Assessing social concerns in water tariffs

Rita Martins\textsuperscript{a,b},* , Luís Cruz\textsuperscript{a,b}, Eduardo Barata\textsuperscript{a,b} and Carlota Quintal\textsuperscript{b,c}

\textsuperscript{a}GEMF – Faculty of Economics, University of Coimbra, Portugal
\textsuperscript{b}Faculty of Economics, University of Coimbra, Av. Dias da Silva 165, 3004–512 Coimbra, Portugal
\textsuperscript{c}CEISUC – Faculty of Economics, University of Coimbra, Portugal
*Corresponding author. E-mail: rvmartin@fe.uc.pt

Abstract

In the European Union, water supply services are referred to as ‘services of general interest’, meaning that they are subject to multiple, potentially conflicting, public service obligations. This paper considers empirical data for Portuguese municipalities and provides a comprehensive approach to assessing the social dimension by evaluating whether the concerns of universal access to water services for basic needs, affordability and equity are embodied in the corresponding water supply tariffs. Accordingly, ‘essential minimum quantities’ (EMQs) of water for representative households are calculated and then compared with the lowest tariff block’s upper limit, by water utility. Next, charges underlying the EMQs are calculated and compared with the average income of each representative household, by municipality. The results show that, in general, the EMQs are enclosed in the first block of consumption and also that the corresponding water charges do not represent a disproportionate burden on average household size and income. Nonetheless, our findings indicate that, when considering the 20% poorest households, the water charges raise affordability concerns in an important number of municipalities. Further, the results show that there is a socio-economic inequity that favours the better-off households.

Keywords: Affordability; Equity; Increasing block tariffs (IBT); Portugal; Universal access; Water pricing

1. Introduction

Water pricing aims to promote greater economic efficiency (the emphasis for most studies) as well as to achieve the objectives of equity, public health, environmental sustainability, financial stability, simplicity, and public and political acceptability. As a consequence of this multi-objective context, tariffs design is a complex procedure and the prevailing pricing schemes are expected to be difficult to justify due to several (potential) trade-offs. In addition, according to the White Paper on Services of General Interest (European Commission, 2004), water supply services are considered to be of general interest by public authorities and therefore subject to specific public service obligations, such as universality, continuity, quality, affordability, transparency and consumer protection.

doi: 10.2166/wp.2012.024

© IWA Publishing 2013
The Portuguese Water and Waste Services Regulation Authority (Entidade Reguladora dos Serviços de Águas e Resíduos: ERSAR) accordingly recognizes that ‘the main objective of regulation is to protect the interests of consumers by promoting the quality of service rendered by the operators and guaranteeing socially acceptable pricing, materialized in the following principles: essentiality, universality, equity, reliability and cost efficiency associated with the quality of the service’ (ERSAR, 2011: 23). These principles are in line with the EU and national legislation obligation that water suppliers should consider the principle of complete recovery of costs, including environmental and resource ones (as is explicitly established in the European Water Framework Directive’s (WFD) Article 9).

The purpose of this paper is to discuss and evaluate to what extent the water pricing schemes in Portuguese municipalities accommodate several of these dimensions, with a special emphasis on the universal access to water services for basic needs, affordability and equity concerns. This research addresses water supply tariffs for residential uses (which are the most important uses in an urban context) and for which the required patterns are the most demanding and, therefore, costly.

Most empirical economic analyses on water industry issues have addressed the estimation of demand; a few have addressed the topics of affordability and equity but even these have been mostly qualitative and theoretical assessments of water tariffs. This study contributes to the literature by suggesting and implementing some steps towards a comprehensive quantification of key theoretical concepts in the context of water pricing and social concerns.

The paper is organized as follows. Section 2 explores the critical concepts of universal access, affordability and equity that underlie this study’s quantitative analysis, and reviews the relevant economic literature on water pricing for domestic uses, with a particular focus on increasing block tariffs (IBT), given that this is the price structure prevailing in Portugal, as well as in the OECD countries (OECD, 2010).

Section 3 contains a description of the Portuguese water industry, followed by the methodology adopted to analyse whether the water supply tariff schemes in Portugal truly include universal access, affordability and equity concerns. For this, we have estimated the essential minimum quantities (EMQs) of water for representative households (in terms of the average number of people per household); these quantities are then compared with the lowest tariff block’s upper limit implemented in the corresponding municipalities. Next, representative households are ranked by the charges underlying the EMQs and by income, and the analysis of the affordability dimension is then supplemented by measuring the weight of these charges in the average income of each representative household, by municipality. This analysis also considers concentration curves (CCs) and indices, with the aim of assessing the potential existence of proportionality between water charges and household income. Section 4 concludes the paper with a discussion of the main results of this research and various policy implications.

2. Water pricing for residential uses in the economic literature

2.1. Economic classification for different levels of water consumption

Given that water is required for a multiplicity of purposes, whenever existing resources are unable to satisfy all its uses simultaneously, it must be considered as a scarce good and associated with various economic classifications (Liu et al., 2003: 209). In extreme scarcity scenarios, water use can be restricted to the satisfaction of a vital human need: thirst. At this level, and considering that there is a minimum quantity of water needed to support human life (a Vital Minimum Quantity), water
should be classified as a merit good. Beyond this minimum there are other basic needs (e.g., cooking, hygiene and sanitation) that one can consider in order to identify an Essential Minimum Quantity (EMQ), i.e., the water consumption needed to maintain acceptable or minimum living standards, as suggested by the World Health Organization (WHO). The EMQ can also embrace social concerns as it might be seen as a ‘decent minimum’ that should be guaranteed for all (Buchanan, 1985: 59). Finally, regarding uses that exceed EMQ, water may be fairly considered as an economic good, in the sense acknowledged at the 1992 United Nations International Conference on Water and Environment.

When water was considered a relatively cheap and abundant resource it was expected to be provided to final users for next to nothing. However, once water scarcity becomes recognized, a possible approach to ensure that everyone has access to this good is to ration it in a way that promotes the most valued uses (Moran & Dann (2008) locate the debate about the economic value of water, considering its competing uses, in the requirements of the WFD). This task has been handled by putting a price on water services, and setting tariff schemes to meet different and often diverging goals in different situations (Rogers et al., 2002: 5).

2.2. Water tariffs’ objectives: the ‘social concerns’ dimension

The multiplicity of objectives pursued by water tariffs can be structured around four main dimensions, as proposed in Table 1. Synergies between the various water tariff objectives are possible since economic efficiency can promote the financial and environmental sustainability of service provision, because reducing the wasteful use of water can, for instance, lower requirements for investment to expand water supply infrastructure. However, given the multi-dimensional nature of water’s total economic value (Rogers et al., 2002), the policy objectives outlined in Table 1 may as well be in conflict with one another. This research focuses on the analysis of the ‘social concerns’ dimension, rather than discussing the tariffs’ role in managing the potential synergies or trade-offs among the various dimensions. More specifically, this study proposes an in-depth understanding of water tariffs’ performance with respect to universal access for basic needs, affordability, and equity of water services in terms of the EMQ.

Although there is some ambiguity about the meaning of affordability, this concept is often considered as the ability to pay for a minimum level of a certain service (see, for example, Komives et al., 2005: 40;

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Water tariff objectives</th>
<th>Key idea (principle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic efficiency</td>
<td>Allocative efficiency</td>
<td>As a valuable economic good, water should be allocated to the uses that maximize overall benefits to society</td>
</tr>
<tr>
<td>Financial sustainability</td>
<td>Sustainability of the service provider</td>
<td>Water resources management and water services provision should be kept financially viable over time in order to attract capital, skills and technology</td>
</tr>
<tr>
<td>Ecological/ environmental</td>
<td>Sustainable use and conservation of water resources; intergenerational equity</td>
<td>To promote parsimonious uses in order to guarantee the ecological functions of natural capital, preserving it for current and future generations</td>
</tr>
<tr>
<td>Environmental sustainability</td>
<td>Universal access for basic needs; affordability; equity</td>
<td>As a SGI*, water service in acceptable levels should be accessible and affordable to all, including the more vulnerable groups</td>
</tr>
</tbody>
</table>

*SGI, Service of General Interest.
Fankhauser & Tepic, 2007: 1039; and Barberán & Arbués, 2009: 2107). Regarding residential uses, water charges should not deter poorer households from consuming basic quantities, i.e., water charges for the EMQ must be affordable for all households irrespective of their budget constraints.

The equity principle, however, demands that (un)equals be treated (un)equally (Boland & Whittington, 2000b: 8). In this context, equity exists if the water charges distribution per household follows that of income or, in line with the concept of ‘equity among income groups’ in OECD (2003), if there is a positive association between water charges and household income.

There is an extensive empirical literature dealing with critical water industry issues, most of which concerns the estimation of demand. Arbués et al. (2003) offer a survey on the estimation of residential water demand functions. Another important and related issue which has been explored is the analysis of water pricing welfare effects, frequently supported by the specification and estimation of both water demand and cost (supply) functions (see Renzetti, 1992; Garcia & Thomas, 2001; Garcia & Reynaud, 2004). Fewer studies on the estimation of water demand analyse equity effects using the corresponding income elasticities (Billings & Agthe, 1980; Agthe & Billings, 1987; Martínez-Espiñeira, 2003). Yet existing studies on affordability and equity effects are mostly qualitative (and theoretical) water tariffs assessments (see, for example, Feldstein, 1972; Agthe & Billings, 1987; Boland & Whittington, 2000a; Castro-Rodríguez et al., 2002; Rogers et al., 2002; Bithas, 2008; Diakité et al., 2009).

Examples of empirical approaches include Ruijs et al. (2008), where the water pricing social dimension, particularly the distributional effects of water tariffs, is explored, as well as Gómez-Lobo & Contreras (2003), Komives et al. (2005) and Kogan & Tapiero (2010), where the distributive impacts of water subsidy schemes relating to block pricing models are evaluated. Renzetti (2000) and García-Valiñas (2005), who argue that a two-part tariff with a fixed and a volumetric charge might be a good way to achieve distributional objectives without substantially reducing social welfare, are other relevant contributions to the literature. Furthermore, the empirical literature generally tends to neglect the affordability issue with respect to the amount of water for basic needs. Again, Martínez-Espiñeira & Nauges (2004) and García-Valiñas et al. (2010), both based on the estimation of water demand functions from the Stone-Geary utility function, should be considered as exceptions; indeed, the former estimate a non-zero water consumption quantity that is highly price-inelastic, while the latter also compute a basic or ‘lifeline’ level of residential water use. These might be considered as alternative approaches to determine what has been here designated as ‘EMQs’. García-Valiñas et al. (2010) further calculate water affordability indexes in order to relate the cost of this ‘lifeline’ to average municipal income levels.

2.3. IBT as a tool to achieve social objectives?

The principle of economic efficiency suggests that prices should equal marginal costs. This result might be considered as an argument in favour of uniform water pricing rates. Yet water pricing sets out to pursue not only greater economic efficiency but also a multiplicity of other relevant objectives. As such, in the literature on optimal water pricing, non-linear pricing schemes with two parts are commonly proposed, mainly for reasons of efficiency and producers’ concerns with financial viability (see, for example, Castro-Rodríguez et al., 2002; Elnaboulsi, 2009; Monteiro & Roseta-Palma, 2011). This two-part theoretical structure typically includes a variable charge (VC), intended to reflect the service provider’s marginal costs for supplying an additional cubic meter of water, and a fixed charge (FC), intended to cover the cost fraction that is independent of the amount consumed (production and distribution fixed costs), as well as ensuring that the service provider can break even. In practice, however,
water tariff schemes often deviate widely from this simple structure. Indeed, of the different types of water price structure implemented (see, for example, OECD, 2009: 79), IBT are emerging as the dominant scheme (OECD, 2010; Griffin & Mjelde, 2011). It is also worth noting that, as OECD (2010: 87) recognizes, provided that metering is individual and marginal rates in the upper blocks are high, IBT plus FCs can also help to encourage water saving (in accordance with the ecological/environmental sustainability dimension).

IBT are often justified in light of ‘social concerns’. It is claimed that IBT promote ‘equity among income groups’, by allowing cross-subsidization between poor residential customers and wealthy households. This is expected because water is considered a normal good (water use is supposed to increase with income). Thus, compared with poor households, wealthy ones are expected to use more water (paying extra charges)\(^1\). Furthermore, as stressed by Boland & Whittington (2000a) and Ward & Pulido-Velazquez (2009), the first block should be set taking into account the water quantities that are required to meet the basic needs (the EMQ). Accordingly, for this first block, and in order to not jeopardize affordability, charges are expected to be low (even less than the marginal costs), with the respective quantities being ‘subsidized’ by the higher consumption levels\(^2\).

However, it is open to question whether IBT can achieve social targets and this has been disputed in different ways by various authors. Indeed, if demand is reduced as a response to price signal, the operators need to increase average prices to cover the largely fixed costs, generating what Prevedello (2010) designated as a ‘snowball effect’. Griffin & Mjelde (2011) found some signs of inequity in IBT schemes, showing that they can injure low income or small water consumers in scarce-water conditions. Bithas (2008: 225–226) argued that IBT are likely to fail to promote social equity, since blocks are designed on the basis of an implicit assumption about 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 people per household, i.e., households with more members are expected to consume more water, implying that they will be charged higher prices, even if one accepts that such households more often than not have lower per capita incomes and include more vulnerable members, such as children and the elderly. Accordingly, the effective potential of IBT schemes to promote affordability and equity critically depends on the tariff designer’s success in making the volume of water in the initial block equivalent to households’ essential water needs (Barberán & Arbués, 2009).

To sum up, we consider that the analyses of the equity and affordability effects of existing water tariffs have been mostly qualitative and theoretical assessments, which means that the quantitative empirical analysis of the widespread use of IBT is still insufficient. Therefore, the main contribution of this paper is to provide a comprehensive approach to assessing the social dimension by critically examining the water tariff objectives of equity and affordability in relation to the EMQ that ensures universal water delivery for basic needs – that is, by analysing the effects of using IBT in the residential water industry, in Portuguese municipalities.

\(^1\) It is also widely held 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 residential customers with revenues from commercial and industrial firms (OECD, 2003: 21).

\(^2\) Water conservation and sustainable use may also be promoted through IBT if the price associated with the highest blocks discourages ‘wasteful’ water use (OECD, 2009; Griffin, 2007; Monteiro, 2008), and this in turn may contribute to ‘intergenerational equity’ (OECD, 2003: 21).
3. Case study

3.1. The Portuguese water supply industry

The Portuguese water industry is characterized by the existence of multiple (very heterogeneous) municipal monopolies. Some utilities operate only at the wholesale level, providing bulk water to other utilities, while others distribute water to final users, either operating only at the retail level or managing the entire process. This research focuses on the utilities that operate at the retail level, i.e., that provide water to households and to other non-residential customers.

Local governments in Portugal have been responsible for the provision of water supply and sanitation services since the 1970s. Today, water services can be directly provided by municipalities (representing 90% of the water operators and supplying water to 76% of the population), either through municipal services, municipalized services or companies. In the last case, there are both municipal public firms and concessionaires, which may be private, public or public–private partnerships. With respect to retail activity, there is usually one operator per municipality. The Portuguese water industry is therefore very fragmented. If we consider both wholesale and retail water services, then there are more than 275 water supply service providers for the 308 Portuguese municipalities (ERSAR, 2009).

ERSAR is the Portuguese authority for the (economic) regulation of water and waste services (ERSAR, 2009). However, due to the way that the water sector is organized in Portugal, tariffs are formulated and applied in various ways. Economic regulation has been restricted to concessions and it is limited to a light form of benchmarking regulation, known as ‘sunshine regulation’. This means that the regulator only collects data from operators and discloses information about their relative performance in an annual report. ERSAR’s power in the field of setting prices is limited to issuing non-binding opinions about pricing regimes, based on an allowed rate of return (for further details on the regulatory methods adopted in Portugal, see Marques (2010)). At the retail end and in the case of services directly provided by municipalities, tariffs are approved by their Municipal Assemblies. If municipal concessions are the arrangement, then tariffs are usually fixed in the concession contract, which also establishes the formula for their revisions. ERSAR has recently gained extended powers of price regulation: in 2009, with the revision of its statutes, it started to produce recommendations on tariff schemes to be applied to all operators (thereby including municipalities).

As shown in Table 2, the residential water tariff schemes typically have two main components: an FC (in 89.3% of the 308 municipalities) and a component that considers the amount of water actually consumed, which is the VC and also recognized as the volumetric element. The prevailing tariff structure for the variable charge is IBT. In 84.1% of cases, the tariff structure comprises various consumption blocks, i.e., a multi-part tariff where the volumetric charge changes in steps as consumption increases. A different way to calculate the final tariff, by charging all volume at the price of the last block recorded by metered consumption in the period, is applied in 14.9% of cases – a practice that is designated by the Portuguese Association for Water Distribution and Drainage (APDA) as a ‘full progressive tariff’ (APDA, 2011: 82).

It is important to note that, regardless of the tariff scheme chosen, it is virtually impossible to find two identical tariff designs in the 275 water supply service providers. In fact, even where the structure of blocks coincides (in number of blocks and limits between them) there are significant variations in the prices for each block (Martins & Fortunato, 2007). Moreover, besides the high number of blocks (the average is five, but one can find a maximum of 38 blocks, which cannot be justified in economic
terms), water bills include charges related to sanitation and solid waste services, not to mention other taxes. This multiplicity of items makes water bills very complex, sending confusing price signals to users.

### 3.2. Methodology and data

This section presents the methodological assumptions considered, with details of their implementation, and investigates whether the water supply tariff schemes in Portugal accommodate the universal access, affordability and equity dimensions.

This approach involves the ‘EMQ’ estimation by municipality (as defined in Martins et al., 2009) and its comparison with the corresponding first block upper limit, in order to critically assess the relevance of that arrangement for the various water tariff schemes. This procedure aims to see if the first block dimension matches the corresponding EMQ which is supposed to be accessible to all. Next, a comparative analysis compares the estimated charges for the consumption of those essential quantities, and the average income of each representative household, by municipality. Then, the charges and those households’ incomes are assessed for proportionality. Furthermore, data obtained by this method are then used to define scenarios of annual consumption of 60 and 120 m$^3$ (corresponding to average monthly consumptions of 5 and 10 m$^3$, respectively, which are the reference water consumption quantities for the first block defined by ERSAR, and the approximate average quantities consumed by Portuguese households). Because this study is based on cross-sectional data, a representative household (by municipality) is taken as the observation unit.

#### 3.2.1. Universality of water services for basic needs: EMQ and first block of consumption

As explained in Section 2.1, the EMQ represents the water consumption needed to maintain acceptable or minimum living standards. Howard & Bartram (2003) offered an extensive literature review on the evidence of the relationships between water quantity, access and health, with the aim of providing a basis for establishing minimum quantity and/or access targets for domestic water supplies. Their discussion shows that, whereas norms have been proposed for quantities of water to be supplied in certain specific circumstances (mainly within a range of 20–50 litres per day, per person), not a single international guideline has been suggested for minimum water quantities for domestic use. Since 2003,
the WHO (Reed, 2005) established standard quantities for the minimum amount of water needed for
domestic use, considering a hierarchy of water requirements. To operationalize the concept of EMQ,
we consider that it matches an individual’s indoor needs for ‘drinking, cooking, personal washing
and washing clothes’ which, according to Reed (2005), is 40 litres per person per day. As a starting
procedure, this WHO reference value is taken so as to establish the equivalent of 0.04 m³ as the
EMQ per person per day, to which all citizens should have access under reasonably affordable con-
ditions. Then, taking the household as the relevant observation unit, the average household size
(AHS) was estimated, calculated as the ratio of the resident population (INE, 2009a) and the total
number of households in each municipality. Finally, the monthly EMQ, in cubic meters, for a typical
family, for each municipality was obtained as expressed in Equation (1):

\[ \text{EMQ} = 0.04 \times \text{AHS} \times 30 \text{ days} \]  

3.2.2. Affordability: EMQ charges and income. In the next stage, we calculated the charges associated
with the EMQs by municipality, taking into account that the variable charges depend not only on tariff
structures (price and block dimension), but also on the EMQ size, which differs across municipalities
according to the corresponding AHS. Note that FCs also vary.

Equation (2) shows how to calculate the essential minimum quantity charges (EMQC) (ignoring other
items that may be included in the water bill, such 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
instance, \( p \) is the price of the top block achieved; in the former case, it concerns the price of the first block.
FC is the FC levied and the second element considers the VC of consumption, in each municipality:

\[ \text{EMQC} = \text{FC} + \text{EMQ} \times p \]  

Note that when the EMQ exceeds the first block, and IBT are applied, Equation (2) is adjusted accord-
ing to the blocks covered by the respective quantities and the prices for the various blocks consumed are
applied. For example, if the EMQ reaches the second block, it should be adjusted so that:

\[ \text{EMQC} = \text{FC} + q_1 \times p_1 + (\text{EMQ} - q_1) \times p_2 \]  

where \( q_1 \) represents the upper limit of the first block, and \( p_1 \) and \( p_2 \) are the prices of blocks 1 and 2,
respectively.

All data (FCs, number, dimension and block prices, by water utility) needed for EMQC calculations
were provided by ERSAR and matched the tariff schemes in operation in 2007.

To establish a comparison between the EMQC and income per household, the income per household
in each municipality first has to be computed.

The average municipal income was calculated in two steps. First, the average national income per
household was computed from the national income data and the total number of households in Portugal
(INE, 2009a). Then, a Portuguese Index of Municipal Purchasing Power for 2007 (INE, 2009b) was
used to generate a series for the income of representative households in the 308 municipalities. This
series shows the relative position of each municipality in terms of purchasing power compared with
the national average (index basis). For each municipality, the average national income was multiplied
by the respective value of the Portuguese Index of Municipal Purchasing Power. These data were organized by municipality in terms of income per household, and EMQC in the form of rankings (both cases in decreasing order), making it possible to compare the position of the typical household in each municipality according to these two ordering scales. Then, the procedures to assess the affordability dimension were completed by analysing the typical household burden in each municipality, according to the weight of EMQC (as well as the burden of monthly consumptions of 5, 10 and 15 m³) in the households’ income. Additionally, in order to consider the affordability situation of the relatively less well-off households, and given the lack of reliable published statistics on data per income group or classes, disaggregated by municipality, we estimated the burden by using (in the ratio denominator) the (national) average income for households belonging to the first income quintile (20% poorest households) (INE & INSA, 2007).

### 3.2.3. Equity: concentration curves and indices

CCs provide a means of assessing the degree of inequality in the distribution of any given variable. The Income CC (also known as the Lorenz Curve), typically 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 proposed CC for water charges, the x-axis will be the same as in the Lorenz Curve, while in the y-axis the cumulative percentage of these charges will be considered. As usual, the diagonal is known as the ‘line of equality’, meaning that the greater the distance between the estimated CC and the line of equality, the greater the inequality in the distribution. In addition, from the equity perspective, it is important to further assess whether water charges are related to income (and to what extent). This can be done by comparing the CC of water charges with the Lorenz Curve.

In this study, the distribution of water charges is calculated for the EMQ as well as for the average monthly consumptions of 5, 10 and 15 m³ (provided by ERSAR, 2009).

A Concentration Index may be defined with reference to any CC, providing a means of quantifying the degree of income-related inequality related to a specific variable. In this study, this index 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, our attention is on the comparison between water charges and related income. Therefore, the focus is on the proportionality divergences, i.e., the deviations between the Concentration Index for water charges ($C_W$) and the Concentration Index for income (Gini coefficient). In such cases, summary indices of progressivity are useful, such as the Kakwani Index ($\Pi_K$), which is defined as twice the area between a payment’s CC and the Lorenz Curve, and is calculated as:

$$\Pi_K = C_W - G$$

(4)

In the case of proportionality, the curves coincide, i.e., $C_W = G$ and $\Pi_K$ is zero; if income is more unequally distributed than charges, then $C_W < G$, implying that $\Pi_K$ is negative; finally, a positive value indicates progressivity ($C_W > G$) (van Doorslaer et al., 1993).

Following the approach suggested by Kakwani et al. (1997), this index is directly computed from a regression of the form:

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

(5)
where $R_i$ is the household fractional rank in the income distribution; $\sigma^2_R$ is the sample variance of $R_i$; $W_i$ is the water charge for household $i$ (calculated for the quantities: EMQ, 5, 10 and 15 m$^3$); $\eta$ is its mean; $Y_i$ is the income of household $i$ and $\mu$ is its mean; $\varepsilon_i$ is the error term. The Ordinary Least Squares estimate of $\beta$ in Equation (5) (performed using the gretl software package) is the Kakwani Index.

3.3. Results and discussion

Descriptive statistics for AHS, EMQ and the first block upper limit are shown in Table 3. The AHS varies little across municipalities, and so the same is true for EMQ. Statistics for the first block, however, show large disparities among municipalities.

These results confirm that, on average, the first block upper limit accommodates the EMQ but the breakdown by municipality reveals mixed situations. Indeed, it is important to note that for 35 municipalities (11.4%) the EMQ is not entirely contained in the first consumption block. Of these, the extreme case is that of a municipality where the first block upper limit is 1 m$^3$ while the corresponding EMQ is 3.56 m$^3$. As for the other 273 Portuguese municipalities, the first block upper limit guarantees the EMQ provision. In terms of social concerns, this is a satisfactory result; nonetheless, in no more than 18 municipalities is the difference between the first block upper limit and the EMQ close to zero, i.e., in the majority of the municipalities the first block upper limit considerably exceeds the EMQ (and in 37 municipalities it is approximately three times the EMQ; the most extreme disparity found was an unexpected deviation of 27 m$^3$).

Table 4 presents some descriptive statistics for water charges concerning the EMQ consumption. Contrary to what was observed in Table 3, a wide variance of water charges (for the fixed and variable components) is revealed. Approximately 10% of the municipalities have no FCs. The zero value for the variable component appears in two cases. These results derive from the multiplicity of tariff schemes applied in Portuguese municipalities. Figure 1 illustrates this wide variation in water charges, with the five charge bands considered being spread throughout the country, none being exclusive to a particular region. But note that the darker areas, representing higher charges, are more concentrated in the north and centre of Portugal. Disparities also occur with respect to the average income of representative households, as confirmed by Figure 2.

Table 3. Descriptive statistics: AHS, EMQ and the first block upper limit.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHD (number of people)</td>
<td>2.791</td>
<td>0.285</td>
<td>3.848</td>
<td>2.231</td>
</tr>
<tr>
<td>EMQ (m$^3$)</td>
<td>3.350</td>
<td>0.341</td>
<td>4.618</td>
<td>2.677</td>
</tr>
<tr>
<td>First block upper limit (m$^3$)</td>
<td>6.000</td>
<td>2.980</td>
<td>30.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table 4. EMQC: descriptive statistics.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMQC (€ 2007)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FC</td>
<td>1.99</td>
<td>1.32</td>
<td>7.33</td>
<td>0.00</td>
</tr>
<tr>
<td>VC</td>
<td>1.30</td>
<td>0.58</td>
<td>4.47</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Fig. 1. EMQC by municipality.
Fig. 2. Income per household by municipality.
Fig. 3. Burden of EMQC in household income by municipality.
Again there is a wide variation in the figures for the various geographic regions. But, unlike with charges, the darker areas (higher income) are more concentrated in the southern areas.

Affordability for each municipality is assessed by comparing water charges with the final users’ ability to pay. Although there is no consensus on the absolute level for affordability of water supply and sanitation (for an annual consumption of 180 m$^3$), figures of 3–5% of disposable income or household expenditure are often mentioned as a normative burden limit to gauge it (see, for example, Komives et al., 2005: 40; and OECD, 2010: 28). In this study we have only assessed water supply charges (without taxes). However, according to the ERSAR (2009) database, in 2007, water supply accounted for nearly two-thirds of total charges paid for water services by residential consumers. Therefore, if the burden of water supply charges across household income in the Portuguese municipalities exceeds 2%, affordability problems may well need to be considered.

Higher values are more concentrated in the north and centre, as shown by the darker areas in Figure 3. These results are in accordance with Figures 1 and 2.

The highest burdens obtained are: less than 0.8% for EMQ and 5 m$^3$; less than 1.3% for 10 m$^3$; and less than 1.9% for 15 m$^3$. Even for a monthly water bill of 15 m$^3$, the burden is above 1% in only 97 municipalities, and only in 13 of them does it exceed 1.5%.

Therefore, and reinforced by the fact that these estimations considered average household incomes (i.e., they do not take into account that several municipalities apply ‘social prices’ for low-income households), it can be said that in 2007 the human right to affordable safe and healthy water (at least) for subsistence needs, was achieved in all the Portuguese municipalities. However, it is important to remember that these estimations considered representative average households and affordability concerns must be focused on the most vulnerable households. Accordingly, a similar method was used to calculate the burden of water charges for each household’s income quintile. Table 5 summarizes the results for the poorest 20% of households.

When using household average income figures for the first quintile, the results show that, depending on the amount considered, the poorest households spend from 0.7 to 2.3% of their total income on water charges. It is noteworthy that for 10 and 15 m$^3$ the share of income that households spend on water bills surpasses the 2% threshold in 60 and 188 (out of 308) municipalities, respectively. The scale and consequences of this conclusion might be mitigated, however, by the fact that, in 2007, 46 water utilities’ schemes were considering specific tariff amendments for the most vulnerable households.

Although average affordability is generally achieved, there are significant discrepancies between charges and income, as suggested in Figures 1–3. For example, the fifth richest representative household (Alcochete) is only 298th in the charge rank (starting with the highest). Conversely, the sixth representative household in the charge rank (Santana) is 275th in the income rank.

Table 5. Burden of water charges for low-income households.

<table>
<thead>
<tr>
<th>Monthly water consumption</th>
<th>Mean (%)</th>
<th>Standard deviation</th>
<th>Maximum (%)</th>
<th>Minimum (%)</th>
<th>No. municipalities with burden &gt;2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMQ*</td>
<td>0.7</td>
<td>0.004</td>
<td>2.3</td>
<td>0.0</td>
<td>2</td>
</tr>
<tr>
<td>5 m$^3$</td>
<td>0.8</td>
<td>0.004</td>
<td>2.0</td>
<td>0.1</td>
<td>3</td>
</tr>
<tr>
<td>10 m$^3$</td>
<td>1.5</td>
<td>0.006</td>
<td>3.9</td>
<td>0.1</td>
<td>60</td>
</tr>
<tr>
<td>15 m$^3$</td>
<td>2.3</td>
<td>0.009</td>
<td>6.6</td>
<td>0.2</td>
<td>188</td>
</tr>
</tbody>
</table>

*Essential minimum quantity.
These results suggest that a positive association between water charges and household income cannot always be inferred in the Portuguese municipalities. The Lorenz Curve and CCs for water charges are critical for assessing this relationship (see Figure 4).

Water service payments are regressive when richer households spend a lower percentage of their income on water service than do poorer households. This same conclusion can be drawn by comparing the distribution of total water service payments with the distribution of total income. When richer households get a greater share of income than their share of total payments, then payments are regressive. This is the case in our analysis, as shown in Figure 4, where both income and water charges are unequally distributed, but income is more concentrated than payments, and so the existing inequity is favourable to representative households in better-off municipalities. With regard to the CCs for water charges, the differences among them are minimal but it can be seen that the CC for the EMQ is the closest to the Lorenz Curve, while the curve associated with 15 m³ is the closest to the line of equality.

Our results agree with those of Garcia-Valiñas et al. (2010) in the sense that water bills for a basic level of water consumption appear to be inversely related to average income levels. Our analysis also reveals that the degree of inequity is greater for the quantity of 15 m³ and lower for the EMQ (CC for 5 and 10 m³ were also estimated, but not presented in Figure 3 for reasons of legibility, as they are situated between the curves for EMQ and 15 m³).

Estimates for the Kakwani Index (β in Equation (5)) are presented in Table 6. The estimation shows that all coefficients are statistically significant, meaning that the hypothesis of a null Π Katz is excluded. In other words, the hypothesis of proportional payments is excluded for all the water quantities considered. All coefficients are negative, confirming the payments’ regressivity, as already identified in Figure 3. Also, the lowest value of Π Katz occurs for the EMQ (Π Katz = -0.073) and its greatest value corresponds to the monthly consumption of 15 m³ (Π Katz = -0.087), meaning that this effect is stronger for higher consumption levels.

![Fig. 4. Lorenz Curve and concentration curves for water charges. *CC, concentration curve; *EMQ, essential minimum quantity.](https://iwaponline.com/wp/article-pdf/15/2/193/406238/193.pdf)
Finally, it should be noted that despite widespread implementation of IBT, which are generally pro-
gressive (under the hypothesis that there is a positive association between consumption and income),
water charges include a fixed component. As this latter component is not related to consumption, it
ends up being a regressive form of payment and a ‘snowball effect’ can make the price increase difficult
to stop (Prevedello, 2010). Thus, the results in Table 6 to some extent reflect the combination of these
two effects.

4. Conclusions

This study has ascertained whether the concerns of universal access to water services for basic needs,
affordability and equity are embodied in the water supply tariff schemes in Portugal. Interesting results
were found, with important policy implications.

With regard to the universality of water services for basic needs, one significant result suggests that
the definition of the first block often accommodates the EMQ. In terms of social concerns this is a satis-
factory result, as it shows that all citizens have access to the quantity of water that satisfies their basic
needs under reasonable price conditions. Conversely, it is also noteworthy that the first block upper limit
considerably exceeds the EMQ in the majority of municipalities, and this can be seen as a problem
because those who are consuming beyond the EMQ levels are paying too little for the excess water
(i.e., they are being incorrectly subsidized through a lower first block price): this sends inappropriate
signals to consumers instead of promoting the moderate use of a scarce natural resource, which may
endanger environmental sustainability. Important measures should therefore be implemented: first,
the first block upper limit should be established at a level close to the EMQ; second, the number of
blocks used by most municipalities should be reduced to simplify water tariff schemes and increase
consumer understanding of the water consumption implications for the total amount of the bill.

Regarding the concern of affordability, a comparative analysis of water consumption charges and the
average income of representative households by municipality has confirmed the existence of large dis-
parities. Further, the conclusion, based on AHS and income, that water charges do not represent a
disproportionate burden on household income, indicates that the human right to safe and healthy
water (at least) for subsistence under affordable conditions has been accomplished in Portuguese munici-
palities. But when the analysis is performed for the mean income of the poorest 20% of households
nationwide, the affordability threshold is exceeded for a considerable number of municipalities.
Monteiro (2008: 54) and, more recently, ERSAR (2010: 68) point out that water tariff levels will
surely have to rise to fully comply with the (European) WFD and national legal impositions (Portuguese
Water Law and Water Tariff Recommendations) relating to the full recovery of water supply costs.

With regard to the water tariffs’ equity purposes, in clear divergence with the frequent justification of
IBT based on social equity concerns, charges for the EMQ or other monthly consumption proved to be

Table 6. Kakwani Index: estimation results.

<table>
<thead>
<tr>
<th></th>
<th>EMQ</th>
<th>5 m³ month</th>
<th>10 m³ month</th>
<th>15 m³ month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>P value</td>
<td>Coefficient</td>
<td>P value</td>
</tr>
<tr>
<td>Constant</td>
<td>0.037</td>
<td>&lt; 0.000</td>
<td>0.041</td>
<td>&lt; 0.000</td>
</tr>
<tr>
<td>$\beta$</td>
<td>−0.073</td>
<td>&lt; 0.000</td>
<td>−0.081</td>
<td>&lt; 0.000</td>
</tr>
</tbody>
</table>

Finally, it should be noted that despite widespread implementation of IBT, which are generally pro-
gressive (under the hypothesis that there is a positive association between consumption and income),
water charges include a fixed component. As this latter component is not related to consumption, it
ends up being a regressive form of payment and a ‘snowball effect’ can make the price increase difficult
to stop (Prevedello, 2010). Thus, the results in Table 6 to some extent reflect the combination of these
two effects.
recessive, i.e., the CCs and Kakwani Index calculations implicitly confirmed that, in Portugal, both income and water services payments are unequally distributed, but that income is more concentrated than water charges are.

This means that the equity objective has not been achieved in Portugal, possibly because of the multiplicity of objectives for water tariffs. But any tariff scheme has to deal with (potentially) conflicting objectives, thus implying that it is essential to establish priorities. Once this hierarchy is set, and considering that tariff schemes alone cannot achieve all the objectives at the same time, additional instruments might be implemented. This is in line with recent recommendations (subsequent to the period of our empirical analysis) from the Portuguese water services regulator to set ‘social tariffs’ for low-income households. Another proposal is to supplement cost recovery through water tariffs with transfers/subsidies when large investments in infrastructure need to be covered. As Prevedello (2011) argued, based on the case of Wallonia, better distribution in cost–recovery between users should be one of the main roles of an effective policy. Nonetheless, and despite ERSAR’s recent efforts, the very fragmented structure of the Portuguese water supply industry makes water price harmonization particularly difficult to be achieved in the short/medium term.

Moreover, the conflicts and priorities in water tariff schemes, as well as the institutional and physical systems’ ability to deal with them, evolve over time. Improved income may enable a community to face the costs needed to obtain previously unaffordable services, technological improvements might render their provision cheaper, more effective governance institutions might emerge, and social learning processes might generate new cultural frameworks that enable the community to accept previously unacceptable solutions.

Acknowledgements

We would like to thank the two anonymous reviewers for their constructive and incisive comments. We are also grateful to Ana Pimentel and Tânia Pinto for their valuable help with data collection and management during the early stages of this research, and to Carla Coimbra for assistance with the graphics. The usual disclaimers apply. This work is part of a wider project entitled ‘Pricing and behavioural responses in the water sector’, which is supported by Fundação para a Ciência e a Tecnologia (FCT: Science and Technology Foundation), project PTDC/EGE-ECO/114477/2009.

References


Received 2 February 2012; accepted in revised form 17 August 2012. Available online 1 November 2012.