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WATER PRICING AND SOCIAL EQUITY IN PORTUGUESE MUNICIPALITIES

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Abstract

Water supply services are Services of General Interest (SGI), subject to specific public service obligations, such as universality, continuity, quality, affordability, transparency, and consumer protection.

There is an extensive empirical literature on the design of optimal prices. However, these contributions tend to neglect the issue of universal service and equity concerning the volume of water for basic needs (the 'essential minimum quantity').

Addressing this gap in the literature, and using empirical data for the Portuguese municipalities, this paper aims to evaluate whether income-related equity considerations are embodied in water supply Portuguese municipalities' tariffs. Accordingly, essential minimum quantities of water for representative households are computed, and then compared with the lowest tariff block's upper limit by water utility. Next, representative households are ranked by costs underlying essential minimum quantities and by income. This analysis also considers concentration curves and indexes which show that water bills are regressive, i.e., there is socioeconomic inequity favourable to the better-off representative households.

Keywords: Water Policy, Water Pricing, Social Equity, Efficient Water Use, Portugal

1. INTRODUCTION

Water supply services are Services of General Interest (SGI), which are subject to specific public service obligations, such as universality, continuity, quality, affordability, transparency as well as user and consumer protection, which must be imposed upon SGI operators (White Paper on services of general interest – Commission of the European Communities, 2004).

There is an extensive empirical literature dealing with important issues for the water industry such as the estimation of demand and cost functions and the design of optimal prices (Garcia-Valiñas, 2005; Fabbri and Fraquelli, 2000; Kim, 1995, among others). However, despite the consensus that universality should be a fundamental concern for water services, the vast majority of the empirical literature tends to neglect the issue of universal service and equity concerning the volume of water for basic needs ('essential minimum quantity').

Indeed, pricing is aimed at pursuing not only greater economic efficiency (the emphasis for most studies) but also objectives of equity, public health, environmental sustainability, financial stability, simplicity, public acceptability, and transparency. As a consequence of a multi-objective context, tariff designing is often complex and the prevailing pricing schemes are difficult to justify due to several (potential) trade-offs.

This research is centered on the pricing of water for domestic consumption, because this is the most important use in an urban context and because it refers to water for human consumption, for which the required patterns of quality are the most exigent (and thus, costly). Given the gap in the literature regarding empirical equity assessments in the water industry, the main purpose of this analysis was to evaluate whether, or not, income related equity concerns are embodied in water supply tariffs in the Portuguese municipalities.

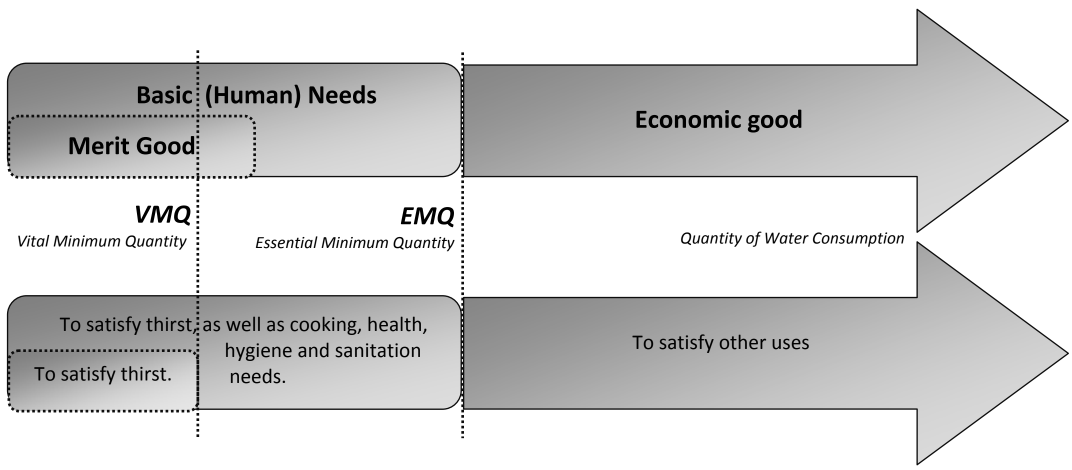
This paper is organized as follows. Section 2 presents a brief analysis concerning water taxonomy (as an economic good) and a discussion on the different water tariff schemes complexities, with special emphasis on the numerous objectives usually considered in water pricing for residential uses. In Section 3, the analysis of the Portuguese case is established. A description of the Portuguese water supply industry is offered, followed by the methodology considered in order to analyze whether the water supply tariff schemes in Portugal truly include equity concerns (between different income groups). For this, our approach involves the estimation of water *essential minimum quantities* for representative households, which are then compared with the lowest tariff block's upper limit implemented on their respective municipalities. Next, representative households are ranked by costs underlying minimum quantities and by income. This analysis also considers concentration curves and indexes, with the aim of assessing the potential existence of proportionality between costs and the households' ability-to-pay. Section 4 concludes the paper analyzing the main results of this research and suggesting some derived policy implications.

2. PRICING WATER FOR DOMESTIC USES

2.1. Water as an economic good

Considering that water resources are required to a multiplicity of purposes, whenever existing water is unable to satisfy their entire alternative uses simultaneously, it must be considered as a scarce good and, as suggested by Liu *et al.* (2003: 209), associated with various economic classifications. According to Figure 1 bellow, in extreme scarcity scenarios, water use's options can be reduced to the satisfaction of a vital human need - thirst (i.e., one can say that there is a *Vital Minimum Quantity* (*VMQ*) of water needed to survive), and, accordingly, water might be classified as a merit good. Next, and considering that water is necessary not only to 'survive', but also to satisfy other *basic needs* (e.g., cooking, health, hygiene and sanitation purposes), an *Essential Minimum Quantity* (*EMQ*) can be acknowledged. Finally, in what concerns quantities that exceed *EMQ*, water can be considered as an economic good, as acknowledged in 1992 at the United Nations International Conference on Water and Environment.

Fig. 1 - Classification of water at different levels of consumption



While water was a relatively cheap and abundant resource it was expected to be provided to final users almost free of charge, namely due to the water role as a basic necessity. However, once water scarcity is recognized, the only way to ensure that everyone has access to this economic good is to ration it in a way that promotes the best and most-valued uses. This task has been handled putting a price on water, and constructing tariff structures to meet different and often diverging goals in different situations (Rogers *et al.*, 2002: 5).

2.2. Principles and objectives of water tariffs

The multiplicity of objectives pursued by water tariffs can be structured around four main dimensions, expressed in Table 1.

Table 1 - Multiplicity of water tariffs objectives

Dimensions	Water tariffs objectives	Key idea (principle)
Economic efficiency	Allocative efficiency.	As a valuable economic good, water should be allocated to the uses that maximize overall benefits to society.
Financial sustainability	Sustainability of the service provider.	Water resources management and water services provision should be kept financially viable over time in order to attract capital, skills and technology.
Ecological/environmental sustainability	Sustainable use and conservation of water resources; Intergenerational equity.	To promote parsimonious uses in order to guarantee the ecological functions of natural capital, preserving it for current and future generations.
Social concerns	Equity; Affordability of low-income households; Universal water delivery for basic needs.	As a SGI, acceptable levels of water services should be accessible and affordable to all, including the more vulnerable groups.

The 'economic efficiency' dimension is the first concern in terms of economic theory, being the marginal pricing rule the first best solution to achieve an efficient allocation of water resources (Armstrong, 1999), i.e., the best way to deal with water allocation limitations is to price it more sensibly—to reflect, so far as possible, the costs of providing it. When the water prices reflect their marginal costs, the resource will be put to its highest-valued uses (Ward and Pulido-Vasquez, 2009).

The need of recovering costs is also critical to comply with the 'financial sustainability' criteria, namely by implementing tariff schemes that are reliable (i.e., capable of automatic adjustments e.g. to inflation) and flexible (i.e., capable of adjusting to changing circumstances, e.g. alterations in cost structures).

Although water reduction use is not considered an objective *per se*, water savings are an important component of the water tariffs 'ecological sustainability' dimension, namely in order to avoid putting unnecessary pressure on the resource (use efficiency). Last, but not the least, the 'social concerns' dimension stresses the tariff structures role regarding the fairness of water resources supply and cost allocation across economic groups. Particularly, the key objective to be taken into account is equity. According to OECD (2003: 21), water sector equity should be pursued according to four basic ways: equity between different income groups, equity among consumer types, equity between regions, and intergenerational equity. To ensure equity among income groups, water charges should not prevent poorer households from consuming basic quantities; thus, charges for the *EMQ* must be affordable by all households irrespective of their budget constraints. Additionally, and given that quantities consumed are usually greater than basic quantities, equity among income groups will be met if there is a positive association between charges and households' ability-to-pay. With regard to equity between consumer types, the point is to ensure that consumers who consume larger quantities of water will pay for it at higher rates. In turn, equity between regions calls for solidarity among regions, taking into account their economic development and local natural resources. Since the natural water allocations are different from region to region, for those where water is scarcer, its price tends to be higher, and in the case of a less developed area, solidarity between regions should prevail. At last, to achieve intergenerational equity, the present generations must use the water resources parsimoniously, i.e., the present level of consumption should not decrease the chances of future generations to benefit from (qualitatively and quantitatively) equivalent water resources.

Finally, beyond these four main dimensions, other criteria might be taken into account when conceiving water tariff structures. Simplicity (crucial to correctly signalize prices comprised in water bills), transparency, political and social acceptability, and administrative feasibility (ease of implementation) are examples of such criteria suggested in the literature (e.g. Bolland and Whittington, 2000; Dalhuisen and Nijkamp, 2002; Griffin, 2007; OECD, 2009). Indeed, although these criteria may be generally less emphasized than the four main dimensions presented above, they should not be disregarded as tariff structures are critically analyzed.

2.3 The tariffs role in managing urban water supply: critical conflicts

Synergies between the various water tariffs objectives are possible, e.g., economic efficiency can support financial and environmental sustainability of service provision as reducing the wasteful use of water will lead to lower requirements for investment in the expansion of water supply infrastructures. However, given the multidimensional nature of water values, the policy objectives described above may as well be in conflict with one another. These conflicts (or 'trade-offs') stress the need of a debate about the cost-benefit balance of the various arrangements and the appropriate compensatory or mitigation measures to minimize possible critical problems (e.g., affordability of the service for low-income households and other vulnerable groups). Indeed, when designing tariffs it may not be possible or advisable to meet one objective at the detriment of the other, but rather assuming that the tariff alone may not be able to achieve all objectives at the same time, and additional instruments may have to be used alongside tariffs.

According to OECD (2009), a critical conflict can emerge between the financial sustainability and the affordability of the water service for low-income households (i.e., attempts to use the tariffs to promote full costs recovery may increase the cost burden on low-income households; on the other hand, attempts to aid low-income households may reduce the incentives for efficient use of water). Two preliminary questions should be considered. The first concerns the portion of the costs that are supposed to be covered by revenues; and the second, the share that should be covered by different income groups, family types, or different geographical units.

Summing up, to define water-pricing strategies, policy makers need to: *(i)* have an informed and transparent debate on the synergies and possible conflicts between objectives; *(ii)* make a decision (based on a democratic and inclusive process) about the acceptable balance between them, or about prioritization, taking into consideration specific local conditions; and *(iii)* decide which combination of policy instruments to use and the role played by pricing mechanisms in this 'policy mix', as tariffs alone may not be able to achieve all objectives. To reach different policy objectives, there is a need to consider three aspects of tariff configuration setting: their average level, their structure and the process for setting and adjusting tariffs.

2.4 Urban water supply services tariffs schemes

In the literature on optimal water pricing there is a noticeable predisposition in favor of non-linear pricing schemes with only two parts, mainly for efficiency reasons and producer's financial viability concerns (see, e.g., Roseta-Palma and Monteiro, 2007; Elnabousi, 2001; Castro-Rodríguez *et al*., 2002). According to these contributions, this two-part tariff structure should include a variable charge, reflecting the marginal costs for the service provider of supplying an additional cubic meter of water; and a fixed charge, intended to cover the portion of the costs which is independent of the quantity consumed (fixed costs of production and distribution), as well as ensuring that the service provider can break even.

In practice however, water tariffs schemes are often slightly different from this simple theoretical structure. The following list presents the most common tariff structures according to OECD (2009: 79):

- Uniform *vs.* differentiated flat rates: In a non-metered environment, customers pay a flat rate regardless of their consumption. This can be uniform or differentiated based on customer characteristics, season, etc.
- Single volumetric rates with/without uniform or differentiated fixed charges: In a metered environment, a single rate per cubic meter is applied regardless of volume consumed. This can be charged with or without a recurrent fixed charge. The fixed charge can also be negative (a coupon). Fixed charges and coupons can be uniform or vary according to customer characteristics.
- Increasing block tariff (IBT): The volumetric charge changes in steps with increasing volumes consumed.
- Adjusted IBTs: Either the volumetric rates applied at each block or the size of the blocks is adjusted based on specific customer characteristics (*e.g.* family size, income).
- Decreasing block tariffs: Volumetric rates decline with successive higher consumption blocks.

Among the different types of price structures presented here, *IBT* are by far the most common all over the world (Rogers *et al.*, 2002; OECD, 2010). Frequently, *IBT* also include fixed charges, which attenuate the traditional distinction between *IBT* and two-part tariffs.

In Portugal, the diversity of structures applied is remarkable. Although *IBT* prevail, as well, there are large variations in terms of the number and size of blocks, as well as of the prices charged in each block (Martins and Fortunato, 2007; Monteiro, 2008).

2.5 *IBT* as a tool to achieve equity objectives

IBT are frequently justified in light of equity concerns. It is claimed that *IBT* promote equity by allowing the water utilities to cross-subsidize poor residential customers with revenues from wealthy households, i.e., as a normal good (water use increases with income), wealthy households are expected to use more water than poor households. Therefore, as stressed by Bolland and Whittington (2000), the range of consumption for the first block should be set taking into consideration the quantities needed to satisfy basic needs (the *EMQ*). Accordingly, for this first block, price should be low (even smaller than the marginal cost), being the respective quantities ‘subsidized’ by higher consumption levels. It is also commonly considered that the high rates charged to industrial and commercial customers relative to household customers may promote ‘equity among consumer types’ by allowing the water utilities to cross-subsidize poor residential customers with revenues from commercial and industrial firms. Additionally, water conservation and sustainable use may be promoted through *IBT* as well, to the extent that the price associated with the highest blocks be made punishingly high and thus discourage or stop ‘wasteful’ water use (OECD, 2009; Griffin, 2009; Monteiro, 2005), which, in turn, contributes to the intergenerational equity.

According to the above argumentation, by creating ‘desirable’ cross-subsidies, *IBT* are expected to promote equity between different income groups, equity among consumer types and intergenerational equity. However, the *IBT* adequacy to equity targets is not fully consensual, and has been disputed in different ways by various authors. Bithas (2008: 225-226) argues that *IBT* is prone to fail in promoting social equity, since blocks are designed on the basis of an implicit assumption concerning each individual's water use, whereas block rates are estimated on the basis of household consumption. Therefore, the outcome of the increasing block rates depends on the number of members in each household. This is particularly important since positive effects of the household number of members on water consumption are widely shown by residential water estimation empirical literature[1]. Thus, a household with a high number of members is charged a higher price, even if one accepts that households with a high number of members have, more often than not, lower *per* capita income and include more fragile members, such as children and retired seniors, i.e., the effective potential of *IBT* schemes to deliver on its promise of effectively promote social equity, critically depends on the tariff designer's success in setting the volume of water in the initial block equal to households' essential water needs. Bolland and Whittington (2000) point out other important potential equity limitations of *IBT*, arguing that, in general, the maximum possible 'subsidy' is not very significant and it is blockwise regressive, i.e., in order to obtain the full 'subsidy' it would be necessary to use water through the entire first block. Thus, as a household reduces its water use, its 'subsidy' becomes smaller.

Finally, there are other disadvantages associated with *IBT* that should not be ignored. Among them are the administrative difficulties and lack of simplicity and transparency of the water tariffs. Taking into account the blocks structure, to assume that consumers respond rationally to price changes and other economic variables might be questionable, namely because the bill adjustments due to an additional unit of consumption are different when that consumption belongs to a level of demand within one unique block or when the resulting water use moves from one block to another. This is an important point because when customers cannot detect a coherent price signal, they cannot respond as expected. In addition, the greater the number of blocks considered, the effects arising from additional consumption will be much more difficult to predict.

In summary, the widespread use of *IBT* deserves more careful examination than it has received. The contribution of this paper is to critically examine the equity between different income groups, namely analyzing effects from *IBT* use in the residential water sector, in Portugal. Furthermore, another purpose is to find why *IBT* are the preferred scheme. Accordingly, we assess whether equity concerns might justify the prevalence of such a tariff scheme.

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[1] See Arbués *et al.* (2003) for an overview of the literature focused on the estimation of residential water demand.

3. Case study

3.1 Portuguese water supply industry

Portuguese water industry configuration can be described as multiple local (municipal) monopolies. Portuguese water utilities are very heterogeneous. Some operators work only at the wholesale level, providing bulk water to other utilities; while other utilities distribute water to final users, operating at the retail level. This research focuses on the utilities operating at the retail level, i.e. providing water to households and to other non-residential customers. Among these utilities, some are in charge of the entire process, from origins to tap, while others buy part or the total volume of water from wholesale operators.

Local governments in Portugal have been responsible for the provision of water supply and sanitation services since the 1970s. Despite some restructuration in the industry that took part since 1993, municipalities still play an important role in this area, especially at the retail level. Nowadays, these water services can be directly provided by municipalities (through municipal services), by municipalized services[2] or by companies. In this last case, one can find both municipal public companies and concessionaries, which can be private, public or public-private partnerships.

The common situation concerning retail activity is the existence of one operator by municipality. Therefore, the Portuguese water industry is considerably fragmented. Indeed, if we consider utilities operating in both wholesale and retail water services then there are more than 275 water supply service providers for the 308 Portuguese municipalities (IRAR, 2009).

Taking into account the way the water sector is organized in Portugal, various approaches of defining and applying tariffs are in practice. In the case of services (directly and indirectly) provided by municipalities, the tariffs are approved by the respective Municipal Assemblies. Concerning municipal concessions, tariffs are usually fixed in the concession contract, which also establishes the formula for their revisions.

[2] These services are business units which, unlike municipal ones, have financial and management autonomy.

In a simplified way, one can consider that the residential segment water bills supported consist essentially of two main components: a fixed charge (*FC*) and a component dependent on the amount of water consumed, corresponding to the variable charge (*VC*), also recognized as the volumetric element. Concerning the variable component, the tariff structure prevailing comprises various blocks of consumption, i.e., the volumetric charge changes in steps with increasing volumes consumed (which are in accordance with the *IBT* approach). Other less frequent tariffs schemes are being put into practice, where the entire quantity of water consumed is paid at the price of the top block reached (*full progressive* tariff scheme), which is dependent on the amount of water consumed.

It is important to note that, irrespective of the tariff scheme chosen, it is virtually impossible to find any identical tariff design. In fact, even in those cases where there is a coincidence in terms of the structure of blocks (their number and size), significant variations between prices for each block are most probable. Moreover, besides the high number of blocks (average number is five), water bills include several other charges related to sanitation and solid waste services, not to mention other taxes. This multiplicity of items makes water bills very complex and therefore difficult to understand price signalization.

3.2 Methodology and data

This Section aims to clarify the methodological assumptions considered, and their implementation, to investigate whether the water supply tariff schemes in Portugal truly include equity concerns, more specifically equity between different income groups.

Our approach involves the quantification of 'essential minimum quantities' *(EMQ)* and the comparison of these with the dimension of the first block, in order to evaluate the judiciousness of that arrangement. This procedure is intended to identify, in the various Portuguese municipalities, possible relationships between the size of that first block and the *EMQ* which, by their nature, must be accessible to all citizens.

Next, a comparative analysis between the charges associated with the consumption of those essential quantities and the average income of each representative household by municipality is performed. The existence, or not, of proportionality between costs and the households ability-to-pay is assessed. These data are then considered to define scenarios of an annual consumption of 60m^3 (which is equivalent to a monthly consumption of 5m^3) and 120m^3, respectively the reference water quantity consumption as defined by the Portuguese Economic regulator for water supply and sanitation (IRAR; ERSAR, as of October 2009), and the approximate average quantities consumed by Portuguese households. Because this study is based on sectional data a representative household, by municipality, is considered as the observation unit.

3.2.1 EMQ and first block of consumption

As a starting procedure, the reference value to satisfy water consumption essential needs, as defined by the World Health Organization, approximately 40 liters *per* day *per* person, is considered to establish the corresponding equivalence, in cubic meters (measure of water consumption), of 0,04m^3 as the *EMQ per* day *per* person (Howard and Bartram, 2003), to which all citizens should have access in reasonable affordable conditions.

Given that the relevant observation unit is the household, it is necessary to calculate the average household dimension (*AHD*). The *AHD* is obtained as the ratio of the resident population (INE, 2009a) and the total number of households in each municipality.

The *EMQ,* in cubic meters for a typical family, for each municipality is obtained as expressed in equation (1).

$$EMQ = 0{,}04 \times AHD \times 30 \qquad (1)$$

Multiplication by 30 is due to the fact that the tariffs are applied to monthly consumption.

3.2.2 Water charges and income

In the next stage, we proceed to the calculation of the charges associated with the essential minimum quantities (*EMQC*) by municipality. The variable charge depends not only on tariff structures (price and size of blocks), as well as on *EMQ*, which varies across municipalities, according to the corresponding household average size. The fixed charge is also different for various municipalities.

Equation (2) bellow shows how to calculate the *EMQC*, ignoring eventual other items to be included in the water bill, as taxes and fees, when the *EMQ* is fully covered by the first block, or when the *EMQ* exceeds the first block and a *full progressive tariff* is applied. In the latter, *p* is the price of the top block achieved; in the first case it concerns the price of the first block. *FC* corresponds to the fixed charge levied in each municipality. The second element of the second member of equation (2) corresponds to the volumetric component (*VC*) of consumption in each municipality.

$$EMQC = FC + EMQ \times p \tag{2}$$

In cases where the *EMQ* exceeds the first block, and *IBT* are applied, then the equation (2) must be adjusted by dividing the *EMQ* according to the blocks covered by the respective quantities and applying the prices of various blocks achieved. Therefore, for example, a situation in which the *EMQ* reaches the second block, equation (2) is adjusted as expressed by equation (3).

$$EMQC = FC + q_1 \times p_1 + (EMQ - q_1) \times p_2 \tag{3}$$

where q_1 represents the upper limit of the first block and p_1 and p_2 correspond to the prices of blocks 1 and 2, respectively.

All data (fixed charge, number, size blocks and prices) needed to *EMQC* calculations were provided by IRAR and match tariffs schemes used by each operator in each municipality, in 2007.

To establish a comparison between the *EMQC* and income *per* household, one needs to prior compute the income *per* household in each municipality. Considering the national income data and the total number of households in Portugal, was obtained the average national income *per* household. Then, the Portuguese Index of Municipal Purchasing Power for 2007 (INE, 2009b) was used to generate a series for the income of representative households for the 308 municipalities.

Subsequently, these data are organized by municipality in terms of income *per* household, and in terms of *EMQC* in the form of rankings (both cases in order of decreasing values of each series). From here, it becomes possible to compare the position of the typical household in each municipality according to this two ordering scales. In order to assess the varying degrees of the typical household 'penalty' in each municipality, the weight of *EMQC* (as well as the burden of monthly consumption of 5, 10 and 15m^3) in household income, is also determined for each of the 308 Portuguese municipalities.

3.2.3. Concentration curves and indexes

Concentration curves provide a means of assessing the degree of inequality in the distribution of any given variable. The *Income Concentration Curve* is the well known *Lorenz Curve*, which plots the cumulative percentage of income (*y-axis*) against the cumulative percentage of the population, ranked by living standards, beginning with the poorest, and ending with the richest (*x-axis*). Regarding the *Concentration Curve* (*CC*) for water charges, the *x-axis* is the same as in the *Lorenz Curve*, while in the *y-axis*, instead of income, one has the cumulative percentage of these charges.

The diagonal is known as the *line of equality*. The greater the distance between a *CC* and the *line of equality*, the greater the inequality in the distribution *(of the variable under analysis)*. However, from the perspective of equity, it matters to assess whether, or not, water charges are related (and into what extent) with the ability-to-pay. This can be done comparing the *CC* of water charges with the *Lorenz Curve*. Under proportionality, the curves coincide. Under regressivity, the *CC* of water charges lies above the *Lorenz Curve* (implying that poorer households pay water bills proportionately higher than their richer counterparts), and vice-versa for progressivity.

In this study, the distribution of water charges is calculated for the *EMQ* as well as for the monthly charges associated with the annual consumption of 60, 120 and 180m^3 (provided by IRAR, 2009). Moreover, as the unit of analysis is the municipality, it was assumed that each representative household corresponds to 1/308 of the population.

A *Concentration Index* is defined with reference to any *CC*, providing a means of quantifying the degree of income-related inequality regarding a specific variable. It is defined as twice the area between the *CC* and the *line of equality*. Accordingly, there is no inequality if the concentration index is zero. But, again, in terms of equity, the interest lies in the comparison between charges and the ability-to-pay. Therefore, the focus is on departures from proportionality, i.e., on deviations between the *Concentration Index* for water charges (C_W) and the *Gini* coefficient (*G* - *Concentration Index* for income).

In such cases, summary indices of progressivity are useful, like the *Kakwani Index* (Π_K), which is defined as twice the area between a payments' *CC* and the *Lorenz Curve*, and is calculated as:

$$\Pi_K = C_W - G \tag{4}$$

The value of Π_K ranges from -2 to 1. In case of proportionality, the curves coincide, i.e.: $C_W = G$ and Π_K is zero; if income is more unequally distributed than charges, then $C_W < G$, implying that Π_K is negative; finally, a positive value indicates progressivity ($C_W > G$).

Following the methodology suggested by Kakwani *et al.* (1997), the *Kakwani Index* is computed directly from one regression of the form:

$$2\sigma_R^2\left[\frac{W_i}{\eta} - \frac{Y_i}{\mu}\right] = \alpha + \beta R_i + \varepsilon_i \tag{5}$$

where R_i is the household fractional rank in the income distribution; σ_R^2 is the sample variance of R_i; W_i is the water bill for household *i* (calculated for the quantities: *EMQ*, 60, 120 and 180m^3); η is its mean; Y_i is household *i*'s income and μ its mean; ε_i is the error term. The *OLS* estimate of β in equation (5) (performed using the software *gretl)* is the Kakwani Index.

3.3. Main Results

Some descriptive statistics are presented below, in Table 2, namely the mean, standard deviation (*s.d.*), the maximum (*Max*) and minimum (*Min*) values, for the *EMQ* and for the *average household dimension* (*AHD*).

Table 2 – *EMQ* and *AHD*: descriptive statistics

	Mean	s.d.	Max	Min
AHD	2,791	0,285	3,848	2,231
EMQ	3,350	0,341	4,618	2,677

As shown, there is not great variability for both the series. This is expected as the *EMQ* depends on the *AHD* (which is an average, therefore eliminating the intra-municipal variability).

Comparing the *EMQ* with the first block limits, municipality by municipality, it is notable that 36 (i.e. 11,7%) municipalities do not entirely enclose the *EMQ* in the first block of consumption, contrarily to what would be expected from the viewpoint of access to the water quantities that guarantee the satisfaction of the basic needs. However the 'rule' is that the upper limit of the first block is higher than the *EMQ*.

Accordingly, it does not seem that the intention is to 'subsidize' (through a first block with lower price) only the essential amounts of water.

Nevertheless, it is important to notice that the base for these calculations is the *AHD*. Thus, to guarantee the access to *EMQ* inside the first block of consumption for large households, it is necessary to expand this block. However such expansion will end up by benefiting smaller households through a 'subsidized' price. Indeed, when repeating the calculations of the *EMQ* for the case of large households (according to the Portuguese Association of Large Households, those consist in households with five or more members), we come across with a scenario that penalizes them, as the *EMQ* for households with five members was enclosed in the first block of consumption for only 51 (i.e. 16,6%) municipalities.

Regarding water charges there follows (in Table 3) some descriptive statistical information for the fixed and variable components correspondent to the consumption of the households' *EMQ* of the 308 municipalities.

Table 3 – *EMQC*: descriptive statistics

		Mean	s.d.	Max	Min
EMQC	*FC*	1,99	1,32	7,33	0,00
(€ 2007)	*VC*	1,30	0,58	4,47	0,00

Contrarily to what was observed regarding the *EMQ* and the AHD (in Table 2), it is now notorious the great discrepancy for the (fixed and variable parts of) water charges regarding the consumption of *EMQ*. Moreover, the absence of the fixed charge occurs in approximately 10% of the municipalities. Concerning the zero value for the variable component, it occurs in (only two) cases where the charges result from a monthly fixed value. This is the result of the multiplicity of tariff structures and schemes practiced in Portuguese municipalities previously mentioned.

Regarding the ranks correspondent to the households' income and water charges (for the *EMQ*, as well as to monthly consumptions of 5, 10 and 15m^3), and taking as reference the quintiles, the disparities found are numerous. Indeed, between 222 and 232 (of the 308) municipalities assume different positions, in terms of quintiles, for the two ranks compared.

Moreover, five of the municipalities with higher *EMQC* are located in the last quintile of income rank; i.e., five of the poorest support the higher charges with the *EMQ*. Regarding the water charges for consumptions of 5 and 15m^3, the figures change to eight and two municipalities, respectively. Also contradictory, 12 of the municipalities found in the fourth and fifth quintiles of the *EMQC rank* are located in the first quintile of the income rank.

Table 4, below, shows some of these cases, presenting the municipalities that occupy the first position in each quintile of the *EMQC*, as well as a selection of those that present greater differences regarding the positions in the two ranks.

Table 4 – Rank position according to *EMQC* and income - selected cases

Municipality (1)	***EMQC rank*** (2)	***Income rank*** (3)	***EMQC rank* – *Income rank*** *(4)*=(2)-(3)	***EMQC/Income rank*** *(5)*=(2)/(3)
Póvoa de Varzim	1	68	-68	3
Câmara de Lobos	6	275	-269	1
Santana	20	293	-273	4
Seixal	63	50	13	125
Cabec. de Basto	66	278	-212	13
Boticas	103	298	-195	22
Almada	126	15	111	228
Mogadouro	128	262	-134	55
Celorico de Basto	130	306	-176	32
Vila do Bispo	188	198	-10	156
Montijo	228	9	219	286
Benavente	247	35	212	276
Portel	250	256	-6	197
Palmela	272	34	238	294
Alcochete	298	5	293	305

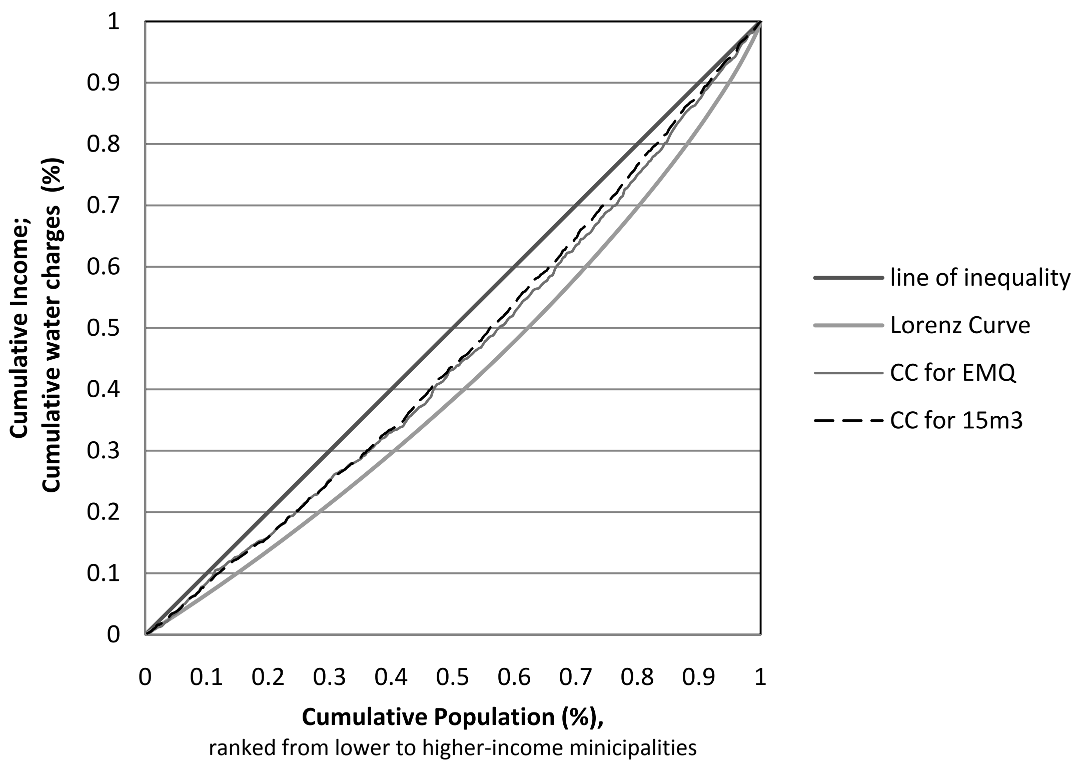
Negative values in column *(4)* indicate the municipalities where the representative households appear in upper position on the water charges' rank than on the income's rank, thus corresponding to cases where households support proportionally higher charges compared with their income. Indeed, the burden of the *EMQC* in income supported by the representative household of Câmara de Lobos is the highest in the country, followed by the ones from Paços de Ferreira, Póvoa de Varzim and Santana.

Conversely, positive values correspond to municipalities whose typical households have relatively high incomes when compared with the water charges supported. At this level it is relevant to note that, e.g., the representative household of Alcochete occupies the fifth place concerning income, but its *EMQC* corresponds only to the 298th place, conferring to them the antepenultimate place regarding the burden of the *EMQC* in the income.

Moreover, (with the exception of four) the municipalities shown in Table 4 present a difference between the respective positions in the two ranks superior to one hundred positions (and seven of them more than two hundred places).

Regarding the distribution of income and water charges, Figure 2, below, presents the concentration curves (*CC*) for: income (or *Lorenz Curve*); monthly charges associated with the annual consumption of the *EMQ* (*CC* for *EMQ*) and of 180m^3 (*CC* for 180m^3).

Fig. 2. *Lorenz Curve* and concentration curves for water charges



Based on Figure 2, it can be seen that the *Lorenz Curve* is farther from the *line of equality* than all the payments' concentration curves, meaning that income presents the most unequal distribution. Regarding the concentration curves for water charges, the differences among them are minimal but it is visible that the *CC* for the *EMQ* is the closest to the *Lorenz Curve* while the curve associated with 180m^3 is the closest to the *line of equality*.

Thus, as curves for water charges do not coincide with the *Lorenz Curve*, water charges are not proportional to income. Moreover, given that all payments' curves are located above the *Lorenz Curve*, water charges are regressive, i.e., existing inequity is favourable to representative households of better-off municipalities. The degree of inequity is greater for the quantity of 180m^3 (larger distance between the Lorenz curve and the curve for water charges) and lower for the *EMQ* (*CC* for 60 and 120m^3 were also estimated, but not presented in Figure 2 for reasons of legibility, as they are situated between the curves for *EMQ* and 180m^3).

The estimates for the *Kakwani Index* (*β* in equation (5)) are presented below in Table 5.

Table 5 – *Kakwani Index* – Estimation Results

	EMQ	
Variable	Coeficient	P value
Constant	0,037	<0,000
β	-0,073	<0,000
	60m^3 Year (5m^3 month)	
Variable	Coeficient	P value
Constant	0,041	<0,000
β	-0,081	<0,000
	120m^3 Year (10m^3 month)	
Variable	Coeficient	P value
Constant	0,040	<0,000
β	-0,079	<0,000
	180m^3 Year (15m^3 month)	
Variable	Coeficient	P value
Constant	0,044	<0,000
β	-0,087	<0,000

The estimation shows that all coefficients are statistically significant, meaning that the hypothesis of a null Π_K is excluded, the same is to say, the hypothesis of proportional payments is excluded for all quantities considered. All coefficients are negative, confirming the regressivity of payments, as already identified in Figure 2. Also, the lowest value of Π_K occurs for the *EMQ* (Π_K=-0,073) and its greatest value corresponds to the monthly consumption of 15m^3 (Π_K=-0,087).

At last, it should be noted that despite the generalisation of *IBT*, which are generally progressive (under the hypothesis that there is a positive association between consumption and income), water charges include a fixed component (*FC*). As this latter component is not related to consumption, it ends up being a regressive form of payment. Thus, results in Table 5 might reflect, to some extent, the combination of these two effects.

Moreover, it is important to characterize the level of affordability for each municipality, namely by comparing the water charges (in our case monthly charges associated with the annual water consumption of *EMQ*, 60, 120 and 180m^3) with the ability-to-pay of final users (i.e. with representative household's income by municipality). Although there is no absolute level for affordability, neither official recommendation, there are often mentioned figures of 3-5% of the disposable income or household expenditure (OECD, 2010: 28), regarding water supply and sanitation (for annual consumption of 180m^3). In our case, although we have assessed the charges (without taxes) only regarding the water supply (which represent the most significant share), it is possible to conclude that the bills do not represent a considerable burden on household income. Indeed, despite the (relatively) large discrepancies between the 308 municipalities, for the municipality with the highest burden, this represents less than 0,8% for *EMQ* and 60m^3, less than 1,3% for 120m^3; and less than 1,9% for 180m^3 (moreover, regarding the water bill for 180m^3, only in 97 of the municipalities the burden was above 1,0% and only in 13 of them exceeding 1,5%).

Therefore, and reinforced by the fact that these estimations considered representative average household income (i.e., it did not take into account that several municipalities practice 'social prices' for low-income earners), it can be said that in 2007, the human right to safe and healthy water (at least) for subsistence water needs at affordable levels was achieved in all the Portuguese municipalities.

Furthermore, from the calculation of the average cost *per* m^3 of the monthly charges associated with annual consumptions of 60, 120 and 180m^3, it was possible to verify that the cost *per* m^3 of 120 and 180m^3 is superior to the one of 60m^3 in only 62 (20,1%) and 125 (40,6%), respectively, of the 308 municipalities. Accordingly, it is also noteworthy that only in 23 (7,5%) of the municipalities is possible to find an increasing rhythm of growth for the average cost *per* m^3 associated with annual consumptions of 60, 120 and 180m^3. This allows to infer that, actually, and in general, the tariff structures do not fulfill the objective of submitting higher consumption to the payment of increasing unitary costs.

4. Conclusion and Policy Implications

Given the economic and environmental status of water resources, the need to adequately price their consumption has gained increasing recognition.

This study revealed interesting results, and important policy implications might be drawn. A critical one is related to the dimension of the water tariffs scheme first block, which does not seem to be in harmony with the *EMQ*, in obvious opposition to the literature suggestions. Actually, cases have been found where the *EMQ* is larger than the upper limit of the first block, which may penalize the affordability goal and, consequently, the universal access to that water quantity. On the other hand, there are also cases which are indicative that there is no intention to subsidize (with a smaller first block price) only the essential quantities of water. The latter are contrary to environmental sustainability and intergenerational equity purposes. Therefore, concerning the dimension of the first block of water consumption tariff schemes, an important policy recommendation can be derived, i.e., to achieve water use efficiency without ignoring equity concerns and successfully targeting vulnerable groups, water volumes in this initial block should be set in accordance with households' essential water needs (*EMQ*). However, it is worthwhile to notice that water pricing based on increasing block rates may be ineffective in promoting social equity when the number of persons in each household is not explicitly taken into account, implicating that, in order to not penalize larger households, a *per capita* water consumption should be considered before applying the *IBT* volumetric rates (in accordance with the OECD 'Adjusted IBT' approach, as presented in Section 2.4).

Comparative analysis between the costs associated with water consumption and average income of a representative household for each municipality allows another important conclusion - there are large disparities in the positions occupied by each municipality in the expenditure and income ranks. The concentration curves and *Kakwani Index* calculation confirmed this analysis' implicit suggestion, i.e., the ability-to-pay principle does not appear to be fulfilled in Portugal. Charges for the *EMQ*, or other annual consumptions, proved regressive. Thus, once again and contrarily to what is widely claimed, this research results are in clear divergence with the frequent justification of *IBT* based on equity concerns.

Another conclusion of this study stresses the small weight of the water bill on the Portuguese household income. Therefore, a significant implication of this study is that there is a margin to increase water prices, which can be of use to comply the European (Water Framework Directive) and national legal impositions (Portuguese Water Law and IRAR's Water Tariff Recommendation) concerning the full recovery of water costs. However, this option must take into account that the tariff structure adjustments should not ignore the need to guarantee universal access to affordable *EMQ*, whose consumption is usually associated with positive externalities. These concerns are, at some extent, reflected on the Portuguese water regulator tariff recommendations published in 2009.

In terms of other policy implications which can be derived from this research, simplifying water tariff schemes is essential. In this regard, reducing the number of blocks and increasing transparency concerning the consequences of the volume of water consumed on the total amount of the bill are crucial measures to be taken. Besides, although its adequacy for conservation purposes, applying *IBT* deserves careful examination. It is crucial to adequately define the number of blocks, the volume of water in each block and per unit prices for each block.

To sum up, any tariff scheme has to deal with conflicts among different objectives being essential to define the priorities, ensuring universal access to essential quantities in terms of fairness, without forgetting that water is a scarce resource. Indeed, considering that tariff schemes alone are not able to achieve all objectives at the same time, additional instruments should be explored. Moreover, these conflicts, and the institutional and physical systems abilities to deal with them, evolve over time. Income improvements may enable a community to face the costs needed to obtain previously unaffordable services; technological improvements might render its provision cheaper; more effective governance institutions might emerge; social learning processes might generate new cultural frameworks enabling the community to accept previously unacceptable solutions. In short, this research demonstrates that the complexities of social, economic and ecological processes involving water pricing and social equity in Portuguese municipalities preclude straightforward and static conclusions.

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