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Consumption-based water charges and public water regulators' equity concerns - an empirical evaluation of alternative tariff structures for Flemish households

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Abstract

While water pricing policy in Flanders is moving towards full cost recovery of its water services (production and supply of drinking water as well as wastewater drainage and sanitation) via consumption-based fees and levies, concerns over regressive effects of the levies and over the affordability of water services among vulnerable population groups have risen accordingly. Along with the average water bill almost tripling over the past 10 years for an average family (VMM 2014), recent evidence also pointed at rising numbers of households having difficulties to pay their water bill, potentially resulting in problems of payment arrears and disconnection from the supply network (SERV 2012).

Looking into the different rationales that can underpin the design of particular water tariff structures for households, attention is paid to the often cited but seldom defined "social equity" objective. The discussion is complemented with an empirical exercise investigating the distributional effects of five alternative pricing schemes to recover the costs of water supply and sanitation services among domestic consumers.

We employ the micro-level information on both income and the water bill for the representative sample of Flemish households in the EU-SILC 2009 and a recently extended module on environmental policy in the Flemish tax-benefit microsimulation model MEFISTO. Making abstraction of the behavioural effects, water use is kept constant in the simulations, in order to present the mechanisms operating at the micro-level driving first round distributional effects of the different ways in which an equity objective of the public water regulator can be translated into the tariff structure.

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1. Introduction

Many issues surround the question of how to appropriately price domestic water use. Water services, from production and supply of drinking water to drainage, sewerage and cleaning of wastewater, are in most countries a public responsibility shared among different public and semi-public actors.[1] Different principles and associated revenue sources can underlie the choice of how to finance the provided services, resulting in a certain cost coverage structure consisting of (a mix of) public budgets, fixed and/or volumetric fees.

Over the past decades, the conception of water as an economic good is increasingly being used as the base for the design of appropriate financing mechanisms. The Dublin conference on Water and the Environment (ICWE 1992) is often cited in this context, where international consensus was reached around the conception of water as "a finite, vulnerable and essential resource (...) with an economic value, [which] should be recognized as an economic good, taking into account affordability and equity criteria." (ICWE 1992, p.1)[2].

While there is no consensus on how an economic conception of water is best translated into the financing equation (see e.g. Savenije and Van der zaag 2002 for a critical perspective), the trends that OECD (2009) identifies with regard to household tariff policies for water supply and sanitation in its member countries, can certainly be interpreted in this way: over the last decades, continued real price increases, continued decline in the use of decreasing block rate tariffs[3] and flat fee systems for household tariffs in favour of a two-part fixed charge plus a (single rate or increasing block) variable fee for the volumetric component.

While certain tensions can already be identified between a pricing structure based on a scarcity-reflecting economic efficiency rationale and one on the principle of cost recovery (see e.g. François et al. 2010) another important concern has influenced the design of water tariff structures in many countries: a sense of what an equitable treatment of different water users consists of. OECD reports, along with real price increases, a "continued attention to social concerns, addressed through innovative tariff structures or parallel income-support mechanisms" (OECD 2009, p.76). Even though there is a consensus on the need to take into account equity considerations (the vast majority of strategic policy documents include it as a

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[1] The question of the adequate governance structure over water resource management (including the provision of water services to domestic users) is principally treated in the governance literature (e.g. Rogers and Hall 2003. Nevertheless, given its importance in the public provision of water services, also lines of argumentation in more economic literature refer to this matter (Hanemann 2005 or OECD 2009). The analysis presented here takes point of departure in the generally valid observation that the appropriate pricing of water services is an exercise taking place at the public level and not in a market setting, albeit with involvement of the a number of semi-public and private stakeholders.

[2] Other Dublin principles emphasized the importance of an integrated perspective on water management (requiring a holistic approach, linking social and economic development with protection of natural ecosystems), the role of participative approaches to water management and stakeholder involvement in decision making, and the central role of women in the provision, management and safeguarding of water (ICWE 1992).

[3] Block rates is the term to a pricing structure where a different price per m³ applies depending on the volume consumed. Block rates can be increasing (where the price per m³ becomes higher) or decreasing (where the price is lower the larger the volume consumed)

central objective, cfr. above), it remains a matter of debate *whether* concerns over the equitable treatment of different water users should enter into the tariff structures (or be kept outside of rate design and be pursued with other instruments) and if yes, *how* this can be best attempted, while keeping the financial and economic objectives in place (Aghte and Billings 1987, Rogers et al. 2002, OECD 2002, Bithas 2008, Barberán and Arbués 2009, García-Valiñas et al. 2010, Peña 2011)

Nevertheless, all of the above considerations around rate design are present in the debate on water pricing in Flanders. With reforms in 1997 and 2005, the way in which water services are financed was gradually shifted from a fixed charge per tax unit to a volumetric charge based on actual water use. A first reform took place in 1997, with the objective to cover drinking water production and supply costs. As of 2005, a new reform allows the gradual recovery of all costs related to sewerage and cleaning of wastewater, via a volumetric-base "wastewater charge", which is added to the drinking water component of the water bill. This shift can be characterized as a move closer towards "the polluter pays" principle, where large water users contribute more to the cost of water sanitation than small water users. At the same time, concerns over affordability for low-income households have resulted in a complex pricing scheme with varying exemptions each applying to the different components of the water bill.

Reforming water pricing structures is a major challenge (de Azevedo & Baltar 2005, García 2005), and requires an appropriate balance among (possibly competing) objectives. Being ultimately a political task, it requires a transparent and democratic process, including debating the appropriate balance between the various policy objectives, as well as a thorough investigation of the impacts, costs and benefits of different tariff structures (OECD 2009).

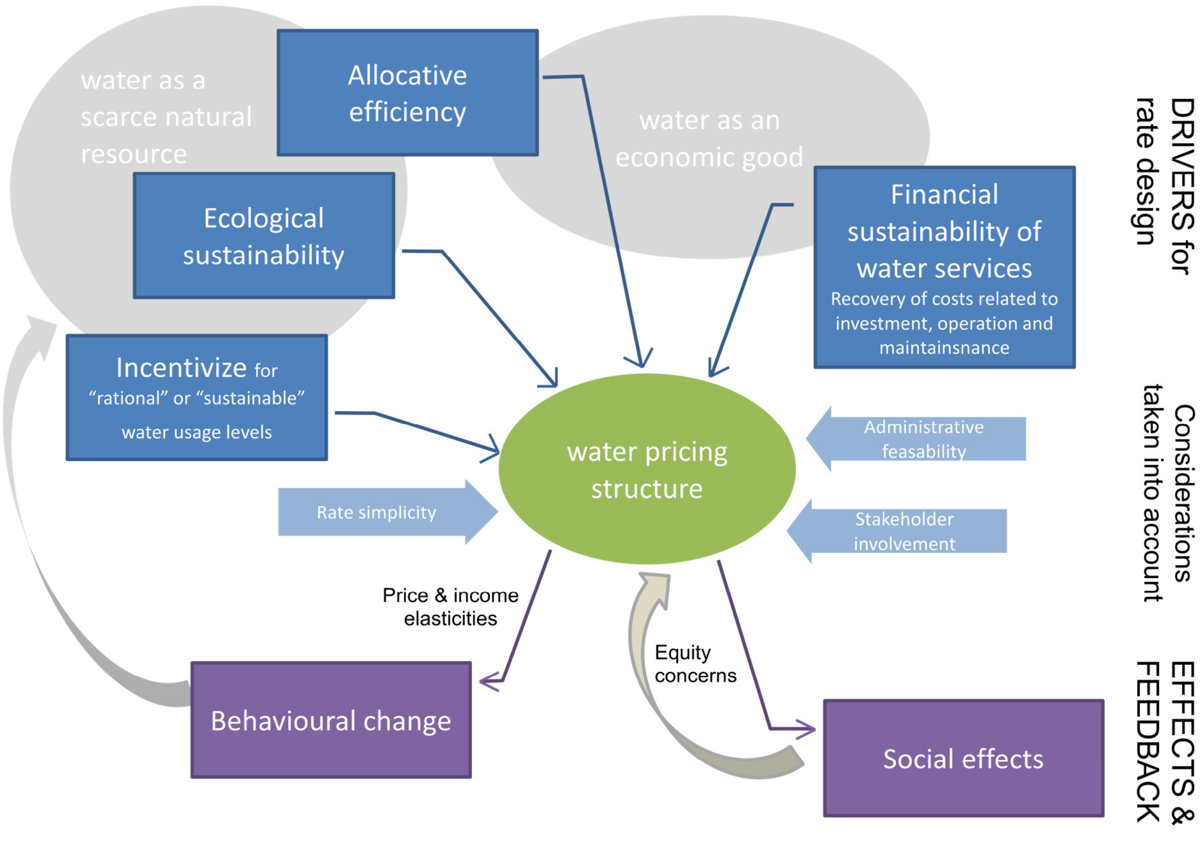
This paper aims to contribute to the latter need, in particular by exploring the distributional consequences of different tariff structures. Theoretically, it is far from clear how the - often cited but rarely specified - equity objective (comprising notions of basic needs, distributional considerations as well as affordability aspects)[4], should be taken into account when prices are set within a framework where a multitude of objectives are to be reconciled. This is explored in Section 2. The empirical exercise in the paper examines the first-order distributional implications of different water tariff structures for households in the region of Flanders, Belgium. Section 3 provides more detail on the case, while Section 4 describes the methodology and data that were used. In Section 5 the analysis and results are presented, to conclude in Section 6.

[4] We leave aside the intergenerational equity concerns, thus restricting the analysis to the equity effects at play between different types of households in today's society.

2. Pricing water: a multi-objective exercise

Designing water rates is an exercise requiring the reconciliation of different, potentially competing, objectives (Hanemann 1999, Garcia 2005, OECD 2009). In this paper, we adopt a political economy perspective, to acknowledge the multiplicity of considerations when a public water regulator sets the water price structure. Figure 1 provides a stylized overview of the most cited drivers, considerations and feedback effects that all go into the water rate equation. This immediately explains why water pricing reforms are often long, complicated and difficult processes which result most often in significant deviations from 'first-best policies' derived from treating water as an economic commodity.

Figure 1 : Objectives for water rate design



Drivers for rate design

The conceptual reasoning behind the design of water tariff structures takes often point of departure in the economic perspective. Since the Dublin Conference, policy documents (from the EU Water Framework Directive to the OECD's recommendations) state univocally that water should be treated as scarce, valuable, and therefore economic good. Theoretically, there is consensus that the "ideal" entails that water tariffs should be sufficient to cover the direct and indirect costs of water supply and sanitation services: from immediate operation costs to the capital costs of replacing and expanding the network infrastructure, as well as incorporating its scarcity value and the externality costs to society now and in the future.

However, it is often immediately admitted that deviating from the ideal can be necessary.[5] Here, the different components of this "ideal" are briefly discussed, in order to understand the often relatively complex tariff structures that result from reconciling these principal objectives.

(1) financial sustainability (also revenue sufficiency or cost recovery)

The most traditional reason for water pricing stipulates that it should generate the revenue that is necessary for the operation, maintenance and necessary expansions of the water services system. Water management is an activity that typically requires investment in costly infrastructures, in order to keep the service viable over time. These infrastructure investments are mostly necessary independent of the quantity of water that is consumed. As such, they tend to give rise to a (part of the) water price that is "fixed" for every customer, often in the form of a yearly fixed charge, irrespective of water usage. In this way, water companies can have higher security that their costs will be covered for.

Attaining the objective of financial soundness nevertheless remains a challenge, as the reality shows that across countries both in the developed and developing world, the water sector struggles with serious underinvestment, especially in the necessary infrastructure (OECD 2007, Hukka & Katko 2015).

(2) ecological sustainability

Ecological sustainability is commonly understood to imply that water usage levels are 'environmentally' sustainable (in the long term). Freshwater is a scarce and vulnerable resource, and should therefore be used only to the extent that the basic ecological functions of this natural capital are protected, and that these functions are also guaranteed in the future.

While problems of drought are intensifying in southern countries, also more northern OECD member states (such as Belgium for which the empirical exercise is carried out) see their freshwater ecosystem services threatened because of climate change and overextraction.[6]

(3) allocative efficiency

In a narrow interpretation, it means the 'economically efficient' allocation of existing supplies in the short term, among its different purposes. In a broader interpretation, allocative efficiency could be argued to include ecological sustainability: as a scarce natural resource and thereby a valuable economic good, water should be allocated to the uses that maximise overall benefits to society now and in the future, including uses to preserve ecological functions (ecological sustainability).

These two last drivers are therefore closely connected, and give rise to include in the tariff structure a component that incentivizes water users to restrict their use to a "sustainable" level

[5] Reasons for deviations can range from more practical considerations (such as administrative feasibility) to more conceptual ones (how to calculate scarcity value or externalities in the future?) and include most prominently the "socially adverse effects". Below, this paper elaborates on the latter in particular.

[6] empirical studies specifically for Belgian regions include Vandenbohede et al. 2008

– so as to guarantee that the different purposes of water in society can be served and preserved.

Despite conceptual consensus, there is no consensus on its actual implementation: what cost components should be included to determine the marginal price charged to users? And once one goes beyond immediate financial costs to account for externalities, how can/should this be done? These remain open questions with both methodological and normative aspects. Typically, the result of a scarcity/efficiency reasoning are some sort of volumetric charges, where the customer pays according to the quantity s/he uses.[7] As stated in the introduction, OECD (2009) states that the trends in pricing schemes in OECD countries reveal that over the period 1999-2007, the principle of volumetric pricing – for drinking water as well as for wastewater - has firmly entered the financial equation of water resource management, in addition to the cost recovery objective of water pricing. This shift can be characterized as a move closer towards the polluter-pays-principle, and should induce households to reduce their water use behaviour and reduce consumption, leading to a more efficient allocation of water over its different uses (including uses to preserve ecological functions and ensure availability also for future generations).

While the conceptual lines for water pricing schemes start in these principles that can be well studied with economic analysis, Dinar (2000) among others points to the complexities beyond the calculation of first-best efficient water pricing schemes that stem from models based on the traditional economic assumptions.[8]

Considerations

Different stakeholders generally hold different perceptions with respect to what 'an economic conception of water' exactly implies for the way that its management is financed, and thus what should be considered appropriate pricing. Haneman (2005) overviews the tensions, pointing to the problems both with an overly narrow-economic conception of water pricing - ignoring the complexities of water as an economic good - as well as with conceptions where economic insight is ignored under the pretext of political or social acceptability. Stakeholder involvement is therefore an essential part in the democratic process of determining the appropriate water rates.

Rate simplicity and administrative feasibility are other considerations that feed into the decision on which tariff structure is eventually implemented.

Effects and their feedback

[7] For instance, in a single volumetric scheme, the price will linearly increase with quantity used. In an increasing block rate tariff structure, the marginal price (or the price of the last consumed unit) increases when the total quantity of water use passes over certain pre-determined thresholds (the blocks). The empirical section elaborates both rate designs in more detail.

[8] Typically individuals' rational behaviour, availability of full information at no transaction cost, and clear and consistent preference sets depending on individual maximization of welfare.

Finally, water rates are set in a dynamic context, and the desired and undesired effects they (might) generate, are also taken into account. We distinguish two main areas of these effect-and-feedback considerations. First, behavioral change can well be expected to result from (changes in) the water price or tariff structure. Changed water use in period n again influences the rate set in period n+1. For instance, when higher prices reduce demand, it can be required to adjust water rates upwards in a way that the operation and maintenance costs remain covered. Secondly – and the main focus of this paper – (undesired) social effects are being anticipated. Given that water is essential to fulfill a number of basic needs in the domains of health, hygiene and nutrition, social concerns regard *affordability* (and related, the problems of water bill arrears, debts, and eventually cut-offs) and *fairness or distribution* (what is the fair share in the costs to be paid by different types of water users? How should the costs and benefits be distributed among different population groups / groups of water users?)

The aim of this paper is, first, to disentangle what types of reasoning and what assumptions are underlying the adjustments to water tariff structures made out of equity considerations (the remainder of this section) and then, empirically, to analyse what these different ways to think of equity imply in terms of the distributive mechanisms at work in possible tariff designs (section 4).

When asking the question how the costs of the public service of water supply and sanitation should be distributed over the population, three "strands" of answers can be distinguished:

- according to the *benefit principle*, customers pay in accordance with the benefit that they have derived from the service, i.e. according to the quantity of water that is used. This perspective is most common and generally accepted in the field of publicly supplied services such as water (García-Valiñas 2010). Concerns raised in this context mainly regard the treatment of households of different sizes in a tariff scheme where higher consumption levels are penalized irrespective of the number of persons that are covered (e.g. Arbués & Villanúa, 2010).

- according to the *ability to pay principle*, customers pay according to their financial capability. Although there are no examples of rate structures that have the income of the water user as their main variable, many countries have installed 'social prices' for certain well-defined population groups. This implies that the households that do not belong to the target group (assumed to be the richer households) co-pay for the water bills of the targeted groups (assumed to be the poorer households), through which redistribution from poor to rich is envisaged.

- from a *basic needs perspective*, the focus is on guaranteeing that every citizen can dispose over the quantity of water necessary to fulfill in his basic needs. Here, the focus is primarily on the affordability of the water bill for poor households, how to protect vulnerable groups, and find ways to deal with arrears that avoid cut-offs (Garcia-Vallinas 2010). Besides the installation of legal procedures to mediate arrears and protect for cut-off, basic needs considerations can also translate into the tariff design itself via for instance the provision of a limited 'first' quantity of water for free or against a reduced rate (increasing block-rate structure). This exempted quantity can be interpreted as the amount that is necessary to fulfill the basic needs, and can be determined per household or per person living in the household.

As a final remark, many authors note that there are often clear trade-offs between an equity-inspired tariff adjustment and its goals in terms of efficiency (cfr. discussions in, among others, Rogers et al. 2002, Garcia-Valinas 2010). Social prices for certain groups, for instance, reduce their incentive to economize on their water use, leading to inefficient use of the scarce resource (Olmstead & Stavins 2009). While acknowledging the objective to correct for socially adverse impacts, these authors often advocate the use of income-support instruments (either via taxation, social insurance, or simple lump sum rebates – e.g. the proposal of Boland & Whittington, 2000) instead of correcting via the tariff structure itself.

3. The case of Flanders

In the Belgian federal state, the responsibility over the provision of water services is entirely transferred to the regions. The Brussels Capital Region, the Flemish Region and the Walloon Region thus each carry out water policy over its territory, including the coordination over the supply and sanitation of domestic water conform the EU directives. The Flemish Environmental Agency (VMM) is the institutional body for water policy in Flanders. Multiple water supply companies carry out the production and supply of drinking water, while the responsibility over sewerage and cleaning is shared between the region and the local municipalities.

In Flanders, subsequent water bill reforms were implemented over the past two decades, shifting cost recovery for household water services from a fixed fee per tax unit to a consumption-based tariff. In 1997, the fees for production and supply of drinking water were made volumetric, and from January 2005 onward, also (a gradually increasing part of) the costs for sewerage and cleaning of wastewater were charged on the basis of consumption[9], resulting in what was termed the "integral water bill" (comprising the entire spectrum of household water services) that all Flemish families receive today on a quarterly basis.

Since the introduction of the integral water bill, households have seen their water bills increase sharply (+165% in real terms over the period 2004-2012) (VMM 2014). This shift can be characterized as a move closer towards "the polluter pays" principle, where large water users contribute more to the cost of wastewater sanitation than small water users.

At the same time, concerns over the equity effects of this measure have resulted in a relatively complex pricing scheme. Below, the composition of the water rate is outlined with specific attention for the adjustments out of equity considerations.

Composition of the integral water bill

- $integral\ water\ bill = drinking\ water\ component + wastewater\ component$

[9] 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.

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 sewerage and cleaning of wastewater on the other hand.

- $drinking\ water\ component = F + (q - 15\ m^3 * household\ size) * p_d$

The part of the bill for drinking water is set by the water supply company.[10] 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 F and a variable part that depends on the m³ consumed, q. Some water companies have installed increasing or decreasing block rates (so that the tariff per m³ changes as one uses more or less water), but most use a single volumetric rate, p_d , independent of the amount consumed.

In addition, all water companies are obliged to deliver a first block of 15m³ per year per domiciled household member for free (corresponding to 40 litres per person per day). When this obligation was introduced with the 1997 reform, it was meant to serve different purposes, both socially-inspired as well as based on the view that it would stimulate lower water use among households (Van Humbeek 2000). The socially-inspired 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 15m³ drinking water per person would lead to a reduced demand. This because it introduces an increasing block rates (IBR) tariff system (with a first block at rate 0 and a second block at rate p_d), thus penalizing higher consumption levels. We come back to both of these assumptions below.

Today, the fees collected via this component in the water bill cover the water companies' costs related to the production and distribution of drinking water (VMM 2012). In other words, for the supply side, full cost recovery from tariffs is obtained in Flanders.

- $wastewater\ component = q * (p_{wm} + p_{wr})$

Since 2005, there is a second part of the Flemish households' water bill, which comprises two levies for wastewater. Both consist of a single volumetric charge based on the total m³ consumed (including the 15 m³ that is set free from the variable drinking water tariff). The first tariff is determined by the municipal authorities (p_{wm}), the second is determined by the Flemish region (p_{wr}), and is therefore the same throughout Flanders. This wastewater charge should generate a revenue that reflects the cost of the responsibilities of the municipalities and the Flemish region respectively in the water sewerage and purification process. Towards this goal, wastewater charges have been introduced gradually; rising year after year both at the regional level and at the municipality level. At present, these levies cover (very) roughly a

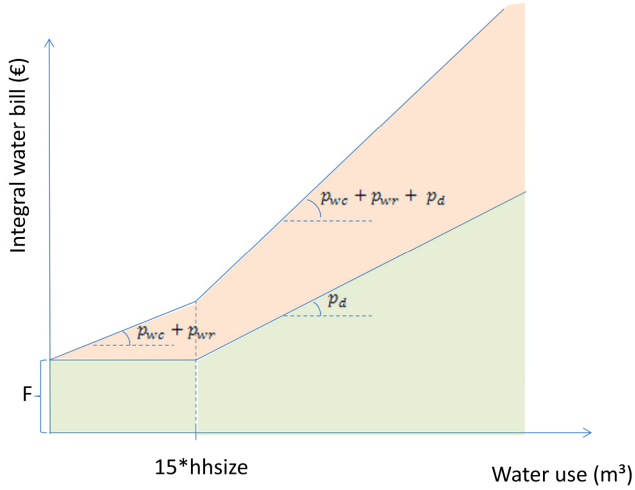
[10] In fact, the only competence that is still held by the Belgian federal state over the water services is that the maximum price that can be charged for drinking water supply in Belgium is set by the federal economic department to count for the three regions.

little over 50% of all costs incurred for investment, operation and maintenance of the sewerage and sanitation systems (VMM 2013).

- General formula: $\mathrm{iwb} = \mathrm{F} + (\mathrm{q} - 15\ \mathrm{m}^3 * \mathrm{household\ size}) * \mathrm{p_d} + \mathrm{q} * (\mathrm{p_{wm}} + \mathrm{p_{wr}})$

Summing up, the general formula used for water pricing in Flanders can be characterised as a household-size-adjusted increasing two-block rate structure with a fixed fee F, where the first block (up to household size * 15 m³) is charged at a rate $(p_{wc} + p_{wr})$, and a second block is charged at the rate $(p_{wc} + p_{wr} + p_d)$. In the schematic representation in **Figure 2**, the green part represents the drinking water component and the orange part the wastewater component.

Figure 2: Schematic representation of the tariff structure in Flanders.



F =yearly fixed fee
q =yearly metered water use
p_d= volumetric rate for drinking water
p_{wm}= wastewater charge per m³ set by municipal authorities
p_{wr}= wastewater charge per m³ set by regional authorities (Flanders)
Note: coloured areas are not proportional to their part in the total revenue

Social concerns

The real price of water has been increasing ever since the mid-1990s[11], with the steepest real price rises occurring since 2005. Over the 6 years 2005-2011, the average water bill rose with 67% (for an average single person households) to 96% (for an average 5-person household) (VMM 2011). Already in the 1990s reform, concerns rose about the affordability of water in socially-vulnerable households. This has led to the exemption of certain groups in the regional and municipal wastewater levy, a system that has persisted ever since. At the time of writing,

[11] A first reform of the water bill took place in 1995. This reform contained the first step from fixed to volumetric fees, with the objective of a greater degree of cost-recovery for 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, where also the wastewater charges were integrated in a volumetric billing system, marks the start of continuing steep real price rises.

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). In addition, some drinking water companies apply varying social corrections with varying conditions in the tariff structure for the drinking water component. In the near future, an additional social correction will be in place, exempting the same group from paying the fixed fee.

In 1997, it was a basic needs-inspired decision to exempt a first block of 15m³ per household member from drinking water charges. The implementation of this feature in 1997 was at least in part socially inspired. It was argued the 15m³ per year, or 40 litres per day, represent an amount corresponding to what is needed to fulfil basic needs in terms of health and hygiene, and to regard it as a societal task to guarantee a universal access to it. Apart from this social motivation, this feature of the tariff structure was expected to have progressive distributive effects, under the assumption that poorer households were expected to consume less water than their richer counterparts and therefore benefit relatively more from the lower rate that applies to this first block.

The decision to assign the free m^3 to each person in the household, and thus not count per water connection, introduces a sensitivity to household size into the tariff structure, which is unique in Europe (VMM 2013). The reasoning behind this feature is at least partly based on the benefit principle. As large households can be expected to have (nominally) higher water use levels, they would be disadvantaged when the same threshold of an IBR structure would apply to small and large households. On the other hand, now, the threshold rises proportionally with the number of persons, making abstraction of potential economies of scale in water use. This benefits large families proportionally more than small ones. [12]

Concluding, all three types of equity considerations as outlined in section 2 are implemented to some extent into the Flemish water tariff structure.

- Following a *basic needs*-inspired reasoning, the first quantity of water is supplied at a heavily reduced rate, thus de facto installing an increasing-block-rate structure.
- The *benefit principle* has lead to the inclusion of household size in the IBR equation: the block thresholds vary with household size.
- Concerns over affordability (the *ability to pay principle*) have lead to varying exemptions for specific vulnerable groups applying to different components of the water bill (de facto installing a complex system of social prices).

[12] Looking proportionally, the part of total household water use that is covered under the "basic needs block" is larger for large families than for small families – necessarily so as it is empirically documented that economies of scale do occur in water use. In this sense, the person-based IBR structure is redistributing from smaller to larger families.

These "social features" of the Flemish tariff system form the point of departure for the empirical investigation. In section 5, the distributional and affordability effects from each of these equity-inspired adjustments are quantified and compared. Section 4 first outlines the data and methodology of microsimulation that are used for this purpose.

4. Data & Methods

The Belgian SILC data of survey year 2009 (with income data referring to 2008) provides us with micro data, which contain more detailed information on housing costs, including detailed utility costs. In the Belgian questionnaire, the household respondent responds to three questions relating to water: first, it is asked whether the household 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 respondent 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 it combines information on yearly water bills with detailed information on income and socio-demographic characteristics for a representative sample of the Flemish population. This direct link at the household level between water use and socio-economic information on the household and its members, is quite rare in household water use studies. 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 calculation of the m³ associated with the reported bill are wrong when we don't observe a fulfilled eligibility condition for social corrections in the data when in reality it is there. In these cases, the calculated consumed m³ would be too low. 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.

Despite these shortcomings, average consumed m³ per household size correspond quite well to the averages that stem from administrative statistics. Unfortunately, the possibilities to validate the water data beyond this aggregate level or according to other variables are very limited, as the administrative statistics do not contain further socio-economic information. For the analysis, it should be kept in mind that representativeness might not hold for the small fraction of vulnerable households that are eligible for social corrections. Because of this and because the main purpose of the paper is to identify structural distributional mechanisms at play under different tariff structures, we refrain from evaluating the effects of fine-grained measures targeted at specific vulnerable groups, or from treating those households who are eligible for social corrections as a separate category. For this kind of questions, a different research setup could be thought of, for which population representativeness is less crucial.

Microsimulation techniques are specifically well-suited to calculate and compare the distributional effects of the alternative pricing structures at the micro-level. Taking a micro-level dataset as its input, the microsimulation model contains all policy rules relevant to the final variable under analysis (typically final disposable income, specific or integral taxes and benefits, and in our case also the integral water bill). By applying the policy rules programmed into the model to the variables in the dataset, the desired outcomes are calculated, first at the micro-level (the household in our case), then aggregated along the dimensions deemed relevant to the analysis, to be presented in any way that one wishes. By changing the policy parameters in the microsimulation model, different scenarios are constructed. The outcomes of these different scenarios can then be compared, for instance with respect to their distributional effects and/or budgetary impact. We use the microsimulation model MEFISTO (Decancq et al. 2012), an ex-ante socio-economic policy evaluation model whose core consists of the same matter as the static tax-benefit model EUROMOD (Sutherland & Figari 2013). To this EUROMOD foundation, additional modules are added to cover a broader range of policy domains, transcending the traditional field of socio-economic policy evaluation from social security and taxation systems to socio-economic policy in the domains of housing, childcare, health services and education. In this case, the extension on environmental policy is used, which (among others) calculates the integral water bill along the programmed tariff structure for a given amount of water consumption per household.

5. Analysis

The analysis consists of a comparison of five scenarios for water pricing in Flanders:
(a) The reference scenario, which approximates the current tariff structure as close as possible.
(b-d) Three budget-neutral alternative tariff structures that allow us to assess the different equity-features of the water rate structure in Flanders.
(e) One full cost recovery scenario, along the same lines as the reference scenario, to assess affordability issues.

a. Reference scenario

Here, the integral water bill (iwb) is simulated with parameters that are the same for all households, reflecting the average Flemish water tariff structure[13]. While the actual water bill faced by a particular household might deviate from the reference bill (given the existing regional differences in fixed fees, drinking water tariff structures and municipal wastewater levies), this intermediary step is necessary to level out the influence of regional disparities when comparing across scenarios.

The stylized formula used to construct the reference scenario is, as explained in more detail in section 3 :

$$iwb = F + (q - 15\ m^3 * household\ size) * p_d + \ q * (p_{wm} + p_{wr})$$

F =yearly fixed fee
q =yearly metered water use
p_d= volumetric rate for drinking water
p_{wm}= wastewater charge per m³ set by municipal authorities
p_{wr}= wastewater charge per m³ set by regional authorities (Flanders)

Its schematic representation corresponds to Figure 2 in Section 3.

[13] In this scenario, we make abstraction of the different social corrections, the different block rates between drinking water companies, and take an average fixed fee, an average single volumetric drinking water rate, and the average municipal wastewater levy to apply for all households in our sample. The total revenue collected through this reference scenario is ensured to be the same as through the actual bills. This implies that in our reference scenario, households living in cheap water areas will have a higher reference water bills than their actual bills, and households living in more expensive water areas will have lower bills.

Next, four alternative tariff structures are simulated. In the first three, the total revenue that is collected from households to pay for water services is kept constant at the current cost recovery rate. In the last scenario, the revenue is calculated to be fully cost-recovering.

a. Single volumetric rate structure

Compared to the reference structure, the fixed fee as well as the from drinking water fee-exempt “free” m^3 per domiciled household member are abolished to attain one flat rate per m^3 of used water:

$$iwb = q * p$$

b. Basic needs structure

Extending the basic needs reasoning feature of the Flemish integral water bill to a full-fledged basic needs tariff structure, in this scenario the first $15m^3$ of water use are exempt from any fees. A household pays only for what used in excess of the $15m^3$ (against a higher volumetric rate).

For analytical clarity, we take the $15m^3$/person/year (or 40 litres/person/day) as a given to correspond to the amount needed to fulfil one person’s basic needs. In Flanders, this volume was determined in 1997, yet, without a firm underpinning. For comparison, the World Health Organization (WHO) and UNICEF (2000) use the threshold of access to 20 litres/person/day (from a source within one kilometer of the user’s dwelling). Gleick (1996) estimates as a ‘basic water requirement’ for domestic users the volume of 50 litres/person/day. An additional question in this respect is what proportion of this quantity needs to be of drinking water quality. The possibilities to use for instance recovered rain water to fulfil basic needs such as toilet flushing, laundry and showering, could also be taken into account.

Ideally, the amount of water needed to fulfil one’s basic needs should be grounded in a thorough assessment with empirical evidence and normative assumptions made explicit. It should also be re-assessed over time in the light of changed circumstances such as the access to alternatives.

$$iwb = \max(0, (q - 15\, m^3 * household\ size) * p)$$

c. Increasing block rate tariff structure, sensitive to household size

To assess the distributional effects stemming from a tariff adjustment based on a reasoning along the benefit principle, we simulate an increasing block-rate structure which takes into account household size. This scenario consists of the two-block IBR structure, of which the blocks’ thresholds depend on the number of persons in the household. Instead of the fixed m^3 per household member in the current tariff structure, the simulated design takes the average water use of households with the same size as the block border, to take into account observed economies of scale in water use.

$$iwb = \min(q, \overline{q_{hh}}) * p_1 + \max(0, q - \overline{q_{hh}}) * \ p_2$$

In this case, p_2 was set at a level equal to 2*p_1, so that a progressive structure is reached. More/less progressive prices can make the observed pattern more/less pronounced.

d. 100% cost recovery

In order to assess affordability effects, a tariff structure along the same lines as the reference scenario is simulated under the constraint that it should be 100% cost-recovering. This implies a substantial increase in the wastewater charges in comparison to the current rate.

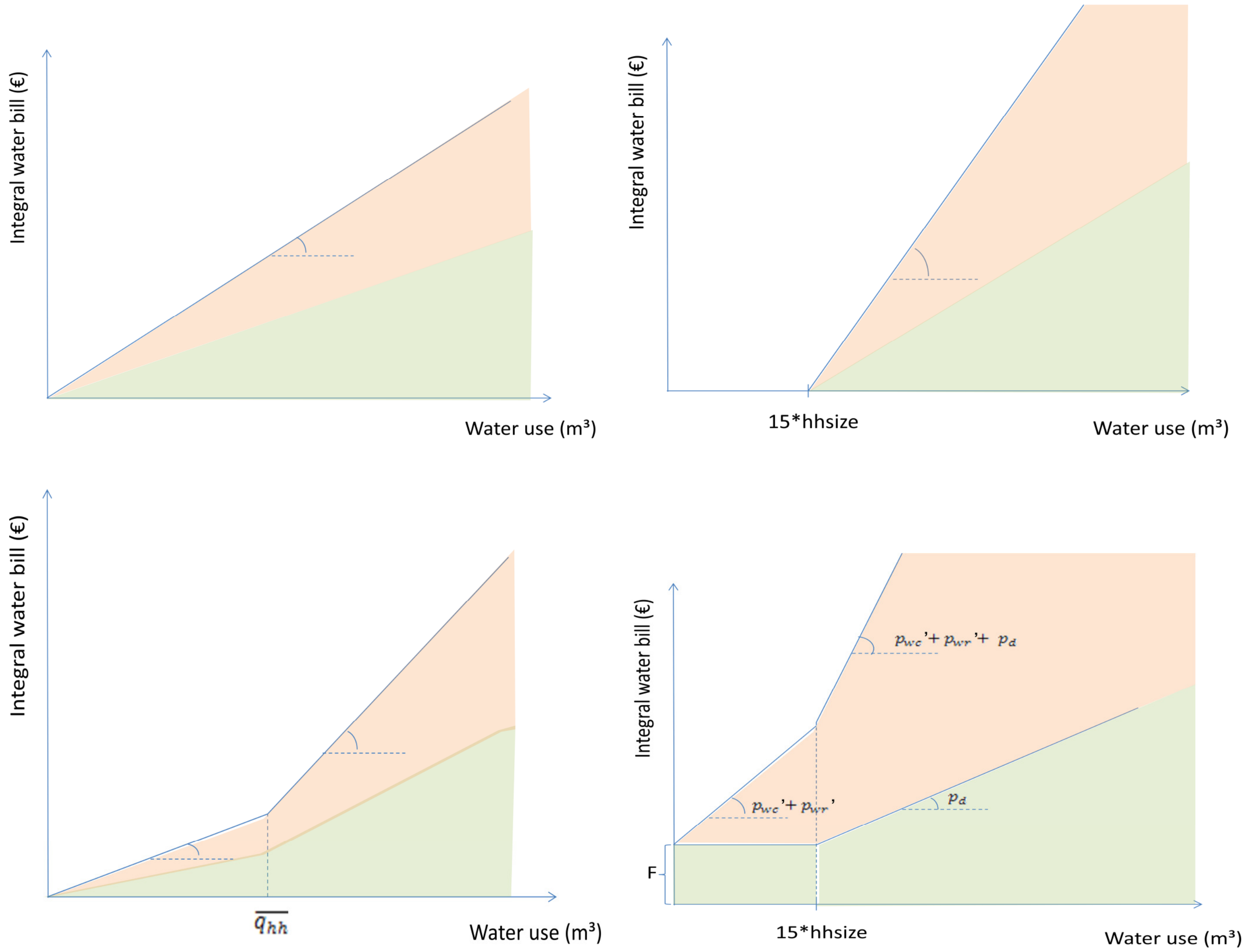
$$iwb = F + (q - 15\, m^3 * household\ size) * p_d + \ q * (p_{wm}' + p_{wr}')$$

As the drinking water component is fully cost-recovering in Flanders (De Nocker and Broekx 2012), the drinking water component part of the bill is left unchanged. For the wastewater component of the integral water bill, parts are currently paid out of the public budget. If this amount were to be recovered from volumetric charging, it would imply a raise in both p_{wm} and p_{wr}. Based on rough estimations by VMM (2013), an increase in total revenue from the wastewater component of the integral water bill of about 300%[14] is simulated.

Figure 3 presents a stylized representation of the four simulated alternative tariff structures.

[14] implying that $(p_{wm}' + p_{wr}')$ would need to equal 5.3€/m³ instead of the 1.7€/m³ in the reference scenario with 2008 tariff structure.

Figure 3 : Structure of the simulated alternative tariff structures: (a) a single volumetric rate (no fixed fee, no exempt m³) – upper left; (b) a basic needs structure, with the first 15m³ exempt from charges – upper right; (c) a increasing block rate structure adjusted to household size – lower left; (d) a full cost recovery scenario along the same lines as the reference scenario yet with increased wastewater charges – lower right.



Simulation results – Distributive effects

The distributive analysis assesses the concern of 'fairness' of the water rate: are the costs of the public water services distributed in a fair way over the different population groups? In this empirical exercise, we focus on three ways to distinguish population: according to household size, income quintiles, and water usage categories.

- Household size is consistently found as one of the key determinants of domestic water use. It is found relevant from an equity perspective (according to the benefit principle) and also administratively feasible to be included as a parameter in a tariff structure.
- Income quintiles[15] are used to reflect a rough indication of one's relative position in the income distribution.

[15] The income quintiles were constructed on the basis of equivalised household net disposable income, in which the modified OECD equivalence scale was used (factor 1 for the first adult in the households, 0.5 for each

- Constructing a variable reflecting relative water usage categories, finally, is less straightforward. In absence of a generally accepted equivalence scale for water use over different household sizes, this variable was constructed on the basis of usage quartiles for each household size separately.[16] This results in four equal groups in which each household size is represented in the same proportion as its share in the total population. This is a rough and incomplete approach, and the question immediately rises whether a three-person family consisting of a single mother with two small children can in terms of water use levels be compared to a couple + teenager family, for instance. Nevertheless, the relative position of the household with respect to its water use provides key information in order to understand the effects from tariff structures that aim to penalise high water usage levels.

In this context it is worth emphasizing again that in the simulation exercise, only the first round effects are investigated, making abstraction of second-round effects of households adjusting their water consumption to the new tariff structure. Rather, the exercise aims to reveal the direct distributional mechanisms stemming from the ways that a tariff structure distributes costs and charges among domestic water users.

Figure 4 shows the distributional flows stemming from each of the budget-neutral alternative scenarios in comparison to the reference scenario, presented along these three categorizations of the population of Flemish households. The three graphs on the left shows the percentage of households in each category that are losing (negative bar) or winning (positive bar) from the alternative pricing structure in comparison to the existing (reference) pricing scheme. A household is defined as winning (losing) when its total integral water bill decreases (increases) with more than one percent with respect to their water bill in the reference scenario. The graphs on the right size show, for the gaining and the losing families within each category, the average amount (€/year) to which this gain or loss corresponds. Nominal euros are chosen as the unit of comparison for the sake of inter- as well as cross-category comparison.[17]

Note that the three tariff structures presented here are revenue-neutral to the reference scenario, by calibrating the parameters to raise exactly the same revenue (under the strong assumption of unchanged water consumption) as in the reference scenario.[18]

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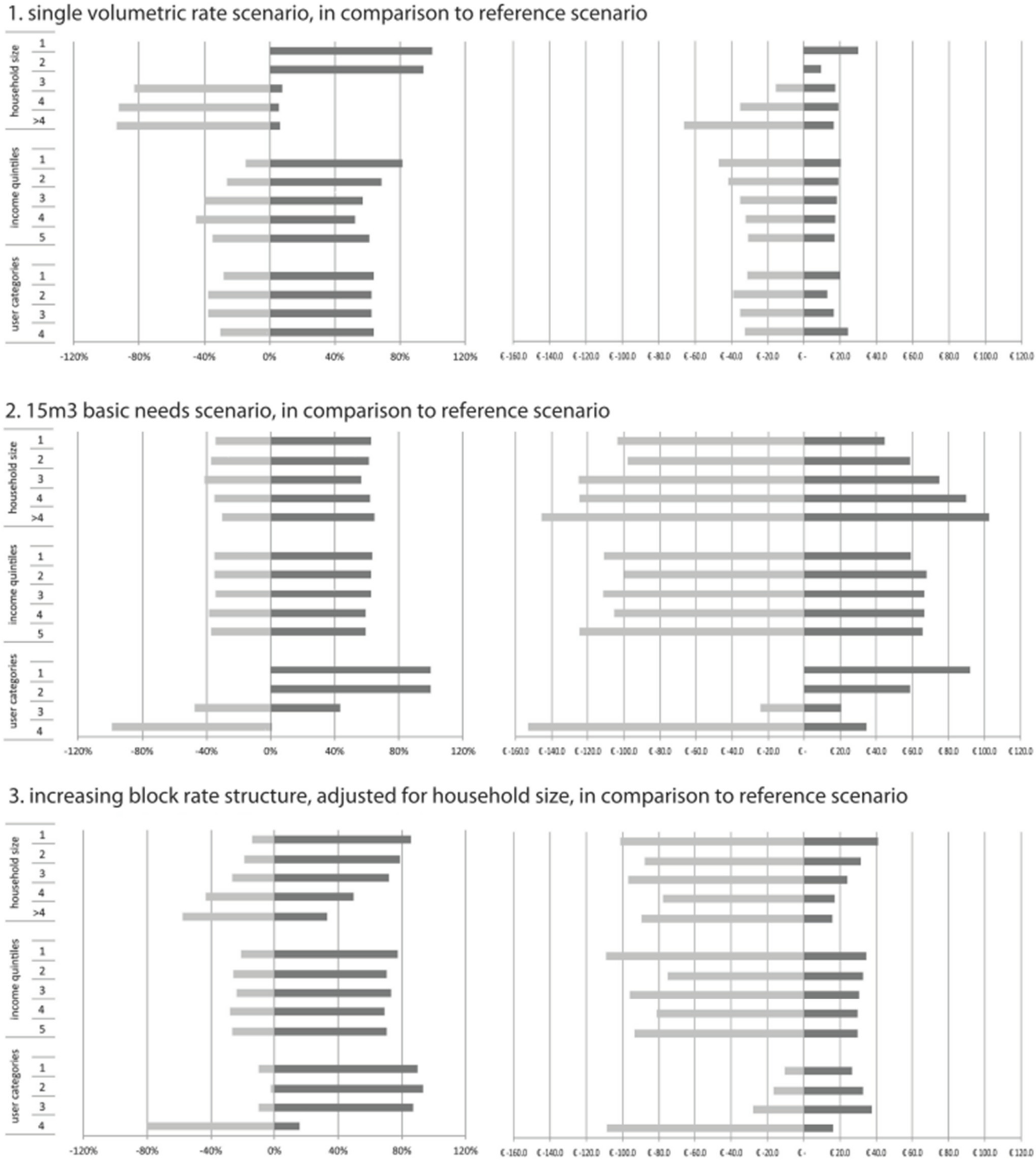
additional person aged 14 or over, and 0.3 for children). Income quintile 1 groups the 20% poorest households, quintile 5 the 20% richest when ranked on the basis of this income concept.

[16] The 25% smallest users, 25% middle-small users (with usage levels between 25^{th} and 50^{th} percentile), 25% middle-large users (between percentiles 50 and 75) and 25% large users were thus identified from ranking the water usage levels among households of the same size.

[17] The gains and losses can be expressed in relative terms too, for instance in comparison to disposable income, or to the total water bill. Therefore, relative figures are sometimes mentioned in the text to put the nominal Euros in perspective. For interpreting the right hand side of the graph, it could be useful to have some rough relative values in mind, for instance that a nominal gain of 40€ corresponds to a water bill decrease of 21% for the average single person household, and to a 12% decrease for the average 4 person household. A loss of 140€ as another example, represents about 1% of annual disposable household income for the average first quintile household, in comparison to 0.02% for the average fifth quintile family.

[18] This means that a larger share of gaining families over losing families necessarily implies that the average loss per losing family will be larger than the average gain per household that would win from this reform. It is

Figure 4 : Distributive impact from the three alternative rate structures. Percentage of households per category losing or gaining in comparison to reference scenario (left column); and average euro/year gained or lost per household which is gaining or losing (right column), over different population categories, Flanders 2009.



Source: author's calculations based on SILC 2009 and MEFISTO.

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therefore primarily the patterns between the categories of the different variables that reveal how different population groups are differently affected.

1. When comparing the *single volumetric rate structure* to the reference scenario, the clearest result is that the structure of gainers and losers is primarily determined by household size. Apparently, abolishing the fixed fee as well as the free m³ per household member, and instead raise the same budget through an (adjusted) variable rate, makes all one and two-person households gain, while almost all households of more than two members lose out. Much less distributive effect is observed between small users and large users. This means that, once corrected for household size, the intended effect of the free m^3 to penalize relatively high water use levels via the IBR-structure (so small users benefit proportionally more from the lower marginal rate of the first block of 15m³ per household member, and large users pay the higher marginal rate for a larger share of their water use) is very limited. Gains and losses are driven entirely by household size, as in the reference scenario, larger households are favoured both by the presence of a fixed fee (the lower the water bill, the more important the fixed fee) and the per-person counting of the free $15m^3$ (thus ignoring economies of scale in water use).

When compared to a single volumetric rate, the reference tariff structure redistributes from all small families to all large families, thereby generating a regressive effect as the lion's share of larger families are situated in the upper half of the income distribution and small families are more frequent in the bottom half. As such, the single volumetric rate scenario is significantly more pro-poor than the reference scenario. With respect to household size, especially larger families, who are relatively favoured by the current tariff structure, would be affected negatively if the tariff structure would turn to a single volumetric rate. They would annually pay on average 65€ more for water, corresponding to an increase in the annual water bill of about 20%. This might affect affordability of the water bill for large families in the lowest quintile.

2. In the *full-fledged basic needs* tariff structure, all revenue is raised from a single volumetric rate on the water that is used in excess of the 15m³ per household member. The structure of winning and losing households in this scenario is shaped along the lines of user categories. Strong redistribution would take place from the 33% largest users to the 66% rest. Most striking, however, are the large amounts with which these gains and losses are associated. Regardless of household size, these large user households see their water bill augment significantly, with 22% (average losing 4 or more persons households) to 31% (average losing one person household). With respect to inter-quintile redistribution, there is no real pattern to observe. Of course, the average loss of 110€ in a losing household is more important in the first quintile (representing 0.8% of annual income), than in a fifth quintile household (where it represents under 0.02% of annual income).

3. When, finally, a *household size-sensitive increasing (two-)block rate* is introduced, a less pronounced yet similar pattern arises with respect to household size as in the shift to a single volumetric rate, with the difference that the influence of household size is a little less strong. Still, an abolishment of the free m³ per household member benefits smaller families much more often and makes large families lose out, even with a household-sensitive correction built in into the tariff structure. In contrast to the shift to the volumetric tariff structure, the relative position of the household in terms of water use comes much more into play: in the category of the largest water users, the majority now loses out in a scenario compared to the reference

scenario. Of the small to middle-large water users, still about three quarters gains from the reform. With its slight favouring of small households (analogous to yet less pronounced than in the shift towards a single volumetric rate presented above), the distributive effect over the income distribution is similar but only very small. Still, households in the first quintile are gaining more frequently than in the upper quintiles.

Simulation results – affordability effects

Affordability can be interpreted in different ways, and/or quantified using different indicators. Self-reported payment difficulties, the frequency of arrears on water bills, the number of network disconnections, or the income share that the water bill represents, can all be used to indicate problems of affordability for households.

For the purpose to compare across scenarios, the affordability analysis here is primarily geared at the relationship between the water bill and household disposable income. The extensive review by Hutton (2012) of income-related indicators for water affordability shows that many countries as well as international institutions such as the World Bank and OECD have adopted indicators that range between 2 to 6% of household disposable income.

Despite its lack of firm conceptual underpinning[19], we use the threshold of the water bill exceeding 3% of household disposable income to capture whether a household is at risk of having affordability problems. This percentage is frequently adopted in industrialized countries to assess affordability issues (sometimes also termed water poverty, e.g. Reynaud 2008) and therefore allows us to make a modest international comparison with e.g. France (Reynaud 2008), Portugal (Pires 2007), and Great-Brittain (Sawkins & Dickie 2005).[20] This reveals that in comparison to these countries, relatively few households in Flanders face water bills that exceed 3% of their disposable income. Under the current tariff structure, we estimate 2.4% of the population at risk of affordability problems. In the UK, the percentage is estimated at 9% for the period 2002-2003, coming from 15% in the 1990s (Sawkins & Dicky 2005). In Portugal, Pires (2007) estimates a percentage of 10,5 on 2004 data, and Reyaud (2008) 4.3% for France (2001 data).

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[19] As Hutton elaborates in detail, there are several problems with an indicator of this type, which essentially limits itself to measuring actual recurrent costs for water over some disposable income concept. Hutton points out that this excludes non-financial costs, especially access time costs. While this is very relevant in the context of developing countries, a second remark that should be made with regard to this affordability indicator – and in particular from a developed country perspective - is that it measures actually incurred costs, not the costs that correspond to covering basic needs. Of course, many households in industrialized nations have higher levels of water use. According to OECD (2003, p. 37) "an increasing proportion in some of the more affluent societies is associated with 'luxuries' such a power showers, garden sprinklers, and pressure washers. The percentage of income spent on water for such purposes should not be of no particular concern of those interested in social and affordability policies, unless this water demand is met only at the expense of essential use by poorer households." Finally, the choice for a particular percentage – 3% in our case – also remains arbitrary.

[20] However, full comparability is hampered because used income concepts still differ between countries. For instance in the UK, a concept of disposable income is used after all fixed housing costs are deducted.

Figure 5: Percentage of household with water bill > 3% of household income over population categories, Flanders 2009.

	reference scenario	single volumetric rate	"basic needs" - free 15m³	household size adjusted IBR	full cost recovery
HH size					
1	4.4%	3.8%	8.0%	5.3%	18.1%
2	1.6%	1.5%	3.8%	2.3%	14.6%
3	2.3%	2.0%	4.4%	3.5%	11.6%
4	0.2%	0.2%	2.3%	1.7%	9.2%
>4	3.0%	3.0%	3.9%	4.9%	14.0%
Quintiles					
Low	11.7%	10.8%	15.6%	13.5%	40.6%
2	1.1%	0.9%	5.5%	3.4%	21.4%
3	1.2%	1.1%	3.1%	1.8%	10.0%
4	0.2%	0.2%	1.5%	0.8%	5.0%
High	0.2%	0.0%	1.4%	0.6%	2.7%
User cat.					
Low	0.0%	0.0%	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%	0.0%	1.0%
3	0.5%	0.5%	0.6%	0.2%	10.4%
High	9.2%	8.2%	18.9%	13.8%	46.3%
Total	2.4%	2.1%	4.8%	3.4%	14.3%

Source: author's calculations based on SILC 2009 and MEFISTO.

Among the budget-neutral scenarios (first four columns), the percentage of households whose water bill would exceed 3% of their net disposable income is lowest in the scenario of a single volumetric rate, and highest in the basic needs inspired scenario. The results suggest that, overall, a stronger penalisation of larger water users increases the percentage of families whose water bill is higher than 3% of their income. With respect to differences between categories, one-person households are consistently more at risk of seeing their water bill rise above the 3%-threshold. The smallest gap between their risk and the population average is under the single volumetric rate structure, where it amounts to 1.7 percentage points (3.8 versus 2.1%). The largest households are also slightly more at risk than population average, while 2, 3 and 4-person households are consistently less vulnerable for affordability problems. The joint vulnerability of both the smallest and the largest households at the same time makes it difficult to use household size in mediating adverse social effects. When orienting the tariff structure to the relative benefit of either small or large families, the other will typically lose out from the same reform. In the increasing block rate scenario, in which the border values of the blocks are determined by observed averages in household water use per family size rather than on a fixed volume per member, the at-risk of affordability problems are more equally distributed among households of different sizes.

Less surprising is the strong relation between low income, high levels of water use, and the risk of affordability. While there are still a number of households with bills exceeding 3% of their income even in the upper quintiles, literally no below-median water users are at risk of an affordability problem.

Full cost recovery, finally, would – under unchanged levels of water consumption – imply a significant raise in the population share whose water bill would exceed the 3% threshold, up to 40% in the lowest quintile, and 46% of the (current) large water users. Nevertheless, among the 50% smallest water users, even a full cost recovery scenario induces still no risk of affordability. This suggests that an extremely effective way to avoid affordability problems with the water bill is to put heavy emphasis on including a strong strategy for helping households, and (financially) vulnerable households in particular, installing the measures that can lower their water use levels significantly.

6. Conclusion

Taking the equity concerns of a public water regulator as the starting point, this paper investigates the distributive effects of different designs for water tariff structures.

While equity is frequently cited as an objective in the public provision of water services (and the setting of the tariff structure in particular), we argue that this term conceals a range of social considerations that imply different conceptions and priorities about what constitutes a "fair" water rate and allocation of the scarce resource. For the context of an industrialized country such as Belgium/Flanders, we disentangle (a) concerns about the affordability of water for vulnerable groups, (b) the public responsibility to guarantee for all citizens the coverage of basic needs that depend on water, and (c) the concern to treat different population groups equally (and households of different sizes in particular), according to the benefit that is obtained from the provided water service.

All three of these types of social concerns have translated into particular features of the Flemish tariff structure in some way. In order to assess the distributional effects that stem from these different "equity features", we use household-level data from the Belgian component of EU-SILC as input for the microsimulation model MEFISTO, calculating outcomes under different water rate structures. A reference scenario was compared with the outcomes of four alternative scenarios (3 budget neutral and 1 full cost recovery scenario).

We find that an equity reasoning according to the benefit principle is not necessarily compatible with a basic-needs type of reasoning. By defining basic needs on a per capita basis, economies of scale in household water use are ignored, which favours large households over small households. Given the relatively high concentration of small households in the lower part of the income distribution, the current Flemish water rate design (an increasing block rate structure with a per capita-dependent threshold) is more regressive than a simple volumetric rate. Switching to a single volumetric rate would generate a pro-poor redistribution, that leaves large households in the bottom of the income distribution however more vulnerable.

When the per capita reasoning is dropped and a two-block IBR tariff structure is implemented with thresholds depending on household size but taking economies of scale into account, it does not yield significantly better results in terms of pro-poor redistribution compared to a single volumetric rate. The highest quarter of water users will pay more under this scheme, but also the percentage of the population that is at risk of affordability problems (water bill > 3% of disposable income) increases.

These observations indicate that the distributive effects from the water rate design are mainly driven by household size (and the economies of scale that thereby occur), and by the relative level of water use of the household[21]. In other words, the income gradient in water use is negligible.[22] This goes counter to the policy makers' intuition on the link between income and water use. Therefore, adjustments based on the assumptions that poor households have lower water consumption have had the effect to favour larger households over smaller ones, with an overall regressive redistributive effect. As vulnerable households occur relatively more in the small and in the larger sizes, household size is insufficient as a parameter to obtain a redistributive effect towards vulnerable households.

Finally, we find a trade-off between the aim to incentivize households for lower water use via the price signal and affordability problems among more vulnerable households. Making abstraction of behavioural response, higher marginal prices for above-average water usage levels increases the proportion of the population that is at risk of affordability problems accordingly. Interesting to note in this respect is that, even under a full cost recovery scenario the water bill of the bottom half water users still remains below the threshold of 3% of disposable income (irrespective of their relative income position). This indicates that policy geared at reducing water usage holds great potential to avoid affordability problems.

However, this ultimately becomes a question of how behavioural change (from cutting back consumption directly, as well as indirectly via adjusting relevant investment decisions[23]) can be best achieved, which certainly requires additional research but goes beyond the scope of this paper.

[21] in comparison to other households of the same size.

[22] Poor households are not more likely to be small water users, neither do rich households tend more to be large water users.

[23] Such as the choice for more efficient equipment (e.g. washing machines) or installing measures to reduce reliance on metered consumption (e.g. collecting rainwater).

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