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A Social Gradient in Households' Environmental Policy Responsiveness?
The Case of Water Pricing in Flanders

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A social gradient in households' environmental policy responsiveness? The case of water pricing in Flanders.

Josefine VANHILLE (*)

Increasing the price of environmentally-harmful consumption constitutes a mechanism on which many environmental policy tools are based. When evaluating efficiency aspects of policy measures, price-based measures often perform best according to Pareto optimality. An often expressed concern is that, when targeting households, environmental policy instruments that are based on changing the relative price of environmentally-harmful consumption, are bound to have regressive effects. Repeated empirical findings of this sort put the equity aspect of this group of policy measures into question. However, the final social impact of a given policy measure also depends of individual households' responsiveness to the price or policy change.

In this paper, we explore the role of socio-demographic household characteristics in the Flemish context of water pricing. We use detailed micro-data from the Belgian part of EU-SILC, which combines information on household income, socio-demographic characteristics, dwelling characteristics as well as utilities expenditure.

First, we assess the importance of various household characteristics as determinants of the quantity of water consumed by the household, employing a loglinear framework. Second, in order to gain insight in the differential responsiveness to changes in prices across the population, we estimate elasticities allowing variation across population subgroups, modelling households' water demand in a quadratic almost ideal demand system (QUAIDS) of Banks, Blundell and Lewbel (1997).

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1- Introduction

Water and other utilities' management have been focusing on demand side policies to foster a more 'sustainable' (VMM 2011), 'rational' (Van Humbeek 2000) or 'reasonable' (Arbués et al. 2010) consumption of natural resources. Increasing the relative price of environmental goods is becoming an increasingly popular policy tool to reach this goal. Higher prices should reflect a more correct valuation of the scarcity and/or incorporate harmful climate effects of these goods and induce consumers to use less.

The effectiveness of price-based policies in reducing natural resource consumption depends on the extent to which different types of consumers are sensitive to changes in the price of the environmental good, i.e. the extent to which they react with adjusted consumption behaviour. This is typically expressed as a price elasticity: the more negative the price elasticity, the more the consumer will reduce consumption upon increases in price. The larger this responsiveness, the more effective price-based policies are at attaining their goal.

For households, the last decades brought considerable price increases for water, gas, oil and electricity. In this framework, knowledge about households' structure of demand and behavioural response to changes in price becomes very relevant.

It is a stylized fact that the ratio of the household's expenses on these utilities over their disposable income declines over the income distribution. Therefore, the often expressed concern is that, when targeting households, environmental policy instruments that are based on changing the relative price of environmentally-harmful consumption, are bound to have regressive effects. This can put the policymaker in a equity-efficiency dilemma and possibly prevent a pricing policy reflecting its scarcity, the related production and distribution costs as well as the environmental costs of its use.

While the static distributive effects of price-based environmental policy measures are well-documented (cf. Section 2), studies vary greatly in the way that behavioural response is taken into account. After all, the final social impact of a given policy measure also depends of households' responsiveness to the price or policy change. This response can vary from behavioural change, such as cutting back consumption, to an adjusted investment decision, by choosing for more efficient equipment (e.g. washing machines) or installing measures to reduce reliance on metered consumption (e.g. collecting rainwater).

Many studies that focus on distributional effects employing micro-data are of a static nature and don't take account of households' responsiveness to a certain policy measure (Dresner and Ekins 2006, Wier et al. 2005). Household demand analysis on the other hand, is often focused on the determination of a single (mean or median) price and income elasticity of a certain resource (fuel, electricity, water) for a given region. These can then for instance be employed by macro and general equilibrium studies to incorporate behavioural reactions, yet often the household sector is stylized as one (or several) representative agent(s) (e.g. Wissema & Dellink 2007), limiting the possibility of investigating distributional, poverty or inequality effects (Savard 2005). Some microlevel data studies on distributional effects also take behavioural response into account by assuming it to be the same across the entire population

(Van Humbeek 2000). Yet, there are many reasons to believe that the vast observed heterogeneity in energy demand translates also into differences in responsiveness of the households to price signals and environmental policy instruments. The latter field remains however largely understudied, with the majority of the available evidence concerns fuel taxation.

This research aims to contribute insight from a water use perspective to this literature, to gain insight in the extent to which households differ in their consumption patterns and in their responsiveness to increased prices for water. After assessing the extent to which socio-demographic characteristics play a role in determining demand, it is investigated whether they are associated with a different responsiveness to changed policy. The latter can have consequences for the distribution of policy-induced burdens (conservation burden and/or financial burdens) among different socio-economic groups.

For the empirical investigation we use the case of water pricing in Flanders, the northern region of Belgium. With the introduction of the "integrale waterfactuur" (integral water bill, integrating costs of production and supply of drinking water on the one hand, and drainage and cleaning of wastewater on the other hand), households have seen their water bills increase sharply over the past few years. At the same time, discretionary control of the local authorities about the pace at which the charges were gradually shifted towards based on metered consumption has brought considerable variation in average prices per m³ consumed between more "quick" (and expensive water bills) and more "slow" (and cheaper water bills) Flemish municipalities.

In Section 2 we overview the equity-efficiency dilemma in the context of environmental policy targeting household utilities use. Section 3 provides more detail on our case of water pricing in Flanders, while Section 3 and 4 describe respectively the data and modelling framework used. In Section 5 the empirical results are presented, to conclude in Section 6.

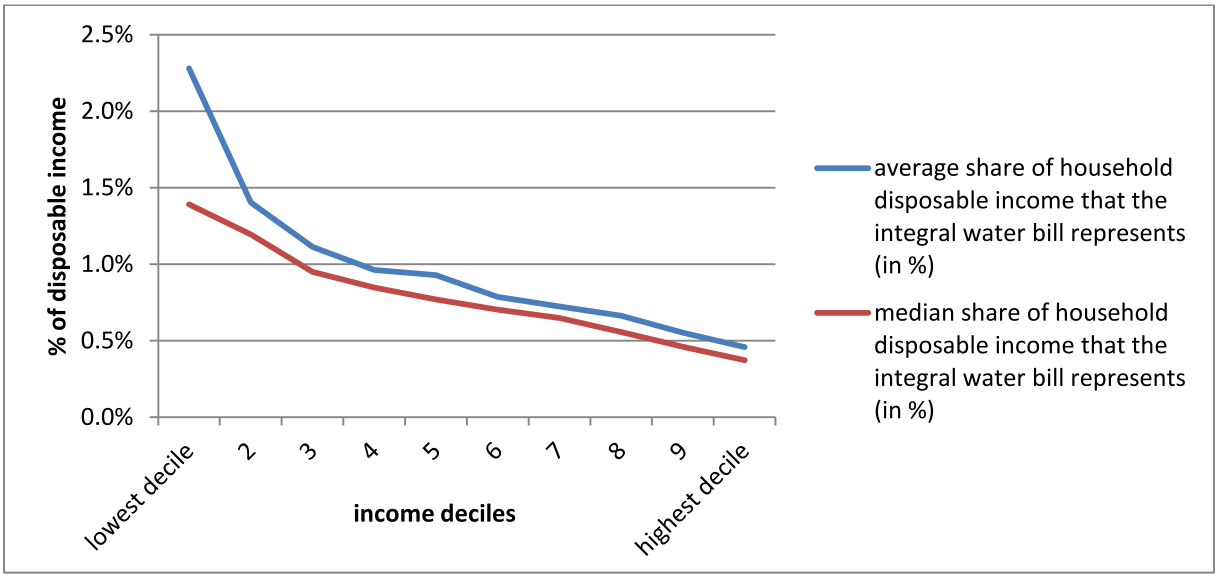
2- *Environmental policy, household utilities use and the equity/efficiency dilemma*

Environmental policy ranges from taxes and levies over efficiency standards, labels, to subsidies and grants e.g. for taking conservation investment. In the paper we focus on the literature on environmental policy operating via this pricing channel (taxation, levies, charges, ...). To reduce environmentally-harmful natural resource consumption, price increases stand out as the most useful instruments from an efficiency point of view: an overwhelming amount of empirical evidence shows that higher prices do reduce consumption.

Zooming in on households' residential water demand, we are particularly interested in how income and socio-demographic characteristics exercise an influence on the structure of household water demand Evidence based on household-level data in this area being relatively scarce, we also draw upon insights from other household utilities, as many parallels can be drawn. Conceptually, this demand has common specific features. To a large extent, demand for energy as well as for water are a derived demand: energy and water are only for a very small part consumed as such, and for a vast majority of consumption these natural resource goods are typically the compliment of services where, in a first instance, a number of basic needs are fulfilled such as hygiene, warmth, cooking, washing, ... Furthermore, they might also function as the compliment of more luxurious household services, from using many electronic appliances to maintaining a swimming pool. From an environmental sustainability point of view, energy resources as well as water are characterised by overconsumption (at least in the developed world), and the need to reduce economy and society's reliance on these natural resources is widely acknowledged.

Over the past decades, the price of water and to some extent of other natural resources has been increasingly viewed as a demand-side resource management instrument, with policy induced price increases being widely applied in the context of households' energy and water consumption (for an overview of the distributional effects on households of various climate policy measures see Buchs et al. 2011, water pricing policy measures are surveyed in Ferrara 2008). As mentioned in the introduction, the share of household disposable income to be paid for utilities bills declines as we move up in the income distribution. Figure 1 illustrates this stylized fact for the case of water in Flemish households.

Figure 1: Share of the "integral water bill" in household income, according to income decile, Flanders 2009.



Source: author's calculations on BE-SILC 2009.

Making abstraction of behavioural response, linear price increases are therefore bound to be regressive: measured as a share of disposable income, the financial burden will be greatest in households who pay the largest share of their income for water, typically low-income households. Yet there are many other household characteristics that can affect household demand for water and thus determine the share in disposable income paid for it. Reviewing the literature, household size is consistently significant across studies when included: more persons in the household invariably increases household water use, yet decreases water use per person, indicating economies of scale (Höglund 1999, Arbués et al. 2004, García-Valiñas 2005). With respect to age, the evidence is unclear. On the one hand, elderly persons are more often at home, and might therefore have a higher demand. On the other hand, they might consume less water than younger age groups due to habits established during earlier historical periods with less abundant conditions. The latter refers rather to a "generation" effect rather than a pure “age” effect. Blahdt and Kranz (2008) find evidence of this generation effect for electricity used for lighting. Education level, employment status, whether or not there are young children and/or teenagers in the household, these factors can hypothetically have an influence on water use patterns, yet remain understudied due to the scarcity of data including both water use and socio-demographic characteristics at the individual/household level.

However secondly, the final social impact of a given policy measure also depends on whether households differ in their reaction to changed prices or policy. When distinguishing households according to their income position, hypotheses can be made for differential responsiveness in both directions. Low-income households might be less responsive because they mainly use water for basic needs, and water use for these is not easily cut back. High-income households might be more responsive to higher prices, because they are less constraint they might use more water than strictly necessary for basic needs, and reduce this “excess” consumption when it becomes too expensive. Alternatively, high-income households might more easily make an upfront investment in water-saving infrastructure, that has a certain payback time. Empirical evidence has shown that low-income families also display greater discount rates in trading off current with future gains, and might be less likely to make water/energy-saving investments (more efficient washing machines, rainwater collector, ...). The other way around, low-income households might also be more responsive because they are forced to keep a close watch on their expenses. When a good becomes significantly more expensive, they will react with reduced consumption. High-income households on the other hand, might not notice changes in the share of their budget that is allocated to water consumption as much, because proportionally it is much lower, and therefore don’t react to changed prices with adjusted consumption.

Drawing upon the empirical literature on fuel taxes, some authors find that low-income households are more responsive to price increases than high-income households (West 2004, Johnstone and Serret 2006). This effect mediates the regressivity of policy measures implying real price increases. In other studies, the differences between high and low income households are less pronounced (Brannlund and Nordstrom 2004), while Nesbakken (1999) finds that in Norway high-income households are more responsive to energy price increases than low-income households. To our knowledge, the only studies investigating differential responsiveness to water price with respect to income and using household-level data are Agthe and Billings (1987), Renwick and Archibald (1998) and Hajispyrou et al. (2002). All three studies find higher responsiveness (more negative elasticities) for low-income households compared to high-income households. Arbués et al. (2010) investigate differential responsiveness according to age group. They find that smaller households have larger elasticities (in absolute value) than larger households.

These results suggest that it is very likely that the burden of pricing policy is far from evenly spread over different socio-economic groups. However, we need to distinguish between two types of burdens: a financial burden and a conservation burden. To the extent that low-incomes are more responsive to reduce their consumption in the case of a price increase, some authors state that the financial burden following from higher prices is overstated when only performing a static analysis without taking this differential responsiveness into account (e.g.

West and Williams 2002). As Buchs et al. (2011) note, however, this purely financial perspective disguises wider fairness implications as it can be argued that poorer households, who already have a lower consumption on average, will experience greater reductions in terms of their broader well-being than rich households when cutting back in their consumption levels. This refers to what Renwick and Archibald (1998) call the "conservation burden". When the uneven spreading of these burdens is considered unfair, policy makers can find themselves in an equity-efficiency dilemma.

A number of responses have been formulated to overcome possible equity-efficiency dilemmas. We identify four broad approaches. First, there is the option to compensate for socially-adverse impacts via the personal income taxation or social insurance system, be it with lump sum transfers or tax breaks for vulnerable households. The rationale of this type of policy is to maintain the incentives to reduce consumption, yet compensate for socially adverse impacts. This is a largely theoretical approach, yet Dresner and Ekins (2006) investigate its possibilities carrying out various simulation exercises in the context of fuel poverty in the United Kingdom. They find that while it is possible to mediate overall regressive effects, compensation payments cannot be designed in a administratively feasible way without leaving a substantial fraction of fuel poor households, most likely those in deepest fuel poverty, worse off. Second, exemptions for specific household groups can be installed within the system charging the levies. This is the option that is currently in place in Flanders in the form of "social corrections" to the integral water bill (cfr. Section 3). The condition is placed at the income source, so that when one of the household members receives social assistance income, income support for the elderly or benefits from a specific type of disability benefits in January of the starting year, the households' water bill is automatically adjusted to exempt the household from all wastewater charges for the entire year. Other discount tariffs are applied in some regions in Italy, Australia and the United States (Ferrara 2008). A third view states that tariffication and charges can be made progressive on the level of water use, in the case of water often in the form of block rate pricing. Agthe and Billings (1987) propose substantially steeper rate progression to improve equity and encourage conservation. However, underlying this recommendation is the assumption that "the largest volume users are supposedly most affluent" (Agthe and Billings 1987 p.273) based on averaged per income group. A strong association between high water consumption and wealth has never been empirically underpinned, on the contrary, in line with previous work we also find the variation within income groups to be much more important than the variation between income groups (cfr. Figure 3 in Section 3). Fourth, many countries have installed programmes of some sort to help households cope with high bills (easier payment plans, funds to write off water debts, etc.). This type of policy, however, does not tackle adverse social impacts an sich, but rather aims at mediating some of the most visible consequences such as household indebtedness.

In the empirical part of this study, our aim is to unravel the influence of possibly relevant socio-demographic characteristics such as age, household size and composition, education level, tenure status, and especially its relative income position, on households' water use decisions and their price responsiveness in particular. A deeper understanding of the determinants and structure of household demand for water can foster the design of demand-side management policy measures that are both effective and equitable.

3- Case: the introduction of volumetric wastewater charges in Flanders

From January 2005 onward, the "integrated water bill" was gradually introduced for Flemish households. The goal of this reform in the pricing structure of water was to shift the way of charging wastewater levies from a fixed charge per tax unit to a volumetric charge based on actual water use.

This shift can be characterized as a move closer towards "the polluter pays" principle, where large water users will contribute more to the cost of cleaning the wastewater then small water users. The economic rationale behind it was that the increased reliance on volumetric charge increases the price per m^3 consumed and should thus induce households to adjust their water use behaviour and reduce consumption. For households that individually collect rainwater to clean, water the garden and/or flush the toilet for example, a fixed wastewater charge is still in place.

Composition of the integral water bill

The water bill for Flemish households is composed of two main parts, related to the production and supply of drinking water on the one hand, and to the drainage and cleaning of wastewater on the other hand.

The part of the bill for drinking water is set by the water supply company. These are public companies and are responsible for the distribution and delivery of drinking water through a publicly owned pipe network. There are currently 12 water suppliers operating in Flanders, each serving a different region. As the tariff structure is set by the water supplier, pricing structure and tariffs vary depending on the place the household lives. Generally, it is composed of a fixed fee and a variable part that depends on the m^3 consumed. Some water companies have installed increasing or decreasing block rates (so that the tariff per m^3 changes as one uses more or less water), others use a flat fee (so that the price per m^3 is independent of the amount consumed). In addition, all water companies are obliged to deliver a first block of $15m^3$ per domiciled household member for free (variable tariff of 0, the fixed fee remains in place).[1]

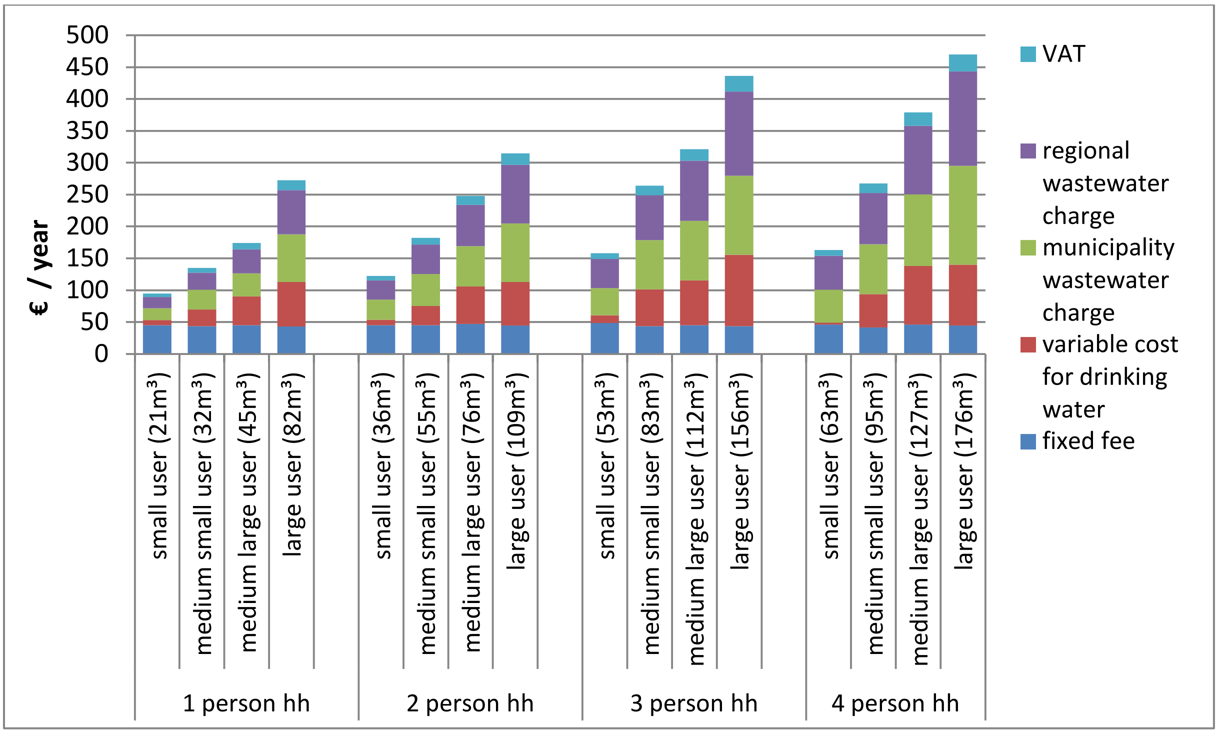
Since 2005, there is a second part of the Flemish households' water bill which comprises two levies for wastewater. Both consist of a flat volumetric charge based on the total m^3 consumed

[1] When this obligation was introduced with the 1990s reform, there were two types of reasoning for its existence, one socially-inspired and one based on the view that it would stimulate rational water consumption among households (Van Humbeek 2000). The first argument was based on the assumption that low-income households would consume less water, thus the benefit of the free allowances would proportionally be higher for them. Policymakers also expressed their expectation that the free supply of $15m^3$ drinking water per person would lead to more rational water consumption patterns: as it introduces a first step towards increasing block tariff system, and therefore provides an incentive to keep consumption low. Neither of both arguments could be quantified, however.

(including the 15 m³ that is set free from the variable drinking water tariff). The first tariff is determined by the municipality, the second is determined by the Flemish region, and is therefore the same throughout Flanders. This wastewater charge should generate a revenue reflecting the cost of the responsibilities of the municipalities and the Flemish region respectively in the water draining and purification process. Towards this goal, wastewater charges have been introduced gradually, rising year after year on average with a factor reflecting a constant rate rise at the regional level of Flanders and the varying rates at the municipality level.

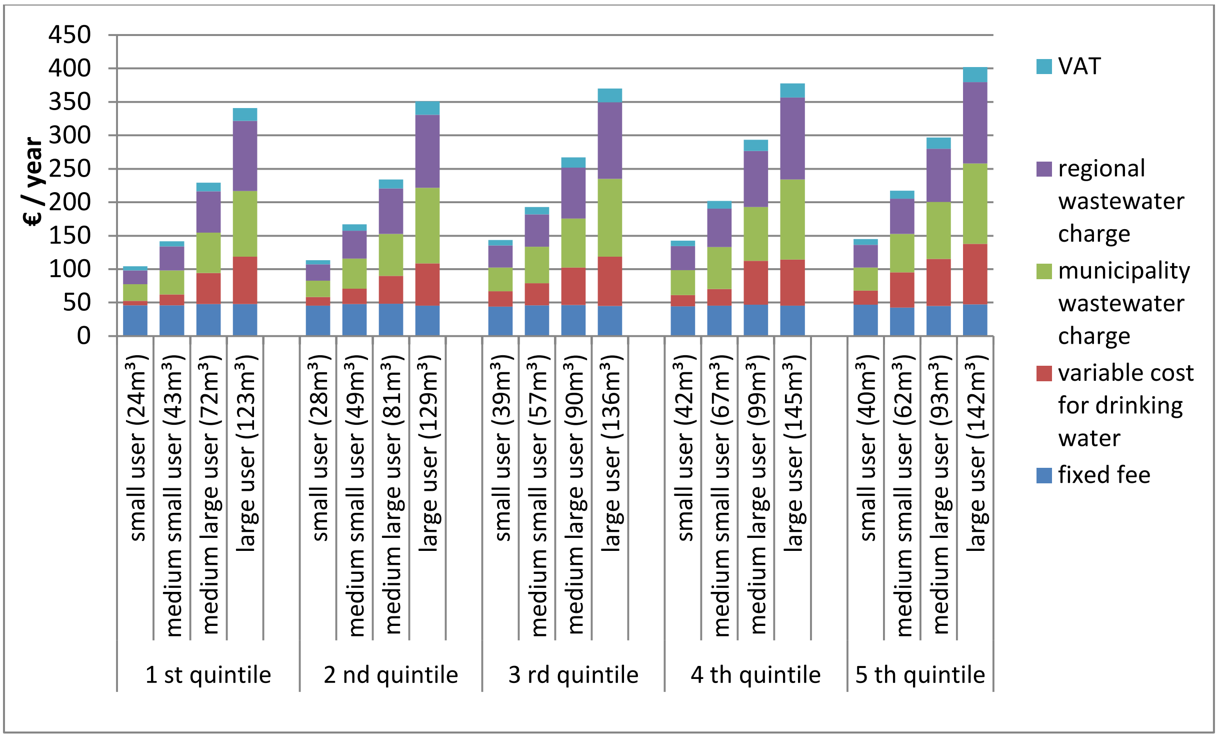
The composition of the integral water bill for different types of households is presented in Figure 2 and 3. Figure 2 shows level of consumption and associated bill structure for small (20th percentile), medium-small (40th percentile), medium-large (60th percentile) and large (80th percentile) water users within families with 1 to 4 household members. In Figure 3, the families are divided according to income quintiles from 1 (lowest income) to 5 (highest income). Following from the different rate structures, we observe that for low-users, the fixed fee is relatively more important, while the variable fee is proportionally less important, also given the free 15 m³ per household member. Expectedly, there is a clear positive correlation between household size and household water use, yet the variation within the group of families with the same size is much larger. The same pattern appears when households are grouped according to income quintile (Figure 3). The positive correlation is present, although less pronounced. Again, variation between families within the same income quintile is much larger than variation in averages between quintiles.

Figure 2: Composition of annual "integral water bill" for different types of users within groups of households with different size, Flanders 2009.



Source: author's calculations on the basis of BE-SILC 2009

Figure 3: Composition of annual "integral water bill" for different types of users within groups of households according to income quintile, Flanders 2009.

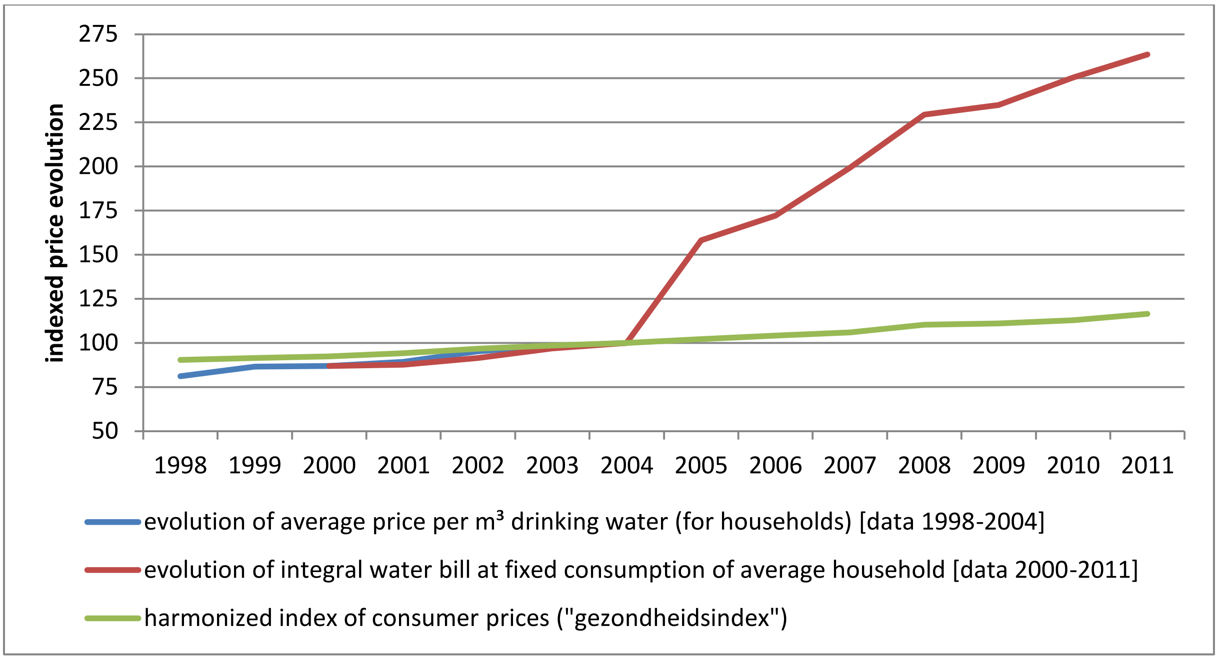


Source: author's calculations on the basis of BE-SILC 2009

Price evolutions and social compensations

Figure 4 takes the longitudinal perspective and shows that the price of water has been increasing faster than average prices ever since the mid-1990s, when the previous important reform of the water bill took place, mainly geared at greater recovery of the costs related to drinking water production and distribution (for a study of the social welfare and distributional effects of the 1990s reform, see Van Humbeek (2000)). However, the impact of the integral water bill reform in 2005 stands out most clearly and marks the start of an area of continuing steep price rises.

Figure 4: Evolution of the price of water for households compared to harmonized index of consumer prices, Belgium/Flanders 1998-2011.



Source: based on statistics from Belgostat and VMM (2011).

Since the first introduction of the wastewater charges in 2005, average water bill has risen further with 67% (for an average single person households) to 96% (for an average 5-person household) between 2005 and 2011 (VMM 2011). Already in the 1990s reform, concerns about the affordability of water in socially-vulnerable households led to the exemption of certain groups in the regional and municipal wastewater levy. At the time of writing, a household qualifies for these so-called "social corrections" when at least one member of the household receives a social assistance allowance or pension or a specific disability benefit. In their case, the household only pays for the drinking water component of the bill. Households that qualify for the social corrections but don't have individual metering of their use, receive a lump sum payment to compensate for the cost of the charges. Since 2008, the exemption and/or compensation payments are automatically allocated to the eligible households, before, the households had to apply for it. In 2009, the social corrections applied to about 5% of the household water bills (VMM 2010).

When taking an average household of 2.37 household members and an annual water consumption of 88m³, the annual water bill in 2009 varied, depending on where the household lives (municipality and drinking water supply region), between 189 and 335 euro, or a ratio of 1.8 between the most 'cheap' and 'expensive' water regions. The variation in tariffication between different drinking water companies produces a variation ratio of 1.5. The introduction of the municipal wastewater charge tariff added significantly to the price variation, as its own variation ratio amounted to 2.4 in 2009 (for the average household).

It is this variation in prices (both average and marginal) that we will use to estimate our demand system for water and derive price and income elasticities across different groups of Flemish households.

4- Data

The most recent available version of the Belgian SILC data (survey year 2009, with income data referring to 2008) provides us with the micro data (ADSEI) which, compared to the EUROSTAT EU-SILC database, contain more detailed information on housing costs. In the Belgian questionnaire, the household respondent responds to three questions relating to water: first, it is asked whether the households pays for the cost of water. If the household answers yes, the respondent is asked to provide an estimation of the monthly cost of water. If the respondent can't give an answer for water separately, the possibility is foreseen that the respondents gives the aggregate total of water and other utilities such as gas or electricity.

We restrict our sample to households living in Flanders, who report to pay for water and are able to indicate a value for the account. The latter condition implies that we can't use 14% of the households in the sample, who don't report a valid value. Partly, this is caused by item non-response, and partly by a reflection of reality, as there is still a share of privately-rented accommodation that doesn't have separate metering. Reported values that appear unreliable because they are extremely low (<1st percentile) or extremely high (>99th percentile) are dropped from the sample as well. Our final sample used for the analysis contains 2741 households.

As mentioned, the data contains the respondents' estimation of the average monthly cost for water. Using the annual equivalent and the necessary information about the place where the household lives (and thus which drinking water tariff and which municipal wastewater charge applies) we calculate the m^3 of water consumed associated with this annual bill using an iterative procedure. We also account for social corrections because nearly all the income components that determine eligibility were surveyed. However, it appears that the question on the specific disability allowance that gives right to the exemption of wastewater charges, was not accurately answered, resulting in an underrepresentation of households eligible for socially corrected water bills. Overall, we obtain a socially-corrected water bill for only 1.9% of the households in our sample (n=47). In part this is due to inaccuracies in recording the exact income components each individual receives, but also we observe that households who would be eligible for social corrections are slightly more present (2.3%) in the group that we had to drop from the sample because there was no reliable information on their water bill. This again illustrates the difficulties to obtain full information on more precarious population groups in nation-wide representative surveys such as EU-SILC.

The main advantage of our dataset is that is combines information on yearly water bills with detailed information on income and socio-demographic characteristics and some basic information on housing situation for a representative sample of the Flemish population. This direct link at the household level between water use, characteristics of the house and information on the household and its member, is quite rare in household water demand analysis. The majority of studies uses data at aggregated (typically community) level (e.g. Martínez-Espiñeira 2002, Nauges and Thomas 2003, Mazzanti and Montini 2006). Studies with household-level data are typically obtained from water company records, implying that the number of independent variables is often quite limited. Studies that included an indicator for household income or wealth have worked so far with proxies such as average net income in the neighbourhood (aggregated data studies) or a measure of fiscal value of the property (e.g. Hewitt and Hanemann 1995; Arbués et al. 2010). In the analysis, we keep in mind that representativeness might be slightly affected by the non-negligible item non-response observed.

The main disadvantage of our dataset is that we work with reported euro instead of metered m³, which automatically introduces a certain error because of possible inaccuracy in the answer of the household respondent. We assume that this error is randomly distributed and does not affect overall results. Also, there is the risk that the calculate of the m³ associated with the reported bill are wrong when we don't observe a fulfilled eligibility condition in the data when in reality it is there, and therefore social corrections are automatically allocated. Finally, we don't observe in the data whether the household collects its own rainwater. Given the small proportion of houses in Flanders that have the infrastructure to do this, we further make abstraction of the special treatment of individual water collectors.

5- *Modelling framework*

A number of different empirical approaches have been developed in the literature on modelling households' residential water demand. Methods used vary in the nature of the data used (microlevel or aggregated, (repeated) cross-sections or panel data), in the specification of the model, in the choice of dependent and independent variables, and in specification of crucial parameters, most notably price. For an excellent overview of the methodological issues, see Arbués et al. (2003) and Worthington and Hoffmann (2008). After the specification of our model in the following paragraph, we focus on those issues raised that are relevant in the context of our analysis: the inclusion of socio-demographic and housing characteristics, the use of household-level cross-sectional data, the specification of the price variable, and the modelling of free allowances.

QUAIDS system

We model households' demand for water using the tools from consumer demand analysis. Our framework is a function $Q_d = f(P, Z)$, where water consumption is related to price (P) and other factors (Z, housing characteristics, socio-demographic characteristics). We opt for the relatively simple, comprehensive yet flexible framework of the Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks, Blundell and Lewbel (1997), extending the Almost Ideal Demand System of Deaton and Muellbauer (1980) to allow for quadratic Engel curves.

Starting point are the households expenditure shares (w_i) given by $w_i = p_i q_i / m_i$, where p_i reflects the price and q_i the quantity of good i, and m stands for the household's total expenditure on all goods in the demand system.

In the QUAIDS system each expenditure share can be estimated as

$$w_i = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln p_j + \beta_i \ln \frac{m}{a(\boldsymbol{p})} + \frac{\lambda_i}{b(p)} \left[\ln \frac{m}{a(\boldsymbol{p})} \right]^2 + \varepsilon_i$$

Where $\boldsymbol{p}$ is the vector of prices, ε_i is the error term,

$$b(\boldsymbol{p}) = \prod_{i=1}^{N} {p_i}^{\beta_i}$$

and the price index is defined by

$$\ln a(\boldsymbol{p}) = \alpha_0 + \sum_{i=1}^{N} \alpha_i \ln p_i + 0.5 \sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{ij} \ln p_i \ln p_j$$

As $\sum_{i=1}^{N} w_i = 1$ (adding-up condition), the parameters fulfill the conditions $\sum_{i=1}^{N} \alpha_i = 1, \sum_{i=1}^{N} \beta_i = 0,\ \sum_{i=1}^{N} \lambda_i = 0$. By homogeneity of degree zero in prices and spending, $\sum_{i=1}^{N} \gamma_{ij} = 0$ for all j, and by Slutsky symmetry, $\gamma_{ij} = \gamma_{ji}$.

As we concentrate on consumer demand for a single commodity (water for domestic use), we assume all other goods to be grouped in a composite good (non-water). Assuming the price of the composite good to be equal to 1, we obtain the budget share equation for water (subscript $i = w$)

$$\begin{aligned} w_w = \alpha_w + \gamma_{ww} \ln p_w + \beta_w [\ln m - \alpha_0 - \alpha_w \ln p_w - 0.5\, \gamma_{ww} (\ln p_w)^2] \\ + \frac{\lambda_w}{{p_w}^{\beta_w}} [\ln m - \alpha_0 - \alpha_w \ln p_w - 0.5\, \gamma_{ww} (\ln p_w)^2]^2 \end{aligned}$$

Once the coefficients in this equation are estimated[2], we can derive from this the budget and uncompensated own-price elasticities as

$$e_w = \frac{1}{w_w} * \frac{\partial w_w}{\partial \ln m} + 1$$

$$e_{ww} = \frac{1}{w_i} * \frac{\partial w_w}{\partial \ln p_w} - 1$$

Including household socio-demographic variables

This framework, however, ignores that demand for water is not only affected by prices and the household's budget, but also by demographic, climatic, housing and other characteristics.

[2] The estimation is done in Stata by adjusting the nlsur_quaids programme developed by Poi (2008) to this two-goods framework. Because α_0 is difficult to estimate empirically, it is set to a value corresponding with the average ln of total expenditure of the lowest first percentile in the dataset, analogous to common practice.

It is very likely that there are systematic differences in consumption behaviour between households with different characteristics. The role of demographic determinants in demand analysis was already brought to attention by Pollak and Wales (1981). More recently, also Moro and Sckokai (2000), Blow (2003) and Dybczak et al. (2010) show empirical evidence for the importance of the role of demographic determinants in demand analysis. Leaving out demographic factors from aggregate demand analysis may produce misleading results.

In the QUAIDS system, we can introduce variation in the intercept and slope parameters by allowing them to depend on household characteristics in each budget share equation of the demand system. Thus, parameters α, β, and λ are allowed to vary depending on the household characteristics, while impact of prices reflected in γ is assumed to be same over households. With this approach, we follow Moro and Sckokai (2000) and Dybczak et al. (2010). In this respect our model also differs from earlier QUAIDS analysis on water by Hajispyrou et al. (2002), as they only allow the intercept to vary with socio-demographic and technical characteristics.

This new, household-specific budget share then becomes

$$
\begin{aligned}
w_i^h(m^h, \boldsymbol{p}, z^h) &= \alpha_i + \sum_{k=1}^{K} \alpha_{ik} z_k^h + \sum_{j=1}^{N} \gamma_{ij} \ln p_j + \left(\beta_i + \sum_{k=1}^{K} \beta_{ik} z_k^h \right) \left[\ln \frac{m^h}{a(\boldsymbol{p}, z^h)} \right] \\
&+ \left(\frac{\lambda_i + \sum_{k=1}^{K} \lambda_{ik} z_k^h}{b(\boldsymbol{p}, z^h)} \right) \left[\ln \frac{m^h}{a(\boldsymbol{p}, z^h)} \right]^2
\end{aligned}
$$

with

$$
b(\boldsymbol{p}, z^h) = \prod_{i=1}^{N} p_i^{\beta_i + \sum_{k=1}^{K} \beta_{ik} z_k^h}
$$

and

$$
\ln a(\boldsymbol{p}, z^h) = \alpha_0 + \sum_{i=1}^{N} \left(\alpha_i + \sum_{k=1}^{K} \alpha_{ik} z_k^h\right) \ln p_i + 0.5 \sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{ij} \ln p_i \ln p_j
$$

Our dataset allows to include several variables with household characteristics that can exercise an influence on household water. In a determinant model, we test their relevance in an integrated way, controlling for the other factors that the data allow to. The variables that are taken up in the analysis are presented in Table 1.

Table 1: Description of variables

Income	(1) nominal disposable household income (2) a rough indicator of a households' relative income position in the form of income quintile dummies.
Household size	dummies for household size 1, 2, 3, 4 and 5 or larger
Household composition	(3) adults without professional activity – under the hypothesis that they spend more time at home, domestic water use is likely to be higher. (4) presence of children under 18 years - they might have different water use patterns compared to adults. (5) presence of household members with a non-Belgian nationality – they might have different water use patterns compared to Belgian nationals.
Education level	dummies for the ISCED levels of (1) lower secondary education or less (2) upper secondary education (3) tertiary education (4) other or missing
Age	age of the household head is included in the specification in normal form, squared or with dummies for different age categories.
Tenure status	whether the households owns or rents the dwelling it lives in
Dwelling type	Whether the household lives in a detached, semi-detached, terraced house or occupies an flat in a small or larger building.
Durable goods ownership	Data availability limits this category to a dummy for ownership of a washing machine.
Province	As a proxy for climatic variation, we include the Flemish provinces in the regression. While western provinces receive more rainfall throughout the year and have more moderate temperatures, eastern provinces are slightly drier and also warmer in summer and colder in winter.
Degree of urbanisation	A dummy indicates whether the region where the household lives is "densely populated". The standard is "intermediate". There are no households in the Flemish sample living in a thinly populated area.
Water tariff design	(1) a dummy for clients of water companies applying an increasing block rate structure (standard is a flat rate) (2) a measure whether the household lives in an comparatively "low-cost" or "high-cost" water area.[3]

Note: an overview of the key statistics of the variables used in the analysis is provided in Table A.1 in the Appendix.

Using household-level cross-sectional data

To our knowledge, there are only a couple of studies investigating water demand with a representative cross-sectional household survey (see e.g. Foster and Beattie 1981; Hajispyrou et al. 2002). The main reason can be expected as the need for sufficient price variation within the dataset, which is not possible to obtain in the case where all households in the sample face the same price structure.

The first main advantages of this type of data is the availability of a link at the household level between water use and factors possibly influencing water demand such as income,

[3] This price indicator was constructed by calculating for each municipality the integral water bill of an average family of 2 household members with the mean yearly consumption of 81 m³. Municipalities whose hypothetical bill for this household would be strictly larger than the value of the bill at the 75th percentile when ranked from cheapest to most expensive, are classified are "relatively high cost", while municipalities where the bill is smaller than the value calculated at the 25th percentile are assigned to be "relatively low cost".

housing characteristics and socio-demographic characteristics of the household. The second advantage is that the cross-sectional variation in price structure within the small and relatively homogeneous region of Flanders allow us to estimate income and price elasticities that reflect more long term responsiveness (when also the capital stock can be adjusted), while estimates based on panel data over a relatively short period (a couple of years) are assumed to reflect short term elasticities (when the capital stock is largely fixed and changes only result from adjusted consumption behaviour).

Expectedly, estimates for short term elasticities are often smaller in absolute value than estimates for long term elasticities, as responses to price changes are found to be significantly larger in the long run, when households have had the time to adjust their capital stock to a certain change in real prices, than when capital stock is fixed and only consumption behaviour is variable.

From a policy perspective, it is the long-term elasticity which is most relevant when one is interested in sustainably reducing levels of water use. We would however be careful to assume our estimates to be real long-term elasticities, as at the time of the survey (2009) the policy changes that have led to the observed price variation in the data have been introduced over the course of only four years (since 2005), making it less probable that all households who faced the steepest price increases already fully adjusted their capital stock.

Specification of the price variable

In the literature, both average and marginal prices have been used in modelling water demand, and the debate on to which water prices consumer respond in the case of complex water price structures is not settled yet (Nordin 1976, Nieswiadomy and Molina 1991, Arbués et al. 2003)

Foster and Beattie (1981) argue that the water tariffication structure with different block rates and the inclusion of wastewater charges lead to too high information costs for households to be able to respond to marginal prices when deciding on their water consumption. Shin (1985) elaborates this argument empirically with respect to electricity bills.

The choice clearly matters, as shown in Table 2, as the average price is determined by the level of consumption (the lower a households' consumption, the more important the fixed fee proportionally, and the higher the average price). The marginal price however, is much less dependent on the level of consumption (once the household consumes more than the allocated free m^3) and reflects in the first place regional differences between drinking water companies and municipal wastewater charges.

Table 2: average and marginal price at different percentiles of household water use.

	water use in m³	median of average price	median of marginal price
5th percentile	15	4.68	3.53
10th percentile	22	4.44	3.24
25th percentile	38	3.57	3.53
50th percentile	66	3.41	3.54
75th percentile	106	3.29	3.53
90th percentile	156	3.19	3.31
95th percentile	196	3.13	3.29

Source: author's calculations on BE-SILC.

Arbués et al. (2003) and Worthington and Hoffman (2008) map the wide variation in price specifications present in the literature of the past decades.

In line with basic economic theory on consumer behaviour and with more recent practice (Dandy 1997, Hajispyrou et al. 2002, Nataraj and Hanemann 2011), we opt to use marginal prices calculated as the price of a hypothetical m³ water consumption in addition to the households' current use. In the majority of the cases, this is the flat rate that applies to all consumption in excess of the free allowance of 15m³ per household member. In the few cases of households using less than their allocated free allowance, it is substantially lower. In the case where households face an increasing block rate price structure, this corresponds to the marginal tariff of the block in which their consumption is situated.

The modelling of free allowances.

The econometric specificities of modelling free allowances are treated in Dandy et al. (1997). The problem of a zero marginal price as long as households consume less than the allocated 15 m³ per household member is not applicable in the Flemish case, as the free allocation only concerns the part of the bill related to drinking water. As the levies for wastewater are being charged from the first m³ onwards, there is no consumption with a zero marginal price. As long as a household remains within the free drinking water band, the marginal price is of course considerably lower than when the marginal price includes both the drinking water and the wastewater rate.

6- Results

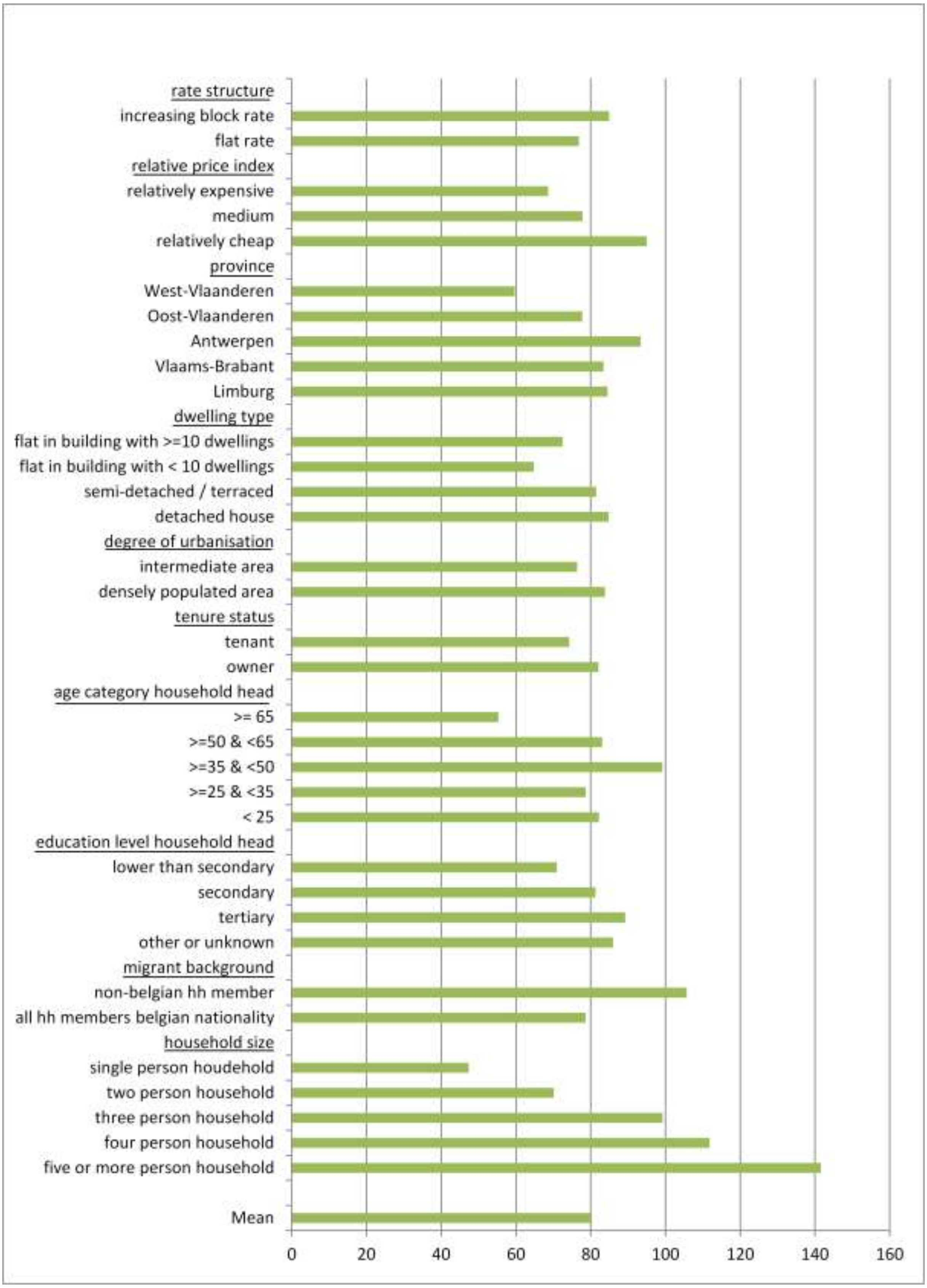
We start this section with a descriptive outline of the relationship between household demand for water and a number of technical characteristics of the water pricing system, and some social, economic and demographic characteristics of the household. Next, we assess which factors are driving household water demand in a multivariate determinant model, and finally turn to estimated elasticities from the QUAIDS demand system.

Descriptive associations between water use and socio-demographic, dwelling and regional variables.

Figure 5 and 6 show average water use over households according to the characteristics described in Section 5. In Figure 5, this is done with the variable of household water use, in Figure 6 with water use per household member. Doing this, a number of patterns are reversed, showing the importance of controlling for household size (and other variables) while assessing the influence of other characteristics.

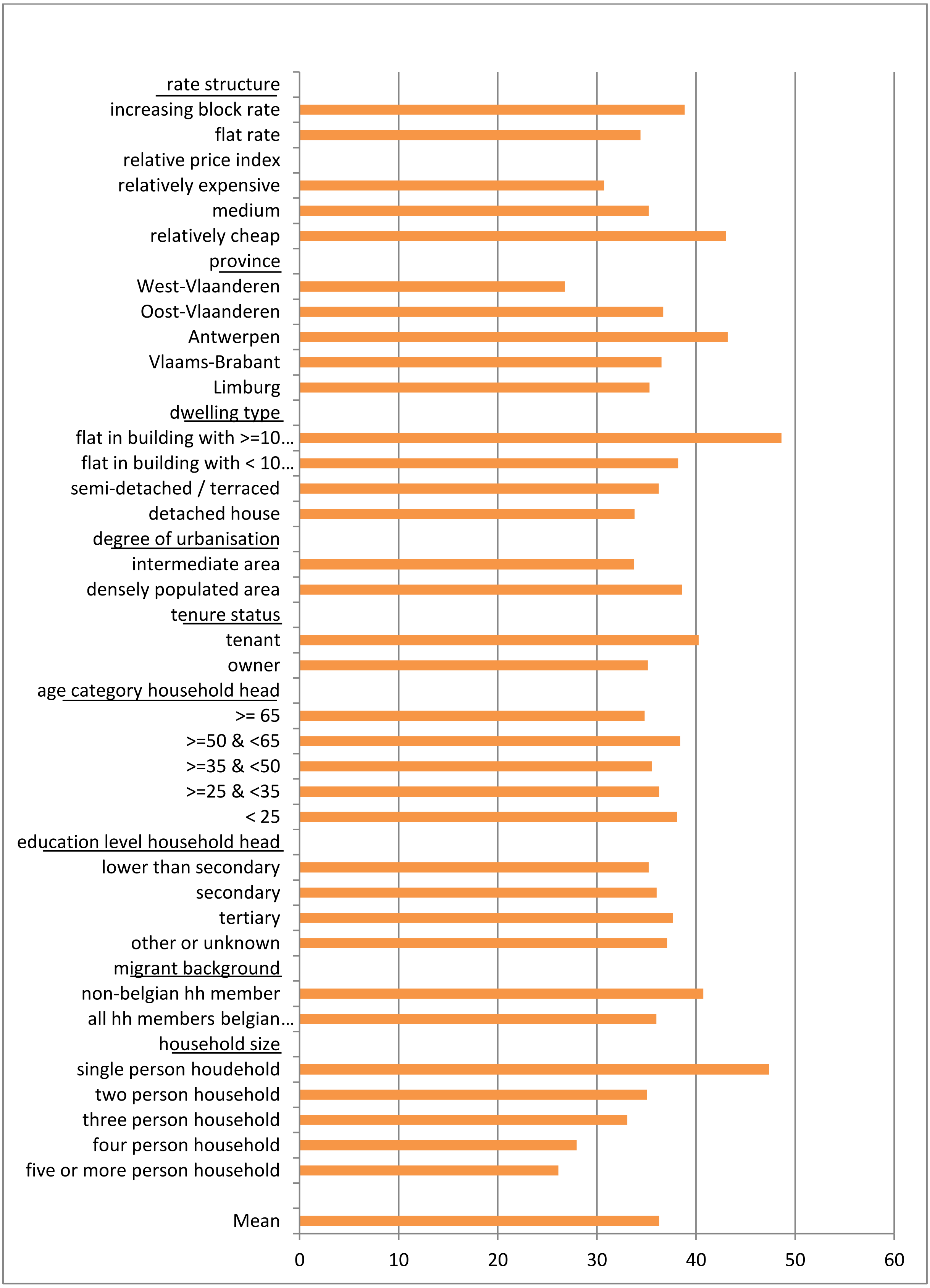
In general, most relationships show the expected direction. In relatively expensive water regions, less water is used, while more is being used is relatively cheap regions. Households living in the Flanders' most western province, West-Vlaanderen, use less water, while in Antwerpen water use per household is higher than in the other provinces. Households living in a flat consume a smaller amount of water on average, however, when expressed as m^3 per household member, they use more than households in (semi-)detached or terraced houses, showing the influence of the fact that households living in an apartment tend to be smaller in size. Households living in densely populated areas use slightly more water, per household as well as per person. On average, owner-occupier households use more water than tenants, however, again the relationship is inversed when looking at average use per household member. The observed differences when looking at the relationship between age of the household head and household water use disappears entirely when measured per household member. When distinguishing households according to education level, the same observation holds. The presence of someone with a non-Belgian nationality in the household appears to be positively correlated with water use both when measured at the household level as when measured at the individual level. Then finally, the relationship between household size and water use displays the most outspoken pattern. When water consumption is measured per household, there is a strong positive correlation, while we observe a consistent negative relationship between household size and water use per individual water consumption, clearly marking the presence of economies of scale (see also Höglund 1999, Arbués et al. 2004, García-Valiñas 2005).

Figure 5: Annual domestic consumption of water per household, in m³, over categories, Flanders 2009.



Source: author’s calculations on BE-SILC 2009

Figure 6: Annual domestic consumption of water per household member, in m³, over categories, Flanders 2009.



Source: author's calculations on BE-SILC 2009

Determinant model of household water use

Next, the possible relevance of the aforementioned variables on households' water use is investigated in a multivariate framework using a regression model with loglinear specifications. The dependent variable is the natural logarithm of the households' annual water use in m³.

Table 3: Determinant analysis of annual household water use in m³, Flanders 2009.

Dependent Variable = ln of annual water use in m³	Coef.	sign.	t-statistic
lnincome	0.0671		0.99
income quintile (reference: middle (3rd) quintile)			
poorest (1st) quintile	0.0132		0.2
second quintile	-0.0477		-1.07
fourth quintile	-0.0427		-0.87
richest (5th) quintile	-0.0805		-1.31
age	0.0243	***	4.05
age squared	-0.0003	***	-5.01
household size (reference: one person household)			
two-person household	0.4158	***	8.7
three person household	0.7295	***	10.27
four person household	0.8621	***	9.91
five person household	1.0478	***	9.64
household composition			
adult not in employment present	0.0938	*	2.14
children < 18 present	-0.0809		-1.49
non-belgian household member present	0.1463	*	2.54
education level (reference: upper secondary education)			
lower secondary education or less	-0.0515		-1.42
tertiary education	0.0008		0.02
other or unknown	-0.0662		-0.52
tenant (reference: owner)	0.1008	*	2.43
no washing machine	-0.0996		-1.22
flat (reference: (semi-)detached/terraced house)	-0.0471		-1.17
province (reference: Antwerpen)			
Limburg	0.0011		0.01
Oost-Vlaanderen	-0.0648		-1.09
Vlaams-Brabant	-0.0311		-0.52
West-Vlaanderen	-0.4089	***	-5.95
densely populated area (reference: intermediate area)	0.1830	***	4.62
increasing block rate pricing system (reference: flat rate)	0.1012	*	2.18
relatively low-cost water area	0.1443	*	2.67
relatively high-cost water area	-0.0410		-0.77
constant	2.4829	***	3.72
Number of Observations	2741	F(28,116)	43.6
Number of PSUs	148	Prob > F	0.0000
Number of strata	5	R^2	0.3424

Source: author's calculations on BE-SILC.
Notes: * significance at 0.05 level; *** significance at 0.001 level

Controlling for these observable characteristics, many relationships turn out not to be significant, implying they were driven by an uneven distribution of other relevant characteristics over the categories. Age and household size appear to be two most pronounced deterministic variables. Living in a densely populated area as well as living in the province of West-Vlaanderen also appears to have a strongly significant (<0.001) influence on households' water consumption. Further, significant relationships at the 5% level could be identified from the variable indicating whether households are tenants, the presence of adults that are not employed and/or non-Belgian nationals, whether households face an increasing block rate pricing system, and live in a low-cost water area. The latter is also found to be significantly correlated with the level of water consumption in Hajispyrou et al. (2002).

Remarkably, in this determinant framework we could not identify any significant relationship between income and the m³ of water consumed. It is difficult to compare this outcome to other studies on determinants of water demand, as the vast majority of the existing studies employ aggregated data mostly at the community level (see e.g. Schleich and Hillenbrand for an example and literature overview). Here, average water consumption are matched with averages of other demand-related characteristics, such as per capita income per community. This approach conceals many possible household-level determinants, in particular socio-demographic characteristics, that can be correlated with income. Studies on water demand that do employ individual household data often don't have household income and other socio-demographic characteristics at their disposal in the dataset either and therefore have to use a proxy for income, typically a fiscal indicator of the value of the dwelling (Arbués et al. 2004, 2010, García-Valiñas 2005, Arbués and Villanúa 2006). Nevertheless, studies that are more similar in methodology to ours, such as Hajispyrou, also find an influence of income although its significance is not mentioned. Studies with a more comparable methodology to ours are found in the literature investigating determinants of energy (space heating, electricity) also do find a statistically significant positive influence of income on energy use (Rehdanz 2007, Meier and Rehdanz 2010, Jamasb and Meier 2010).

QUAIDS demand model and household responsiveness

First, we model household demand for water using the QUAIDS framework, using the information on price, water expenditure and total income at the household level only. As presented in Table X, the estimated values for all parameters, including lambda, are highly significant, indicating the appropriateness of allowing for non-linear or quadratic Engel curves.

Table 4: QUAIDS parameter estimates

w_w	Coef.	sign.	Standard error	z-value
α_w	0.02971	***	0.000964	30.82
β_w	-0.03462	***	0.000749	-46.23
γ_{ww}	0.00249	***	0.000662	3.76
λ_w	0.01004	***	0.000268	37.45

Source: author's calculations on BE-SILC 2009.

The estimated values for these parameters generate an income elasticity estimate of 0.62 evaluated at the population average, and a uncompensated (compensated) price elasticity estimate of -0.615 (-0.609).

In an extension of this model, these variables that proved most deterministic in water demand (age and household size, province of west-vlaanderen and densely populated area) plus quintile dummies enter in the demand model. These variables enter the model by means of dummy variables for the province of west-vlaanderen, for densely populated area, for 5 age categories for the household head (16-24; 25-34; 35-49; 50-64; >=65), for the number of family members (1; 2; 3; 4; 5 or more), and for 5 income quintiles. We assume that living in West-Vlaanderen or in a densely populated area can affect the intercept of water use, while both intercept and slope parameters are allowed to vary with age category of the household head, household size and income quintile.

The estimated parameters are reported in Table A.2 in the appendix. None of the allowed interactions with the age dummies in the model are significant, implying that the dummies fail to capture the more complex relationship found in the determinant model. The household size and income quintile interactions do result in small but significant differences in the parameter estimates for each category in α, β and λ. Also the dummies for West-Vlaanderen and densely populated area significantly alter α a little bit.

The estimates allow us to calculate the price elasticity[4] evaluated at the average of each category, controlling for different distribution in the other category (e.g. uneven distribution of household size over the income quintiles). The estimates are reported in Table X. For each category, the price elasticities are negative, significantly different from zero, and between 0 and 1, indicating that water is an inelastic good. The results suggest that low-income households as well as smaller families have a significantly higher price responsiveness (more negative price elasticity) than high-income families and larger families. The difference between income groups is slightly more pronounced than the difference between households of different sizes, but in both cases confidence intervals at the 95% level for the estimates for the lowest and the highest group are not overlapping.

Table 5: own-price water elasticities according to income quintile and household size, Flanders 2009.

income quintile	estimate	sign	standard error	z-value	95% C.I.	
1	-0.76948	***	0.0304947	-25.23	-0.82925	-0.70971
2	-0.67896	***	0.0522478	-13	-0.78136	-0.57656
3	-0.57768	***	0.0649505	-8.89	-0.70498	-0.45038
4	-0.49989	***	0.0834761	-5.99	-0.6635	-0.33628
5	-0.25182	*	0.1121718	-2.24	-0.47168	-0.03197

household size	estimate	sign	standard error	z-value	95% C.I.	
1	-0.74459	***	0.0433935	-17.16	-0.82964	-0.65954

[4] The estimated values for the income elasticities failed to be significantly different from zero for each category and came with too large confidence intervals to be regarded as reliable estimates.

2	-0.62415	***	0.0612374	-10.19	-0.74417	-0.50413
3	-0.55395	***	0.0715989	-7.74	-0.69428	-0.41362
4	-0.50767	***	0.0802024	-6.33	-0.66486	-0.35047
>=5	-0.34044	***	0.0731229	-4.66	-0.48376	-0.19712

Source: author's calculations on BE-SILC 2009.
Notes: * significance at 0.05 level; *** significance at 0.001 level

This finding is in line with other empirical studies investigating differential responsiveness (Agthe and Billings (1987), Renwick and Archibald (1998), Hajispyrou et al. 2002, Arbués et al. 2010). The first three studies find higher responsiveness (more negative elasticities) for low-income households compared to high-income households, ranging between -0.57 (lowest income group) to 0.40 (high income group) in the study by Agthe and Billings (1987), between -0.53 (lowest income households) and -0.11 (highest income households) in the study by Renwick and Archibald (1998) and between -0.79 (lowest income group) and -0.39 (highest income group) in Hajispyrou et al. (2002).

Arbués et al. (2010) investigate differential responsiveness according to age group. They find that smaller households have larger elasticities (in absolute value) than larger households, ranging from below -1 for small households to -0.26 for large households.

With respect to differentiating according to relative income position, it provides support for the hypotheses that low-income households are more responsive to price changes because they are forced to keep a close watch on their expenses. When a good becomes significantly more expensive, they react more than high-income households by reducing their consumption. High-income households on the other hand, might not notice changes in the share of their budget that is allocated to water consumption as much, because proportionally it represents a smaller part of their income, and therefore react much less to changed prices with adjusted consumption.

With respect to differentiating according to household size, our result imply that small households are better able to adjust to changes in the price of water than large households. Which mechanism is driving this result, is not a priori clear. Arbués et al. (2010) propose two explanations. A first explanation is related to the existence of endogenous transaction costs related to the introduction and spread of new practices that improve the efficiency of water appliances like taps, tanks, washing machines and dish washers. They hypothesize that these transaction costs might be higher in larger households, because the organisation and supervision of household activities is more complex. Secondly, they propose that household size affects the capacity of the household to improve the efficiency of its water use practices: Usually, white goods utilization is less efficient in small households than larger ones due to the fact that they are more often used below full capacity, thereby not fully exploiting economies of scale related to their use. Therefore, it is hypothesized, small households will be better able to obtain efficiency improvements in water consumption in response to exogenous incentives, while larger household are already making use of these economies of scale.

7- Conclusions

The effectiveness of price-based policies in reducing natural resource consumption depends on the extent to which different types of consumers are sensitive to changes in the price of the environmental good. Using the case of volumetric wastewater charges in Flanders, we employ observed price heterogeneity between different water pricing areas to model a quadratic almost ideal demand system, allowing us to estimate households' differential price responsiveness.

We find that all households are responsive to prices, regardless of their relative income position or size. Yet the significant differences in elasticities between household groups suggest that the financial and conservation burden of the installed water pricing policy are not distributed evenly across the population. Lower income households and smaller size households are found to be more responsive to increased prices than higher income households and larger size households.

Future research should assess both social effects in an integrated way, quantifying the distribution of financial incidence as well as the distribution of the conservation burden within a coherent framework. This would allow us to make policy recommendations on the possibilities to overcome the equity-efficiency dilemma typically observed when installing environmental policy measures geared at increasing the price of natural resources that are at the same time consumed by households to fulfil a number of basic needs.

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Appendix

Table A.1: key statistics on variables used in the analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
household annual water consumption in m3	2741	80.28928	59.23396	1.487404	462.8894
household net disposable income	2741	36561.56	26570.39	-178201	907034.3
dummy for household size 1	2741	0.262943	0.440312	0	1
dummy for household size 2	2741	0.36283	0.480904	0	1
dummy for household size 3	2741	0.159758	0.366449	0	1
dummy for household size 4	2741	0.128425	0.334623	0	1
dummy for household size 5 or more	2741	0.086044	0.28048	0	1
dummy for presence of adults without professional activity	2741	0.525073	0.499462	0	1
dummy for presence of children <18	2741	0.274048	0.446115	0	1
dummy for presence of non-belgian nationality member	2741	0.061487	0.240264	0	1
dummy for ISCED level of lower secondary eduction or less	2741	0.358072	0.479521	0	1
dummy for ISCED level of upper secondary education	2741	0.291492	0.454532	0	1
dummy for ISCED level of tertiary education	2741	0.326317	0.46895	0	1
dummy for ISCED level of other or unknown	2741	0.02412	0.153448	0	1
age of the household head	2741	52.74848	16.19033	19	85
dummy for age category 16-24	2741	0.013668	0.11613	0	1
dummy for age category 25-34	2741	0.133906	0.340614	0	1

dummy for age category 34-49	2741	0.310914	0.462952	0	1
dummy for age category 50-64	2741	0.282512	0.450303	0	1
dummy for age category 65 and older	2741	0.259	0.438166	0	1
dummy for tenant household	2741	0.225029	0.417677	0	1
dummy for apartment	2741	0.164582	0.370871	0	1
dummy for no owned washing machine	2741	0.048977	0.215859	0	1
dummy for densely populated area	2741	0.524958	0.499468	0	1
dummy for Antwerp province	2741	0.26835	0.443181	0	1
dummy for Limburg province	2741	0.129718	0.336054	0	1
dummy for Oost-Vlaanderen province	2741	0.232848	0.422723	0	1
dummy for Vlaams-Brabant province	2741	0.174633	0.379722	0	1
dummy for West-Vlaanderen province	2741	0.194453	0.395851	0	1
dummy for household facing increasing block rate price structure	2741	0.426701	0.494688	0	1
dummy for comparatively low water cost area	2741	0.233183	0.422935	0	1
dummy for comparatively average water cost area	2741	0.561858	0.496249	0	1
dummy for comparatively high cost area	2741	0.20496	0.403746	0	1

Source: BE-SILC 2009

Table A.2 Parameter estimates for QUAIDS model extended with socio-demographic characteristics, Flanders 2009.

w_w	Coefficient	sign.	standard error	z-value
α_w	0.016145	***	0.004538	3.56
β_w	-0.03567	***	0.009695	-3.68
γ_{ww}	0.003132	***	0.000532	5.89
λ_w	0.019885	***	0.004969	4
$\alpha_{w,hs2}$	0.013002	***	0.00117	11.11
$\alpha_{w,hs3}$	0.021709	***	0.003446	6.3
$\alpha_{w,hs4}$	0.021803	***	0.004968	4.39
$\alpha_{w,hs5}$	0.037222	***	0.006738	5.52
$\alpha_{w,iq2}$	-0.01316	***	0.00304	-4.33
$\alpha_{w,iq3}$	-0.01031	*	0.005149	-2
$\alpha_{w,iq4}$	-0.02195	**	0.008067	-2.72
$\alpha_{w,iq5}$	-0.04764	***	0.006401	-7.44
$\alpha_{w,ac2}$	0.008467		0.005145	1.65
$\alpha_{w,ac3}$	0.007837		0.004674	1.68
$\alpha_{w,ac4}$	0.00419		0.00458	0.91
$\alpha_{w,ac5}$	0.008808		0.004524	1.95
$\alpha_{w,dp}$	0.000625	*	0.000304	2.06
$\alpha_{w,wv}$	-0.00295	***	0.000366	-8.08
$\beta_{w,hs2}$	-0.02168	***	0.002109	-10.28
$\beta_{w,hs3}$	-0.02905	***	0.004668	-6.22
$\beta_{w,hs4}$	-0.02918	***	0.00622	-4.69
$\beta_{w,hs5}$	-0.04982	***	0.008565	-5.82
$\beta_{w,iq2}$	0.040656	***	0.006008	6.77
$\beta_{w,iq3}$	0.036089	***	0.007896	4.57
$\beta_{w,iq4}$	0.051421	***	0.010049	5.12
$\beta_{w,iq5}$	0.078288	***	0.005707	13.72

$\boldsymbol{\beta}_{w,ac2}$	-0.00653		0.010406	-0.63
$\boldsymbol{\beta}_{w,ac3}$	-0.00645		0.009845	-0.66
$\boldsymbol{\beta}_{w,ac4}$	-0.00148		0.009748	-0.15
$\boldsymbol{\beta}_{w,ac5}$	-0.013		0.0097	-1.34
$\boldsymbol{\lambda}_{w,hs2}$	0.008876	***	0.001086	8.17
$\boldsymbol{\lambda}_{w,hs3}$	0.010396	***	0.001704	6.1
$\boldsymbol{\lambda}_{w,hs4}$	0.010548	***	0.00205	5.15
$\boldsymbol{\lambda}_{w,hs5}$	0.016347	***	0.002618	6.24
$\boldsymbol{\lambda}_{w,iq2}$	-0.02252	***	0.002722	-8.27
$\boldsymbol{\lambda}_{w,iq3}$	-0.02141	***	0.002856	-7.5
$\boldsymbol{\lambda}_{w,iq4}$	-0.02643	***	0.003088	-8.56
$\boldsymbol{\lambda}_{w,iq5}$	-0.03351	***	0.001543	-21.71
$\boldsymbol{\lambda}_{w,ac2}$	0.000242		0.005064	0.05
$\boldsymbol{\lambda}_{w,ac3}$	0.000544		0.004905	0.11
$\boldsymbol{\lambda}_{w,ac4}$	-0.00104		0.004878	-0.21
$\boldsymbol{\lambda}_{w,ac5}$	0.00372		0.004875	0.76

Source: author’s calculations on BE-SILC 2009.

Notes: * significance at 0.05 level; ** significance at 0.01 level; *** significance at 0.001 level. *hs2-5* refers to household size 2 to 5 or more, reference group is household size 1. *iq2-5* refers to income quintile 2 to 5, reference group is income quintile 1. *ac2-5* refers to age category 2 to 5, reference category is age category 1. *dp* refers to densely populated, *wv* refers to the West-Vlaanderen province.