tariff preparation method introduced by the Italian Regulatory Authority for Energy, Networks, and Environment (ARERA) aims to simplify the mechanism for identifying the water tariff for those managements characterized by enduring critical issues regarding investment planning and management of the Urban Water Management. The application of the Convergence scheme provides for the estimate of parametric costs to be considered in the construction of the water tariff, considering different cases depending on the management information available. But the same convergence mechanism also provides obligations for the Managers, including the structuring of tariff classes in compliance with the provisions of the ARERA resolutions. The initial point for defining the user's tariff structure is the Manager's Revenue Constraint, estimated based on a reference benchmark. This study proposes a mathematical programming model that allows, in compliance with the constraints dictated by the ARERA resolutions, to define the tariff structure for users in the application of the Convergence Regulatory Scheme, thus supporting in the complex decision process all those Operators that present serious problems in the management of the water service.

Keywords: Urban Water Management, Economic Evaluation of Projects, Optimizing Tools, Water Tariff, Decision Making

1. Introduction

Water, an indispensable commodity for life, is also the main resource for sustainable development. According to the United Nations, access to water is a fundamental human right (United Nations, 2010). In fact, among the 17 Sustainable Development Goals (SDGs) we have that of ensuring the availability and sustainable management of water and sanitation for all (SDG 6). The goal is to incentivize an integrated and efficient way of managing the water resource (United Nations, 2015; Guppy, Mehta, and Qadir, 2019). Nevertheless, the gap between areas of the planet where access to the resource is easy and the quality of water services is satisfactory, and the other parts of the globe where we have bad examples of management and water is increasingly becoming a scarce good of questionable quality, remains significant. As in the rest of the world, in the last years also in Italy, the water service divide between the North and the South of the country has grown. The Centre-North in the management of the resource appears similar to the main European countries, being characterized by the presence of multiutilities of large size and high efficiency (Macchiaroli et al., 2019). With few exceptions, most of the problems are instead concentrated in the South, where are encountered water losses higher than 50%, deficiencies in sewerage and purification systems, difficulties in the disposal of sludge, adduction networks mostly dating back to the post-war period, low levels of turnover for the managers that do not exceed ten million euros (Mazzola, 2020). The Regulatory Authority for Energy, Networks, and Environment (ARERA), the regulator of the Integrated Urban Water Management in Italy, has for years been intent on strengthening the processes of aggregation between the managers, hoping to reorganize the governance of the water sector. In particular, the Authority intends to promote institutional building in disadvantaged areas. The objective is to reduce growing differentials in-service performance levels and in the possibility of access to water between areas of the country, overcoming the water service divide. To this end, actions are promoted for the convergence of the most disadvantaged areas of the South towards the ordinary national performance levels. This objective has prompted the Authority to provide for simplified forms of tariff regulation (Convergence Regulatory Scheme) to which recourse can be made in the event of persistent criticalities in the start of management planning activities and the implementation of infrastructure interventions (ARERA, 2020). Although the simplifications introduced are necessary to strengthen the aggregation processes and to reduce the differences in service quality between different areas of the country, they do not eliminate some critical issues. Due to the lack of technical and economic data, typical of low-budget managements, it remains complicated to determine the fees applied to users and to identify the consumption bands for each type of user. This study proposes a mathematical programming model that allows the definition of tariff classes in the application of the Convergence mechanism, supporting, therefore, the decision-making process for all those managements that present serious criticalities in the management of the water service.

2. State of Art

2.1. The Convergence Regulatory Scheme

In Italy, with Resolution 580/2019/R/idr (Approval of the Water Tariff Method for the third regulatory period MTI-3) ARERA introduces the new provisions concerning the determination of the fees for the provision of aqueduct, sewerage, and purification services for the years 2020-2023. Following the dictates of Attachment A of the regulation, the tariff values are determined, for each year of the regulatory period, by multiplying the tariff values in force by a coefficient known as the *tariff multiplier* ϑ. The applicable tariff rules fall into two schemes: (i) the *Matrix of Regulatory Schemes*, where operators in possession of all the required technical and economic data can select the most appropriate operating scheme based on the starting conditions of their management; (ii) the *Convergence Regulatory Scheme*, which presents simplified rules for those managements where there is a lack of data needed to prepare water tariffs.

As far as the Convergence Regulatory Scheme is concerned, governed by article 31 of Attachment A of Resolution 580/2019/R/idr, it applies to the operators with persistent criticalities in the performance of the service planning and investment activities and which present conditions of exclusion. In the case of the Convergence Scheme, the cost items to be recognized in the tariff are reconstructed parametrically based on a reference benchmark. The simplified rules are applicable only for the 2020-2023 regulatory period, after which the operators will have to refer to the matrix of regulatory schemes.

The Convergence Scheme is applicable to those operations falling into one of the following cases:

1. Both tariff revenues, costs and quality management data are known.
2. Only tariff revenues are known.
3. Neither the tariff revenues nor the costs of operation are known.

In the first two cases, the tariff multiplier, for each $a = \{2020, 2021, 2022, 2023\}$, shall be calculated as follows:

$$\vartheta^{a} = (1 + \alpha Y), \qquad (1)$$

where (α) is the *aggregation factor*, equal to 1.5 for those managements that have started an aggregation process and equal to 1 in the absence of this process. The parameter (Y), on the other hand, is the *increase factor*, which represents the manager's ability over time to comply with current regulatory provisions. It is equal to 5% for the first year, 4% for the second, 3% for the third and 2% for the last year.

In the absence of both revenue and cost data, the tariff multiplier is a function of the Manager's Revenue Constraint (VRG), i.e., the maximum value of revenues that can normally be obtained from service management, as established for ordinary managements that refer to the matrix of regulatory schemes. However, in the case of the Convergence Scheme, this constraint is calculated in a simplified way, considering only two cost items estimated on a parametric basis. We have:

$$VRG^{a}_{conv} = \left(Capex^{a}_{conv} + CO^{S}_{conv}\right), \qquad (2)$$

where VRG^{a}_{conv} is the Manager's Revenue Constraint who does not have the revenue and cost data, $Capex^{a}_{conv}$ is the cost of capital set equal to $16\% \cdot CO^{S}_{conv}$, and CO^{S}_{conv} are the operating costs also estimated on a parametric basis, following the provisions of art. 17 of Resolution 580/2019/R/idr, to which appropriate simplifications are applied, which we will overlook for the sake of brevity.

Local Government Body (Ente di Governo dell'Ambito - EGA), to which the management for which the Convergence Regulatory Scheme is applicable refers, is required to fulfil a series of obligations for each year of the regulatory period. In particular, the obligations to be fulfilled within the first year are as follows: To carry out a survey of the level of availability and reliability of technical data, to assess whether the water distributed to users complies with the regulations on the quality of service (RQTI), to adopt a program for achieving compliance with the regulations on the management of urban wastewater (RQTI). The obligations for the second year consist of certifying that the technical-accounting records are properly prepared and defining the fee structure for each service. For the third year, the EGA must check whether the operator has complied with the obligations to communicate and record the contractual quality data required by the standard (RQSII). Finally, for the fourth year, the monitoring obligations, the preparation of registers, the communication of technical quality data, and the reliability of the measurement data must be attested (ARERA, 2019).

From the obligations of the EGA, it emerges that the structure of the fees for water services must be defined within the second year of the regulatory period, following the indications of Annex A of Resolution 580/2019/R/idr (Integrated Text for Water Services Tariffs - TICSI).

2.2. Definition of Water Services Tariffs

Here we will analyse only the fees applied to resident domestic users for the aqueduct service. In this case, the 665/201 7/R/idr establishes that the tariffs must be composed of a fixed fee, not related to the consumption, and a variable fee, proportionate to the consumption and variable for consumption bands. The latter should be determined once the consumption bands have been established based on per capita quantities, i.e., considering the actual consumption of each of the members of the resident households. If the data relating to the number of members of each user are not available, the EGA may define the variable quota of the aqueduct service using a *standard per capita criterion*. In this case, a typical resident household of three people is considered. In the articulation of the brackets, there is a consumption band with a facilitated tariff (T_{agev}), a basic tariff band (T_{base}), and excess bands that can vary from 1 to 3 (T_{ecc1}, T_{ecc2}, T_{ecc3}). If the standard per-capita criterion is adopted, for each resident domestic user, the facilitated consumption band corresponds to the interval between 0,00 m^3/year and

55,00 m^3/year (minimum quantity of water to guarantee for a user composed of three people). s established by updating the previous base tariff by means of the ϑ multiplier. T_{agev} must be between 50% and 80% of T_{base} (often it is set at T_{agev}=65%·T_{base}). The maximum excess tariff must be less than or equal to six times T_{agev}. In addition, the excess bands must be increasing with each other. The fixed tariff must not exceed 20% of the total revenues obtainable from water service. Finally, the TICCSI provides that the following constraint is respected (the revenues must be the same compared to the two-year period preceding the regulatory review):

$$\sum_u \text{tarif}_u^a \cdot (vs_u^{a-2})^T = \sum_u \text{tarif}_u^{new,\,a} \cdot \left(vs_u^{new,\,a-2}\right)^T, \qquad (3)$$

where $\sum_u \text{tarif}_u^a \cdot (vs_u^{a-2})^T$ is the revenue from pre–existing articulations, while $\sum_u \text{tarif}_u^{new,\,a} \cdot \left(vs_u^{new,\,a-2}\right)^T$ is the revenue obtainable by applying the new tariff articulation to the new reclassification of consumed volumes (or scale variables, vs) defined according to the TICSI criteria (ARERA, 2017).

It is evident how, in the case of managements that refer to the Convergence Regulatory Scheme, some critical aspects emerge. This occurs above all for case 3, that is when the manager does not have either tariff or cost data. As is often found, these managers do not even have suitable measurement data of the effective consumption of each user, or in any case the information is incomplete and fragmentary. Therefore, it becomes complicated to use both the per capita criterion based on actual consumption and the standard criterion to establish the consumption bands. Therefore, it is not possible to define in equation (3) the values of vs_u^{a-2} and $vs_u^{new,\,a-2}$, which are indispensable to respect this constraint imposed by the Authority. To find a solution to the problem, in the next paragraph further simplifying hypotheses are introduced and a mathematical programming model is proposed which allows the tariffs to be applied to each consumption class to be defined, even for those operators which make use of the Convergence mechanism in the total absence of data.

3. The Model

In applying the TICSII to management using the Convergence Scheme, the following water tariff classes were considered:

Table 1. Tariff bands for the aqueduct service

Tariff	Consumption band	
	Min (m^3/year)	Min (m^3/year)
T_{agev}	0	q_a = 55
T_{base}	56	q_b = 200
T_{ecc1}	> 200	

The definition of the size of the three consumption classes and the use of a single excess tariff are derived from the observation of national average data on small municipal low-budget management.

In the absence of information on previous revenues and consumption for each user, in the proposed model we opt to replace the first member of (3) with the Manager's Revenue Constraint as defined in the case of Convergence through equation (2). In this way, the constraint (3) can be rewritten as follows:

$$VRG^a{}_{conv} = \sum_u \text{tarif}_u^{new,\,a} \cdot \left(vs_u^{new,\,a-2}\right)^T. \qquad (4)$$

The second member of (4) is equal to:

$$\sum_u \text{tarif}_u^{new,\,a} \cdot \left(vs_u^{new,\,a-2}\right)^T = \sum_u T_{RES}^{new,\,a}, \qquad (5)$$

where $T_{RES}^{new,a}$ is the total expense for the aqueduct service for a resident domestic user, equal to:

$$\begin{aligned} T_{RES}^{new,\,a} &= QF_{ACQ}{}^{new,a} + T_{agev}{}^{new,a} q_a + \\ &+ T_{base}{}^{new,a}\left(q_b - q_a\right) + T_{ecc1}{}^{new,a}\left(vc - q_b\right), \end{aligned} \qquad (6)$$

where $QF_{ACQ}{}^{new,a}$ is the fixed share of the aqueduct service and vc represents the volumes totally consumed by a user in a year. If it is not possible to establish the actual annual consumption per user, vc is considered equal to the average annual consumption of an average family of three people, which for 2020 is 459 m^3/year (ISTAT, 2020). Having defined the multiplier ϑ with the Convergence Scheme, the T_{base} is known. Let us also set T_{agev}=65%·T_{base}. But $QF_{ACQ}{}^{new,a}$ and $T_{ecc1}{}^{new,a}$ remain unknown. To estimate these unknown variables, defining a tariff structure that respects the constraints provided by the ICTSI, we decided to use mathematical optimization tools (Dolores et al., 2020a; De Mare et al., 2017; Dolores et al., 2020c). The objective function is represented by (5), which for (4) must tend to $VRG_{conv}{}^a$, respecting the following constraints:

$$\begin{cases} T_{ecc,1} \leq 6\ T_{agev} \\ QF_{ACQ}{}^{new,a} \leq 20\% \cdot VRG^a{}_{conv} \end{cases}. \qquad (7)$$

Defined the objective function, it is possible to solve the problem by resorting to linear programming. For its resolution, the Simplex Method has been used, which considers a problem in standard form and requires a starting basic admissible solution (Dantzig, 1990). The method iteratively moves from a basic admissible solution to an adjacent one that allows the current value of the objective function to be improved, until the optimum is reached or until it is determined that the problem is unbounded. The case of an impermissible problem is excluded since we start from a basic admissible solution (Dolores et al., 2020b; Nesticò et al., 2019; Dolores et al., 2018). With the Simplex Method, which can be implemented with Excel software using the "solver" command, it is possible to estimate T_{ecc1} and $QF_{ACQ}{}^{new,a}$, and thus define the complete tariff articulation even in the Convergence case.

4. Conclusions

In Italy, even though the Regulatory Authority for Energy, Networks and Environment (ARERA) has contributed to the improvement of the Integrated Water Service, a significant gap still emerges in the capacity of management and implementation of investments between some areas, mainly located in the South and on the islands, and the rest of the country. The serious deficiencies of the South are to be attributed to limited managerial and organizational capacities, rather than to a lack of funds. This is especially true for those managements directly entrusted to municipalities that manage water services on a tight budget (Macchiaroli et al., 2020; Nesticò et al., 2020). To reduce the Water Service Divide, new regulatory provisions have recently been introduced. To overcome the North-South differences and to lead towards the national standard the late managers, with the Water Tariff Method - MT3 the national Authority has introduced the Convergence Regulatory Scheme, which allows the less efficient managers to apply a simplified system of definition of the tariff multiplier ϑ. However, the simplifications introduced are not sufficient to carry out the complete articulation of tariffs by consumption bands as envisaged by the Integrated Text for Water Services Tariffs (TICSI). To solve this problem, a model is proposed that, using the Simplex Method, allows not only to obtain the complete articulation of water tariffs, but also to respect the constraints imposed by ARERA. The model makes it feasible to apply the provisions of the TICSI also to those operators that do not have either tariff or cost data.

The next objective of the research is to apply the model to a case study, quantifying the actual benefits obtained by the aqueduct service manager following the definition of tariff classes carried out even in the absence of data.

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