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Efficiency and Equity in Two-Part Tariffs: The Case of Residential Water Rates*

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Abstract

As first noticed by Coase (1946), a standard result in utility regulation is that efficiency requires two-part tariffs with marginal prices set to marginal costs and fixed fees equal to each customer's share of fixed costs. Residential water customers in France face marginal prices for water that average about 8% more than marginal costs. Rebalancing rates from current tariffs to Coasian tariffs results in lower bills for consumers on average but does create strong distributional consequences. Under price elasticity estimates that are consistent with previous results in the literature, efficiency costs represent around 8 million euros of welfare losses for 2008. Even though the impact is fairly small, efficiency gains from reformed tariffs could be used to fund water assistance programs focused on financially stressed households.

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1 Introduction

In regulated markets such as energy, electricity, water and wired phone service, where price schedules can have strong distributional consequences and economic distortions, it is crucial that pricing appropriately encourages equity and efficiency in use. This historical debate has given way to a rich theoretical literature examining utility pricing in relation to the public interest. Hotelling [1938] first argues that all prices in an economy should be set equal to marginal cost, with fixed costs paid for with government subsidies from income, inheritance and land taxes. Coase [1946] considered that efficient pricing in regulated markets implies two-part tariffs. Further theoretical developments usually consider a Ramsey-Boiteux pricing to derive how prices should be marked up above marginal cost (Baumol and Bradford [1970]) in order to meet the social revenue requirement. Equity is first incorporated into the efficiency analysis by Feldstein [1972] who assumes a functional form of the social welfare function and derives formulas for the socially optimal two-part tariff. These Ramsey-Boiteux pricing schemes however represent second-best optima as they suppose deviations from marginal cost pricing. The challenge in regulating markets is that price be set such as to enforce efficiency and equity.

Water supply exemplifies this issue. Water is a large market that directly affects over 99% of French households. The French water market - including water provision and sewage - represented a market of 5.4 billions euros in 2008. The same year, 4 billions cubic meters of water have been billed to domestic users and industrial consumers. The main costs for water provision can be divided in three parts. First, water provision implies costs for extracting, treating and distributing water to the consumer. Once water enters the network, around 10% is lost in leakages. In addition to these costs, water utilities face the fixed and sunk costs of processing bills and taking calls. Moreover, water utilities have to maintain networks and connections and install water meters. The scale of the costs thus differ from one utility to another: the costs of production depend on the volumetric charge while the scale of the fixed costs is largely invariant to the number of customers, such as customer service or meters management, or to the size of the network, such as maintenance.

In France, regulation is made through a contract between a private operator and the municipality when the public service is outsourced and through a public council decision when the public service is managed in-house. As a result, local monopolies are largely unregulated: they tend to maximize profit by pricing above marginal cost, resulting in a level of output below the socially optimal level. As in many regulated industries, in the simplest case, the tariff is divided in two parts: a fixed fee, no matter the level of consumption, and a volumetric charge depending on water consumption. A standard result first developed by Coase [1946] is that setting marginal prices to marginal costs would eliminate the deadweight loss associated with monopolies. The local monopoly then recoups its fixed costs through fixed fees equal to each customer's share of fixed costs.

Although it is compulsory to use two-part tariffs in the French water sector, operators tend to charge fixed fees and volumetric charge that differ from the theoretical ideal. This paper applies the standard monopoly framework to answer the following questions: (1) How do marginal prices differ from marginal costs? (2) What are the distributional impacts of a switch from current tariffs to Coasian tariffs? (3) Do the reformed tariffs fit better the equity considerations? (4) What are the efficiency costs from the observed deviations from marginal cost pricing?

This paper examines a nationally representative dataset of 4,500 French municipalities for 2008. The dataset contains demographic and economic information about households at the municipal level, but also a large set of information on water demand and supply, such as consumption, spendings, rates and some water utilities characteristics. We find that marginal prices differ from marginal costs. Even if the range of the deviation is limited - a 8% deviation is observed for the volumetric charge - these markups impose a deadweight loss by leading customers to consume too little water and to support fees that do not represent capital costs. Rebalancing rates to match the Coasian tariffs imply large increase in welfare for consumers, especially those living in cities with lower incomes. This is due to the fact that the correlation between water consumption and income is significantly positive but weak. Consequently, reformed price tariffs benefit more to large consumers more than low incomes. As a matter of fact, after the transition to Coasian tariffs, cities in the first fourth quintiles regarding the per-unit income would experience decreases in bills that are almost similar, between 21.45 and 20.07 euros per year. We thus consider alternative water assistance programs focusing directly on cities with lower per-unit incomes. We particularly find that a free fixed fee policy could be implemented for poor cities, without loss of profits for firms, at the cost of 1.90 euros per non recipient.

We then compare the costs of these assistance policies to the current efficiency costs. Under conservative levels of price elasticities, a transition to marginal cost pricing implies efficiency gains of 8 million in 2008, a level that is low compared to the global profits of water industries in France[1]. However, these efficiency gains are sufficient to fund assistance programs such as decreased fixed fees for poor households.

The paper finally highlights several explanations for the current price distortion, such as firms' profit maximization (small versus large consumers?), resource scarcity (markup versus Pigouvian taxes?) and management structure (public versus private?). We then briefly discuss the validity of the results, precisely regarding consumers' responses to marginal prices and the link with related markets, such as sanitation.

The paper contributes to the literature on public utility regulation in several ways. First, it shows that contrary to other regulated industries, water supply in France has low-margins. However, deviations from marginal cost can have strong welfare and distributional impacts. Second, several assistance policies are empirically tested and shows that at low-cost for water suppliers, it is possible to fund some assistance programs. These assistance programs have stronger distributional consequences than tariff reforms. The results of the paper are similar to those of Garcia and Reynaud [2003] who estimated the benefits of efficient water pricing in France using a sample of 50 water utilities for four years. Even if the authors found that marginal prices were on average lower than marginal costs while fixed fee were marked up above each customer' share of fixed costs, they find a low-price elasticity as in this paper, resulting in rather small welfare gains of efficient pricing. However, they conclude on the positive impact of rebalancing rates under some

[1] These are national estimations and profits include industrial and residential consumption. At the scale of our dataset, the deadweight loss from current tariffs for residential customers is 5.36 million euros for 2008 and the global profits of water industries for residential customers are 3 billion euros.

social objectives. In this paper, we complement this approach by simulating the impact of some social policies.

The paper proceeds as follows. Section 2 presents relevant background information about the organization and the regulation of the French water market. Section 3 describes the two datasets, their validity and performs a test of marginal cost pricing. Section 4 examines the distributional consequences of a transition to Coasian tariffs when demand elasticity is null. Section 5 performs an estimation of price elasticities, computes the efficiency effects of marginal cost pricing and examines the reasons for current markups. Section 6 discusses the results. A brief conclusion follows.

2 The French Water Market

2.1 Organization and Regulation

In France, as in most European countries, municipalities must provide local public services that have public good characteristics. Water provision and sewage are two of these public services and can be managed by two different operators[2]. However, if the responsibility for public services' provision is public, its management can be either public or private. Although some municipalities manage production through direct public management and undertake all operations and investments needed for the provision of the service, the dominating contractual form is delegated management[3]. In this case, a private operator, independent of the local government, is hired to manage the service and operate facilities, through one of the four different private-public arrangements. The most common is the *lease* contract in which the operator manages the service, invests in the network and gets a financial compensation through consumer receipts. Under a *concession contract*, the external operator also undertakes construction risks, as it must finance a large part of investments over the duration of the contract. These contractual agreements differ from the previous ones in that operators share risk in exchange for greater decision rights and claims on revenues. Other contracts can be chosen by the local authority such as the *gerance* in which it pays an external operator a fixed fee, or an *intermediary management contract*, i.e. a gerance contract but with a small part of the operator's revenues depending on its performance. Such contracts provide few incentives to reduce costs and transfer no risks and decision rights to a private operator. Although there are a large variety of contracts, the participation of the private sector is characterized by a concentration on three major companies. These companies share with their subsidies more than 90% of the private market and other private companies operate mainly in small cities.

Contrary to other industrialized countries, there is no price-cap or rate-of-return regulation for water utilities in France as there is no national regulator. Such regulation

[2] *Water provision* refers to the production and the distribution of water and *sewage* implies wastewater collection and treatment. We focus in this paper on water provision.

[3] An official report by Dexia, a French financial intermediary, states that 63% of French medium-sized cities contract out the services of drinking water treatment and distribution and 58% also contract out their sewerage services. It is however difficult to have a precise estimation of how many municipalities and communities have contracted out both services with the same operator. In our database, more than 60% of the municipalities are managed by private operators. According to the Cour des Comptes [2011], the highest financial court in France, 71% of the population is covered by a private operator for water provision and 56% for water sewage.

has been replaced by a contract, in the case of a private operator, or a decision of the municipality board, in the case of public operation. In the case of delegated management, rules have been defined to ensure that standards are respected during the operation to limit the opportunistic behavior of operators and guarantee competition between firms. First, since the Sapin Law (1993) a national legislative framework governs the form of the private sector participation and the conduct of the bidding process. Second, a strong regulation on contract duration and delegatee obligations was implemented in 1995 with the Barnier Law. As a matter of fact, water quality in France has increased and is now relevant for more than 99% of the tests and a lot of investments have been implemented to deter leaks. However, because regulation is made through contracts between the two parties, depending on the respective power of negotiators, with some contracts signed a century ago, there are doubts about the possibility of the parties to regularly adapt tariffs to the needs of the utilities. Even if they did, water tariffs may not be efficient nor equitable from the economic point of view.

2.2 Tariffs

Applying an efficient tariff for water is difficult to achieve. To be efficient, the design of the tariff must satisfy several conditions. The main objective of the pricing scheme is to generate revenues covering costs. However, the pricing rate should also allow different costs between users with heterogeneous financial means as much as it has to provide incentives for efficient use of the resource. As these criteria may be contradictory, finding a rate structure balancing efficiency and equity is not an easy task.

Previous studies on efficient pricing focused on which price schedule yields the highest level of utility, using the framework of the second-best pricing, the so-called "Ramsey-Boiteux" pricing. When searching for utility maximization under linear prices solved by Ramsey [1947], Boiteux [1956] shows that the welfare-maximizing price markup is proportional to the inverse of the elasticity of demand. "Ramsey-Boiteux" pricing ensures the welfare maximization under a budget constraint. In this framework, a monopolist facing inverse demand function $p_i(x_i)$ for good i, a social planner constrained to using linear prices can maximize social surplus by setting prices

$$\frac{p_i - \frac{\partial C(X)}{\partial x_i}}{p_i} = -\left(\frac{\partial p_i x_i}{\partial x_i p_i}\right)\left(\frac{\lambda}{1+\lambda}\right) \tag{1}$$

where λ is a non-negative constant. Such a framework is for example used by Garcia and Reynaud [2003] to reform French water tariffs but also by Diakité et al. [2009] to implement social pricing in Côte d'Ivoire. However, this optimal solution implies that the utility knows demand-elasticities for each consumer and that regulators or parties to the contract constrain themselves to linear prices. In practice, network industries such as water but also electricity or gas have long implemented two-part tariffs. Water tariffs in France have two compulsory components since 1994. On the one hand, each customer must pay a fixed charge corresponding to provisions for capital stock renewal and debt service. On the other hand, a marginal tariff corresponds to operating expenses of the volumetric charge. For a baseline annual household water consumption of 120 cubic meters, the fixed-part of the tariff represents 25% of the total price. Moreover, there are additional fees going to the Basin Agency and a value-added tax for the State.

A standard result in regulation is that efficiency requires marginal prices to equal marginal costs. In the water industries, the obligation to have a two-part tariff facilitates pricing at marginal cost because the volumetric charge can be set equal to marginal cost and the fixed monthly fee set to cover fixed costs. Pricing at marginal cost may have many drawbacks. Indeed, it is inappropriate when managers have no budget constraints as they would have no incentive to reduce costs. Moreover, marginal cost pricing implies that the utility runs a deficit if there are increasing returns to scale. This deficit might lead to distortionary taxes if there are no lump-sum transfers. As first suggested by Coase [1946], an alternative solution to marginal cost pricing is to use two-part tariffs with a marginal price corresponding to the marginal cost and the fixed fee set to cover the total fixed costs. In water industries with declining average costs and constant marginal costs[4], this would imply setting the fixed monthly fee equal to each customer's share of the utilities' fixed costs.

Efficient pricing may however not be achieved in water industries for two reasons. On the one hand, water utilities face volatile revenues. For example, water consumption is often higher during summers than winters while some touristic areas face high consumption levels during national vacations. Over the years, billed volume of water tend also to decrease, probably due to changing consumer behavior towards sustainable water use and to less consuming intermediary goods. This revenue volatility is a source of concern for water utilities. On the other hand, operators and city councils set tariffs such as the expected revenues from water sales covering the forecasted expenses, which is close to an average-cost pricing. In practice, water tariffs thus differ from the theoretical ideal of marginal cost pricing.

There are at least two reasons why marginal cost pricing has not been implemented. The first one comes from the diminished profits that would occur for the water industries if fixed fees remain the same. The second one lies in the distributional implications of such a reform. Such a decrease in marginal prices would especially benefit large consumers rather than small consumers. To the extent that income and water consumption are related[5], this would mean that higher incomes would face larger decrease in their bills than lower incomes would.

One might argue that water tariffs already include distributional considerations because rates can include non-linear pricing schemes. These pricing schemes aim at taking into account resource sustainability and distributional considerations. In our dataset, 1,260 municipalities have non-linear tariff schemes. Even if we have little details about the tiers - we know the kink points at which consumers switch from one tier to another - we observe only 152 municipalities with a two-tier tariff limitation below 300 cubic meters, which is higher than the average consumption of the top 10% residential consumers. Most of the multi-tier tariff schemes thus benefit huge consumers such as industries, public administrations and agricultural holdings.

[4]Because of the fixed tariff, average costs are declining with consumption. Marginal costs are supposed here to be constant as scale effects used in alternative regressions are very weak. Discussions with professionals let us know that marginal cost depends first of all on the age of the plant more than on the volumetric charge.

[5]This assumption is tested below. The result is a significant positive but weak correlation between income and water consumption.

2.3 Water-poor in France

In France, 13.5% of French households have an income lower than 60% of the median income. For the lowest 10% incomes, the share of constraint households' expenditures has risen from 24% to 48% between 1979 and 2005 (Mareuge and Ruiz [2008]). Water affordability and access has been a hot topic in France as the French Parliament has been voting the right for an existing governmental agency to pay a part of the bill of households with financial difficulties, e.g. experiencing overindebtedness or unsanitary housing. While access to water is a recognized right in international conventions, public and private operators jointly created in 2000 a special fund to subsidize poor households which could not pay for their water bills. There are however very few statistics about water poverty in France. According to Smets [2004], there are 3 million French people experiencing difficulties to pay their water, electricity, gas or phone bills. The same year, over 700,000 households have asked to reschedule their water bills.

Defining water poverty is difficult as the threshold depends on local conditions. This is especially true for the French case where prices and incomes differ from one municipality to another. According to Smets [2004], the affordability index for households with an income below 40% of the median income varies from 2.5 to 3.5% in developed countries. A threshold of 3% was also proposed by the OECD and by the United Nations specifically for France (Reynaud [2007])[6]. Using this definition, Reynaud [2008] finds that 4.31% of French households are water-poor in 2006. As we only consider the first part of the bill representing exactly 50% of the whole tariff with value-added taxes, we consider water-poor as households paying more than 1.5% of their income in their water bill. Using this definition, there are 479,974 out of 16.5 million households in our dataset potentially experience water poverty. On average in our database, French households pay water provision bills lower than 0.7% of their income, a figure that is consistent with the UNRISD report by Reynaud [2007][7].

This definition of poverty is however limited. First, "water-poor" may not be household facing financial stress. A simple example can illustrate the limits of the definition. Households with swimming-pools can consume large amount of water resulting in consistent water bills. Second, from one consumer behavior perspective, water consumption may only be the result of utility-maximizing behaviors. For these reasons, we will use a broader definition of poverty and needs-based on the national poverty threshold.

3 Data and Research Design

We developed a unique dataset by combining data from the French Environment Institute (IFEN-SOeS), the French Health Ministry (DGS) and the French National Institute for Economics and Statistics (INSEE) on 5,215 representative municipalities in 2008. Because of missing data, our results are extracted from a 4,500 observations dataset. We match this

[6] Several studies such as Fitch and Price [2002] for the UK and Reynaud [2008] for France conclude that water poverty means that the share of income spent by households for water services is equal or higher than 3% for the three lowest deciles. They however consider a bill including water provision and sewage. Hence, being water-poor can result from one decision for the highest deciles.

[7] According to a report by Reynaud [2007] for the UNRISD, the average percentage of income spent on paying water charges is 1.20% in 2001 for French households.

large dataset with a sub-sample of 650 observations on net results in the water industries for 2009. The unit of observation is a municipality.

3.1 IFEN-SOeS database

The IFEN-SOeS, collected by the French Environment Institute and the Environment Minister, is a nationally-representative municipal survey of the public service of water. This sample is representative of the total French population and the local public authorities where they are living: all sizes of local authorities are proportionally represented and municipalities with more than 5000 inhabitants are all included. The IFEN-SOeS database provides detailed information about public water services and municipalities' characteristics. There has been four data collection in the last ten years. The data collection proceeds as follows. Municipalities fulfill the database, then data is checked by the Environment Minister. The IFEN-SOeS is the only national representative dataset on public water services.

The database includes a lot of information at the municipal level about water consumption by domestic customers[8] and municipalities' characteristics that can influence water consumption. We know for example whether the city is located in a touristic area or not or in which region the city is located. The latest variables are important controls when one tries to explain water consumption: on the one hand, touristic areas face larger levels of consumption during some periods of the year; on the other hand, water consumption is higher in some regions such as the south of France. Moreover, we can create dummies to take into account the density of water consumption on the network. Using regulatory indicators provided by the French Observatory of Water and Aquatic Environments (ONEMA in French), we consider a city to be rural if the ratio of billed water and the length of mains is smaller than 10 and to be urban if this ratio is larger than 30. Cities with a ratio between 10 and 30 are considered semi-urban. These dummies provide helpful controls to normalize consumption levels from one municipality to another.

Table (2) reports covariate means and standard deviation by consumption-unit household income quintile. The first quintile for example includes cities in which the median income is between 0 and 159%. Annual per consumption-unit median income increases from an average of 14,275 euros in the first quintile to an average of 23,755 euros in the fifth quintile. Panel (A) in Table (2) shows some cities economic and demographic characteristics such as its touristic and urban status. Mean annual consumption and expenditure are relatively stable from one quintile to another in Panel (B). Mean annual consumption goes from 136.145 cubic meters per year in the first quintile to 139.541 in the fifth quintile for a relatively close expenditure. Marginal prices are similar in the quintiles 1 to 4 but very different in the fifth quintile where they are 7 to 10 cents more expensive. This difference in marginal prices is fulfilled by lower fixed fees in the fifth quintile. Cities with higher incomes face fixed fees equal on average to 38.611 euros while the first and second quintiles respectively pay 48.93 and 49.456 euros for their fixed fees.

[8]Domestic customers include households but also small firms and agricultural firms. In some cases, big firms are also included in domestic customers. We however do not take into account exports and a part of billed water sold to non-domestic customers, usually big firms with a particular tariff rate.

Panel (C) describes water utilities characteristics that are useful to understand the differences in prices or costs of water production and distribution. On the one hand, ground water is usually associated with higher treatment complexity because it is more polluted than underground water. On the other hand, underground water is more costly to extract. Its impact on costs is thus not clear. Treatment complexity has a direct impact on costs and thus on the price of water. As Table (2) shows, higher quintiles are associated with higher complexity and lower underground water that explains the differences in marginal prices.

An important feature of the IFEN-SOeS dataset is that, in addition to characteristics about the contract such as ownership structure, it provides high-quality information about water bill structure. Even if we have little information about differentiated rates, we have a lot of information about the bill composition of a baseline bill for a household, defined by the National French Statistics Institute as a consumption of 120 cubic meters a year per household. At the baseline consumption level, we know the amount of the fixed-part and we can compute the marginal price per unit. As there are different rate schemes, one might consider that observed marginal prices do not fit non-linear pricing schemes. Table (1) shows the result of our test for consumption split in different tiers of the marginal tariff rate. For all the municipalities with multi-tier marginal tariffs, we reject the null hypothesis H_0 of an average consumption higher than the second-tier break even point with a p-value less than 0.001. Overall, the test provides strong evidence of average consumption levels lower than the second-tier of the marginal price. The hypothesis of a single unit price experienced by households is thus validated.

3.2 INSEE database

The INSEE database gives us information about household characteristics at the municipal level that is presented in Panel (A) of Table (2). We have the number of households, the population structure of the municipality and median income per households. We will briefly discuss the representativeness of this dataset.

We use median declared fiscal incomes as a proxy for a typical household standard of living. Incomes include labor and capital incomes before tax and deductions and do not include cash and non-cash benefits from public assistance. We however assume that income is a good proxy for the standard of living. Using weighted incomes, we find a median income of 17,923 for a single person, while the standard of living - including benefits and subtracting taxes - is 17,170 according to INSEE. However, our measure of incomes has two drawbacks. First, it is upward biased for low-income as the average income in the lower quintile is higher than it is for the standard of living (14,275 versus 10,530 euros). Second, it is downward biased for higher incomes as the average income in the top quintile is lower than the one of the standard of living (23,755 versus 35,580 euros). Our measure of household incomes is thus more concentrated than the distribution of the standard of living.

In order to gauge the financial stress on poor households, we must measure the impact of water tariffs on a household adjusted for its composition. To do so, we took into account household composition at the municipal level to compute an income per consumption unit. INSEE defines consumption units in the following way: household members aged less than

15 years old count for 0.3 unit, the first household member aged more than 15 counts for a single unit and other members aged more than 15 count for 0.5 unit. We can thus build an adjusted household income which takes into account that there are differences in the standard of living across households depending on the number of household members. Panel (A) in Table (2) shows that demographic structures are quite similar except for the proportion of adults above 60 that is higher in lower quintiles.

INSEE defines the poverty threshold as an income of 9804 euros per year for a single unit of consumption for 2008. As we consider median municipal incomes before taxes and without subsidies or benefits at the municipal level - we cannot take into account isolated single parents with children - where poverty is usually higher. Using municipal-level units, we have to consider reforms regarding "poor cities" rather than poor households.

There are no formal definitions of what a "poor city" is. Studies made by INSEE usually define poor cities as cities with high-level of unemployment, a large share of households living on public benefits and annual incomes per households below 12,000 euros. For simplicity, we consider as "poor" cities with a median income per unit below the minimum wage for a full-time employed person, that is 12,450 euros a year[9]. In our dataset, "poor cities" are thus cities with at least 50% of their households not earning the full-time minimum wage per unit. This definition is restrictive for several reasons. One that can be particularly strengthened is that it does not take into account inequalities within cities, as could approximate consumer-level studies. In this case, a high price of water can have no negative impact on the average consumption of the city and at the same time be very distorsive for poor consumers. However, using a municipal-level analysis is useful for at least two reasons. First, as there is no national regulator, prices could tend to be higher in rural areas with incomes generally lower than in large cities such as Paris or Lyon. Second, cities represent an interesting laboratory to simulate the impact of the rebalanced tariffs. In the latter case, one could extend the municipal-level results to the district-level within a given city. Overall, city-level data provides a large heterogeneity in prices and consumption.

3.3 OSEA database

To better understand water rate schedules in France, data on revenues, costs, the number of customers and billed volumes has been collected for 139 big water utilities for 2009. The data collection has proceeded as follows. We launched a data collection on the top 720 cities in France, representing 320 water utilities. We got data for 297 and, because of missing data, obtained a complete sample of 139 water utilities. As these water utilities all include at least one city with 15,000 inhabitants, they usually share their network with small cities around. We finally have a dataset covering revenues and costs for 650 cities of the IFEN-SOeS dataset. For 139 water utilities, the dataset contains information about the global revenues and costs so one can compute a net revenue equal to revenues minus costs. It is impossible to have detailed information about costs and investments in order to extract water production and distribution costs on the one hand and capital cost on the other hand. The dataset is completed using numerous variables that we can find also in the IFEN-SOeS database such as the number of customers, billed volumes of water and

[9]In 2008, the minimum wage in France is 1,037.53 euros per month corresponding to 12,450.36 a year

water production specific indicators such as water sources and treatments.

OSEA dataset is useful to have information about the cost structure of the 4,500 IFEN-SOeS cities. However, we have to make several assumptions. First, we assume that marginal costs and revenues are moving in the same way between 2008 and 2009 as our data was mostly available only for 2009. Second, data is often aggregated at the contract level. A contract usually implies water production and distribution for several cities, i.e. a territory. So one might assume that customer density and consumption habits are the same from one city to another within the same territory, which is not always the case. When it is possible to split cities one from another, we do so. Thirdly, we have sometimes data aggregating different contracts from the same operator within the same territory. This case is particular because *marginal costs* are the same within the territory but *marginal prices* differ from one contract to another while we are only able to extract one marginal price for the whole territory. Finally, we have to assume that results issued from the OSEA database have an external validity and are thus expandable for the other French municipalities. The next subsection discusses the potential selection-bias that can occur from this study.

3.4 Sample-Selection Bias

Due to data collection, our merged sample is truncated. One question that arises is whether results from this sub-sample can be generalized to the whole representative sample. To check the sub-sample external validity, we apply a simple Heckman [1979] selection model. In the first stage, we use a Probit model of the probability of observing the data regarding a function of regressors independent from observed marginal costs. The selection equation is:

$$V_i = \beta_0 + \beta Z_i + \eta_i \tag{2}$$

where V_i is a latent variable equal to one if the city is included in the sample, β the vector of coefficients for the selection equation, Z_i the vector of covariates for city i and η_i the random disturbance for a given city i. The vector of covariates includes dummies for the urban, semi-urban or rural status and a dummy equal to 1 if water is privately managed.

The second-stage of the model regresses net revenues per customer on billed water per customer to test for marginal cost pricing. A similar model is used in Borenstein and Davis [2011] and Davis and Muehlegger [2010] for example. The following equation gives us the average margin per billed unit and per customer:

$$NRC_i = \alpha_0 + \alpha_1 q_i + \alpha_2 X_i + \Phi_i \epsilon_i \tag{3}$$

where net revenue per customer from water sales, NRC_i, is regressed on the annual consumption per customer of a given utility, q_i. X_i is a vector of variables shifting costs - treatment types and water origins - crossed with the consumption per customer q_i and Φ_i is the inverse Mills ratio derived from the selection equation. The coefficient α is the average mark-up per unit i.e. the difference between marginal prices and operating costs. We exploit differences in water sources and water treatments to generate different mark-ups[10]. The constant α_0 is the average extra-amount paid in fixed fees, i.e. the difference between fixed fees and capital expenditures. The inverse Mills ratio Φ_i makes this mark-up on fixed price vary from one city to another.

Table (3) shows the Heckman-selection regression results. Results can be interpreted in the following way. From the selection equation, we observe that our sub-sample tends to over-represent semi-urban, urban and privately managed cities. The highly-significant coefficient of the inverse Mills ratio means that there was a selection bias from our sub-sample. We can however control for this bias by correcting our predicted results from the second-stage equation. Results from the test of marginal cost shows that marginal prices tend to differ from marginal costs. Indeed, for each volumetric unit sold, a consumer pays on average 0.1239 euros more than the marginal cost of water provision. Considering cross-variables, bad water quality seems to be positively marked-up on per-unit prices while more complex treatments lead to lower per-unit mark-ups. Regarding fixed prices, interpreting the sign of the mark-up is less straightforward: while the constant suggest a negative loss for water producers, the inverse Mills ratio has a significant positive coefficient. Using the model and the coefficients from the regression, we build counterfactual bills using a second database with 4,500 observations at the municipal level. The results are detailed in the next section.

4 Switching to Marginal Cost Pricing

4.1 Graphical Analysis

In this subsection, we use computed city-level natural water consumption and expenditure to describe the rate schedules faced by French residential customers. Figure (1) plots a fitted least squares regression line of average annual consumption and expenditure (the solid line). There is large variation across households in annual consumption but the figure shows a strong correlation between consumption and expenditure. There is, however, a large degree of heterogeneity in expenditure across the country. In many cases, different households consuming the exact same amount of water in the same basin pay considerably different amounts. Costs may vary across utilities based on the mix of residential, commercial and industrial customers, scale economies, age of the meter and transportation costs when water is imported. Once again, data are computed from overall municipal consumption and not from customers' bills. Several limitations result: we cannot consider whether seasonal differences in consumption have an impact on the average annual bill for example; we can neither compare bills from different households of the same city. We can only conclude on differences on the typical bill of a consumer in a given city.

For simplicity, we assume that consumption elasticity is null and that revenue is neutral to consumption. A simple reason why null consumption elasticity can be a reasonable assumption is that consumers can have limited attention to complex and less salient price incentives. This situation arises when consumers do not know their marginal price of water (Carter and Milon [2005]). While several studies assume that income and water

[10]In other regressions, we also included dummies for touristic areas, operators or whether municipalities are interconnected, but the results remained stable. In order to keep an intelligible form of the cost function, we decided to apply a simple model focusing on production costs.

consumption are strongly related (Diakité et al. [2009] for example), this assumption can be relaxed here by the fact that income and water consumption are weakly correlated. Figure (3) plots an fitted least square of the two variables. Each observation is a city. The figure illustrates a positive correlation but little of the variation in water consumption is explained by income variation. The OLS regression reveals a 0.0006 R^2. Part of this lack of correlation comes from differences of consumption in geographic divisions. However, even in the same regions, income explains a small fraction of the variation in water consumption. This weak correlation illustrates the difficulties to have strong distributional impacts with tariff reforms. Any tariff reform must take into account household composition and structure to target water assistance programs and have stronger equity effects, something that we consider using per-unit income.

In Figure (1), the dashed-line plots the bill faced by households under marginal cost pricing. As the fitted least square line is flatter under marginal cost pricing, customers consuming the same amount of water than in the current rate scheme would face significantly lower bills. Overall, less than 3% of customers would face higher prices under marginal cost pricing. Households with low levels of annual consumption could face increasing bills due to higher fixed-fees, while household with high levels of annual consumption would tend to pay less. In the following subsection we examine distributional consequences in detail, comparing the characteristics of households with different levels of incomes, household composition and consumption.

Factors that can create differences in rate schedules are urban density and organizational choice to provide water. Figure (2) shows different bills reflecting alternative consumption in rural (solid black line), semi-urban (dash line) and urban (dash-dot line) areas when the utility is publicly and privately managed. This graph does not take into account controls for selection effects that could explain differences in rates between public and private management. However, one can see that under private management, the slope of the line is higher than under public management, meaning that prices increase faster under private management. Another noteworthy element is that under private management, urban areas face higher marginal prices than semi-urban areas.

4.2 Rebalancing rates in water tariffs

Table (4) describes the rate schemes for different types of water utilities. We present marginal and fixed prices for different organizational choices and different consumption density. The unit of observation is a municipality. Results are unweighted by the number of households. So when considering marginal price in public and private management for example, we consider average price between municipalities, not between households. Household-level results would be different as there are heterogeneity in the number of inhabitants between and within the different categories. For example, if all the inhabitants of Paris support an increase in prices, this has a more important impact at the national level than it could have in a small city. However, as the nature of our data is municipally-leveled, we present change in tariffs at the city-level.

The first column shows current water tariffs while the second column gives the rebalanced rate schedules when the Coasian tariff is implemented. In many cases, different households consuming the exact same amount of water in the same region pay considerably different amounts. This heterogeneity in water prices is at first sight surprising. In most cases, water production is quiet cheap and does not change a lot across regions or basins. However, differences arise from the cost of local distribution and other fixed costs that are recovered in the utility's volumetric charge or fixed costs. The difference in per-unit price between public and private management is a little bit more than 18 cents, representing a 16.8% deviation from mean price. The gap between private and public management is even wider when one considers the fixed-part of the tariff. There is indeed a 12.63 euros difference per customer, representing a 27% deviation from the mean fixed-price.

In column (2), marginal tariffs are rebalanced such as the water industry tend towards to a null profit, in the idea of Coase [1946]. In column (2), the reformed rates are derived from the marginal cost model corresponding to equation (1) and Table (3). All prices logically decrease on average but some heterogeneity is found between organizational choices and different consumption densities. While marginal prices decrease in rural areas, they tend to increase in urban areas and to remain stable in semi-urban areas.

On average, marginal price is set 0.154 euros higher than marginal cost under public management while unit price is 0.119 higher than marginal cost under private management. Differences between organizational choices are higher under marginal cost pricing: on average, unit price under private management will be 0.218 euros more expensive while it is 0.183 under current rates. Public managed utilities thus tend to have higher per-unit margins than privately managed utilities. The gap between public and private management is even wider if one considers the fixed-part of water rates. While in column (1), the gap is 12.63 euros, it is 17.06 euros in column (2). One might consider that this wider gap between public and private management is counterintuitive. In the public debate, public management is often viewed as being cheaper because it has lower margins than private management. We argue here that per-unit prices under public management could be even cheaper while private managers tend to keep low per-unit margins to remain competitive[11].

Another factor that creates differences in rate schedules within divisions is population density. Consumers in urban areas face higher unit prices than consumers in rural areas. The gap is however balanced by the differences in fixed costs. Urban customers pay on average 34.89 euros per year for their subscription while rural customers pay 57.81 euros per year. This is surely because a part of fixed costs in urban areas is recovered by the volumetric charges while in rural areas where consumption density is lower, utilities secure their revenues through high fixed tariffs. Note that rural areas represent 40% of our observations but only 1,670,649 households versus 9,391,694 households living in urban areas and 5,590,629 living in semi-urban areas. Even if cities experience on average decreasing fixed fees, households experience overall increasing fixed fees when they switch from current tariffs to Coasian rates. Column (2) shows that current water tariffs are far from being well-designed and could be rebalanced in order to slightly increase fixed-price and lower marginal prices. This would also fit firms' willingness to ensure sustainable

[11] Accounting rules in public budget are clear. All margins are automatically used to fund next year operating expenses or can be used as provisions for future investments. However, these provisions i) are against lower prices for consumers, ii) do not represent the cost of water supply and are distorsive and iii) do not imply larger investments under public management.

profits using access fees and to maintain the optimal level of investments[12].

4.3 Counterfactual Bills

Table (5) describes the distributional impact of a change to marginal cost pricing assuming zero demand elasticity. Panel (A) reports results by household income quintile. Households in the first quintile would pay on average 22.32 euros less under marginal cost pricing and only 1.1% of the households of this quintile would experience a bill increase. Households in the fifth quintile would experience smaller decreases in bills and 4.67% of this class would experience increase in prices.

Results in panel (B) by adjusted income quintile are somewhat similar to the previous results. When one considers household composition, households in the first quintile face larger decreases in bills than households from the fifth quintile. The former would annually pay 21.45 euros less while the latter would pay on average 15.90 euros less. The pattern of the change comes from the fact that lower adjusted income quintiles can be those with higher consumption if the lower income is due to numerous members in the household. For example, a family of two adults and three children would have a lower adjusted income than in panel (A) while their consumption would remain the same.

Panel (C) examines consumption quintiles. As Figure (1) shows, the transition from current tariffs to marginal cost pricing is assumed to advantage households consuming the biggest amount of water. The first quintile in panel (C) has a probability of 4.33% of experiencing increase in bills because of increasing fixed-prices. Panel (D) focuses only on water-poor and poor cities. Applying marginal cost pricing leads to lower prices for water-poor and households below the poverty line. Municipalities with water-poor experience a 54.26 euros decrease in their bills and municipalities with incomes below the poverty line experience a 22.19 euros decrease in their bills. The gap between the two groups of households comes from the fact that water poverty is correlated with consumption and incomes while the poverty line depends only on income considerations. A few municipalities with water-poor citizens or median incomes below the annual minimum wage experience increased bills under Coasian tariffs.

Even if Table (5) is instructive to understand the impact of reformed tariffs, there are two drawbacks to the correct interpretation of the table. On the one hand, one might argue that household income may not be a good indicator of the financial stress that households face. Cutler and Katz [1992] state for example that permanent income is a more accurate measure of the distribution of resources than current income. Poterba [1989] argues that households can base their spending on their expected lifetime income, meaning that consumption would provide a more accurate measure of households' resources. On the other hand, our residential approach to water consumption does not take into account households' appliances, that can be a proxy for expected lifetime income. There is unfortunately no available data on durable goods owned by households at the municipal level. However, this could be an interesting point to explore using a household-level dataset. Ideally, we could also have information on consumers' housing such as the number of bathrooms they have, whether they rent or own their housing and whether

[12] One of the theoretical features of public-private contracts is that, in a principal-agent model, the agent in charge of providing the service will underinvest if it has no incentives to do other.

they live in multiple-unit buildings or not.

4.4 Including Water Assistance Programs

Table (5) gives clear-cut results in favor of efficient pricing for consumers. However, its redistributive impact can be considered insufficient and can be criticized in terms of outcomes for operators who would experience substantial profit losses. In this section, we consider that the regulatory profile would ensure marginal cost pricing for the volumetric charge. We then assume two situations corresponding to Part I and Part II in Table (6). In Part I, a Coasian tariff is implemented and firms have to bear null profits in favor of consumers. In Part II, we assume that firms charge per-unit consumption at the marginal cost but increase fixed fees in order to maintain the same level of profits than under current tariffs. We run four reforms that could be discussed at the national level. In panels (A) and (B) of Part I, we consider two reforms. The first one provides free fixed fees for households in poor cities. The second one consists in a refund of increased fixed fees that can result from Coasian tariff schedules, no matter if the city is considered as being poor or not. The result of the later reform can be expressed in the following way. Cities with increased fixed fees under rebalanced tariffs will be funded in order to face the current fixed fees. We then compare their distributional impacts regarding current price schedules.

In panel (C) and (D) of Part II, we consider marginal cost pricing with increased fixed-fees such as water industries keep the profits constant and we apply a free-fixed fees policies for poor cities and for cities with median incomes below 159% of the poverty line. Table (6) reports the results of these simulations on five categories: cities with median income below 159% of the poverty line, water-poor cities, poor cities, the annual cost per non-recipient and the overall cost in millions.

Panel (A) in Table (6) shows the impact of free-fixed fees on poor cities before rebalancing tariffs. Because households below the poverty line represent 576,399 households out of 16.7 million in our dataset, it is relatively costless to fund a free-fixed fee policy by non-recipient households. The impact on tariffs in poor cities is a decrease of 29.14% of the water bill, representing 50.51 euros. On average, cities with a median income below 159% of the poverty line experience a decrease of their water bill by 9.372 euros per year but 79% of this category has to participate in the funding of poor cities. The annual cost per non recipient is 1.44 euros per year for an overall cost of 23 million euros.

Panel (B) is the case in which tariff reform is guaranteed with no increase in fixed-fees in any city regarding the current tariffs, no matter whether the city is considered poor or not. In this case, households living in a municipality within the first quintile face an average decrease of 0.33 euro in their annual bills. Poor cities experience a decrease of 1.25 euros on average of the water bill and no poor cities would experience increased tariffs, meaning that poor cities are all cities facing increasing fixed rates when we switch from current to Coasian tariffs. The annual cost of this program is 1.20 euros per non-recipient household and the overall cost is 19.4 million euros, both are below what is observed in panel (A). Costs of reforms in panels (A) and (B) are comparable but they do not target the same cities. Programs described in panel (B) will especially advantage urbanized areas that are more represented within the 5th quintile (a quarter of the cities) than within the 1st quintile (around 13% of the cities) as it is shown in Table (2).

Results in Part I of Table (6) provide a better understanding of the costs of tariff reforms. While households would on average largely benefit from Coasian tariffs, small consumers could be disadvantaged regarding large consumers. Panels (A) and (B) give solutions to mitigate the distributional impacts of reforms. Note that these reforms could be implemented under current tariffs.

In part II of Table (6), we assume marginal cost pricing and rebalanced fixed fees such as firms do not support profit losses under the 0-demand elasticity assumption. In this case we assume marginal cost pricing for the volumetric charge and higher fixed fees to maintain constant profits for the firm. One of the arguments against marginal cost pricing when firms maintain their profits is that it results in larger fixed fees that can affect particularly poor households. We offer here two alternative reforms that can mitigate the distributional impacts of a transition to marginal cost pricing with a significant increase in fixed fees. This solutions can associate efficiency in pricing at marginal cost and equity by decreasing bills in poor cities.

Panel (C) shows the result of a free fixed fee policy in poor cities funded by non-poor cities' households. Because of increased fixed fees for all the households, cities within the first quintile and poor cities would experience larger decreases in their bills. The cost per non-recipient would be 0.46 euro higher. For the same level of consumption, each household in non-poor cities would have to pay 1.90 euros more than under current pricing. Overall costs are 30.60 million euros, 7 million more than under Coasian tariffs.

Panel (D) shows the impact on water bills of a free fixed fees policy for cities with a median income in the first quintile. In this case, the scope of the policy is wider as the number of households targeted largely outpasses the number of households living in poor cities (3,319,712 vs. 576,399 households). As one can expect, the policy has a larger impact on the mean annual bill of cities within the first per-unit income quintile with an average decrease of 88.15 euros per year. The annual cost per non-recipient is 11.86 euros, representing 6.64% of the typical bill of a non-recipient, a 166 million euros overall annual cost. Matching efficiency with equity is thus possbile if the implementation of marginal cost pricing for the volumetric charge is combined with transfers between cities.

Under rate reforms such as those presented in panel (C) and (D), poor cities would experience larger decreases in their annual water bills at a low cost for a non-recipient. In more ambitious reforms such as the one presented in panel (D), cities with median incomes in the first quintile would have average bills decreased by more than 69 euros, a result that is more than three times higher than under marginal cost and capital cost pricing without water assistance programs. These results suggest that it may be possible for water assistance programs to take into account distributional considerations without losses of revenues for water utilities, a solution that is more credible than perfect Coasian tariffs.

Nevertheless, designing consistent water assistance programs is difficult. First, threshold-effects are important. Households in cities with incomes just above the defined poverty threshold would face increased tariffs to fund households below the poverty line. Second, it implies that water utilities fix their rates considering household incomes instead of their costs. Even if they were subsidized by other customers, this would imply limitations in their capacity to negotiate contracts that reflect their needs.

It is also worth emphasizing that these mean impacts obscure substantial heterogeneity across households. Because households differ substantially in their level of water consumption, the lump sum payment can be far too much for small consumers and not incentive enough to sustain water resources for others. Moreover, utilities differ in their needs to invest in capital. Suppressing fixed-fees for a whole set of utilities, even if they get national subsidies, could be alarming as the level of investments would depend on other subsidies rather than their capacity to raise fixed prices. Finally, these reforms would face political challenges, as municipalities are keen on administering their contracts, even if the proposed reform would probably better match the needs of poor households than the current tariffs. For all these reasons, efforts should go in the direction of efficient pricing, potentially closer to marginal cost pricing.

5 Welfare Effects of Changing Retail Prices

In order to evaluate the total deadweight loss from the observed departures from marginal cost and capital cost pricing, we first estimate the price-elasticity of demand for each per-unit of consumption income quintile. We then calculate the welfare changes and the deadweight loss associated with the current pricing schedules compared to efficient pricing.

5.1 Consumer elasticities

The counterfactual bills we have considered thus far show how household expenditure on water would change under marginal cost pricing if demand elasticity were zero, which implies huge efficiency consequences of the change. With non-zero elasticity, it is interesting to see whether households would consume more water, thus leading to a proper deadweight loss. Table (7) reports demand elasticities for the five household adjusted-income quintiles. In order to compute elasticities, we regressed the log of annual consumption per household on the logs of marginal price, income and demand shifters such as regional fixed-effects, urban density, touristic area, household size and the share of population aged between 15-64 years old.

Demand is significantly negatively correlated with marginal prices. The elasticity point estimates for the first quintile is -0.281 while it is -0.223 for the last quintile. The second and the third quintile face higher elasticities than the first one with respectively -0.287 and -0.304. These results are consistent with previous studies on the French water market (Nauges and Thomas [2003]; Garcia and Reynaud [2003]) but also in developing countries (Nauges and Whittington [2009]) and other markets such as gas or electricity in the USA (Borenstein and Davis [2011]; Ito [2010]). This estimation includes income elasticity by using crossed variables between per-unit of consumption quintiles and marginal prices. Even if one could consider linear effects of income elasticity, here we take into account different price-elasticity intensities following revenue distribution.

Municipalities' demographic and geographical characteristics have strong effects on water consumption. Regional fixed effects are significant to explain differences in level of consumption. Touristic areas are associated with higher level of consumptions because of a high level of seasonal consumption. Urban and semi-urban areas tend to have less per-household water consumption than rural areas. Average household size and structure matters. The larger the number of family members, the larger the consumption. A large share of 15 to 64 year old inhabitants is also associated with lower levels of consumption, perhaps because cities with a lot of working inhabitants are often urbanized and thus correlated with less-consuming capital goods.

From our demand-elasticity results, we can conclude that changing retailing prices would improve economic efficiency as consumers would change their behavior in response to the price changes. The efficiency impact can however be limited because consumer behavior is difficult to predict, and decreased marginal prices do not automatically lead to increased consumption. This is especially true in cities experiencing increased fixed fees such as urbanized areas. Computing welfare changes implies taking into account the linear welfare impact of marginal-cost pricing, the increased consumption that results from lower prices and the change in fixed fees.

5.2 Welfare Effects including Marginal Quantity Changes

Counterfactual bills presented so far showed welfare changes under the assumption of zero demand elasticity. In this subsection, we use elasticities from Table (7) to compute the deadweight loss of restrained water consumption due to inefficient pricing. We assume here that the tariff change does not lead any consumers to enter or exit the market. Table (8) reports deadweight loss generated by using existing pricing tariffs relative to marginal cost prices. We separately report mean welfare changes for each adjusted-income quintiles at the municipal level and for the whole set of households taking, weighting the municipal observations by the number of households. To compute welfare changes, we consider a constant elasticity for each income quintile. Price-elasticity is thus the same to a certain threshold of per-unit of consumption income. On average, in the sample, lowering the volumetric charge implies a 12% decrease. With a -0.22 to -0.3 price elasticity, this yields an increase in consumption of 5.5 cubic meters for the average consumer of a city compared to the initial level of 136.8 units. We consider the change in consumer welfare as the area to the left of the demand curve that computes the area of the difference between the original price and the marginal cost and the new level of consumption, and we substract the difference between annual fixed fees. The deadweight loss corresponds to the triangle ABC in figure (4).

Overall, the current marginal price schedule creates 5,357,913 euros in deadweight loss, relative to efficient pricing. The dataset represents a market of more than 16.7 million households and a gross market of 3.05 billion euros[13] so the deadweight loss represents approximatively 3% of the considered market. As a thought exercise, one can compute the deadweight loss for the whole water market in 2008 as the full dataset is representative of French municipalities. As there are 26.615 million households, the deadweight loss for the water market in 2008 could be set to 8 million euros for household consumption. Even in the case of counterbalanced fixed-part tariffs in order to maintain water industries' prof-

[13]For simplicity, we excluded taxes that are proportional to the volumetric consumption of water, such as value-added taxes but also a whole set of fees related to water production and distribution. When it is possible to dissociate domestic from industrial consumption, we do so. We also exclude sanitation and sewage from our analysis as we do not have information about the cost structure of these services.

its, the deadweight loss would remain the same, as it is the result of differences between marginal prices and costs. These results help clarify the overall debate about tariffs in France.

In Table 6, we find that a free-fixed fee policy in poor cities has an annual cost of 23 million euros under Coasian tariffs (see panel (A) in Part I of 6), while the efficiency cost of non marginal-cost pricing is 5.36 million euros. For the price elasticity of demand found above, the deadweight loss from transferring these funds is lower than 25%, meaning than the distortionary impact of a 20% take-up of fixed fees in poor cities for example could be offset under Coasian tariffs. Under marginal cost pricing with current profits, a full take-up of fixed fees in poor cities would cost 30.60 million euros (see panel (C) in Part II of 6). This is far more than the efficiency cost of current tariffs. In this context, water assistance programs could fund a minor part of fixed fees, e.g. a subsidy of 5 to 10 euros per household that could barely offset the negative impact of increased fixed fees.

The effect of marginal cost pricing on water conservation is also another feature of the deadweight loss analysis that must be discussed. Under marginal cost pricing and the assumption that customers respond to their marginal price, a typical household would consume 5.5 cubic meters more per year on average than under current tariffs, a result that goes against the argument for sustainable water use. In an extensive way, one could imagine that consumers paying cheaper bills would invest in less-consuming durable goods and thus promote water conservation.

These estimates provide a valuable preliminary assessment of the welfare consequences of the observed departures from marginal cost pricing. However, it is necessary to underline that the calculation of the deadweight loss is sensitive to the estimation of the elasticity demand. This has two limitations. First, demand elasticity might differ when one considers marginal price and average price (Borenstein [2010], Ito [2010]), or different estimates of long-term elasticity (Nauges and Thomas [2003]). We will discuss these limitations in the following section. Second, consumer elasticities assume that individuals respond to a pricing scheme in a way that the standard economic model predicts. Heckman [1983] shows for example that in nonlinear price schedules, the absence of bunching around the kink points could imply that individuals respond to other perceptions of price rather than the actual marginal price they are paying. Cognitive difficulties to understand rate schemes or simply missing information about their marginal price of water could also limit the possibility of evolving consumption when marginal price decreases.

5.3 Possible Explanations for Maintaining Efficiency Costs

Departures from efficiency pricing may have three explanations (a similar discussion is made by Davis and Muehlegger [2010] for the US gas industry). The first one lies in firms' profit maximization. In the last years, water operators in France have been justifying the increasing marginal prices of water by the diminishing demand from consumers. Increasing marginal price was thus a means to maintain stable profits. Moreover, some commentators argue that fixed fees are too large regarding capital costs because firms want to maximize their profits using fixed fees. The marginal cost of a new customer is indeed null and does not vary with the utilities' characteristics. In practice, small customers are sensitive to fixed fees while large customers are sensitive to unit fees when they make their demand decision. In Table (4), the transition from current schedules to Coasian pricing shows that utilities currently advantage small customers in urban areas and large consumers in rural areas. We undoubtedly lack information as we do not have the details about the stock of capital and the forthcoming investments. However, water companies have probably different pricing strategies depending on cost structures and water utilities' characteristics that can explain different styles in departures from Coasian tariffs.

Environmental considerations provide a second alternative explanation for setting high per-unit margins. In this view, departures from marginal costs could be justified by the need to address environmental externalities (such as water pollution) and sustainable water use[14]. In the standard view of externalities, the gap between marginal prices and costs is comparable to a Pigouvian tax that would reflect marginal damages. In this case, current tariffs[15] reflect the socially optimal level of exchange on the market because marginal prices equal the sum of private marginal costs and the costs of marginal damages. However, while this assumption is reasonable in competitive markets, they are less reasonable for regulated markets such as water in France. As noticed by Davis and Muehlegger [2010], in regulated markets, the standard Pigouvian solution is only verified and thus not distortionary if prices are set equal to marginal cost. An alternative view is that tariffs reflect the need for sustainable water use, including a discount rate in current tariffs. However, recent renegotiations in France tend to prove that tariffs probably reflect more the market structure than the real need for sustainable use[16].

Moreover, in France, negative externalities and resource protection are considered in the tariff structure of water. Two fees, one to protect resources and one to struggle against pollution, have been implemented. These fees are per-unit taxes that finance Basin Agencies' in order to subsidize projects which struggle against pollution and ensure resource protection. The per-unit rates of these fees are fixed by the Agencies and depends on the geological characteristics of the Basin. These characteristics are the origin of water and the condition of the sources for the resource protection fee and pollution intensity for the pollution fee. On average, the pollution fee is a 0.21 euro tax per unit while the resource protection rate is a 0.52 euro tax per unit. These fees are largely higher than the margins from current tariff, that are around 0.15 euro. Moreover, per-unit margins are higher in rural than urban areas while pollution and resource protection fees are higher in urban areas than in rural areas. Margins are thus not justified by the search for more sustainable use, neither by the scope of struggling against negative externalities.

[14]One might argue that the difference between marginal prices and marginal costs could reflect different level of leaks between utilities. As Garcia and Thomas [2001] noticed, when demand increases, utilities face two choices. On the one hand, they can repair leaks, which is costly as it is largely labor-intensive. On the other hand, they can produce more water, which is less costly as it is electricity-intensive. Utilities with low leak-ratio may have to deal with higher costs. This explanation can explain why utilities have different marginal prices, as some include water scarcity in their pricing strategies, but not why marginal prices and marginal costs differ.

[15]To the best of our knowledge, there are few studies evaluating the price of scarce resources. Moncur and Pollock [1988] consider for example the change of marginal cost that would occur at the complete use of the current water source. In their study, they consider that water demand would be satisfied through a desalination technology or a trans-basins diversion, leading to a marginal cost twice higher than the current one.

[16]Recently, the price of Antibes, a city in the south of France where water stress is important, has been divided by 1.5.

These fees should be the main instrument to ensure environmental considerations and regulatory rules should incite firms to fix water rates regarding costs rather than sustainable use. These fees could however be reformed in order to be set by progressive tiers matching the marginal private impact of consumption on resource safety, assuming that consuming more water has a more negative impact on resource sustainability. However, the distributional impact would be uncertain as the correlation between consumption and income is positive but very flat. For this reason, agencies could consider regional price elasticities and incomes to define the levels of the fees.

A third explanation to current efficiency costs is private operators' participation in the market. Private operators' participation has been growing since the 1980s and is often pointed as being responsible for high marginal prices. On the contrary, public provision is often regarded as an alternative approach for lowering per-unit prices. However, in our OSEA sample, public provision is associated with higher net results than private management, thus leading to higher distorsions. There are several reasons for this situation. According to the highest French financial court (Cour des Comptes [2011]), public providers tend to underestimate the depreciation rate of capital in order to get higher net results and to refund their water debt; on contrary, private providers tend to overestimate capital depreciation to decrease their results and the amount that they have to pay in taxes. Moreover, in municipalities with less than 3,000 inhabitants, public managers can use the profits of their water services to finance other prerogatives of the municipality. Finally, public and private management face different tax rates, particularly on labor. Private firms have to pay extra-taxes to fund their retirement schemes; in public management, these fees are paid through taxation at the national level. In the latter case, this means that current lower public management fees are associated with tax distortions in other parts of the economy. In this case, a general rule following Hotelling [1938] could be to directly fund fixed-costs using public subsidies to break the differences in taxation between public and private management.

6 Discussion and Further Extensions

6.1 To Which Price Do Consumers Respond?

The previous analysis maintains the assumption that households have perfect information and respond to marginal cost pricing, an assumption that is common to several papers, e.g. Saez [2004] on income taxation, Reiss and White [2005] on electricity pricing and Olmstead et al. [2007] on water pricing. These may not be reasonable assumptions. Although water bills are reasonably clear about the distinction between the fixed part tariff and the volumetric charge, many customers have not thought much about the distinction. As a matter of fact, a large number of surveys show that a majority of people do not know the marginal price of their nonlinear tax, electricity and water rates. For example, Carter and Milon [2005] find that only 6% of households know their marginal price of water. Rebalanced prices could then have no clear effects.

Customers who are not aware of the existing two-part tariffs, or that do not understand the two-part tariff, might respond to the total bill, rather than the volumetric charge[17]. Such an assumption would consistently change the previous results as price-elasticities critically depends on whether consumers respond to marginal or average price. Recent empirical evidence on the electricity distribution in the United States shows that customers respond to average price rather than marginal, expected marginal or average price (Ito [2010], Borenstein [2010]). Ito [2010] finds evidence that Californian households respond to average price rather than marginal prices concerning electricity. Although these results are interesting, they do not fit overall water market regulation in France as Californian households face four and five-tier increasing block tariffs. As we have shown in our test of non-linear pricing schemes in section 2, the structure of rates in the French water industries is simpler and allows households to distinguish average and marginal volumetric prices. However, this leaves interesting studies to do in France in geographic areas where there are two or three-part marginal tariffs.

Borenstein [2010] uses electricity consumption household-level data from Californian utilities and suggests that individuals may use expected marginal price rather than their average price in the presence of uncertainty. Such utility-maximization models can be implemented with annual or monthly series. Our whole dataset contains data for four separate years -1998, 2001, 2004 and 2008 - which makes results less consistent. Indeed, consumers may not choose their level of consumption for a given year using marginal or average prices from their consumption level four years ago.

As a thought exercise, it would be interesting to consider how the welfare implications would change under the alternative hypothesis that households respond to average prices. Under a transition to marginal cost pricing, households with high consumption levels experience decreases in both average and marginal price, implying welfare gains regardless of how well the customer understands the tariff. In contrast, households with low consumption levels could experience decreasing marginal price with increasing average price, potentially moving consumption in the wrong direction. The total change in welfare could be positive or negative.

As an extension, we computed elasticities under average prices. Results are shown in Table 9. Price-elasticities when consumers respond to average price varies between -0.606 for the first quintile to -0.581 for the fifth quintile. This leads to a deadweight loss of 9,105,368 euros for 16.7 million households, a higher value than when consumers respond to marginal prices. The reason is that price-elasticities are higher under average price responses. As a result, distributional consequences could be more equitable for poor households under this assumption as the deadweight loss would be higher. Efficiency gains could fund for example 50% of the fixed fees for poor households through water assistance programs. However, the interval of price elasticities suggests increases in consumption that would weaken the achievement of water conservation.

However, one should bear in mind that elasticites computed with average price raise several endogeneity and identification problems as Borenstein [2010] and Ito [2010] noticed. Indeed, as average price depends directly on the level of consumption, the OLS average-price elasticity estimates are probably biased. An instrumented regression should be used, including as instruments consumption shifters that could explain different sta-

[17] de Bartolome [1995] finds for example that many individuals in laboratory experiments use their average tax rate as if it is their marginal tax rate when making economic decisions based on tax tables

ble consumption levels. Further extensions, using panel data, would provide consistent demand-elasticity estimates when consumers respond to average price.

Overall, if customers respond to average price rather than marginal price, then the welfare gains from rebalancing water tariffs could be slightly different. This raises other questions such as the design of water bills or transparency about marginal and average prices and about fixed fees and volumetric charges. Because of this lack of information, consumers have probably under-maximizing behaviors. In particular, suggested reforms should be clearly explained to consumers, in order to incite them to change their behaviors in the expected way.

6.2 Distortions in Connected Markets

A complete empirical investigation of the distortions on connected markets is far beyond the scope of the paper. However, one might consider that sanitation tariffs are also important to consider. Sanitation costs and prices have been growing in recent years for at least two reasons. First, regulation on pollution has been hardened by the need to improve water quality. Second, private participation within this particular sector has been growing because of the large amounts of investments to undertake. Negative net results in sanitation could thus explain the need for margins in water distribution.

Further studies could investigate the global efficiency costs of the water and sanitation markets. As the markets are related, a part of the distortion in one market could be the results from the other market. An interesting question lies particularly in the scope economies that could benefit operators that bundle both public services. Desrieux et al. [2012] for example find strong evidence of scope economies between water and sanitation markets in France leading to reduced bills under bundled services. The study of net results from these two connected markets would be interesting as a part of the investments are shared between the two sectors.

Another connected market is the quality and protection of forest lands. Abildtrup et al. [2011] for example shows using a French sample of cities in France that the proportion of forest land at the local level has a significant negative impact on water production costs. Forest preservation is costly but can lead to the preservation of water resources. Further studies could examine this point, by comparing the marginal cost of protecting forest lands and the marginal impact of this protection on marginal water production costs.

Further studies could focus on the impact of distortions between connected markets. There could be especially some tax distortions between directly and privately managed water utilities that could explain differences in prices and margins at the local level.

7 Conclusion

In this paper, we used nationally-representative city-level data to characterize the transition to marginal cost pricing in French water industries. The results confirm that price reform would have positive distributional consequences, but tends to be similar from one quintile to another. Needs-based reforms, such as free fixed fees in poor cities, could likely increase the distributional consequences in favor of households at the bottom of the income distribution.

We have three main results. First, we find that departures from marginal cost pricing are not very important - an 8% gap between marginal prices and costs - regarding other regulated industries. However, margins result in a transfer from consumers to producers that results in a 201 million euros gain for operators at the expense of consumers. Second, we compute estimates of the price elasticity of demand that are consistent with previous literature and we estimate the efficiency costs of current rate structure to be around 8 million euros for the French water market for 2008. In short, the current tariffs induce a level of consumption that is too small for a range of households because of inefficient prices. Third, efficient pricing does not level out the existing differences between consumers. Water assistance programs can be implemented to erase the negative impact of marginal cost pricing, especially when fixed fees increase to maintain firms' profits. These programs can be funded by customers themselves through cross-transfers. However, such transfers result in distorsions that should not exceed the efficiency gains of marginal cost pricing. Transfers could thus only cover a part of fixed fees for households living in poor cities.

The broader conclusion is that policy makers, firms and municipalities should bear in mind the trade-off between equity and efficiency when implementing rate structures. Stronger regulation in France could lead to the broader use of redistributive tariffs or to the constitution of funds to directly finance households experiencing difficulties to pay their bills. Because of the strong implications of the subject, more analyses, using real world data, are needed to study the impact and the magnitude of rebalanced tariffs and assistance programs.

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Figure 1: Rebalancing Water Rates

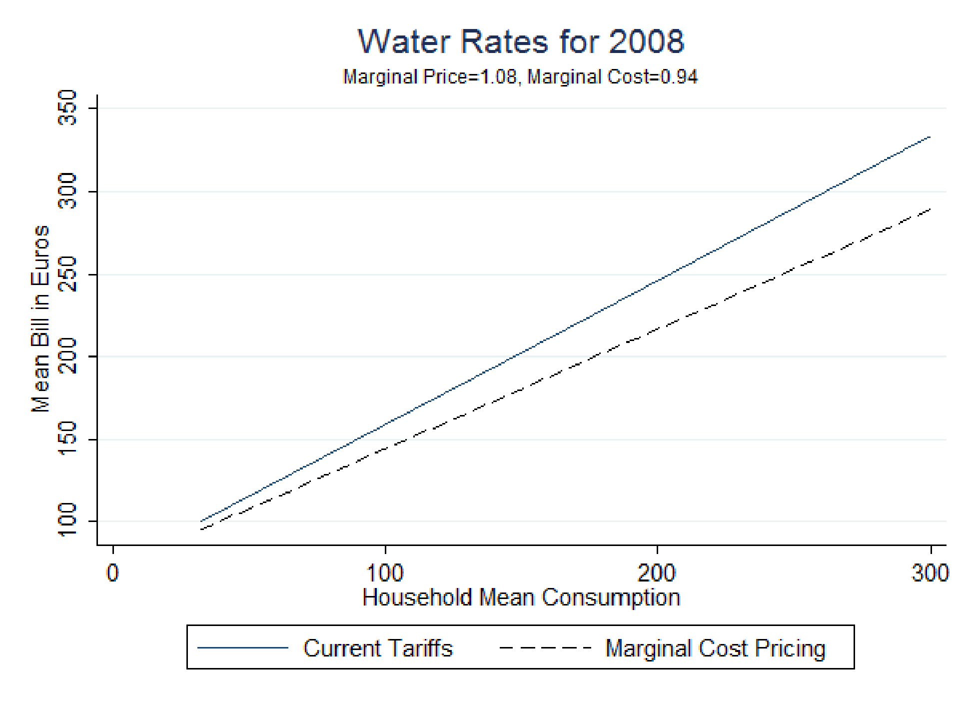


Figure 2: Rebalancing Water Rates, by Urban Density and Organizational Type

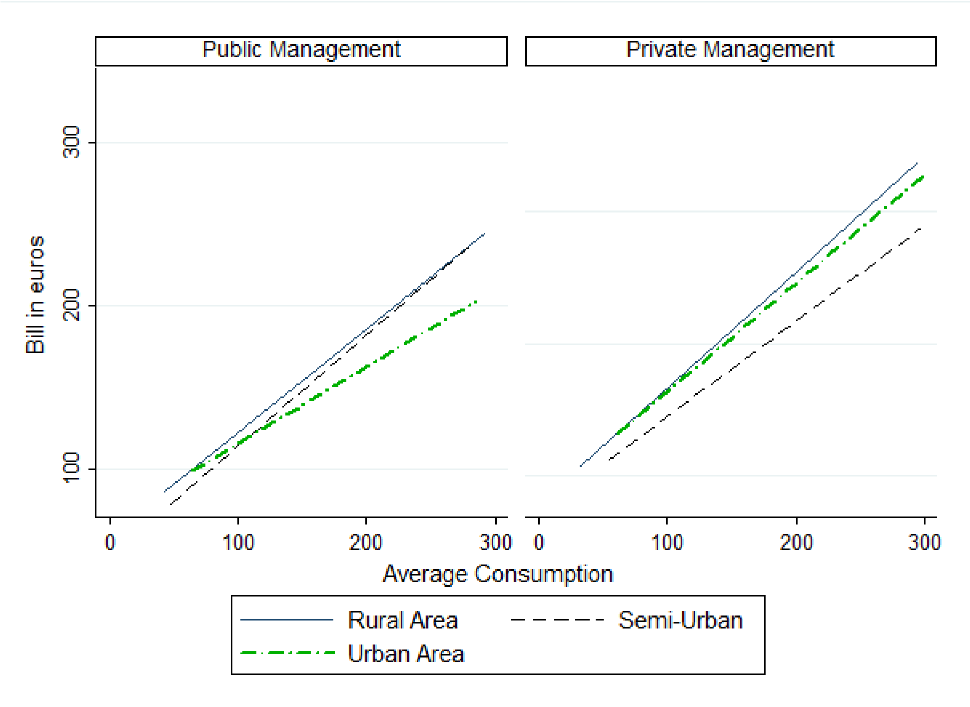


Figure 3: Water Consumption and Income

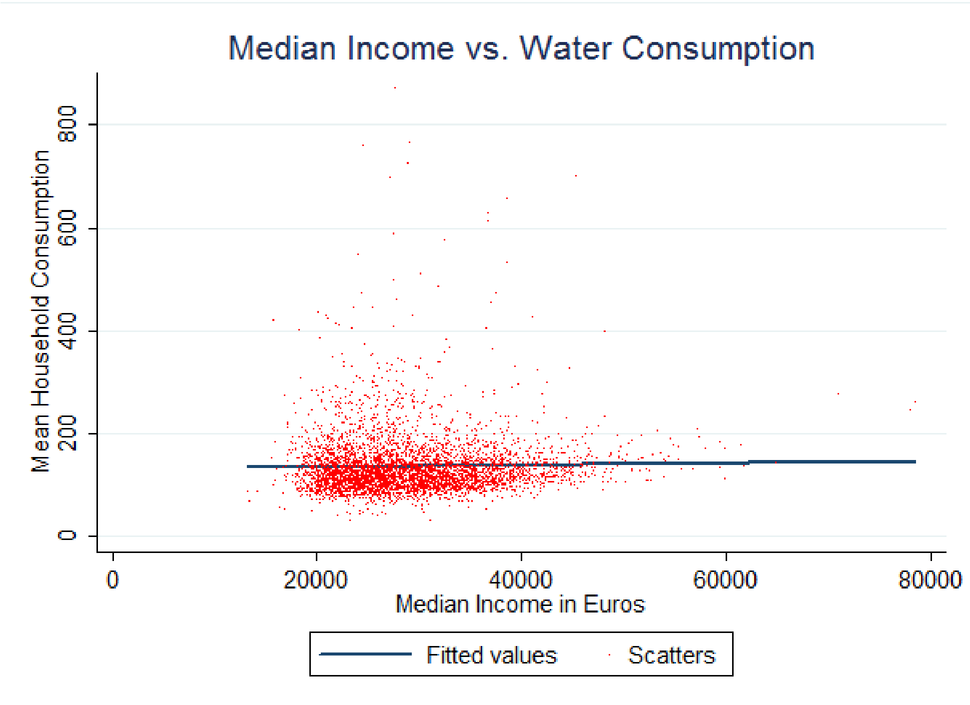
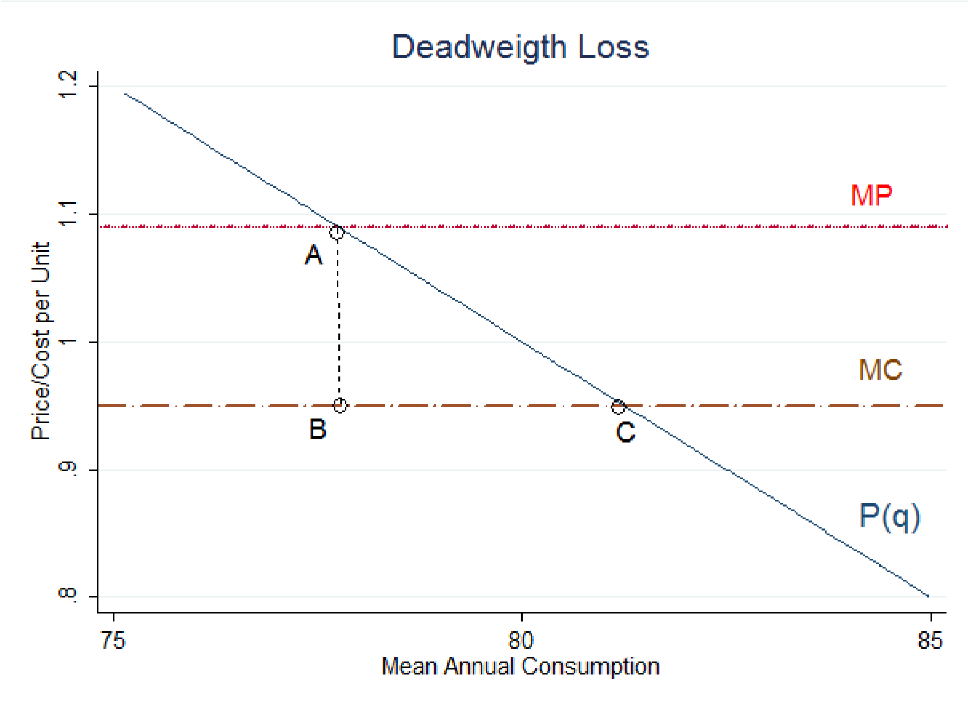


Figure 4: Water Consumption and Income



Note: The line MC is the constant marginal cost and the line MP is the constant marginal price. P(q) is the inverse Marshallian demand function. The deadweight loss is the ABC region in the graph.

Table 1: A test of non-linear pricing schemes in the French public water services

H_0	Degrees of freedom	$Pr \neq H_0$	Confidence Interval
Consumption $\succ$Second-tier threshold	1270	100%	0.001

Note: H_0 is the hypothesis that the average consumption is higher than the threshold of the second-tier of the tariff. We reject the null hypothesis with a confidence interval of 0.001.

Table 2: Descriptive Statistics by Per-Unit Adjusted Income Quintiles

Percent of Poverty-Line	**<159%**		**160-173%**		**173-187%**		**187-211%**		**>211%**	
A. Cities Economic and Demographic Characteristics										
Mean Annual Median Income	14274.95	(1152.104)	16252.64	(401.4486)	17639.02	(407.7273)	19401.02	(672.9867)	23754.71	3338.452
Number of Household Members	2.401	(0.256)	2.347	(0.219)	2.38	(0.255)	2.44	(0.242)	2.536	(0.224)
Proportion of Children under 15	0.181	(0.035)	0.179	(0.034)	0.187	(0.034)	0.189	(0.033)	0.194	(0.027)
Proportion of Adults above 60	0.262	(0.734)	0.256	(0.065)	0.233	(0.0633)	0.220	(0.064)	0.200	(0.051)
Touristic Area	0.098	(0.297)	0.153	(0.361)	0.162	(0.369)	0.160	(0.367)	0.096	(0.294)
Urban Area	0.133	(0.34)	0.092	(0.29)	0.117	(0.321)	0.139	(0.346)	0.249	(0.433)
B. Water Consumption and Expenditure										
Mean Annual Consumption	136.145	(57.52)	132.738	(49.972)	135.97	(98.144)	139.527	(70.748)	139.541	(57.964)
Mean Annual Expenditure	192.651	(80.63)	187.527	(70.231)	191.193	(96.62)	188.668	(81.585)	196.66	(80.444)
Expenditure as a Fraction of Income	0.009	(0.004)	0.007	(0.003)	0.007	(0.004)	0.006	(0.002)	0.005	(0.002)
Marginal Price	1.074	(0.32)	1.065	(0.324)	1.087	(0.351)	1.058	(0.324)	1.154	(0.337)
Fixed-Price	48.93	(27.175)	49.456	(27.198)	48.79	(27.176)	44.119	(24.758)	38.611	(23.905)
C. Water Utilities Characteristics										
Proportion of Privately Managed	0.658	(0.475)	0.612	(0.488)	0.63	(0.483)	0.634	(0.482)	0.69	(0.463)
Underground Water	0.739	(0.439)	0.688	(0.464)	0.652	(0.477)	0.653	(0.476)	0.574	(0.494)
Ground Water	0.10	(0.30)	0.144	(0.352)	0.136	(0.343)	0.152	(0.359)	0.15	(0.357)
Treatment Complexity[a]	2.919	(1.299)	2.935	(2.990)	2.990	(1.285)	3.006	(1.238)	3.184	(1.281)
Net Revenues per Customer (Subsample) [b]	23.959	(27.079)	29.618	(33.055)	27.058	(27.797)	26.416	(26.291)	25.736	(29.694)

Note: These municipal-level data come from IFEN-SOeS, INSEE and OSEA datasets. The sample includes 4,500 municipalities, 900 per quintile, except for the subsample on marginal cost, that includes data for 650 cities. These municipalities represent 16.7 million households. The first per-unit of consumption quintile of municipalities represent 3,319,712 households; the second 3,105,233; the third 3,315,489; the fourth 2,941,573 and the top quintile 3,970,965. Means and standard deviations (in parentheses) are calculated using 2008 euros.

[a]For ease in reading, there are six possible treatments numbered from 1 to 6, treatments 1 to 3 are easy, 4 and 5 are complex and 6 is intermediary complex. Water treatment performed by the operator before the water is distributed are important cost-shifters. Indeed, water treatment does not only approximate the complexity of service provision but also the level of specific investments needed to operate the service. A telltale story is that underground water is generally more stable over time which has two advantages. First, it reduces uncertainty about the evolution of costs. Second, treatment costs are usually lower when water is pumped from the underground. Under mixed sources of water, costs might be higher than under ground or underground sources as the utility might need a treatment factory for each type of water. Treatments are sixfold and coded between 1 and 6 in the IFEN-SOeS dataset. In the simplest case, there is no treatment. In this case, the *treatment* variable takes value 1. When raw water needs disinfection, *treatment* takes value 2. The value is equal to 3 if raw water needs a heavy disinfection treatment and equals 4 if water needs a heavy disinfection treatment plus extra-controls. The variable takes 5 and 6 when mixed treatments are needed, the most difficult treatment being 5.

[b]Fulfilled for the subsample including costs and revenues.

Table 3: A test of marginal cost pricing in the French public water services

Variables	*NRA*
q	0.218***
	(0.0499)
$q \times$ Ground Water	0.0247
	(0.0181)
$q \times$ Mixed-Water	0.0673***
	(0.0150)
$q \times$ Treat2	-0.0874***
	(0.0492)
$q \times$ Treat3	-0.152***
	(0.0470)
$q \times$ Treat4	-0.183***
	(0.0444)
$q \times$ Treat5	-0.121***
	(0.0437)
$q \times$ Treat6	0.0756
	(0.0663)
Φ	-7.961***
	(2.844)
Constant	-13.29*
	(7.301)
N	650
R^2	0.362
Marginal effect of q	0.1240***
	(0.0232)
Results from the Selection Equation	
Variables	*V*
Semi-Urban	0.759***
	(0.0652)
Urban	1.654***
	(0.0722)
Private Management	0.597***
	(0.0603)
Constant	-2.278***
	(0.0691)
N	5,215
Pseudo R^2	0.1991

Robust Standard Errors in Parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Rate Schemes Implemented in Different Types of Water Utilities

	Current Rate Scheme (1)				Reformed Rate Scheme (2)			
	Marginal Price		Fixed-part		Marginal Cost		Capital Cost	
Public Management	0.968***	(0.00725)	38.04***	(0.543)	0.814***	(0.00771)	33.31***	(0.532)
Private Management	1.151***	(0.00632)	50.67***	(0.529)	1.032***	(0.00647)	50.37***	(0.490)
Rural	1.097***	(0.00734)	57.81***	(0.604)	0.950***	(0.00772)	52.14***	(0.60)
Semi-Urban	1.054***	(0.00793)	37.04***	(0.899)	0.920***	(0.00822)	37.33***	(0.517)
Urban	1.151***	(0.0123)	34.89***	(0.516)	1.065***	(0.0133)	38.94***	(0.922)

Note: This table reports how customers expenditure on water would change under Coasian tariffs. Bootstrap standard errors based on 1000 replications in parentheses with *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: Impact on Bills of Rebalanced Tariffs

	Mean Change in Euros		**Mean Change in Percent**		**% Experiencing Bill Increase**	
			A. By Income Quintile			
1st Quintile	-22.32***	(0.709)	-12.43***	(0.336)	1.332***	(0.377)
2nd Quintile	-21.36***	(0.541)	-11.97***	(0.289)	1.332***	(0.389)
3rd Quintile	-20.89***	(0.697)	-11.58***	(0.320)	2.558***	(0.534)
4th Quintile	-19.33***	(0.465)	-11.28***	(0.284)	3.444***	(0.586)
5th Quintile	-16.95***	(0.482)	-9.563***	(0.271)	4.672***	(0.706)
			B. By Adjusted Income Quintile			
1st Quintile	-21.45***	(0.598)	-11.95***	(0.319)	1.776***	(0.440)
2nd Quintile	-21.85***	(0.545)	-12.56***	(0.313)	1.333***	(0.388)
3rd Quintile	-21.57***	(0.747)	-11.93***	(0.305)	1.556***	(0.423)
4th Quintile	-20.07***	(0.514)	-11.45***	(0.275)	2.667***	(0.528)
5th Quintile	-15.90***	(0.498)	-8.933***	(0.265)	6.007***	(0.820)
			C. By Consumption Quintile			
1st Quintile	-12.99***	(0.305)	-9.401***	(0.260)	4.329***	(0.686)
2nd Quintile	-16.39***	(0.315)	-10.73***	(0.242)	2.000***	(0.466)
3rd Quintile	-18.29***	(0.396)	-11.50***	(0.287)	1.444***	(0.416)
4th Quintile	-20.88***	(0.478)	-11.94***	(0.315)	2.667***	(0.528)
5th Quintile	-32.32***	(0.953)	-13.25***	(0.370)	2.892***	(0.536)
			D. By Poverty Status			
Water-Poor	-54.26***	(5.272)	-10.96***	(0.880)	0	
Poor Cities	-22.19***	(1.434)	-11.68***	(0.765)	2.030***	(0.988)

Note: This table reports how customers expenditure on water would change under Coasian tariffs. Bootstrap standard errors based on 1000 replications are shown in parentheses with *** p<0.01, ** p<0.05, * p<0.1. In panel (D), water-poor are defined as cities in which the average water bill represents more than 1.5% of the household median income. Poor Cities are defined as cities in which the annual median per-unit income is lower than 12,450 euros a year. Poor and water-poor cities represent respectively 576,399 and 126,466 households.

Table 6: The Impact of Four Reforms on Lower Incomes

	Mean Change in Euros		Mean Change in Percent		% Experiencing Bill Increase	
I. Assistance Programs Under Coasian Tariffs						
A. Free Fixed-fees for Poor Cities						
20% lower per-unit incomes	-9.372***	(0.824)	-5.299***	(0.455)	79.02***	(1.368)
Water-poor	-14.79***	(3.394)	-4.221***	(0.969)	79.05***	(3.990)
Poor Cities	-50.51***	(1.813)	-29.14***	(0.908)	0	-
Annual cost per non-recipient	1.442***	(0.000)	0.999***	(0.007)	100	-
Overall Cost (in millions euros)	23.2***	(0.000)	-	-	-	-
B. No Increase in Fixed Fees						
20% lower per-unit incomes	-0.329***	(0.072)	-0.168***	(0.053)	79.02***	(1.368)
Water-poor	-1.252***	(0.349)	-0.245***	(0.091)	79.05***	(3.990)
Poor Cities	-0.245***	(0.151)	-0.082***	(0.102)	0	-
Annual cost per non-recipient	1.204***	(0.000)	0.870***	(0.008)	100	-
Overall Cost (in millions euros)	19.4***	(0.000)	-	-	-	-
II. Assistance Programs Under Marginal Cost Pricing and Current Profits						
C. Free Fixed Fees for Poor Cities						
20% lower per-unit incomes	-21.12***	(1.876)	-8.318***	(0.672)	79.02***	(1.368)
Water-poor	-35.56***	(7.837)	-7.653***	(1.658)	79.05***	(3.990)
Poor Cities	-107.73***	(4.954)	-43.63***	(1.288)	0	-
Annual cost per non-recipient	1.901***	(0.000)	1.065***	(0.006)	100	-
Overall Cost (in millions euros)	30.60***	(0.000)	-	-	-	-
D. Free Fixed Fees for Cities with Median Income <159% of the Poverty Line						
20% lower per-unit incomes	-88.15***	(1.855)	-40.98***	(0.565)	0	-
Water-poor	-81.73***	(8.874)	-19.23***	(2.011)	43.81***	(4.657)
Poor Cities	-102.99***	(5.242)	-41.69***	(1.448)	0	-
Annual cost per non-recipient	11.86***	(0.000)	6.642***	(0.040)	100	-
Overall Cost (in millions euros)	166***	(0.000)	-	-	-	-

Note: This table reports how customers expenditure on water would change under Coasian tariffs in part (I) and under marginal cost pricing with increased fixed fees such as firms' profit is unchanged in part (II). Bootstrap standard errors based on 1000 replications are shown in parentheses with *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Costs per non-recipients are computed using weights for the number of households. The 20% cities with the lower incomes represent 3,319,712 households; Poor and Water-poor cities represent respectively 576,399 and 126,466 households.

Table 7: Price-Elasticity of Demand

Variables	Ln(Consumption)
Ln(MP) × 1st Quintile	-0.281***
	(0.0332)
Ln(MP) × 2nd Quintile	-0.304***
	(0.0325)
Ln(MP) × 3rd Quintile	-0.287***
	(0.0324)
Ln(MP) × 4th Quintile	-0.269***
	(0.0320)
Ln(MP) × 5th Quintile	-0.223***
	(0.0314)
Semi-Urban	-0.163***
	(0.0198)
Urban	-0.120***
	(0.0181)
Household Size	0.217***
	(0.0300)
Touristic Area	0.138***
	(0.0167)
Share of Population 15-64 YO	-0.805***
	(0.147)
Region FE	Yes
Constant	5.120***
	(0.0966)
Observations	4,500
R-squared	0.197

Note: Robust Standard Errors in Parentheses.*** p<0.01, ** p<0.05, * p<0.1.
Demand Elasticity is computed for current marginal prices.

Table 8: Welfare Change and Deadweight Loss Estimates for 2008

Mean Annual Welfare Change in euros		
1st Quintile	22.31***	(0.561)
2nd Quintile	22.98***	(0.566)
3rd Quintile	22.63***	(0.777)
4th Quintile	20.92***	(0.526)
5th Quintile	17.06***	(0.473)
Water-Poor	52.94***	(5.545)
Poor Cities	24.53***	(1.473)
Consumers' Welfare Change (in millions)	201	(0.000)
Deadweight Loss (in millions)	5.358	(0.000)

Note: This table reports how customers welfare change for per-unit of consumption income quintiles. Bootstrap standard errors based on 1000 replications are shown in parentheses with *** p<0.01, ** p<0.05, * p<0.1. Consumers' welfare change under Coasian tariffs includes the deadweight loss and subtracts increased fixed fees. The deadweight loss is the net efficiency gains from marginal cost pricing.

Table 9: Price-Elasticity of Demand when Consumers Respond to Average Price

Variables	Ln(Consumption)
Ln(AP) × 1st Quintile	-0.606***
	(0.0294)
Ln(AP) × 2nd Quintile	-0.630***
	(0.0292)
Ln(AP) × 3rd Quintile	-0.624***
	(0.0284)
Ln(AP) × 4th Quintile	-0.608***
	(0.0297)
Ln(AP) × 5th Quintile	-0.581***
	(0.0294)
Semi-Urban	-0.109***
	(0.0186)
Urban	-0.111***
	(0.0175)
Household Size	0.206***
	(0.0290)
Touristic Area	0.121***
	(0.0159)
Share of Population 15-64 YO	-0.816***
	(0.139)
Region FE	Yes
Constant	5.435***
	(0.0927)
Observations	4,500
R-squared	0.274

Note: Robust Standard Errors in Parentheses.*** p<0.01, ** p<0.05, * p<0.1.
Price-Elasticity is computed for current average prices.