

Determinants of Residential Water Demand in OECD Countries

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Overview

- Respondents were asked questions on household characteristics, environmental attitudes and h/hold behaviours including residential water consumption.
- Using responses from up to 1,600 individuals who provided information on water consumption, this study presents an analysis of factors that affect h/hold water consumption.

Key Research Questions

- (1) Is there a significant difference in water consumption between households that face unit water charges and those which do not?
- (2) How do general attitudes towards the environment (environmental awareness, membership in environmental organization...) influence water consumption?
- (3) How does household water consumption vary with differences in water charges?
- (4) Who would be most adversely affected by increases in water charges?

Survey Water Use Questions (1)

How is your household charged for water consumption?

- Charged according to how much water is used (e.g. via a water meter)
- Flat fee (e.g. lump sum included in charges or rent)
- Don't know

Survey Water Use Questions (2)

Approximately how much was the total annual cost for water consumption for your primary residence?

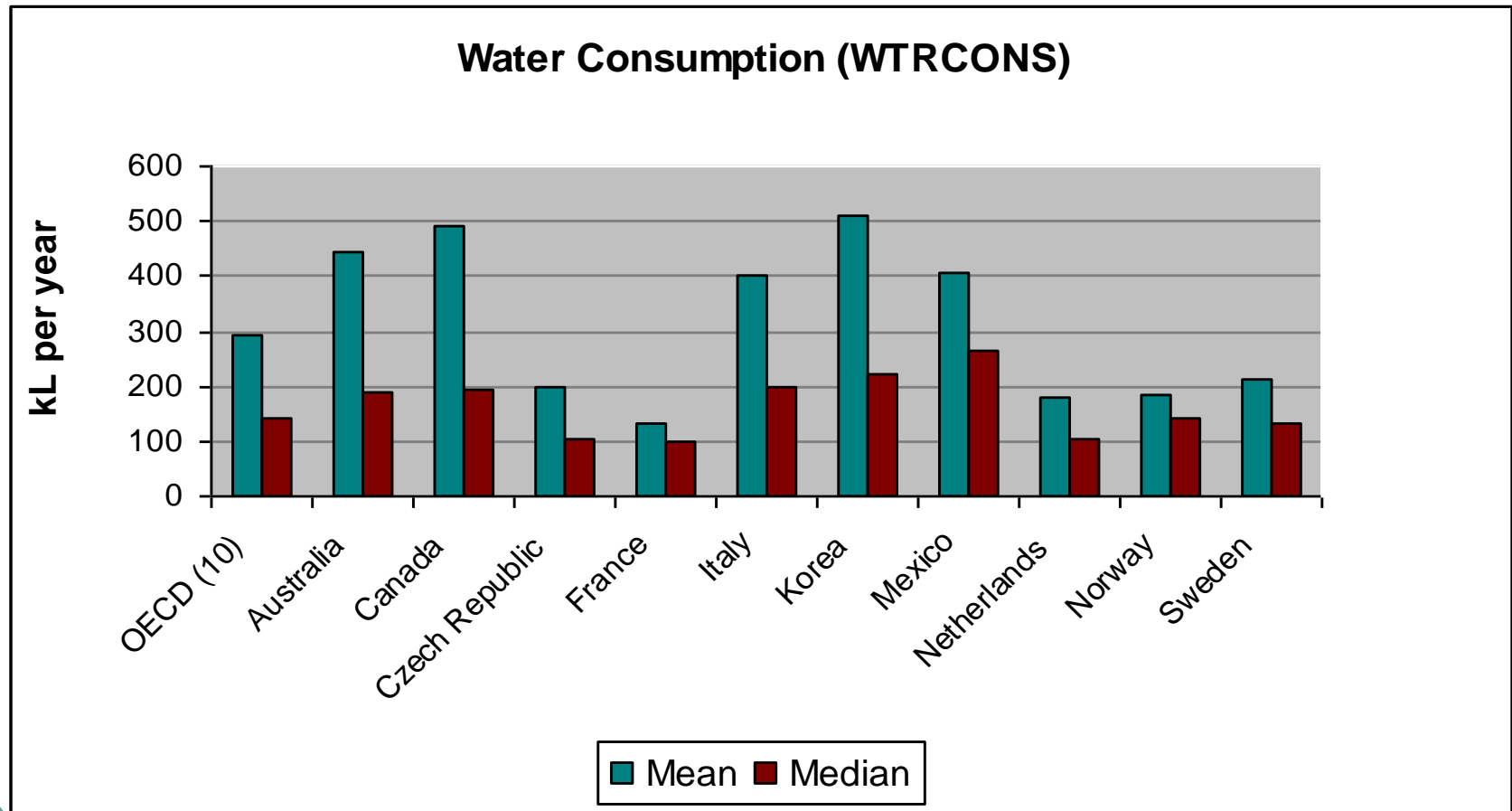
Please indicate if possible amount in \$ per year and corresponding annual consumption in kL

Survey Water Use Questions (3)

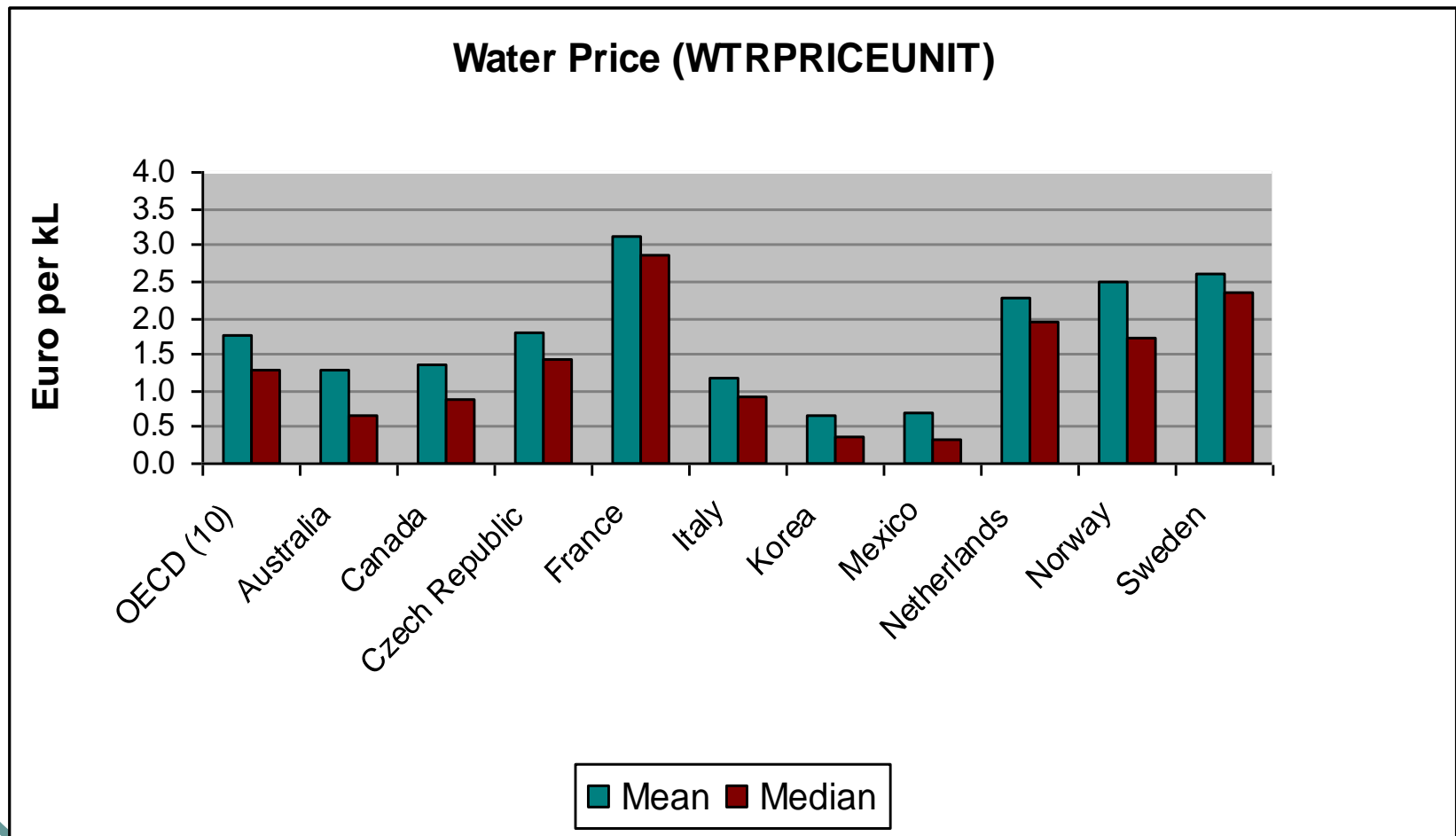
How often do you do the following in your daily life? (never, occasionally, often, always, NA)

- (1) Turn off water brushing teeth
- (2) Take showers instead of baths
- (3) Plug the sink washing dishes
- (4) Water garden in coolest part of the day
- (5) Collect rainwater or recycle waste water

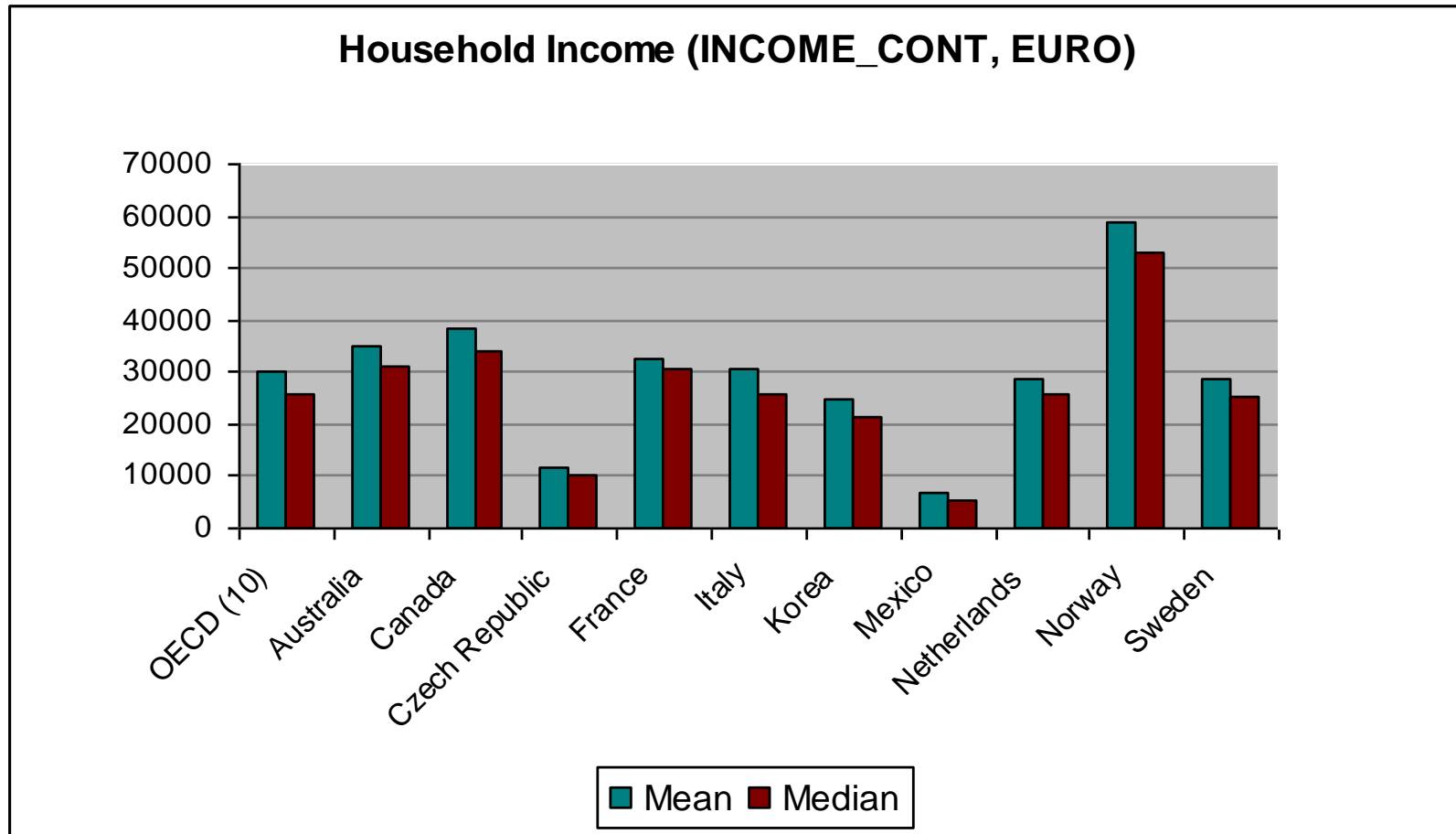
Summary Statistics: Water Consumption



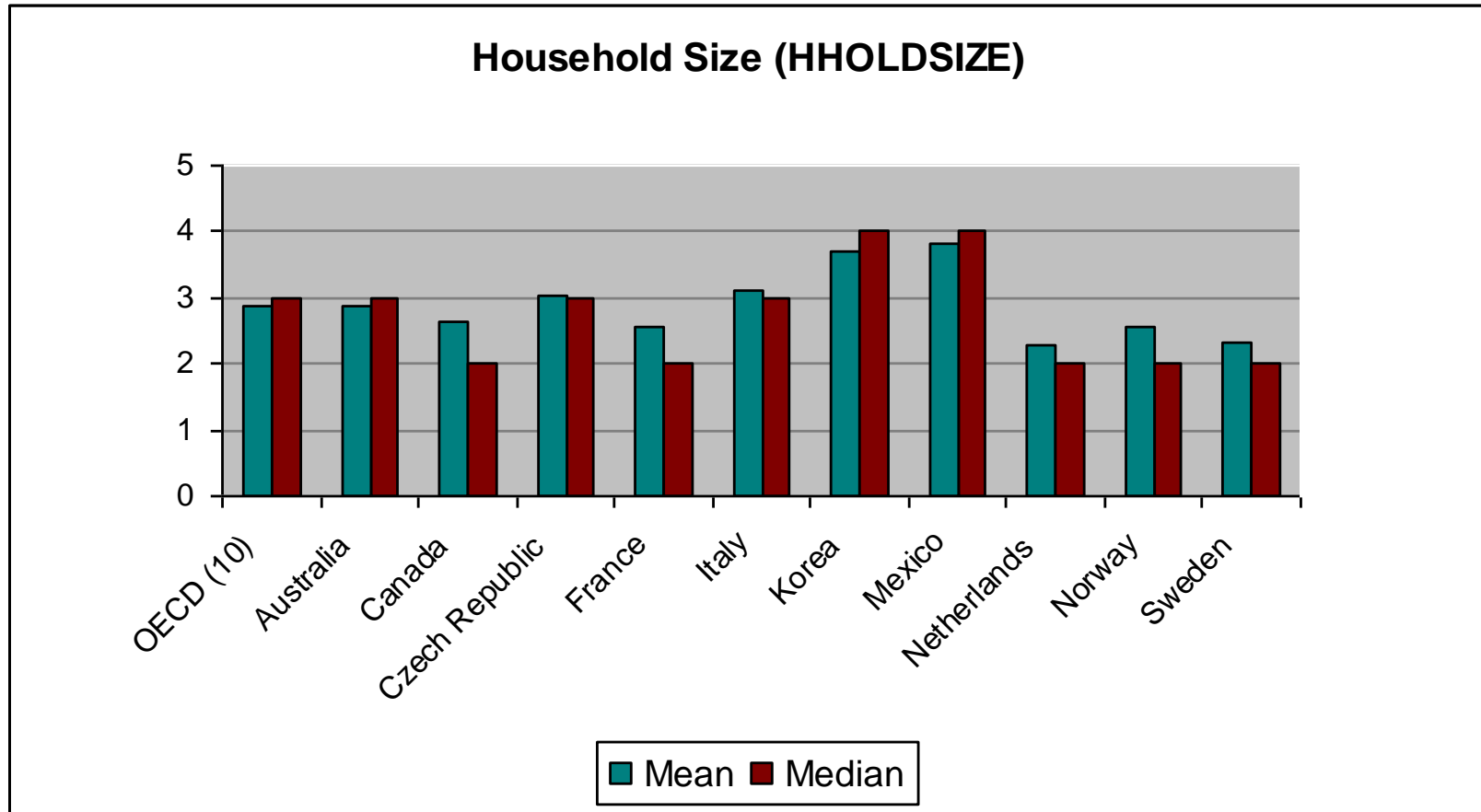
Summary Statistics: Water Price



Summary Statistics: H/Hold Income



Summary Statistics: H/Hold Size



Summary Statistics

Country	Water Bill (Euros)	Median Water Price (Euros/kL)	Water Bill/Income (%)
Australia	226	0.66	0.62
Canada	332	0.88	0.74
Czech. Rep.	229	1.44	1.91
France	373	2.88	1.01
Italy	270	0.93	0.90
Korea	116	0.36	0.50
Mexico	104	0.31	1.42
Netherlands	230	1.93	0.75
Norway	318	1.72	0.50
Sweden	394	2.35	0.98

Results: Volumetric pricing

Dependent Variable: LWTRCONS

Variable	Coefficient	Prob.
WTRFEETYPE_UNIT	-0.280785*	0.0663
INCOME_CONT	-8.94E-07	0.3395
ADULTS	0.211877***	0.0000
CHILDREN_NEW	0.058416***	0.0063
HIGHEDUC	0.081053*	0.0559
RESDSIZE	0.001845***	0.0000
RESDAGE	-0.002422***	0.0023
AGE	0.002091	0.3126
EMPL_FT	0.093937**	0.0419
RESOWNR_NEW	0.097524*	0.0520
AREADESC_URBN	0.134740***	0.0012
WTRINV_DUAL_1	-0.089158**	0.0299
C	4.422778***	0.0000

Water Use and Volumetric Pricing

- Consistent finding (in all countries and in sample as a whole) there is a statistically significant and negative impact on water use from charging households volumetrically (overall impact = 28% reduction water use).
- No statistically significant effect of environmental attitudes or actions on water use.
- Factors that have statistically significant + effect on water use are: # adults, # children, house area, higher education, employment status, owner-occupier status and urban dwelling.
- Factors that have statistically significant - effect on water use are: charged volumetrically, age of house, and use of dual flush toilet.

Results: H/hold Responses to Water Charges

Dependent Variable: LWTRCONS					
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
LWTRPRICEUNIT	-0.561119***	0.0000	AREADESC_URBN	-0.021973	0.5805
LINCOME_CONT	0.096618***	0.0005	RESTYPE_HOUSE	0.0137	0.7597
ADULTS	0.124511***	0.0000	VOTE_NEW	-0.081833	0.2116
CHILDREN_NEW	0.053333**	0.0107	TIMEENVR	-0.060457	0.3384
HIGHEDUC	-0.011196	0.7821	ENVIMEMBER_NEW	-0.006254	0.9018
RESDSIZE	0.001447***	0.0005	ENVATTID_INDXX	-0.016434	0.5653
GRDNSIZE	7.37E-05	0.7006	WTRINV_WMCH_1	0.110527***	0.0039
RESDAGE	0.00097	0.1718	WTRINV_DUAL_1	-0.096283**	0.0128
AGE	0.002479	0.1713	WTRINV_LOWF_1	-0.020689	0.5779
EMPL_FT	0.018888	0.6548	WTRINV_RAIN_1	0.005824	0.8922
EMPL_PT	-0.015266	0.8144	WTRBHV_EXPS	0.004115	0.8668
RESOWNR_NEW	0.025446	0.5793	C	3.596627***	0.0000

Results: H/hold Responses to Water Charges (IV estimation)

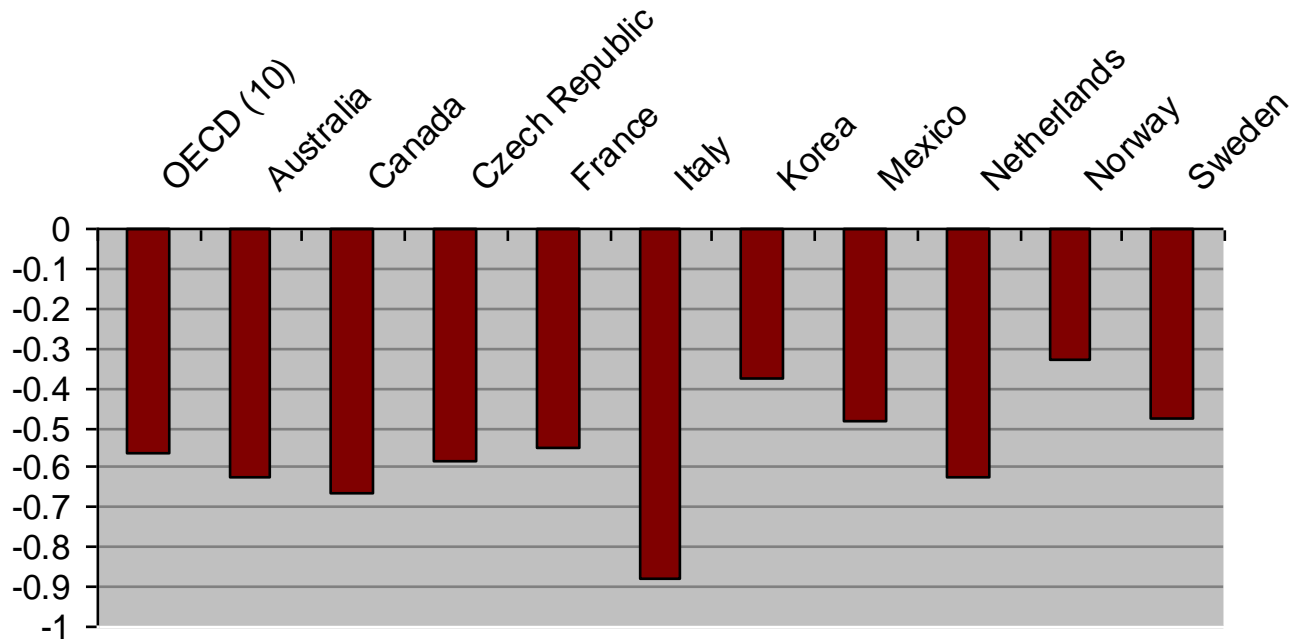
Dependent Variable: LWTRCONS

(IV estimation with instruments: country dummy variables and average bill for each country and urban/rural area, HCE)

Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
LWTRPRICEUNIT	-0.456534***	0.0000	AREADESC_URBN	-0.011784	0.7704
LINCOME_CONT	0.065158**	0.0191	RESTYPE_HOUSE	0.015761	0.7313
ADULTS	0.138864***	0.0000	RESTYPE_HOUSE	0.015761	0.7313
CHILDREN_NEW	0.057394***	0.0062	VOTE_NEW	-0.075609	0.2617
HIGHEDUC	0.016982	0.6728	TIMEENVR	-0.033275	0.6023
RESDSIZE	0.001485***	0.0006	ENVIMEMBER_NEW	-0.002063	0.9680
GRDNSIZE	-0.000100	0.6162	ENVATTID_INDXX	-0.024185	0.3949
RESDAGE	0.000330	0.6618	WTRINV_WMCH_1	0.102421***	0.0086
AGE	0.002354	0.1944	WTRINV_DUAL_1**	-0.091963**	0.0193
EMPL_FT	0.023139	0.5870	WTRINV_LOWF_1	-0.025354	0.4982
EMPL_PT	-0.003027	0.9632	WTRINV_RAIN_1	-0.002385	0.9567
RESOWNR_NEW	0.037357	0.4235	WTRBHV_EXPS	-0.008241	0.7501
			C	3.918264***	0.0000

Price Elasticities

Price Elasticity of Water Demand



Water Use and Water Charges

- Price elasticity of demand is inelastic but statistically significant from zero in all countries (overall a price elasticity of about -0.5).
- No statistically significant effect of environmental attitudes or actions on water use.
- Factors that have statistically significant + effect on water use are: h'hold income, # adults, # children & house area
- Factors that have statistically significant - effect on water use are: water charges and dual flush toilets.

Household Characteristics and Water Charges

- Using interaction terms between low and high income and average water price, can test for changes in response to price change. Find high income households are less responsive to change in price than medium and low income households.
- No statistically significant difference in price response based on household size.

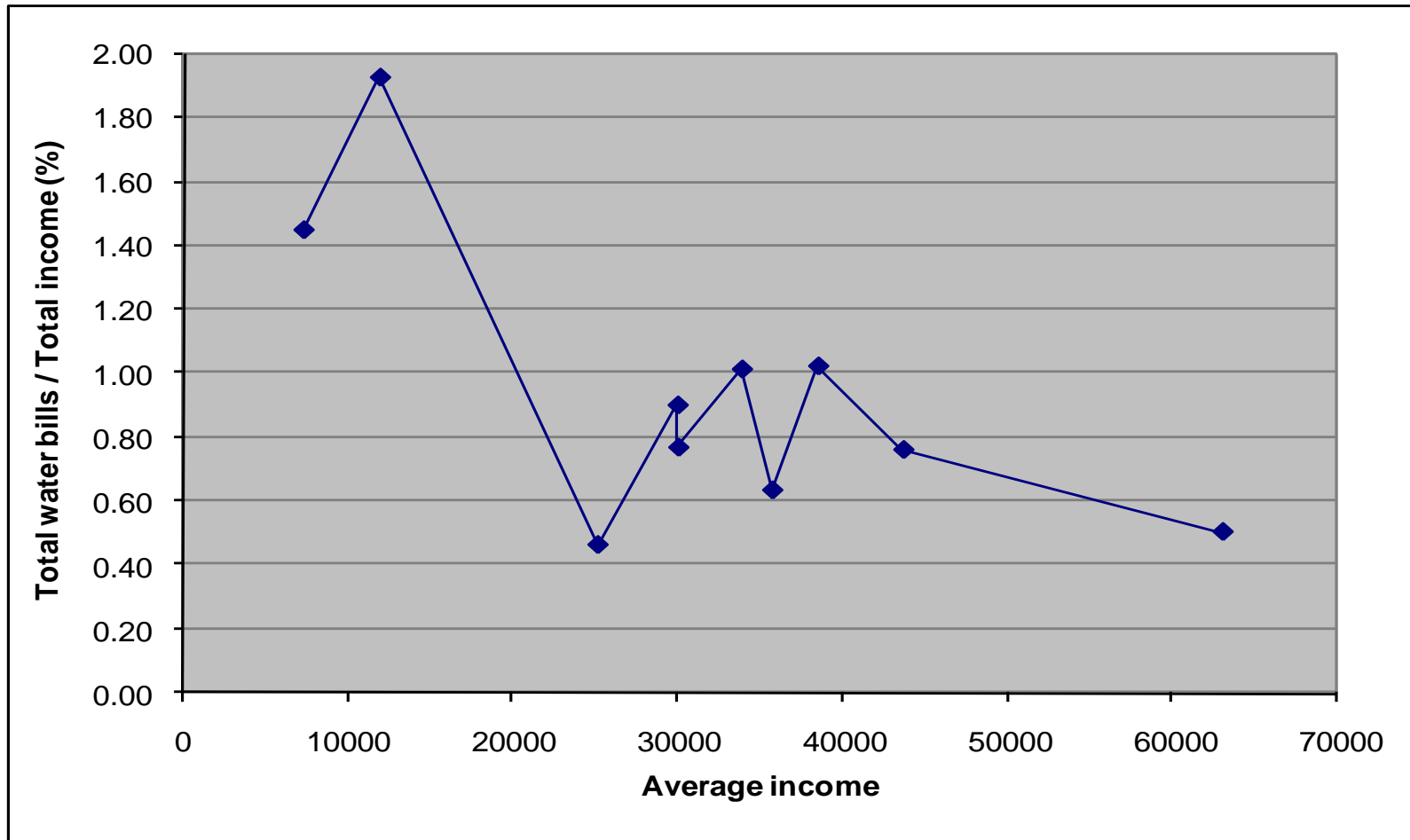
Summary of Results (1)

Survey Variable	Description	Estimated Sign in the OECD (10) survey	Expected sign in literature	Related literature
WTREFEETYPE_UNIT	Dummy variable if households faces volumetric charge	-	-	Dalhusien (2000) (-), Nauges and Thomas (-)
WTRPRICEUNIT	Average water price (€/kL)	-	-	Howe and Linaweaver (-), Renwick & Archibald (-), etc.
INCOME_CONT	Household income (€)	+	+	Dalhuisen et al. (2000, 2003) (+), Schleich and Hillenbrand (2008), etc.
ADULTS	Number of Adults in Household	+	+	Hanke and Maré (+), Lyman (+) , Gaudin (2006), etc.

Summary of Results (2)

Survey Variable	Description	Estimated Sign in the OECD (10) survey	Expected sign in literature	Related literature
CHILDREN_NEW	Number of children	+	+	Lyman (+)
HIGHEDUC	Dummy variable for tertiary education	+	?	
REDSIZE	Residence size (sq. meters)	+	+	Nieswiadomy and Molina (+)
RESDAGE	Residence age (years)	-	+	Lyman (+), Nauges and Thomas (2000) (+)
AREADESC_URBAN	Dummy variable for household living in urban or suburban region	+	-	Domene and Sauri (-), Gaudin (-)
WTRINV_DUAL_1	Dummy variable for having low flush toilet	-	-	Renwick & Archibald (-)

Potential Adverse Effects of Water Charges



Results: Water Saving Behaviours (facing water charges)

	Marginal effects on Prob ("Often" or "Always")				
	Turn off the water while brushing teeth	Take shower instead of bath specifically to save water	Plug the sink when washing dishes	Water the garden in the coolest part of the day to save water	Collect rainwater/ recycle waste water
Australia	0.1971***	0.0404***	0.2477***	0.2126***	0.2271***
Canada	0.1283***		0.1676***	0.1467***	
Czech Republic	0.0711***	-0.0865***	-0.0749***	-0.0599**	0.3404***
France	0.2083***	0.0655***		0.1318***	0.1753***
Italy		0.0456***	-0.0864***	0.1000***	0.4788***
Korea	0.0940***	-0.0270**	-0.2312***	-0.2723***	-0.1320***
Mexico	0.2194***		-0.1752***	0.0425**	-0.1340***
Netherlands	0.1744***	0.0932***	0.1318***	0.1085***	
Norway	-0.0437			-0.1203***	-0.1172***
Sweden	0.0906***	0.1042***			0.0858**

Water Use and Water Saving Behaviours

- In OECD (10) H/holds that have a volumetric water charge have an increased marginal probability of undertaking all five water saving behaviours except 'plug the sink'.
- Environmental attitudes (high level of concern about environment, participation in env. activities, membership of env. organisations) increase marginal probability of undertaking water saving behaviours.

Policy Conclusions (1)

- In OECD (10) H/holds that face volumetric charge for water consume about quarter less water than h/holds that do not.
- Higher average water prices reduces water consumption (OECD (10) 10% price rise reduces h/hold water use by about 5%).
- Water bill, on average, accounts for less than 1% of h/hold income but more than twice as much for low-income versus high-income households.
- High-income households are less price elastic than low and medium-income households.
- Measured environmental attitudes have no statistically significant effect on h/hold water use but do increase marginal probability of undertaking some water saving behaviours.

Policy Conclusions (2)

- H/holds that incur a volumetric charge for water have a higher likelihood they will undertake water saving behaviours.
- # people in h/hold, residence size and h/hold income have a statistically significant and positive effect on h/hold water consumption.
- Use of dual flush toilets and age of residence have statistically significant and negative impact on water consumption.
- Key policy implication is that metering and charging h/holds on basis of water they consume is an highly effective instrument to manage residential water demand.