¿DISPONEN LOS HOGARES DE INFORMACIÓN PARA LA TOMA DE DECISIONES? EL CASO DE LOS SERVICIOS MUNICIPALES DE AGUA

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Introduction

- Pricing measures are demand-side strategies that have been systematically applied to manage water resources. Researchers and policy makers have devoted a lot of attention to this tool.

- Water tariff design is a difficult process that involves multiple objectives, especially at the residential level (OECD, 2003, 2010) → A matter of principles:

  - **S**ufficiency
  - **E**fficiency
  - **A**ffordability
  - **T**ransparency

Introduction

- Tailoring tariffs to policy objectives usually occurs at the expense of simplicity.

- ”Misperception of prices is most likely to occur when pricing schedules are complex, when the connection between consumption and payoffs is remote, and when other features of the economic environment make it difficult to learn from past experience. ”(Liebman and Zeckhauser, 2004, p. 2).

- Particularly cumbersome water pricing system in Spain: institutional and environmental complexity

Introduction

- Information is a crucial ingredient in rational decision-making and in the design of powerful tools to manage water resources

- Aim: analysing key informational issues about water pricing in the residential sector

- We study the level of user knowledge about consumption and bill→ comparing actual data and self-perceptions of residential water users in the city of Granada, Spain

- Several econometric models (CMP; LCM) will be proposed to explore the role of different informational and socioeconomic aspects in explaining those deviations, while detecting profiles of users that may respond differently to those informational policies

Background and literature review

- Cognitive costs have been documented as an important factor in explaining a reduced response of consumers to price, since most consumers find it complex to understand tariffs (Nieswiadomy and Molina, 1989; de Bartolome, 1995)

- When prices and consumption are misperceived, suboptimal choices emerge that may cause substantial losses in social welfare (Liebman and Zeckhauser, 2004)

- However, literature addressing informational issues in the water sector is still scarce

Background and literature review

- Consumption perceptions:
  - Actual water consumption units for which households are paying are different from the units on which consumers base their consumption decisions (Binet et al. 2014)
  - Sometimes, deviations were especially large in the case of intensive water-use activities (Atari 2014)
  - Older and male respondents stated more accurate perceptions of water use. No clear profiles in terms of education level, previous experience with drought or the adoption of water-efficient appliances (Atari, 2014)

Background and literature review

- Price perceptions:
  - Non-transparent price information lead residential water users to inaccurate price perceptions (Lott, 2017)
  - Higher probability that households know their bill than their marginal price or other price schedule details (Brent and Ward, 2019)
  - Older respondents more likely to have better information about the marginal price. Respondents' confidence levels were positively correlated with the probability of having more accurate information about water prices (Brent and Ward, 2019)

- Other findings:
  - No clear profile on over/under estimation of consumption or/and prices/bill (Binet et al. 2014; Brent and Ward, 2019)
  - Households using more water had more accurate information about water bills and prices (Brent and Ward, 2019).

The context

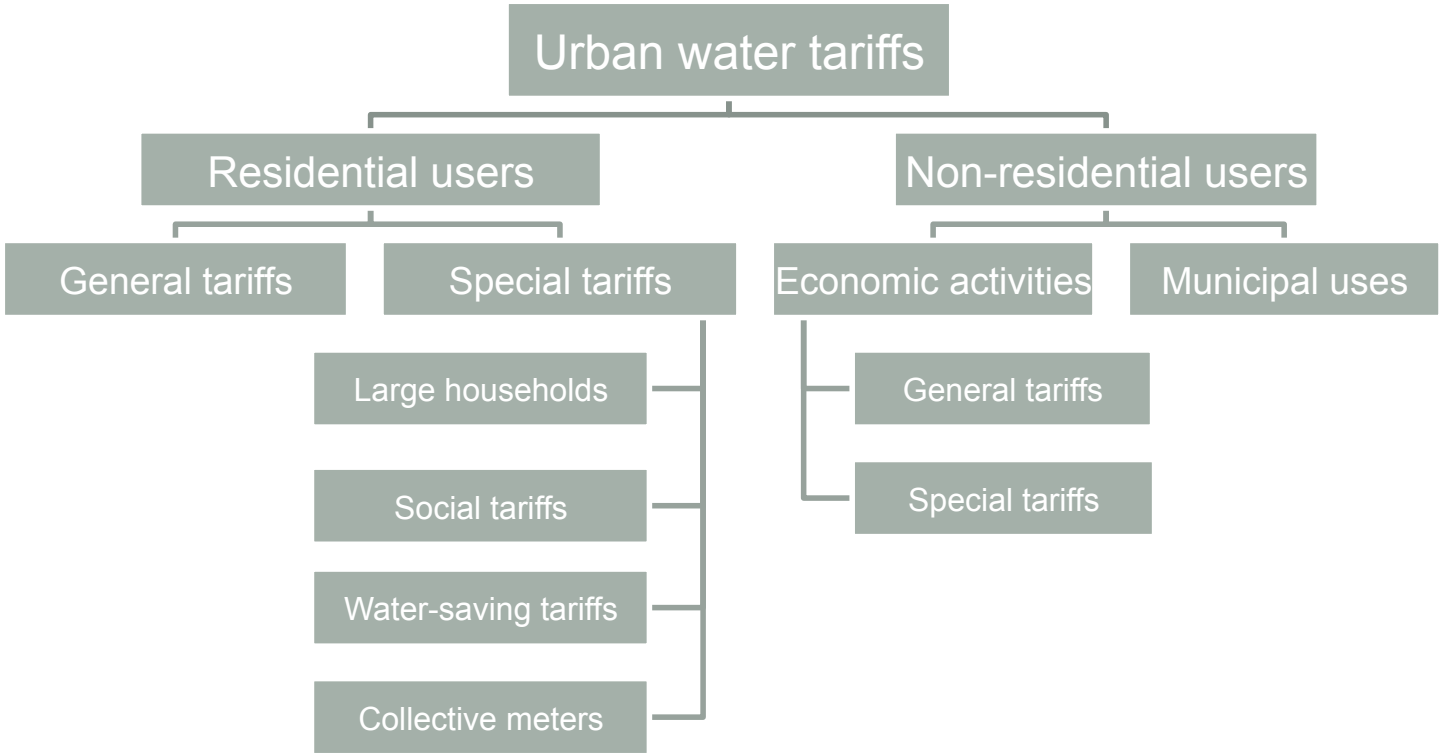
- Spain is a country with strong regional differences in weather conditions, dealing with frequent droughts and quality related problems (Lopez-Gunn et al. 2012; Willaarts et al. 2014).

- Complex water-pricing map in Spain due to institutional and governance factors (Calatrava et al., 2015).

- Both central and sub-central governments actively participating in the design of public water policies. Extreme atomization of local governments with a broad variety of tariff schedules (Calatrava et al., 2015; Garcia-Valiñas, 2019; Arbués and García-Valiñas, 2020). No central regulatory body.

The context

Figure 3. Urban water tariffs in Spain



Source: Arbués and García-Valiñas (2020)

The context

Table 1. Residential water tariff structure: water supply volumetric charge at the 15 most populated cities in Spain

City	Billing period	Type of tariff	Number of blocks	First block size (m^3/month)	Last block: Kink point (m^3/month)	First block price, p_{first} (€/m^3)	Last block price, p_{last} (€/m^3)	Ratio (p_{last}/p_{first})
Alicante	Quarterly	IBT	4	4.00	21.00	0.01	2.56	256.00
Barcelona	Monthly	IBT	5	7.00	18.00	0.61	3.04	5.00
Bilbao	Quarterly	IBT	3	8.33	25.00	0.57	1.25	2.20
Córdoba	Bimonthly	IBT	3	9.00	18.00	0.79	1.23	1.55
Gijón	Bimonthly	IBT	3	15.00	25.00	0.38	0.71	1.88
Las Palmas de Gran Canaria	Bimonthly	IBT	3	5.00	14.00	1.21	3.17	2.62
Madrid	Bimonthly	IBT	3	12.50	25.00	0.13	0.50	3.76
Málaga	Monthly	IBT	4	2.00	5.00	0.21	1.41	6.76
Murcia[1]	Bimonthly	IBT	5	3.00	45.00	0.99	2.64	2.67
Palma de Mallorca	Bimonthly	IBT	5	5.00	40.00	0.60	5.76	9.60
Sevilla	Monthly	IBT	3	4.00	5.00	0.50	1.61	3.22
Valencia	Bimonthly	IBT	2	6.00	6.00	0.47	0.55	1.17
Valladolid	Quarterly	IBT	5	5.33	15.00	0.27	0.66	2.45
Vigo	Bimonthly	IBT + MB	5+1	15.00	100.00	0.39	1.17	3.03
Zaragoza	Quarterly	IBT	3	6.00	18.48	0.21	1.26	5.99

Legend: IBT: Increasing block tariff; MB: Minimum-billed water consumption

[1] The size of the blocks varies according to the diameter of the meter. In this table a 13mm diameter water meter is considered.

Source: Arbues and García-Valiñas (2020)

The context

Table 2. Residential wastewater tariff structure: volumetric charge

City	Services included	Type of tariff	Number of blocks [1]	First block size (m^3/month)	Last block: Kink point (m^3/month)	First block price, p_{first} (€/m^3)	Last block price, p_{last} (€/m^3)	Ratio (p_{last}/p_{first})
Alicante	Sewerage	IBT	4	4.00	20.00	0.01	0.64	64.00
Barcelona[a]	Sewerage	IBT	2	12.00	12.00	0.15	0.22	1.50
Bilbao	Sewerage+Treatment	IBT	3	8.30	25.00	0.56	1.24	2.20
Córdoba	Sewerage+Treatment	IBT	3	9.00	18.00	0.34	0.53	1.55
Gijón	Sewerage	UVT	1	-	-	0,18	0,18	1.00
Las Palmas de Gran Canaria	Sewerage+Treatment	UVT	1	-	-	0.27	0.27	1.00
Madrid	Sewerage	IBT	3	8.30	16.70	0.10	0.14	1.35
	Treatment	IBT	3	8.30	16.70	0.31	0.54	1.74
Málaga	Sewerage	IBT	4	2.00	5.00	0.13	0.56	4.14
	Treatment	IBT	4	2.00	5.00	0.16	0.48	2.88
Murcia	Sewerage	UVT	1	-	-	0.32	0.32	1.00
Palma de Mallorca	Sewerage	IBT	6	5.00	60.00	0.19	2.98	15.50
Sevilla	Sewerage	IBT	3	4.00	5.00	0.31	0.91	2.93
	Treatment	IBT	3	4.00	5.00	0.32	0.98	3.04
Valencia	Sewerage	UVT	1	-	-	0.30	0.30	1.00
Valladolid[a]	Sewerage	IBT	4	5.00	12.00	0.16	0.42	2.59
Valladolid[b]	Treatment	IBT	2	5.00	5.00	0.17	0.29	1.74
Vigo	Sewerage+Treatment	IBT+MB	5+1	15.00	100.00	0.41	0.97	2.32
Zaragoza	Sewerage+Treatment	IBT	3	6.00	18.48	0.26	1.58	5.99

Note: For simplicity, all figures are reported with two decimals

Legend: IBT: Increasing block tariff; MB: Minimum-billed water consumption; UVT: Uniform Volumetric Tariff

[1] In those cities where there is a MB or free allowance, this is shown separately (e.g. 2+1); [a] Sewerage; [b] Treatment

Source: Arbués and García-Valiñas (2020)

The context

- Granada is a midsize city (232,462 inhabitants, 2019) located in Andalusia, Southern Spain
- Very popular touristic destination
- Water services are supplied by EMASAGRA, a mixed company (51% publicly owned)

The context

Table 3. General residential water tariff schedule in Granada, 2010

Block size ($m^3/month$)	Supply (€/m^3)	Sewerage (€/m^3)	Treatment (€/m^3)	Drought surcharge (€/m^3)	Total (€/m^3)
>0-8	0.3895	0.2749	0.2834	0.0840	1.0318
>8-10	1.1401	0.4222	0.2902	0.0840	1.9365
>10-16	1.1401	0.4222	0.2902	0.1020	1.9545
>16-30	1.6020	0.5336	0.3035	0.1020	2.5411
>30	1.8980	0.5931	0.3206	0.1020	2.9137
Fixed charge (*) (€/$month$)	2.3912	0.1610	0.0000	0.0000	2.5522

Legend: (*) 13 mm. meter

Source: Own elaboration

Data and variables

- Database: 1,465 households along the period 2009-2011:
  - Water consumption and water tariffs/bills→ EMASAGRA
  - Self-perceptions on water consumption and prices/ bill, socioeconomic status, housing characteristics and environmental and conservation habits→ survey conducted in 2011

Table 4. Actual and perceived values

Variable	Obs	Mean	Std. Dev.	Min	Max
perceivedbill	3825	42.744	15.546	4.167	180
perceivedcons	948	13.608	13.542	1	145
totalbill	7157	24.511	13.849	5.35	97.63
totalconsumption	7157	16.077	9.323	1	63

Data and variables

- Dependent variables:
  - Providing an estimation: *estimatedcons, estimatedbill* (CMP), *estimatedORD* (LCM)
  - Proportional deviation in absolute terms (*d*) between the actual (*av*) and perceived values (*pv*): *pdcons_abs, pdbill_abs* (CMP), av*pdcons_abs, avpdbill_abs* (LCM)

$$d = /(av - pv)//av$$

- Independent variables:
  - Socioeconomic variables: *satisf, college, ownership, householdsize, p_age18, p_age65*
  - Environmental attitudes and behaviours: *enviro, ap_ effic, waterhabitindex*
  - Information profile variables: *consultedbill, ndbill, knowscampaign, knowsweb, knowstariff*
  - Other variables*: hotshared, b1-b5*

Data and variables

Table 5. Main descriptives

Variable	Obs	Mean	Std. Dev.	Min	Max
avpdbill_abs	3825	1.136	.74	.034	3.984
avpdcons_abs	948	.513	.411	.017	3.267
app_effic	7157	.254	.436	0	1
b1	7157	.172	.378	0	1
b2	7157	.173	.378	0	1
b3	7157	.172	.377	0	1
b4	7157	.158	.365	0	1
b5	7157	.157	.364	0	1
college	6990	.676	.468	0	1
consultedbill	7157	.054	.226	0	1
enviro	7157	.794	.404	0	1
estimatedbill	7157	.538	.499	0	1
estimatedcons	7157	.133	.34	0	1
estimatedORD	7157	.671	.674	0	2
hotshared	7134	.523	.499	0	1
householdsize	7116	2.671	1.215	1	9
knowscampaign	7157	.535	.499	0	1
knowstariff	7157	.337	.473	0	1
knowsweb	7157	.205	.404	0	1
ndbill	7157	.497	.5	0	1
ownership	7145	.753	.431	0	1
overbill	3825	.882	.323	0	1
overcons	948	.36	.48	0	1
p_age18	7116	.06	.152	0	1
p_age65	7116	.337	.429	0	1
pdbill	3825	-1.071	.96	-4.241	1
pdbill_abs	3825	1.136	.882	.001	4.241
pdcons	948	.008	.776	-5	1
pdcons_abs	948	.513	.583	0	5
satisfied	6812	.89	.313	0	1
waterhabitindex	7157	.575	.176	0	1

Econometric models

- A first analysis is based on conditional mixed process (CMP) to jointly estimate several dependent variables (*estimatedcons* and *estimatedbill*, jointly with *pdcons* abs and *pdbill* abs, respectively). Accounting for the likely endogeneity among the unobservable factors explaining the variability of those dependent variables.

- Our second analysis is based on the application of Latent Class Analysis (LCA) in order for unobservable factors to inform a distribution of consumers in terms of their level of awareness of water prices and water use into a finite number of groups or “classes”. This approach involves two simultaneous steps: estimation of the main regression of interest and estimation of the *probability that each respondent household belongs to a specific class*.

Results: CMP

Table 6. CMP estimates

	Estimation of Consumption		Estimation of Bill	
	estimatedcons	pdcons_abs	estimatedbill	pdbill_abs
satisfied	0.158	-0.313***	-0.335***	0.009
college	0.203***	0.039	-0.210***	0.020
ownership	0.285***	0.102	-0.015	-0.153***
householdsize	0.024	0.060**	-0.104***	-0.077***
p_age18	-0.583***	-0.262	0.082	0.275**
p_age65	0.220***	0.112*	-0.225***	-0.077
ndbill	-0.483***	0.079	-0.905***	0.105*
consultedbill	1.568***	-0.269**	1.909***	-0.003
knowscampaign	-0.072	0.026	-0.178***	-0.051
knowstariff	0.545***	-0.077	0.262***	0.082**
knowsweb	0.309***	0.072	0.326***	0.023
hotshared	-0.004	-0.029	-0.170***	0.120***
enviro	0.440***	0.087	0.119**	-0.166***
app_effic	0.161**	0.016	-0.111*	-0.021
waterhabitindex	0.189	-0.419***	-0.108	-0.036
b1	-0.000	0.038	0.026	0.057
b2	0.020	0.039	0.029	-0.016
b3	0.004	0.012	0.028	-0.070
b4	0.044	0.057	0.033	-0.080
b5	0.014	0.304***	-0.016	0.356***
N	6655		6655	
log-likelihood	-2767		-8426	
$\chi 2$	1349		1642	
p-value	0.000		0.000	
atanh(β_{cons})	-0.060			
atanh(ρ_{bill})			-0.214	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results: LCM

Table 7. LCM estimates

	1.C	avpdcons_abs	avpdbill_abs
consultedbill	4.636***		
ndbill	-2.053***		
knowstariff	0.633***		
knowsweb	0.534**		
knowscampaign	-0.353*		
satisfied	-0.457		
college	-0.512**		
ownership	0.073		
p_age18	0.159		
p_age65	-0.306		
householdsize	-0.239**		
enviro	0.467		
app_effic	-0.186		
hotshared	-0.209		
waterhabitindex	-0.573		
1.C		0.463***	1.160***
2.C		2.461***	1.097***
_cons	1.950***		
N	1150		
log-likelihood	-1767.54		

LCM classifying households according to the number of estimates (about their consumption and their bill) they provided and how they deviated from actual values. Class 2 is the benchmark of the Fractional Logit Model.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results: LCM

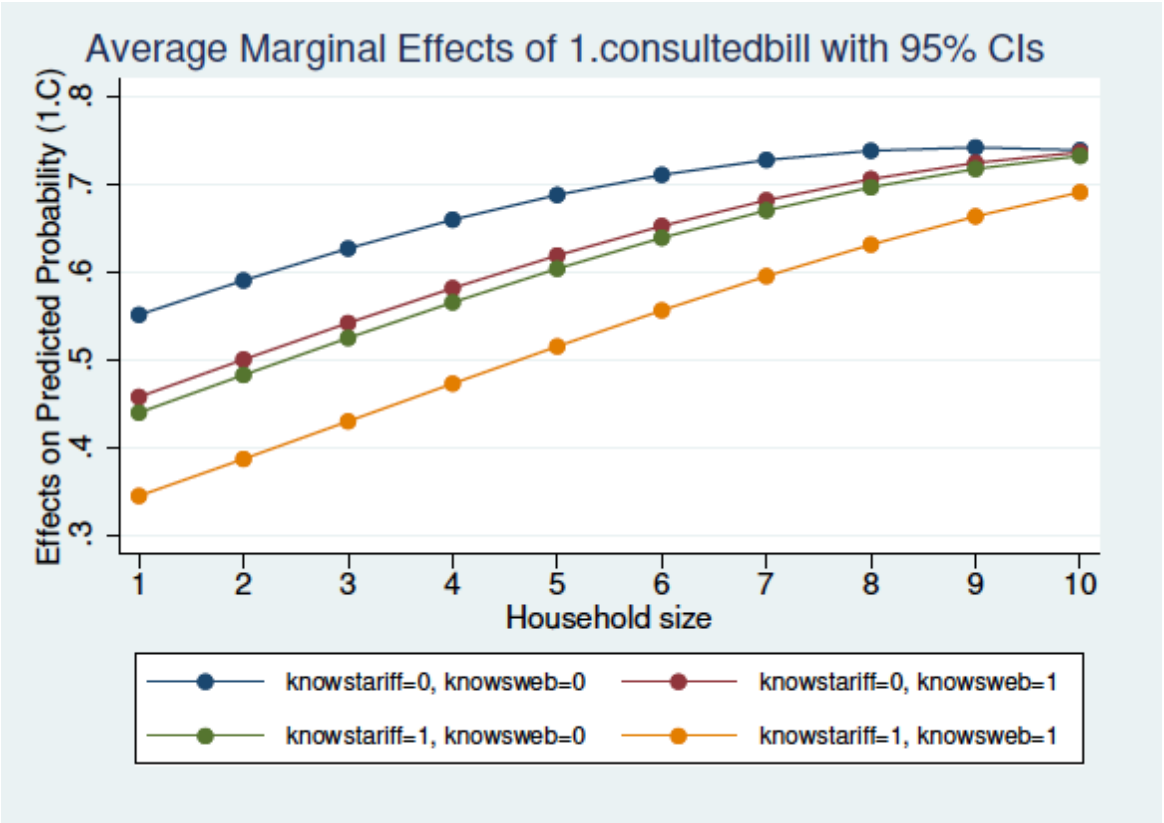
Table 8. Class membership probabilities and marginal means of dependent variables

Marginal mean	Class 1	Class 2
Class membership	0.44	0.56
estimatedORD = 0	0.00	0.78
estimatedORD = 1	0.74	0.21
estimatedORD = 2	0.26	0.01
avpdcons_abs	0.46	2.46
avpdbill_abs	1.16	1.10

Table 9. Means of selected variables after using posterior probabilities to classify sample households

	Class1	Class2
totalconsumption	15.911	16.127
totalbill	24.309	24.501
overcons	0.344	1.000
overbill	0.887	0.844
knowscampaign	0.547	0.536
knowstariff	0.443	0.235
knowsweb	0.274	0.156
college	0.641	0.704
ndbill	0.198	0.746
consultedbill	0.117	0.001

Results: LCM


Average Marginal Effects of 1.consultedbill with 95% CIs
Effects on Predicted Probability (1.C)
.3
.4
.5
.6
.7
.8
1
2
3
4
5
6
7
8
9
10
Household size
knowstariff=0, knowsweb=0
knowstariff=0, knowsweb=1
knowstariff=1, knowsweb=0
knowstariff=1, knowsweb=1

Conclusions

- The level of knowledge of both consumption and bill is rather low. Most consumers do not even attempt at giving at answer. When an estimate is provided, we find that deviations from actual values are high
- In explaining how consumers' perceptions of the key economic variables deviate from reality, information has been shown to have, as expected, a key role
- Behavioural economics policies aiming at promoting the careful reading of one's bill are strongly recommendable
- Better detailing the bills so that consumers find them more explanatory could, therefore, significantly improve people's awareness of the relevant economic variables in demand-side policies
- Public administrations should, therefore, strive to either convey the information in a simpler and didactic manner, or directly simplify the tariffs so that they do not distort consumer perceptions

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