Newts microsimulation model for an informative and co-creative public-decision making

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NEWTS

NUDGES FOR ECONOMICS OF WATER TARIFFS

NEWTS MICROSIMULATION MODEL

FOR AN INFORMATIVE AND CO-CREATIVE PUBLIC DECISION MAKING

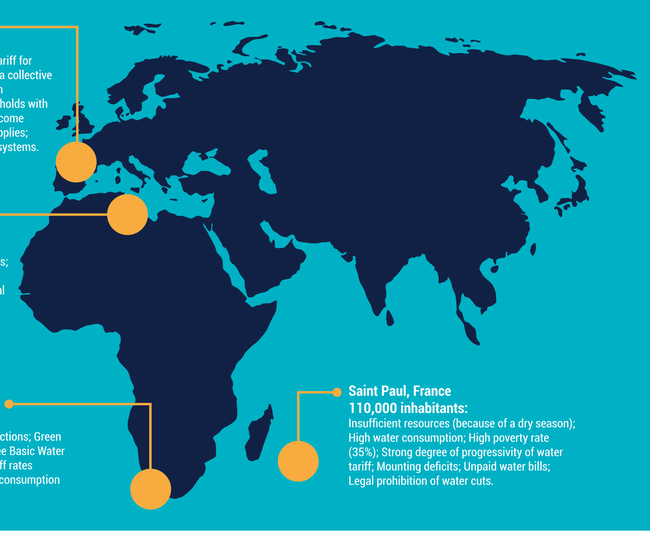
THE NEWTS PROJECT

The research program addresses the issue of household water demand management. Prima facie, it aims to provide a socio-economic assessment of green nudging policies, focusing on water consumption controlling and proper understanding of the charging system by the households, taking into account adjustments in the pricing policy that nudges may generate (in view of their effects on water demand functions). From an operational point of view, it consists in developing a micro-simulation model, based on econometric estimates of household water demands, to assess the socio-economic returns of mix policies, combining nudges and pricing instruments, and identify financially sustainable DSM (demand-side management) policies to improve current water utility tariffs.

SOCIAL INCENTIVE PRICING POLICY

- Affordability
- Incentive Pricing
- Equity
- Full Cost Recovery
  Including Environmental Costs
- Financial Stability

STUDY SITES



Gijón, Spain
271,000 inhabitants:
Three-blocks water tariff; Special tariff for households living in buildings with a collective metering system (two-blocks); High percentage of water billed to households with collective meters (57% in 2017); Income public policies supporting basic supplies; Pending investments in sanitation systems.

Sfax, Tunisia
900,000 inhabitants:
Semi-arid climate; Very high mobilization cost of water resources; Super-progressive pricing (all the water use is charged at the marginal price); High disparity in regular access to water; Insufficient water supply; High demand of water.

Cape Town,South Africa,
4 million inhabitants:
Water crisis (Day Zero); Water restrictions; Green nudges campaign (2015-2016); Free Basic Water Policy; Substantial increases of tariff rates (15.55 €/kl (water + sanitation) for consumption slightly above 10.5 kl /month).

Saint Paul, France
110,000 inhabitants:
Insufficient resources (because of a dry season); High water consumption; High poverty rate (35%); Strong degree of progressivity of water tariff; Mounting deficits; Unpaid water bills; Legal prohibition of water cuts.

THE SCIENTIFIC PROJECT

1 LINKING NUDGES AND WATER DEMAND FUNCTIONS

Econometric estimate of local water demand functions

Nudges campaign / Randomized control trials / Impacts on water consumption (treatment effects)

Econometric estimation of resulting changes in local water demand functions

Identification of transmission channels:
- decrease in captive consumption?
- greater price-sensitivity?
- improved perceptions of tariffs?

2 DSM POLICY DESIGN

Socio-economic evaluation of local current water tariffs (through a dashboard of appropriate indicators, in each area of the EDF for water, making use of the information provided by econometric estimates of water demand functions)

Assessment of the contributions of nudges to the socio-economic performance of local current water tariffs.

Simulations of mixed programs, combining nudges and tariff instruments, making use of estimated econometric models and relied data sets.

3 ADVANCING RESEARCH IN BIS

Lab experiments to deal with time dimension and spillover effects (social interactions)

Improving the information conveyed by benchmarking and social normal information treatments
(large consumer vs. over-consumer)

The use of smart technologies (nudges design, static vs. dynamic infographics, dark patterns)

Nudges perception (additional feedbacks from the field with local public consultation, local stakeholder consultation and focus groups)

GENERAL ARCHITECTURE

"Policy makers and water professionals often rely too heavily on their intuition to assess how changes in water tariff regimes affect financial self-sufficiency, equity, and economic efficiency. Quantitative assessment of these impacts requires the specification of a set of nonlinear relationships with numerous parameters, and then formal simulation procedures to analyze how changes in the tariff structure and price levels affect outcomes of policy interest. Intuition is an unreliable guide for understanding the behavior of systems of nonlinear equations."

Nauges C. & Whittington D. [2017], Evaluating the Performance of Alternative Municipal Water Tariff Designs: Quantifying the Tradeoffs between Equity, Economic Efficiency, and Cost Recovery, World Development, 91, pp. 125-143

POPULATION MODULE

describes the population of households with regard to some relevant variables for calculation and decomposition of (i) consumption, (ii) bills and (iii) indicators making up the dashboard.

PRICING MODULE

describes the tariff system (based on French regulation) that applies for the households listed in the Population Module.
- In the case of IBTs: fixed part, number and size of consumption blocks, unit prices within each block, VAT rate and environmental charges for water service and wastewater service.
- The user is also asked to provide information on service costs (fixed charges, number of subscribers, unit variable cost of production for, successively, water and sanitation) and environmental costs (if available).

DEMAND MODULE

makes use of the econometric model to calculate for each household in the Population module:
- its water consumption $q_i = q_i^d(\bullet)$
- the related captive part and the size of its basic consumption like:
  $\ln \underline{q}_i = -2.56 + 0.48 \cdot \ln N_i + 0.44 \cdot SNWA_i$
  (for instance ; captive part is reprocessed by the user).

INVOICE MODULE

- computes the water bills with $T_i = T(q_i)$
- breaks down the water bill into a minimum basic type part (for water) $T_i^{min} = T(\underline{q}_i)$ and a non-basic type part $T_i - T_i^{min}$
- reconstructs the amount of invoice by distinguishing different subsidies and contributions to service funding (with reference to a structurally balanced two-part tariff $(F,\pi) = (\frac{CF}{n}, c)$

EVALUATION MODULE

includes a scoreboard and about fifty indicators (for level 1 information) allowing to measure the socio-economic performance of the pricing policy in the 5 fields of analysis set by E-WFD.
These indicators correspond:
- to those commonly used in academic literature on water;
- to other measures commonly used in other fields of Economics (Poverty Economics, Production Economics, Tax Economics, Banking and Finance ...) that are thought to be relevant for the field of analysis considered.

EVALUATION MODULE NEWTS DASHBOARD

More information:
CAR by income decile • PAR by income decile...

PAR by standard of living decile:

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
H RATE	1	1	0.957	0.822	0.478	0.5	0.378	0.109	0	0
MEAN	50.32	44.65	36.97	32	21.62	15.87	9.05	2.13	0	0
MEDIAN	33.77	30.68	34.8	30.43	27.04	19.95	16.12	6.46	0	0
STD	35.24	40.67	16.84	24.7	0	0.06	0	0	0	0

Confusion Matrix

	D+	D-	
T*	Q_0^+=6024.5	$(Q-Q_0)^+$=6507.7	Q^+=12532.2
T-	Q_0^-=2396.7	$(Q-Q_0)^-$=1159.3	Q^-=3556.0
	Q_0=8421.2	$Q-Q_0$=7667.0	Q=16088.2

TPR: **71.5%** • Miss Rate: **28.5%** • TNR: **15.1%** ... DOR: **0.448**
Kappa score: **-0.137** • Cohen Ratio: **-0.288**

More information:
Lambert & Aronson sub-group decomposition

	GINI INDEX	WITHIN	BETWEEN	TRANSVARIATION
TBSE	-	-	-	-
IBT	-	-	-	-

AFFORDABILITY			INCENTIVE EFFECT		ECONOMIC EFFICIENCY		EQUITY	FUNDING
	CAR	PAR	**Consumptions**		**Service level**		Gini Index	
Mean	2.7 (%)	1.2 (%)	IBT	45.12	First best	Q^*	**Household income**	
AV TBSE	+ 1.3	+ 0.6	TBSE	34.98	IBT	Q	IBT	
Median	2.7 (%)	1.2 (%)	PP IBT:	38.00	PP IBTI	Q_{k+1}	TBSE	
Std dev	3.4	4.1	**Effective overconsumptions**		Full TBSE	$Q_{Full\ TBSE}$	IBTQ_TBSE	
Incidence			Household	14.2	Actual TBSE	Q_{TBSE}	SFB IBT	
	CAR	PAR	Per capita	2.7				
Household	0.628	0.424	Std dev IBT	11.87	Gap (en %)	...	RS Index	
Individual	0.649	0.556	Std dev PP IBT	8.4			Pfähler Index	
Child	0.884	0.507	Std dev TBSE	12.57				
Intensity EHAD					**Change in Agg. Surplus**		**Per capita income**	
		TBSE			IBT	$\Delta\Gamma$=...		
Mean	40.58	+ 7.2	Invoices (euros per trim.)		PP IBT	$\Delta\Gamma\|_{k+1}$	Concentration coefficients for H income with respect to living standard:	
Median	33.78	+ 3.4	IBT	167.33	Full TBSE	$\Delta\Gamma\|_{Full\ TBSE}$	...	
Std dev AD	29.78	-8.07	PP IBT	129.12	Actual TBSE	$\Delta\Gamma\|_{TBSE}$	Relative net benefit distribution curve and Quasi-Gini Coefficients	
Inequality			TBSE	141.04	**Change in consumer (household) surplus (first rank)**		...	
Gini Index	0.410	0.405			IBT	ΔU=...		
Schutz Index	0.217	0.220	**Mismanagement costs (effective)**		PP IBT	$\Delta U\|_{k+1}$=		
Decile ratio	6.1	4.7	Household	14.25				
Decime ratio	8.2	5.9	Per capita	4.01				

[1]*Effective Household Affordability Deficit*

Funding (Cost Recovery) - Operating result

	S^+	T^-	Δ_{q_0}	S^-	T^+	Δ_{q-q_0}	Δ_q	Access Fee	Δ_{DAI}
d_1	$S^1_{q_0}$	$T^1_{q_0}$	$\Delta^1_{q_0}$	$S^1_{q-q_0}$	$T^1_{q-q_0}$	$\Delta^1_{q-q_0}$	Δ^1_q	$\pi_1\Delta_1$	Δ^1_{DAI}
d_2	$S^2_{q_0}$	$T^2_{q_0}$	$\Delta^2_{q_0}$	$S^2_{q-q_0}$	$T^2_{q-q_0}$	$\Delta^2_{q-q_0}$	Δ^2_q	$\pi_2\Delta_1$	Δ^2_{DAI}
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
d_{10}	$S^{10}_{q_0}$	$T^{10}_{q_0}$	$\Delta^{10}_{q_0}$	$S^{10}_{q-q_0}$	$T^{10}_{q-q_0}$	$\Delta^{10}_{q-q_0}$	Δ^{10}_q	$\pi_{10}\Delta_1$	Δ^{10}_{DAI}
	S_{q_0}	T_{q_0}	Δ_{q_0}	S_{q-q_0}	T_{q-q_0}	Δ_{q-q_0}	Δ_q	$\pi\Delta_0$	π

Taxation

	VAT	GREEN TAXATION	ENVIRONMENTAL COST	REMAINING BALANCE
d_1				
d_2				
⋮				
d_{10}				

Funding Structure

	FIXED	VARIABLE	
REVENUES	nF + $R(Q_0)$	$R(Q - Q_0)$	R(Q)
COST	CF + cQ_0	$c(Q - Q_0)$	C(Q)
	π_0	π_1	π

Operating Result Sensitivity

	g_Q = -1%			IMPACT LARGE CONSUMERS
Revenues	ΔR_0 = ...	ΔR_1 = ...	ΔR = ...	...
Cost	ΔC_0 = ...	ΔC_1 = ...	ΔC = ...	
Operating Result	$\Delta\pi_0$ = ...	$\Delta\pi_1$ = ...	$\Delta\pi$ = ...	

FUTURE DEVELOPMENTS

Specific improvements with:

- Consideration of the amenities (for the measure of the environmental cost);
- Additional indicators related to Political Economics (polarization index) and social part of the water pricing policy;
- Assistance program module for means-tested measures (e.g. aid for unpaid bills, water vouchers, water cheque rebate);
- Decision support Module with reinforcement learning algorithms (artificial intelligence);
- Efficient digital environment (dashboard design, data visualization, information depth, usability engineering ...)
- Up-scaling at the basin level (for integrated management of water resources) with the setting of an aggregated dashboard, mapping of the socio-economic performance of decentralized water DSM policies and spatial inequalities, and integration into a CGE Model (and WEFE nexus)

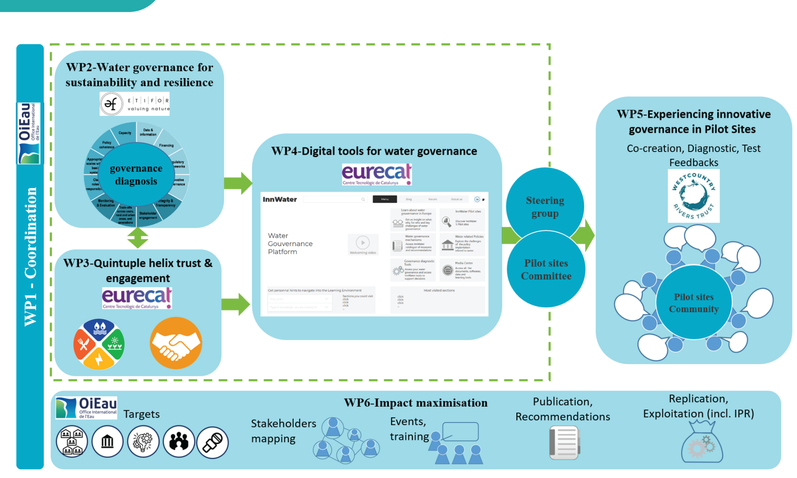
Participant organisation name	Acronym	Country
International Office for Water (CC)	OiEau	FR
University of La Réunion	UR	FR
ETIFOR | Valuing Nature	ETIFOR	IT
University of Rouen Normandy	URN	FR
EURECAT	EUT	ES
SIWI	SIWI	S
REKK Energiapiaci Tanacsado Kft	REKK	HU
West country River Trust	WRT	UK
Association of European Regulators in the drinking water and wastewater sector	WAREG	IT
European University Institute	EUI	IT
Middle Tisza Water Directorate	KÖTIVIZIG	HU
Consiglio Bacino Brenta	CBB	IT
Ajuntament de Figueres	FIGUERES	ES

INN WATER **Pillars**

- Improved water governance assessment framework
- Quintuple Helix and Social Engagement
- Improved economic and financial tools design for basin authorities and utilities

Social innovation — supporting InnWater cross-sector and multi level governance platform for improving water governance and policy recommendations

INN WATER
WORKPACKAGES



Water JPI

UNIVERSITÉ DE LA RÉUNION

CEMOI Université de La Réunion

ANR: Agence nationale de la recherche (ANR) pour la France

AEI: Agencia Estatal de Investigación

MHESR: Ministry of Higher Education and Scientific Research

WRC: Water Research Commission of South Africa

The authors would like to thank the European Commission and the French National Research Agency ANR for funding in the frame of the collaborative international consortium NEWTS financed under the 2018 Joint call of the WaterWorks2017 ERA-NET Cofund. This ERA-NET is an integral part of the activities developed by the Water JPI.