The budgetary situation of households with respect to water pricing in Spain

Marcos García-López (marcos.garcialopez@ua.es)
University of Alicante
University Institute of Water and Environmental Sciences
ORCID: 0000-0001-7184-1809

Borja Montano
University of Alicante
University Institute of Water and Environmental Sciences
ORCID: 0000-0002-3975-5529

Joaquín Melgarejo
University of Alicante
University Institute of Water and Environmental Sciences
ORCID: 0000-0002-9752-2854

Abstract

This research examines the differences in the price for water supply for the Spanish households according to the type of household and the region of residence, which is of great relevance in terms of equity. The analysis covers the entire Spanish territory with the aim of establishing comparisons between regions, determining the current situation of the various household types and highlighting some considerations on the water policy financing. The evidence obtained shows how the invoice has an unequal impact on the various types of household, as well as that there are large differences between territories. Nevertheless, it is worth noting that the differences are greater as household income decreases, thus affecting households with tighter budgets or more members. For this reason, modifying the water price policy with the objective of inducing equality and efficiency, in addition to pursuing a cost recovery that is not achieved in Spain, would be convenient.

Keywords: Water pricing; Tariff structure; Regional prices; Spain; Cost recovery; Water policy; Household characteristics.

Introduction

Water pricing policy is a key aspect of water resource management, as it pursues many objectives and has diverse effects, including adequate financing of water services and discouraging excessive consumption (Rogers, da Silva & Bhatia, 2002). For this reason, research on this policy has increased in recent years with the aim of developing it in the most efficient and coordinated way possible together with regulatory measures external to prices, thus achieving optimum management of the resource. In this sense, in order to consider it optimal, a series of factors must be met, starting with the sustainability of the resource and the recovery of costs of water services. To these aspects, others such as the minimisation of environmental impact or equity in the financing of water policy should be added. The water pricing policy is one of the main tools with the objective to reach efficiency in water resources management, highlighting the financing of the provided services (Rogers, da Silva & Bhatia, 2002). Like any economic activity, water supply cannot be considered sustainable or self-sufficient if it is not able to recover the costs itself, hence the importance of water pricing. In this sense, the Water Framework Directive (EU, 2000) establishes as mandatory the recovery of total costs, including environmental and resource costs, however, it allows leaving aside environmental objectives that represent an excessive economic cost for the benefit achieved (Alcon et al, 2012). As Rogers, de Silva & Bhatia (2002) state, different types of costs can be distinguished, the clearest being the economic cost of the project itself, which includes investment and operation and maintenance costs, but there are also opportunity costs, economic externality costs, and environmental and resource externality costs. It should be noted, however, that there is no single way to carry out water policy, but rather there are various alternatives depending on geographical, economic, demographic or even political characteristics. This is an additional difficulty when designing the policy, but it allows it to be developed more efficiently, thus reducing the difficulty of recovering costs (Melgarejo et al, 2016). Although the full costs recovery is essential in the long term to avoid inefficiencies, it should be borne in mind that it is not the only criterion to be assessed when designing pricing policy, since a number of other factors must be considered in the short term (Rogers, de Silva & Bhatia, 2002). It may also be the case that total costs are too high and recovering them will have a significant impact on consumers. For this reason, it may be more feasible to recover first the costs related to the operation and maintenance of the service, which are socially acceptable and allow the

service to be maintained, and to seek to achieve full recovery in the long term (Tardieu & Préfol, 2012). In addition, it should be considered that some water services have direct financing, such as water treatment and reuse or sewerage, but the main source of financing comes from the consumption charge. In line with the objective of this research, the analysis of the capacity of prices to finance water policy and its effects on consumption and tariff equity are addressed.

Spain is a particular case in terms of water resources, as it is a country where the unequal distribution of these resources leads to abundance in some regions and serious problems of scarcity in others. Moreover, the climatic situation is not stable, but the incidence of droughts is increasing and annual rainfall is decreasing (Navarro, 2018). In this way, Spain is one of the European Union countries with the largest surface area under water stress: specifically, water consumption exceeds 40% of the total available in 72% of the national surface area (Melgarejo and López, 2016). This problem is associated with a higher economic cost when managing resources, since in regions with shortages the development of non-conventional sources of supply is becoming important, which are more costly than the conventional sources. These additional costs have an impact on the prices faced by consumers, which are higher in regions with greater shortages, and lead to imbalances in cost recovery. In this sense, cost recovery for Spain is measured on a river basin district scale as shown in Table A.1 for the hydrological cycles 2015-2021 and 2021-2027. Thus, independently of the abundance or scarcity of resources, total cost recovery is not achieved in any region, so that analysing the income obtained from water services is of great importance. It should be noted that the conclusions are the same for both hydrological cycles, so it should not be considered as a conjunctural phenomenon, but rather as a structural problem that will persist until at least the year 2027 when the current EU WFD implementation ends. The current situation of cost recovery justifies the elaboration of analyses in order to introduce improvements in the system. Therefore, the particular situation of water resources in Spain, as well as the pricing policy applied, leads to consider the situation as unsustainable. In order to correct the current problems, it is necessary to reduce costs and/or increase revenues, so that water policy is financed entirely by its own revenues rather than requiring external funds. With regard to income, there are major differences between the various regions of Spain, since the tariff is set by each city council and its study is relevant in order to propose a change in prices. In this

way, a significant part of the income from water services comes from households, directly affecting their budgets.

Thus, in order to modify the current water price and improve financing, a key aspect is to know, on average, how households react to price, an aspect widely studied in the literature. The delay in households price perception due to imperfect information is widely accepted (Carver & Boland, 1980; Shin, 1985; Arbúes, Barberán & Villanúa, 2004), but there are different opinions concerning which price consumers react to between two alternatives. On the one hand, it is considered a reaction to the marginal price (Opaluch, 1984), which is the one that would be paid at the time of consumption and is more difficult to detect and, on the other hand, a reaction to the average price (Shin, 1985, Carver & Boland, 1980), which would be the final average price of each invoicing period, which can easily be seen in the invoice. The problematic of price is therefore of great interest, which has sometimes led to analyse, before performing the analysis, to which price (average or marginal) the consumer reacts to (Arbúes, Barberán & Villanúa, 2004). This phenomenon implies the need to adequately study water consumption in relation to the price before making modifications to it. Therefore, knowing the consumption patterns of Spanish households is of great importance, as well as distinguishing different patterns derived from differences between households, for example, geographical, demographic, social, economic and even political.

It should be noted that the reaction to price varies across households, although, in general, urban water demand is found to be relatively inelastic due to low prices and the lack of a substitute (Howe & Linaweaver, 1967; Hung & Chie, 2013), as increases are difficult to detect since households spending increases slowly (Ipe & Bhagwat, 2002). In addition, income differences between households can influence consumption, with lower income households reacting more strongly to price increases (Ruijs, Zimmermann & van der Berg, 2008). However, it is not only their different reaction that should be considered, but also the possibility of looking for a tool able to soften the price of water for low incomes. In this way, the variable of interest would not simply be the price, but the fraction of the water invoice in the total household budget. In addition, not all consumption reacts in the same way to price, as there is consumption that is fundamental for all people that will not be reduced in the face of a price increase (Gaudin, Griffin & Sickles, 2001, Martínez-Espiñeira & Nauges, 2004). This aspect is particularly relevant, since a pricing policy that does not take it into account could affect households with fewer resources more severely

(Arbúes, Barberán & Villanúa, 2004, Martínez-Espiñeira & Nauges, 2004). Therefore, the tariff should be designed so that the average price for basic consumption is relatively low while the marginal price is a disincentive to efficient consumption (Martin & Wilder, 1992). In this regard, it should be noted that the structure of the household is an important aspect, since the more members of the household, the greater the consumption and, therefore, the higher the bill paid. This situation would occur in Spain, since rates do not take into account the structure of the households, except for certain places which offer some rebates to large families. Consequently, households with a larger number of members move faster through the consumption blocks, thus increasing the price compared to households with fewer members. A good example of this problem can be found in the city of Barcelona, where in the early 1990s a sharp price increase was introduced, which caused some social unrest (Domene & Sauri, 2011). However, the latter divide the fixed part of the water invoice between a smaller number of persons, so that a certain balance could be considered to exist, despite the fact that in most cases the most populated households are due to the presence of dependent children without income.

In addition, Spain is a country with an important tourist sector, which entails a certain consumption of water by visitors. This consumption does not react in the same way to prices, as tourists pay a fixed price for a hotel, apartment or similar and are not affected by the tax on water consumption. This issue is especially relevant in the summer, when a significant number of tourists come, so that consumption occurs at the time of greatest scarcity of the year; and establishing a seasonal tariff could induce efficiency and improve financing (Renzetti, 1992; Hughes, Hafi & Goesch, 2009). In this sense, the territorial dimension is very important in order to analyse the price and consumption of water with the aim of making improvements in water policy, since the coastal areas are those that receive a significant part of the tourists and, therefore, on which the application of seasonal tariffs would be focused. It should also be noted that regions with similar characteristics may have different responses to the same stimulus, so policies should be designed to each particular region and not just by region type (Espey, Espey & Shaw, 1997; Pinto, Simões & Marques, 2017). Therefore, the territorial aspect is of great importance, with the governments of each city setting tariffs to its inhabitants based on the different characteristics of the territory, since the activities carried out in a city or territory can directly influence consumption (Carver & Boland, 1980). This can lead to

reduced prices in places where resources are abundant compared to regions that suffer shortages and need to invest more financial resources in managing.

In short, there are price differences between regions for the same water consumption, but, in any case, they do not adequately value the household size or income. A price modification that considers the two previous aspects could contribute to the well-being of citizens, since the resulting tariff (equitable tariff) would allow for more efficient management of water resources (Grafton & Ward, 2008). On the other hand, the changes would favour lower incomes through either price reduction or revenue support focused on the neediest groups (Mansur & Olmstead, 2012). However, prices are not capable of inducing efficiency and equity on their own but must be accompanied by an appropriate analysis of the characteristics of consumers and households, as well as by regulatory measures (Barrett, 2004). A pricing system that is unable to distinguish between different types of consumers could lead to inequality in contributions, with a greater impact on households in financial difficulty, problems in recovering costs and difficulties in maintaining the natural environment in good condition. Yet, all consumers must contribute to a greater or lesser extent to the pursuit of cost recovery, as failure to do so will result in external funding. This is because water services must necessarily be financed, thus reducing the possibility of introducing improvements and innovations in the system.

For all these reasons, the objective of this article is to analyse the situation of fair pricing in Spain, differentiating both by region and by type of household, through the price paid for the water consumed and, especially, the weight of the water invoice in the household income. This information would be useful when making modifications in the water pricing policy, since it would be very beneficial to tariff equity with respect to its incidence on the various types of households. After this introduction are presented the data used, the methodology followed, the results obtained and, finally, the discussion generated.

Materials and methods

With the aim of analysing the relationship between the budgetary situation of households and water tariffs, this section contains relevant information about the materials used, highlighting a households survey, as well as the methodology followed, which consists of regression techniques.

Materials

The analysis is mainly based on data from the *Family Budget Survey* carried out by the National Statistics Institute (INE). The information available begins in 2006 but, due to a methodological change that took place in 2016, only the data available in the editions published in 2016, 2017 and 2018 will be used in order to have enough observations to analyse all categories of interest. In order to avoid problems related to the scarcity of data or to the simple pooling of data from different years, bootstrapping has been performed on the available sample. Specifically, bootstrapping has been carried out with 1000 simulations stratifying by year. In addition, the new sampling of each survey year prevents working the data as a panel, so they are treated as cross-sectional data controlling by year. This survey is based on all the households expenses, in such a way that the specific information on water is scarce, and it is not possible to include all the aspects of interest, such as certain characteristics of the households or the delay in prices. Thus, in order to complement the data set, regional data from the INE and Turespaña (from the Secretariat of State for Tourism) have been incorporated with the aim of establishing links between the price/cost of supply and aspects such as the method of collection or the availability of resources. These data, unlike those from the survey, are available from 2001 to 2014, so that panel data are available for 17 regions over 14 years.

In order to carry out a more complete analysis of current water pricing, the main variable of interest is the proportion of the annual water tariff payment in the household's annual income. In this sense, water consumption (cubic metres), its price (euros) and the household income (euros) are variables of great importance for the research. Unfortunately, the variable included as price only includes water supply, as wastewater treatment payments are part of a different data item in the survey. The problem is that the variable where wastewater treatment payments are included is a combination of several payments, some of which have no relation to the objective of the analysis or to the quantity of water consumed. In addition, there is a significant lack of information on this variable, so only the price for water supply is used in this analysis, despite the limitation it implies. Another fundamental objective consists of analysing the differences between the regions of Spain, as well as between the main types of households (available in Table A.2, where 8 categories can be distinguished in which the number of members is increasing), in such a way that the region of residence and the type of household are included, as they have been found relevant in the preexisting literature (Yoo *et al*, 2014;

Nauges & Whittington, 2010; Carver & Boland, 1980; Espey, Espey & Shaw, 1997). Finally, population density and municipality size are included with the objective of determining their influence (Martinez-Espineira, Garcia-Valinas & González-Gómez, 2009; Espey, Espey & Shaw, 1997). These variables will be treated as dichotomous, leaving as a reference the lowest category, which is dispersed population in the case of density, population less than 10,000 inhabitants in the case of municipality size, Aragón in the case of regions (since it is the region with the least weight of the invoice on income) and, lastly, the type of household excluded, one which only has one adult person without children. It is worth commenting that, throughout the article, when talking about children, we refer to dependent children.

Moreover, since these data do not include aspects of resource availability or cost recovery, the regional data collected allow these limitations to be addressed, although, unfortunately, the information available ends in 2014. These data collect fundamental aspects about water resources such as the unit cost or the amount of water either treated, supplied, available, recorded, lost or total water collected by source. In this sense, it is possible to distinguish the amount of water collected depending on the method of collection (surface, groundwater, desalinated or reused) or on its destination (households, public sector or economic sectors). While the supply and collection variables are measured in million cubic metres, available water is measured in thousands cubic metres per person and the amount of water reused in cubic metres per inhabitant per day. Finally, data on the investment made in the system, the population, population per square kilometre and tourist arrivals is also available. These data, as can be seen, include fundamental aspects of water resources, but do not allow for institutional analysis. This is due to the fact that there is no institutional information for the entire Spanish territory, making it impossible to analyse the institutional component, even though it has been shown to be significant (Bel, Gonzalez-Gomez & Picazo-Tadeo, 2015).

In order to eliminate responses that are too far from the average in the *Household Budget Survey*, outliers have been eliminated based on several criteria. Firstly, cases where the invoice represents more than 25% of the household income or shows an annual income of more than 180,000 Euros have been eliminated. Secondly, observations with consumption per person above 400 cubic metres per year, with household consumption above 1000 cubic metres per year or that show a log of consumption per person below 0 have been eliminated. Finally, those cases with invoices per person higher than 400 Euros

per year, with invoices per household higher than 1000 Euros per year, with a logarithm of the household invoice lower than 0.5 or with a unit price higher than 6 Euros have been eliminated. These are very specific situations that occur in very few cases, which is consistent with the reduced loss of 578 observations out of a total of 62,320, slightly less than 1%. Throughout the empirical analysis, the sample weights provided by the survey have been considered, and therefore, the results are representative of the group of Spanish households.

Methods

This research used, firstly, descriptive evidence derived from the above data and, secondly, estimates using Ordinary Least Squares. In the case of these estimates, a total of 9 equations are performed in order to analyse various aspects related to water services. Firstly, the weight of the water invoicewas analysed according to the household's available income. For this purpose, an equation is used with the form:

$$W_h = X_h\beta + \varepsilon_h \qquad (1)$$

Where W represents the weight of the water invoice on income; X is a vector of individual explanatory variables plus a constant term; β is a vector of parameters and ε is a random error term. Subscript h refers to the unit of analysis, households.

Secondly, two estimateswere made where the variables to be explained are consumption per household and per person and price per person. The objective of these estimates is to analyse the behaviour of consumption and price in relation to the available interest factors, among which the type of household stands out. The equations used in this case are:

$$C_h = X_h\beta + \varepsilon_h \qquad (2)$$

$$P_h = X_h\beta + \varepsilon_h \qquad (3)$$

Where C represents water consumption per household or per person and P the unit price of water; X is a vector of individual explanatory variables plus a constant term; β is a vector of parameters and ε is a random error term. Subscript h refers to the unit of analysis used, households.

Finally, and in order to analyse the impact of certain aspects on the cost of supply of the Spanish regions, two estimates are made using regional data from the INE and Turespaña.

Specifically, the aim is to analyse the impact that the availability of resources shows on the cost of supply, as well as to relate the revenues obtained through water pricing with cost recovery. These estimates are made through equations (4) and (5):

$$U_r = X_r\beta + \varepsilon_r \qquad (4)$$

$$P_r = X_r\beta + \varepsilon_r \qquad (5)$$

Where U represents the unit cost of water supply and sewerage and P the unit price of water; X is a vector of individual explanatory variables plus a constant term; β is a vector of parameters and ε is a random error term. The subscript r refers to the unit of analysis used, the regions.

Thus, the estimates made with equation (1) allow for comparisons between groups of households that differ in income, in addition to observing the possible existence of divergences between regions and types of household by income level. The estimates of consumption per household and per person and unit price, on the other hand, allow for analysing the behaviour of these variables in response to various factors, highlighting the differences between types of households. Finally, regional data allow for an aggregated analysis, impossible to achieve with households survey data, which allows for establishing links between supply costs and territorial characteristics. It should be noted that, due to the presence of heteroscedasticity among the variables used from the *Household Budget Survey*, the estimates of equations (1), (2) and (3) will be made with robust errors.

Results

In order to achieve the proposed objective, the results begin by presenting descriptive evidence about the available sample. After that, the use of the methodology explained allow a deeper understanding of the relationship between the budgetary situation of households and water rates.

Descriptive evidence

Descriptive evidence on the variables taken into account in the analysis appears in Tables A.2 to A.4 of the appendix. First, Table A.2 shows the mean and standard deviation of all variables in the households analysis. The standard deviation of the variables reveals a high variability of aspects such as water consumption, the price they pay, income or the number of household members, which shows the importance of the analysis

differentiating by household characteristics. On the other hand, the average of the region variables shows the proportion of observations that belong to said region, so their consideration is also important. In addition, it is worth noting that an important part of the households in Spain is composed of one or two adults without children, and that those composed of one adult and at least one child represent a small part, for which reason the latter are a particular case that requires greater attention. On the other hand, households with two adults and three or more children are also relatively scarce, since it is more common for households to have one or two children. Therefore, the distribution of households is a relevant aspect in the development of an efficient pricing policy, since a tariff must adequately assess the characteristics of consumers.

Secondly, Table A.3 shows the average per region and type of household of water consumption per person, income per household, the amount of the water invoice, the unit price per cubic metre and the weight of the invoice on income. Regarding regions, the variables show great variability among them, highlighting differences between the 37.9 cubic metres per person consumed in Aragón and the 88.77 in the Balearic Islands, a difference that may be an indication of inefficient consumption, although the presence of a large number of swimming pools could also be a reason for this. Aragon is a particular case, as it has a consumption per person, invoice amount and weight that is significantly lower than the Spanish average, while the unit price they pay is slightly lower and their income is close to the average. In general, the relatively higher price paid by certain regions is related to comparatively higher water consumption, so that, although income is a factor that would be interesting to consider when preparing the tariff, one of the fundamental objectives of water pricing should not be overlooked, as it is to discourage excessive and/or inefficient consumption. For its part, weight is a fundamental variable of the analysis, since it connects in the same indicator the price paid for water with the income of the households. In this sense, all regions where weight exceed 1% have unit prices above the average and are regions with a great scarcity of resources, such as those located on the Mediterranean coast, the Balearic Islands, the Canary Islands and Ceuta. It should be noted that there does not appear to be a causal relationship between income and price, but rather that prices respond to other aspects, probably the cost of the service, which is related to the scarcity or abundance of the resource. In this way, low unit prices in high-income regions and regions suffering from greater scarcity with higher prices, without necessarily having a greater income, are observed.

As regards the type of household, the second part of Table A.3 shows the values of the variables according to the composition of the households. In the first place, per capita consumption is superior in the households with few members, in particular in single-person ones; however, the presence of fewer members is linked to the fact that the total water consumed is lower, as well as the amount of the invoice. On the other hand, the unit price does not vary strongly between types of households, which could indicate a scarce effective progressiveness of the current water rates. Regarding income, it is lower for households with fewer adults, as would be expected, although in these cases the lower number of members allows for achieving lower total consumption, higher income per person and lower household expenses. Finally, the weight stands out in the particular case of households formed by an adult and at least one child, followed by those formed by a single adult, since they have a lower income and, in the case of the former, a greater consumption related to the greater number of members of the households. This fact is of great relevance, since households formed by one adult and one or more children are probably those that suffer more financial problems due to the presence of dependent children, so it would be advisable to seek a solution to this situation.

Finally, as regards the available regional data, Table A.4 contains basic descriptive information in order to show the situation for the whole of Spain. It is clearly shown how the unit price is always lower than the unit cost of supply, thus revealing a structural problem of cost recovery, so that the analysis of supply costs and water pricing are necessary. As regards consumption and availability of resources, water consumption per person is decreasing, but the population is growing and the available water is decreasing in the same period. Therefore, over time the consumption pattern of citizens has been improving, but significant improvements are still needed in order to achieve efficient management of water resources to finance costs and to deal with the situation of scarcity. However, depending on the region, price, cost, consumption and available resources vary, so it is a problem that must be approached taking into account the characteristics of each territory.

Empirical evidence

In order to deepen the analysis of the weight of the water invoice on the family budgets, Table 1 contains 4 estimates of equation (1), where the weight variable is explained by a series of factors according to 4 income groups. Specifically, estimation (1) corresponds to households with a monthly income lower than or equal to 1500 euros, (2) to households

with a monthly income between 1500 and 3000 euros, (3) refers to households with an income equal to more than 3000 euros, while (4) collects the total of the sample. The differences between the 4 estimates are considerable, especially if we compare the first (households with a monthly income lower than or equal to 1500 euros) with the third (households with a monthly income equal to or higher than 3000 euros), since a large part of the coefficients obtained in the latter are significantly lower or not significant. In the first place, regarding the territorial variables, no specific pattern of the phenomenon is observed, both by size of municipality, since significance is only shown in specific sizes, and by population density, a variable that is not statistically significant. As regards the unit price, a large difference is observed between income sections, as might be expected, with 0.843 for low income sections standing out in contrast to 0.243 for high income sections. This is reasonable, as the price of water remains constant between groups while income is significantly different. In low income households, the incidence of the unit price is high in contrast to high income households, since as the household income increases, the unit price shows less relevance on the budget. This fact is corroborated with the coefficient obtained in the household income variable, which is significant in the three cases, since a greater relevance of this variable is observed when the income is low (-0.178 of low income by -0.004 of high income). The last of the continuous variables is water consumption, which again shows greater importance in low income households, since its tighter budget means that each cubic metre consumed represents a proportionally high cost.

In addition, in order to make relevant comparisons between regions and households, variables related to households composition and region of residence have been added to the model. Without wishing to be exhaustive, it can be seen how in the case of high-income households the differences between households and regions are reduced in comparison to the other models. As regards the estimate for intermediate income households, the differences are extended both between regions and between types of households, but they do not reach such a high volume as for low income households. In the latter, the differences are higher, although unevenly for regions, highlighting that all household structures are significant and with relatively high coefficients. It should be noted that the differences between regions have a strong geographical component, as the areas with the greatest pressure on water resources (Valencia and Murcia in theMediterranean coast, island territories and Ceuta in North Africa) have the greatest

weight of the invoice on household income. However, the signs of the household type variables are not those that could be expected, since according to the descriptive evidence the household type excluded as a reference category, an adult without children, has the second highest weight of the various groups, while in the estimates the signs of all the household type variables are positive. This indicates that, once the differences in characteristics are considered, this type of household shows a relatively low importance of the invoice on its budget. Furthermore, this type of household shows a high income per person, as well as the highest consumption per person, so that a reduced weight shows how the increasing block rates have a reduced impact on its consumption pattern. As for the rest of the household types, as the number of members increases, income per person decreases and the weight they show is higher, despite showing a lower consumption per person. Finally, as might be expected, the differences between types of households are greater for low income households, where the economic situation is more adjusted. Due to these results, going deeper into the differences in price and consumption between types of households is key in order to determine the influence of the water rate according to the characteristics of the households.

Table 1. Estimates with weight as a dependent variable, differentiating according to income.

Dependent variable: Weight	(1)	(2)	(3)	(4)
Municipality of 10,000 to 20,000 inhabitants	0.070 (0.019)***	0.027 (0.005)***	0.020 (0.004)***	0.023 (0.010)
Municipality of 20,000 to 50,000 inhabitants	0.014 (0.026)	0.016 (0.006)**	0.017 (0.006)***	0.012 (0.014)
Municipality of 50,000 to 100,000 inhabitants	0.040 (0.029)	0.014 (0.007)*	0.018 (0.007)***	0.021 (0.015)
Municipality of more than 100,000 inhabitants	-0.011 (0.028)	0.010 (0.007)	0.024 (0.007)***	-0.014 (0.015)
Medium population density	-0.004	0.004	0.001	-0.005
	(0.016)	(0.004)	(0.004)	(0.009)
High population density	0.027	0.005	0.011	0.010
	(0.027)	(0.007)	(0.006)*	(0.014)
Annual income	-0.178	-0.022	-0.004	-0.038
	(0.002)***	(0.001)***	(0.000)***	(0.000)***
Total expenditure	-0.000	0.000	0.000	-0.000
	(0.000)***	(0.000)***	(0.000)	(0.000)***
Income*expenses	0.000	-0.000	-0.000	0.000
	(0.000)***	(0.000)***	(0.000)	(0.000)***
Unit price	0.843	0.398	0.243	0.509
	(0.012)***	(0.003)***	(0.003)***	(0.006)***
Water consumption	0.009	0.004	0.002	0.005
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Two adults without children	0.130	0.034	0.008	-0.021
	(0.012)***	(0.004)***	(0.008)	(0.008)*
Other households without children	0.178 (0.019)***	0.061 (0.005)***	0.026 (0.008)***	0.057 (0.010)***

One adult with at least one child	0.198 (0.021)***	0.034 (0.009)***	0.003 (0.014)	0.205 (0.015)***
Two adults with one child	0.162	0.052	0.011	0.044
	(0.018)***	(0.005)***	(0.008)	(0.010)***
Two adults with two children	0.225	0.059	0.020	0.060
	(0.019)***	(0.005)***	(0.008)**	(0.010)***
Two adults with three or more children	0.205 (0.031)***	0.083 (0.009)***	0.019 (0.009)**	0.128 (0.017)***
Other households with children	0.239 (0.025)***	0.083 (0.006)***	0.033 (0.009)***	0.090 (0.012)***
Andalusia	0.058	0.044	0.037	0.120
	(0.026)**	(0.007)***	(0.007)***	(0.014)***
Asturias	0.018	-0.026	-0.019	-0.023
	(0.033)	(0.008)***	(0.008)**	(0.017)
Balearic Islands	0.192	0.101	0.064	0.147
	(0.036)***	(0.009)***	(0.009)***	(0.019)***
Canary Islands	0.215	0.099	0.044	0.269
	(0.030)***	(0.008)***	(0.009)**	(0.017)***
Cantabria	0.092	0.026	0.012	0.063
	(0.034)***	(0.008)***	(0.008)	(0.018)***
Castilla and León	-0.036	-0.020	-0.029	-0.050
	(0.029)	(0.007)***	(0.007)***	(0.015)***
Castilla-La Mancha	-0.018	-0.009	-0.001	-0.011
	(0.029)	(0.008)	(0.008)	(0.016)
Catalonia	-0.010	0.021	0.017	0.026
	(0.029)	(0.007)***	(0.007)***	(0.015)*
Valencia	0.123	0.054	0.024	0.113
	(0.029)***	(0.007)***	(0.007)***	(0.015)***
Extremadura	-0.024	0.020	0.023	-0.007
	(0.029)	(0.008)**	(0.009)**	(0.017)
Galicia	0.080	0.008	0.006	0.026
	(0.030)***	(0.007)	(0.008)	(0.016)
Madrid	0.111	0.084	0.039	0.080
	(0.031)***	(0.007)***	(0.007)***	(0.016)***
Murcia	0.217	0.133	0.077	0.258
	(0.031)***	(0.008)***	(0.008)***	(0.017)***
Navarra	0.033	0.022	0.014	0.028
	(0.035)	(0.008)***	(0.008)*	(0.018)
Basque Country	0.078	0.037	0.016	0.061
	(0.029)***	(0.007)***	(0.006)**	(0.015)***
La Rioja	0.013	-0.003	-0.005	0.002
	(0.034)	(0.009)	(0.008)	(0.018)
Ceuta	0.323	0.098	0.049	0.413
	(0.062)***	(0.020)***	(0.015)**	(0.037)***
Melilla	-0.436	-0.116	-0.062	-0.002
	(0.062)***	(0.021)***	(0.015)***	(0.038)
Observation of the year 2017	-0.014	0.010	0.011	-0.004
	(0.011)	(0.003)***	(0.003)***	(0.006)
Observation of the year 2018	-0.043	-0.018	-0.008	-0.040
	(0.011)***	(0.003)***	(0.003)***	(0.006)***
Constant	1.087	0.100	-0.071	0.555
	(0.048)***	(0.017)***	(0.014)***	(0.022)***
Adjusted R^2	0.637	0.773	0.768	0.492
N	23,954	26,646	11,862	61,742

436 * p<0.1; ** p<0.05; *** p<0.01

Consequently, Table 2 contains three estimates referring to equations (2) and (3) that help to explain the situation of the various types of households and regions in terms of water consumption and price. In this sense, the first estimate seeks to explain the consumption per household, the second the consumption per person and the third the unit price. In terms of consumption, the two estimates are similar in terms of coefficients, except for the household type variables, as a household with more members is associated with higher total consumption but lower consumption per person. Regarding the explanatory variables, the results show the relevance of the size of the municipality, although without a clear pattern, while the higher the population density, the higher the consumption per person and household, although on other occasions the density has not been found relevant (Espey, Espey and Shaw, 1997). The financial characteristics of households are also significant, showing higher consumption as total household income or expenditure increases as indicated by economic theory as water is a normal good, but they also reveal the significance of the interaction of these two variables, that is, consumer behaviour varies according to the budgetary situation of the households. With regard to the price, a relatively high elasticity can be observed (variable Unit price in Table 2), so the reaction to a price change would be important. Elasticity is generally higher in advanced countries, while in emerging countries it is lower due to the significant need for water resources despite limited monetary resources (Billings & Agthe, 1980; Gaudin, Griffin & Sickles, 2001; Martínez-Espiñeira & Nauges, 2004; Grafton & Ward, 2008). As for the advanced countries, the United States has several researches that have worked on price elasticity of demand. These elasticities are between -0.02 and -3.33, although in 90% of cases they are between 0 and -0.75 (Espey, Espey & Shaw, 1997). This shows how relatively high the elasticity obtained in our results is, as it amounts to -0.876. By region, the differences in consumption are also significant, which reinforces the need to design water policy according to the situation in each place. As can be seen, the regions that used to have a relatively high weight of the invoice on income now show higher consumption than the other regions, although this time Madrid is added to the high consumption. However, in the previous estimates, consumption was included as a variable, so this should not be the only explanation. Therefore, we find both higher consumption and prices in the regions with the greatest shortage of resources. Even with these results, it should not be asserted that the management of available resources in these regions is very poor, as it must be taken into account that these regions suffer from different climatic conditions than the rest of the territory, notably higher temperatures.

On the other hand, the estimation for the unit price shows how a larger municipality size implies a lower price as expected (Martinez-Espineira, Garcia-Valinas & González-Gómez, 2009), while the population density shows no relevance. As for the economic characteristics of households, the results show that they affect price in a similar way as consumption and that the unit price decreases as consumption increases. This is due to the relative importance of the fixed part of the invoice over the total and the reduced progressiveness of the invoice. Again, large differences can be found between regions, so that, depending on the place of residence, the price assumed by each household varies. This is the expected result, as the institutional and water resources situation varies significantly between the regions of the country. Furthermore, this result is in line with the previous one, as the regions with the highest prices are those with the highest water consumption. Finally, the household type variables show how, as the number of members grows, the unit price increases, which occurs while consumption per person is decreasing, so the tariff structure is charging large households with a higher unit price, probably because the increasing block tariffs are not designed per capita but per household. These results are a good example that tariff changes must be careful, as not only the reaction to the price is relatively high, but the invoice has an unequal impact on income as was the case in Barcelona (Domene & Sauri, 2011). It is important to note that this occurs when it is being controlled by a series of factors, so regardless of the region or economic situation of the households, this is a problem that must be addressed in order to induce efficiency in the system. However, this analysis only involves Spanish households and it should be remembered that the main objective of water pricing is to finance the service.

Table 2. Estimates with consumption per household, consumption per person and unit price as dependent variables.

	Consumption per household	Consumption per person	Unit price
Municipality of 10,000 to 20,000 inhabitants	0.037 (0.008)***	0.038 (0.008)***	0.015 (0.005)***
Municipality of 20,000 to 50,000 inhabitants	-0.001 (0.011)	0.002 (0.011)	-0.045 (0.006)***
Municipality of 50,000 to 100,000 inhabitants	0.004 (0.012)	0.006 (0.013)	-0.058 (0.007)***
Municipality of more than 100,000 inhabitants	-0.047 (0.012)***	-0.042 (0.012)***	-0.126 (0.007)***
Medium population density	0.070	0.070	0.028
	(0.007)***	(0.007)***	(0.004)***
High population density	0.066	0.069	-0.008
	(0.012)***	(0.012)***	(0.007)
Annual income	0.003	0.011	0.001
	(0.000)***	(0.001)***	(0.000)***

Total expenditure	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***
Income*expenses	-0.000	-0.000	-0.000
	(0.000)***	(0.000)***	(0.000)***
Unit price	-0.876	-0.861	-
	(0.009)***	(0.009)***	-
Unit price * Annual income	0.000	-0.002	-
	(0.000)*	(0.001)***	-
Water consumption	-	-	-0.300
	-	-	(0.002)***
Two adults without children	0.168	-0.441	0.032
	(0.006)***	(0.006)***	(0.004)***
Other households without children	0.297	-0.722	0.063
	(0.008)***	(0.008)***	(0.005)***
One adult with at least one child	0.188	-0.576	0.046
	(0.012)***	(0.012)***	(0.007)***
Two adults with one child	0.215	-0.739	0.053
	(0.008)***	(0.008)***	(0.005)***
Two adults with two children	0.292	-0.907	0.071
	(0.008)***	(0.008)***	(0.005)***
Two adults with three or more children	0.351	-1.075	0.083
	(0.014)***	(0.014)***	(0.008)***
Other households with children	0.390	-0.929	0.093
	(0.010)***	(0.010)***	(0.006)***
Andalusia	0.648	0.643	0.330
	(0.012)***	(0.012)***	(0.007)***
Asturias	0.474	0.478	0.186
	(0.014)***	(0.014)***	(0.008)***
Balearic Islands	0.941	0.942	0.418
	(0.015)***	(0.015)***	(0.009)***
Canary Islands	0.769	0.764	0.402
	(0.014)***	(0.014)***	(0.008)***
Cantabria	0.467	0.465	0.206
	(0.015)***	(0.015)***	(0.009)***
Castilla and León	0.125	0.127	0.005
	(0.013)***	(0.013)***	(0.007)
Castilla-La Mancha	0.341	0.343	0.169
	(0.013)***	(0.013)***	(0.008)***
Catalonia	0.752	0.754	0.466
	(0.012)***	(0.012)***	(0.007)***
Valencia	0.736	0.738	0.460
	(0.012)***	(0.013)***	(0.007)***
Extremadura	0.408	0.407	0.257
	(0.014)***	(0.014)***	(0.008)***
Galicia	0.366	0.366	0.145
	(0.013)***	(0.013)***	(0.008)***
Madrid	0.884	0.883	0.483
	(0.013)***	(0.013)***	(0.007)***
Murcia	0.923	0.924	0.436
	(0.014)***	(0.014)***	(0.008)***
Navarra	0.471	0.469	0.258
	(0.015)***	(0.015)***	(0.009)***
Basque Country	0.349	0.347	0.119
	(0.012)***	(0.012)***	(0.007)***
La Rioja	0.348	0.348	0.094
	(0.015)***	(0.015)***	(0.009)***

Ceuta	0.694	0.657	0.307
	(0.030)***	(0.030)***	(0.017)***
Melilla	0.184	0.129	-0.412
	(0.031)***	(0.031)***	(0.018)***
Observation of the year 2017	0.017	0.018	-0.002
	(0.005)***	(0.005)***	(0.003)
Observation of the year 2018	-0.011	-0.011	0.009
	(0.005)**	(0.005)**	(0.003)***
Constant	3.911	3.772	1.285
	(0.016)***	(0.017)***	(0.012)***
Adjusted R^2	0.377	0.483	0.389
N	61,742	61,742	61,742

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

For this reason, Table 3 contains regional information that allows for the analysis of the unit price and cost of the water supply service. Thus, the unit cost varies depending on the type of consumption, with municipal consumption being the lowest cost. Depending on the type of catchment or the origin of the water, only a slight increase in cost is observed when the water comes from desalination, but a significant increase when it comes from purification and reuse. In addition, higher population and tourist arrivals are associated with higher unit costs. Finally, a high importance of available water per person can be observed, as it significantly reduces the unit cost of supply. In other words, regions with greater abundance of resources show lower costs, allowing lower prices to be applied to users of the service. This is supported by the second estimate, which shows a high explanatory capacity due to the unit cost. Therefore, even though there are other variables that show significance, the cost of supply is the main determinant of tariffs and, given its current structure, this leads to problems such as those analysed through the previous estimates. However, the explanatory capacity of the estimate of the cost of supply is lower, so there are other determinants that cannot be observed. In any case, the determination of the tariff based on the cost of supply, leaving aside other aspects of the situation in each region, leads to problems of inefficiency in pricing. Moreover, even in this situation, cost recovery of the service is not being achieved as found in many cases (Damkjaer, 2020), so that, both an increase in the average price paid by users and a restructuring of the tariff are needed.

Table 3. Estimates from regional data with unit cost and unit price as dependent variables.

	Unit cost	Unit price
Unit cost (€)		0.470
		(0.016)***
Water supplied to households (millions of cubic meters)	-0.004 (0.001)***	0.001 (0.000)**
Water supplied to economic sectors	-0.003	-0.000

(millions of cubic meters)	(0.001)*	(0.000)
Water supplied to municipal consumption (millions of cubic meters)	-0.006 (0.002)***	0.001 (0.001)
Amount of water per surface catchment (millions of cubic meters)	0.000 (0.000)	-0.000 (0.000)**
Amount of water per groundwater catchment (millions of cubic meters)	0.000 (0.001)	-0.000 (0.000)
Amount of water collected by desalination (millions of cubic meters)	0.003 (0.002)*	0.003 (0.001)***
Available water per person (Thousands of cubic meters per person)	-5.727 (1.211)***	-0.227 (0.317)
Amount of water reused (Cubic meters per inhabitant per day)	4.153 (0.651)***	0.247 (0.205)
Investment in supply services (Millions of Euros)	-0.892 (1.169)	-0.721 (0.279)***
Population (Millions)	0.261	-0.000
	(0.047)***	(0.016)
Population per km^2	0.000	0.000
	(0.000)	(0.000)*
Number of tourists (Millions)	0.034	-0.014
	(0.012)***	(0.006)**
Constant	1.805	0.137
	(0.169)***	(0.061)**
***R*^{2}:**		
Overall	0.718	0.903
Within	0.564	0.908
Between	0.883	0.924
N	231	231

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Discussion

The main objective of this research is to analyse the differences in the price of water between regions of Spain, as well as between types of households, so that one can determine whether there is equity in pricing and, if not, provide relevant information to pursue it. This objective has been pursued through the study of a series of descriptive indicators from a nationally representative survey, in addition to regional data, and through the estimation of linear regression models.

The evidence obtained reveals significant differences, both by region and by type of households, in relevant variables such as water consumption, household income, price or weight of the water invoice on income, since the same price has a different impact on households depending on their specific characteristics. However, the situation is complex,

since the differences in income hide additional difficulties. In this sense, making the estimate only for medium or low incomes shows that single-person households enjoy a relatively better situation thanks to their reduced total consumption. This means that they progress slowly along the consumption sections of the tariff despite their higher individual consumption. As the number of household members grows, consumption increases while income per person decreases, which explains the relationship that households composition shows with the weight of the invoice. These issues are significantly related to the structure of the water tariff since, due to the lack of consideration of the composition of the households, as well as its other characteristics, the price has an unequal impact on the various types of users. The fact that households with more members have lower levels of consumption per person associated with them but face higher unit prices is a good example. Therefore, the current water tariff structure is affecting households with more members and its modification, for example by altering the balance between the fixed and variable parts of the tariff, is necessary. However, this can be very complicated due to the limited information available when designing tariffs, not to mention that the relatively high elasticity obtained limits the possibility of price increases, which could affect large households because its structure cannot be included in the tariff. In any case, the relationship between households members and consumption per person suggests that there is something related to the size of the household that affects water consumption., so it could be considered unfair to overtax the consumption of small households without analysing this issue. Consequently, it can be expected that the reaction to a change in tariffs will vary between household types or regions, although the estimations show a relatively high sensitivity to price changes. This could imply that revenues of the public utility do not grow as desired in the face of a price increase due to consumer reaction. Thus, in the current situation of lack of cost recovery, the option of increasing prices may not be the most appropriate, which shows the difficulty of solving problems in the economic management of water resources in Spain.

As for the regional situation, the results obtained reveal large differences between the various regions of Spain in terms of weight and consumption and price of water. Regarding the weight, the regional differences are relatively small, but they increase as household income decreases. The differences are higher in terms of consumption per person, however, the price differences shown by regions are noteworthy. In this sense, those regions with the greatest scarcity of resources show a relatively higher price, so that

households living in an area with a shortage are facing a higher price because of their place of residence. The available regional data allow for developing this link, since the estimates clearly show how the availability of water resources reduces the cost of the water supply service. In other words, regions with greater water scarcity show higher supply costs which, in turn, are transferred to prices, with their corresponding effects on households budgets and cost recovery. As regards the unit price available through these data, a clear relationship is found between the cost of supply as a price determinant, leaving a reduced explanatory capacity for the socio-economic characteristics of a region. Of course, the characteristics of water supply affect price, at least, to the extent that they influence the costs. Finally, the price and cost situation in the various regions results in significant differences in terms of cost recovery. Although in no case the full costs recovery is achieved, the current situation allows for the consideration of introducing some type of mechanism that contributes to balancing the price paid between regions in order to reduce inequality. However, the introduction of a universal price is not an alternative, since this would mean not considering the characteristics in which the supply takes place and, therefore, a significant inefficiency. Unfortunately, this is a very complicated issue in a country like Spain where water services are managed at different geographical scales, such as the municipal and various supra-municipal scales such as the regional government and the hydrographic confederation. This is a further example of the difficulty of the issue, as there is a lack of income as well as inequalites, but the limited information available, tight households budgets and inequality between households and regions is a major barrier to change. These results are of great relevance, as there is not only a lack of funding for water services in Spain, but also a complex situation depending on the socio-economic differences between households, as well as between regions. This significantly conditions the choice of policy, or combination of policies, with the aim of solving the problems of scarcity and financing of water services in Spain.

This research shows the importance, as well as the difficulty, of developing a fair water pricing policy between regions and types of households, as its unequal incidence and variety of effects can lead to imbalances and harm lower incomes. Thus, including factors such as households composition or income in water pricing, as well as altering the balance between the fixed and variable parts of the invoice can lead to greater effectiveness in financing the service and discourage inefficient consumption.

As a future line of research, investigating in greater depth the differences between households across regions with respect to their water invoices would be necessary. The information is yet correct, but it does not allow to adopt a tariff reform at national level. Furthermore, full cost recovery is not achieved in Spain, so progress on this issue is of great importance, since it would not only allow for reducing the imbalances derived from current water pricing, but also contribute to the adequate financing of water policy.

Data Availability Statement: The data utilised (Household Budget Survey and regional data) is available on the Spanish National Statistics Institute website, which can be accessed through this link for the survey and this link for the regional data. As already mentioned during the article, the 2016, 2017 and 2018 edition are used. In addition, it should be noted that the previous webpage can be consulted in English, but the design of the survey is only available in Spanish. Finally, the data about cost recovery by river basin is available at the webpage of the European Environment Agency through this link.

Acknowledgements: This work was supported by the Office of the Vice President of Research and Knowledge Transfer of the University of Alicante, Spain (Marcos García-López has a scholarship for The Training of University Teachers from the University of Alicante, UAFPU2019-16), by the Water Chair of the University of Alicante-Alicante Provincial Council (2020), by the University Institute of Water and Environmental Sciences of the University of Alicante and by the Hábitat5U network of excellence. Finally, many thanks to the editors and reviewers who have contributed to the improvement of this article, as well as to Ana De Souza Bossler for her help with the data.

References

Alcon, F., Martin-Ortega, J., Berbel, J. & De Miguel, M. D. (2012). Environmental benefits of reclaimed water: an economic assessment in the context of the Water Framework Directive. *Water Policy*, 14(1), 148-159. https://doi.org/10.2166/wp.2011.001

Arbúes, F., Barberan, R., & Villanua, I. (2004). Price impact on urban residential water demand: A dynamic panel data approach. *Water Resources Research*, *40*(11). https://doi.org/10.1029/2004WR003092

623 Barrett, G. (2004). Water conservation: the role of price and regulation in residential
624 water consumption. *Economic Papers: A journal of applied economics and policy*, 23(3),
625 271-285. https://doi.org/10.1111/j.1759-3441.2004.tb00371.x

626 Bel, G., Gonzalez-Gomez, F., & Picazo-Tadeo, A. J. (2015). Does market concentration
627 affect prices in the urban water industry?. *Environment and Planning C: Government and*
628 *Policy*, 33(6), 1546-1565. https://doi.org/10.1177%2F0263774X15614144

629 Billings, R. B., & Agthe, D. E. (1980). Price elasticities for water: a case of increasing
630 block rates. Land Economics, 56(1), 73-84. https://doi.org/10.2307/3145794

631 Carver, P. H. & Boland, J. J. (1980). Short-and long-run effects of price on municipal
632 water use. Water Resources Research, 16(4), 609-616.
633 https://doi.org/10.1029/WR016i004p00609

634 Damkjaer, S. (2020). Drivers of change in urban water and wastewater tariffs. *H2Open*
635 *Journal*, 3(1), 355–372. https://doi.org/10.2166/h2oj.2020.031

636 Domene, E., & Sauri, D. (2011). Water, public responsibility and equity: The
637 Barcelona'water war'of the 1990s. In *Urban Water Conflicts: UNESCO-IHP* (pp. 33-37).
638 Taylor and Francis.

639 Espey, M., Espey, J. & Shaw, W. D. (1997). Price elasticity of residential demand for
640 water: A meta-analysis. Water resources research, 33(6), 1369-1374.
641 https://doi.org/10.1029/97WR00571

642 EU, (2000). Directiva 2000/60/CE del parlamento europeo y del consejo de 23 de octubre
643 de 2000 por la que se establece un marco comunitario de actuación en el ámbito de la
644 política de aguas. http://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-
645 bdf8-756d3d694eeb.0008.02/DOC_1&format=PDF (Consultado 15/05/2018).

646 García-López, M., Montano, B. & Melgarejo, J. (2020). La recuperación de costes y la
647 financiación de las medidas de mitigación de daños de inundaciones. En Mª. I. López-
648 Ortiz y J. Melgarejo (Eds.) *Riesgo de inundación en España: análisis y soluciones para*
649 *la generación de territorios resilientes*, pp.897-907. Universidad de Alicante.

650 Gaudin, S., Griffin, R. C. & Sickles, R. C. (2001). Demand specification for municipal
651 water management: evaluation of the Stone-Geary form. Land Economics, 77(3), 399-
652 422. https://doi.org/10.2307/3147133

Grafton, R. Q. & Ward, M. B. (2008). Prices versus rationing: Marshallian surplus and mandatory water restrictions. Economic Record, 84, S57-S65. https://doi.org/10.1111/j.1475-4932.2008.00483.x

Howe, C. W. & Linaweaver Jr, F. P. (1967). The impact of price on residential water demand and its relation to system design and price structure. Water Resources Research, 3(1), 13-32. https://doi.org/10.1029/WR003i001p00013

Hughes, N., Hafi, A., & Goesch, T. (2009). Urban water management: optimal price and investment policy under climate variability. *Australian Journal of Agricultural and Resource Economics*, 53(2), 175-192. https://doi.org/10.1111/j.1467-8489.2007.00446.x

Hung, M. F., & Chie, B. T. (2013). Residential water use: Efficiency, affordability, and price elasticity. *Water resources management*, 27(1), 275-291. https://doi.org/10.1007/s11269-012-0185-z

Ipe, V. C. & Bhagwat, S. B. (2002). Chicago's water market: dynamics of demand, prices and scarcity rents. Applied Economics, 34(17), 2157-2163. https://doi.org/10.1080/00036840210138383

Mansur, E. T. & Olmstead, S. M. (2012). The value of scarce water: Measuring the inefficiency of municipal regulations. Journal of Urban Economics, 71(3), 332-346. https://doi.org/10.1016/j.jue.2011.11.003

Martin, R. C. & Wilder, R. P. (1992). Residential demand for water and the pricing of municipal water services. Public Finance Quarterly, 20(1), 93-102. https://doi.org/10.1177/109114219202000106

Martinez-Espineira, R., Garcia-Valinas, M. A., & González-Gómez, F. (2009). Does private management of water supply services really increase prices? An empirical analysis in Spain. *Urban Studies*, 46(4), 923-945. https://doi.org/10.1177%2F0042098009102135

Martínez-Espiñeira, R. & Nauges, C. (2004). Is all domestic water consumption sensitive to price control?. Applied economics, 36(15), 1697-1703. https://doi.org/10.1080/0003684042000218570

Melgarejo J., Prats D., Molina A. & Trapote A. (2016). A case study of urban wastewater reclamation in Spain: Comparison of water quality produced by using alternative

683 processes and related costs. Journal Of Water Reuse And Desalination, 6(1), 72-81.
684 https://doi.org/10.2166/wrd.2015.147

685 Melgarejo, J. & López, M.I. (2016). La economía del ciclo urbano del agua en España.
686 En **Desafíos del Derecho de Aguas**, Aranzadi, Pamplona.

687 Nauges, C., & Whittington, D. (2010). Estimation of water demand in developing
688 countries: An overview. *The World Bank Research Observer*, 25(2), 263-294. DOI:
689 10.2307/40891376

690 Navarro, T. (2018). Water reuse and desalination in Spain–challenges and opportunities.
691 Journal of Water Reuse and Desalination, 8(2), 153-168.
692 https://doi.org/10.2166/wrd.2018.043

693 Opaluch, J. J. (1984). A Test of Consumer Demand Response to Water Prices: Reply.
694 Land Economics, 60(4). https://doi.org/10.2307/3145721

695 Pinto, F. S., Simões, P., & Marques, R. C. (2017). Water services performance: do
696 operational environment and quality factors count?. *Urban Water Journal*, 14(8), 773-
697 781. https://doi.org/10.1080/1573062X.2016.1254254

698 Renzetti, S. (1992). Evaluating the welfare effects of reforming municipal water prices.
699 Journal of Environmental Economics and Management, 22(2), 147-163.
700 https://doi.org/10.1016/0095-0696(92)90011-K

701 Rogers, P., De Silva, R. & Bhatia, R. (2002). Water is an economic good: How to use
702 prices to promote equity, efficiency, and sustainability. Water policy, 4(1), 1-17.
703 https://doi.org/10.1016/S1366-7017(02)00004-1

704 Ruijs, A., Zimmermann, A. & van den Berg, M. (2008). Demand and distributional effects
705 of water pricing policies. Ecological Economics, 66(2-3), 506-516.
706 https://doi.org/10.1016/j.ecolecon.2007.10.015

707 Shin, J. S. (1985). Perception of price when price information is costly: evidence from
708 residential electricity demand. The review of economics and statistics, 591-598.
709 https://doi.org/10.2307/1924803

710 Tardieu, H. & Préfol, B. (2002). Full cost or "sustainability cost" pricing in irrigated
711 agriculture. Charging for water can be effective, but is it sufficient?. Irrigation and

712 Drainage: The journal of the International Commission on Irrigation and Drainage, 51(2),
713 97-107. https://doi.org/10.1002/ird.44

714 Yoo, J., Simonit, S., Kinzig, A. P., & Perrings, C. (2014). Estimating the price elasticity
715 of residential water demand: the case of Phoenix, Arizona. *Applied Economic*
716 *Perspectives and Policy*, 36(2), 333-350. https://doi.org/10.1093/aepp/ppt054

717 Appendix

718 Table A.1. Total and financial cost recovery of the Spanish Hydrographic Confederations for
719 the hydrological cycles 2015-2021 and 2021-2027.

Cost Recovery[1]	Financial Costs		Total costs	
River basin	2015-2021	2021-2027[2]	2015-2021	2021-2027[2]
Western Cantabrian	85%	86%	76%	77%
Eastern Cantabrian	74%	79%	67%	74%
Ceuta	69%	68%	56%	66%
Melilla	41%	37%	40%	37%
Duero	64%	82%	49%	49%
Ebro	76%	83%	65%	70%
Guadalquivir	83%	84%	74%	79%
Guadiana	80%	71%	59%	50%
Tagus	91%	88%	81%	73%
Júcar	84%	93%	78%	87%
Segura	83%	82%	57%	63%
Miño-Sil	38%	49%	34%	47%
Balearic Islands	75%	-[3]	58%	-[3]
Galicia-Coast	49%	-[3]	41%	-[3]
Tinto, Odiel and Piedras	89%	90%	74%	76%

720 [1]Data are rounded and do not include La Gomera (Canary Islands) due to lack of data and the Catalonia
721 River Basin because it is measured as a budget instead of the traditional form of cost recovery.
722 [2]In some cases, in the documents under public consultation for the planning of the next hydrological cycle
723 (2021-2027), the cost recovery data of the current cycle (2015-2021) have varied slightly, but it has been
724 chosen to keep the data from the current River Basin Management Plan, as these new documents only
725 provide the total cost recovery data of the current plans, leaving out the distinction between financial and
726 environmental costs.
727 [3]The Balearic Islands and Galicia-Coast still do not have a document for the new cycle.
728 Source: García-López, Montano & Melgarejo, 2020.
729
730 Table A.2. Descriptive statistics of exploratory variables.

Variable	Mean	Standard deviation
Water consumption per household (m^3)	126.74	94.01
Water consumption per person (m^3)	56.40	46.42
Price of water consumed per household (€)	157.03	99.41
Price of water consumed per person (€)	69.95	50.68
Unit price of water consumed (€/m^3)	1.36	0.48
Number of members in the household	2.65	1.23
Annual income of the household (€)	25,299.02	16,475.09

Total household expenses (€)	23,938.23	15,753.50
Weight (%)	0.86	0.87
One adult without children	0.18	0.39
Two adults without children	0.31	0.46
Other households without children	0.13	0.34
One adult with at least one child	0.03	0.18
Two adults with one child	0.12	0.33
Two adults with two children	0.14	0.34
Two adults with three or more children	0.03	0.16
Other households with children	0.06	0.24
Andalusia	0.11	0.31
Aragon	0.04	0.20
Asturias	0.04	0.19
Balearic Islands	0.03	0.17
Canary Islands	0.05	0.21
Cantabria	0.04	0.19
Castilla and León	0.07	0.25
Castilla-La Mancha	0.06	0.23
Catalonia	0.09	0.29
Valencia	0.08	0.27
Extremadura	0.04	0.21
Galicia	0.05	0.23
Madrid	0.07	0.26
Murcia	0.04	0.21
Navarra	0.04	0.18
Basque Country	0.10	0.31
La Rioja	0.03	0.18
Ceuta	0.01	0.07
Melilla	0.01	0.07
Residing in a city with less than 10,000 inhabitants	0.38	0.49
Residing in a city between 10000 and 20000 inhabitants	0.13	0.33
Residing in a city between 20000 and 50000 inhabitants	0.16	0.36
Residing in a city between 50000 and 100000 inhabitants	0.11	0.31
Residing in a city with more than 100000 inhabitants	0.23	0.42
Residing in a low-density area	0.28	0.45
Residing in a medium density area	0.25	0.43
Residing in a high-density area	0.48	0.50
Observation of the year 2016	0.34	0.47
Observation of the year 2017	0.34	0.47
Observation of the year 2018	0.33	0.47

731 Source: own elaboration with INE data.

732 Table A.3. Summary of the main variables of interest by region and type of household.

Variable	Consumption per person (m^3)	Income per household (€)	Water invoice (€)	Unit price (€)	Weight (%)
Region					

Andalusia	60.22	21,571.95	165.71	1.39	1.07
Aragón	37.91	25,219.14	82.15	1.18	0.45
Asturias	66.89	24,845.58	133.11	1.29	0.73
Balearic Islands	88.77	26,740.59	239.03	1.42	1.20
Canary Islands	68.06	20,766.79	199.68	1.47	1.38
Cantabria	57.82	24,425.29	128.52	1.23	0.73
Castilla and León	52.72	23,915.12	101.54	1.16	0.56
Castilla – La Mancha	49.67	20,972.61	119.55	1.24	0.75
Catalonia	63.26	26,088.75	188.40	1.67	0.96
Region of Valencia	58.41	23,505.74	178.13	1.61	1.07
Extremadura	47.21	19,340.12	122.26	1.32	0.82
Galicia	55.19	22,683.21	124.78	1.22	0.76
Madrid	72.60	28,734.24	215.97	1.63	1.04
Murcia	70.36	23,326.68	212.41	1.43	1.29
Navarra	55.44	25,566.01	134.51	1.31	0.68
Basque Country	54.01	29,687.25	119.46	1.16	0.53
La Rioja	58.99	24,348.98	120.12	1.16	0.66
Ceuta	60.69	26,573.18	195.59	1.34	1.27
Melilla	75.72	26,334.80	115.55	0.68	0.75
Tipo de hogar					
One adult without children	96.30	14,712.92	126.88	1.46	1.12
Two adults without children	62.21	24,674.24	159.66	1.44	0.84
Other households without children	46.79	31,653.28	194.38	1.42	0.84
One adult with at least one child	53.78	17,492.15	167.02	1.46	1.36
Two adults with one child	44.53	27,354.39	175.37	1.46	0.86
Two adults with two children	37.26	31,340.34	195.25	1.44	0.84
Two adults with three or more children	31.69	29,418.52	211.32	1.44	1.07
Other households with children	37.80	31,487.51	223.22	1.43	1.00
Spain	56.40	25,299.02	157.03	1.36	0.86

733 Source: own elaboration with INE data.

734 Table A.4. Spanish values for unit price, unit cost, distributed water and available water.

Year	Unit price (€/m^3)	Unit cost (€/m^3)	Registered and distributed water per person (m^3)	Available water per person (m^3)
2001	0.57	0.76	79.70	135.83
2002	0.61	0.81	76.61	134.94
2003	0.64	0.86	79.04	141.34
2004	0.66	0.95	77.10	140.90
2005	0.67	1.00	71.58	135.81
2006	0.71	1.07	67.46	127.53
2007	0.75	1.26	64.40	121.82
2008	0.81	1.31	65.24	115.17

2009	0.88	1.42	67.09	108.20
2010	0.92	1.51	64.42	105.28
2011	0.95	1.54	60.19	104.72
2012	1.03	1.73	58.09	103.72
2013	1.09	1.83	52.92	104.85
2014	1.10	1.89	49.49	104.13

735 Source: own elaboration with INE data.