

Assessing the impact of public regulation and private participation on water affordability for poor households: An empirical investigation of the French case.⁺

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We analyse the affordability of water services in France with a particular reference to low-income households. Using quantitative analyses of French household microeconomic surveys, we investigate whether private sector participation and public regulation in water supply has helped the poorer sections of the community. We show that 4.31% of households in France (representing around 11.6 millions of households) needed to spend more than 3% of their income on paying water charges in 2001. Our results also demonstrate that single parent families (especially if the head of the household is a woman) or on contrary large families for which social aid represents a large proportion of the total income should be considered as the most vulnerable groups in terms of water affordability. Our results also suggest that private participation into the water sector has not helped the poor in terms of their affordability problem.

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Introduction

Access and affordability of water for poor households have been discussed in France since the beginning of the 90ies. A good example is the Law, promulgated in 1992, creating a minimum insertion income which states that “*all families must have an access to energy and water*”. A recent major change in term of water-related social regulation has been in 2000 the creation, jointly by public and private water operators, of a fund specifically dedicated to subsidizing the poorest households. If these social measures reflect a wish both from the public authorities and the private water companies to address the issue of water affordability in France, there is still a lack of formal statistical analysis of the affordability of the water service for the low-income and for other vulnerable household groups in France. In this article, we wish to explore the various social policies and regulation taken by private water companies and by public authorities in charge of the water sector that are intended to help the poor. Assessing the impact of the private sector on water affordability in France is an issue we will address using econometric and statistical methods based on household income and expenditure surveys regularly conducted by the French National Institute for Statistics and Economic Studies.

Since France has been a pioneer in terms of private-public partnership (PPP) in water supply, it is natural to try to empirically assess if the private participation has resulted in favouring poor households in terms of water access or water affordability. The first well-documented case of PPP in France dates back to October 25th 1776 when the city of Paris decided to allocate to “Sieurs Perrier” a 15 years exclusive concession of the water supply system, see Duroy (1996).¹ It is very interesting to notice that water affordability to the poor households was already at that time an objective specified into the concession contract since the Louis XVI text stipulates that “The Sieurs Perrier must build some water fountains in order to guaranty a moderate price for poor households”.

Currently, the water industry in France is organised on a municipal basis. Even if the French local communities have been responsible for water supply, treatment and sanitation since the end of the 18th century², local communities really started to organize water delivery since the middle of the 19th century. There are now approximately 29,300 water services in France for 36,851 local communities. The main specificity of the French water sector is that local communities can either directly manage water services or they may choose to delegate it to a private firm. In case of private management, the relationship between the local municipality and the firm can take different forms: management contracts, affermage (lease contract) where the municipality remains the owner of assets, and concession where the private operator is responsible for financing all new investments over the period of delegation. Whatever the type of management chosen by local communities (public versus delegated), water services must have the characteristics of a public service: equal access for all consumers, continuity, and adaptability to the general interest. The participation of the private sector has progressively increased in France during the 20th century to reach now around 80% of the market share, see Guérin-Schneider and Lorrain (2004).

¹ On February 7th 1778, the Perrier's brothers where given by Louis XVI the exclusive right “to build and establish all facilities (pumping machines, pipes, etc.) required to bring water from the Seine to all Parisian districts and suburbs”.

² The Paris example is particularly symptomatic. A dual system of water property rights has coexisted during a long time. The responsibility (and the property) of the water supply used to be shared between the city of Paris (“Eaux de ville” that is pumping Notre-Dame and all water sources in North areas) and the King (“Eaux du Roi” that is pumping of the Samaritaine and all sources located in South areas). However, from 1803, all the property rights have been given to the city of Paris which has become the only public authority in charge of water supply.

Given the prominent size of the private water industry in France and the specific PPP, it is natural to investigate and analyse how the private sector involvement impacts on the poverty-related issues of equity, access and affordability. Hence, during the last 20 years, the water charges have increased in France twice more quickly than the consumer price index. Yet, the effect of this large and rapid price rise for water and sewerage services on low-income and other vulnerable household groups has not emerged as an important issue of the French social policy. Evaluating the problem of water affordability in France, whether due to the size of water bills or to inadequate low-income, is the central topic this article.

The remaining of this article is organised as follows. In the following section, we focus on social policies and regulations dealing with water affordability in France. In particular, we describe and analyse critically the recent, current and proposed support mechanisms to assist low-income households in paying water and sewerage charges. We also discuss alternative approaches to the measurement of affordability of water in France. Using the Family Income and Expenditure surveys published by the National Institute for Statistics and Economic Studies and the existing literature, we provide a formal definition of water affordability in France. In the second section, we identify the determinants of water affordability. We focus in particular on the private participation into the water sector as a potential determinant. We also estimate a logit model in order to predict, for each household, the probability of being water-poor.³ We conclude by deriving some policy implications from our findings.

1. The issue of water affordability in France

1.1 Water affordability in France, some empirical facts

In 2005, according to the French “Observatoire des Inégalités”, there were between 3.6 and 7.1 millions of people experiencing poverty conditions in France.⁴ More than 3 millions people used to live in unsanitary housings and almost 5 millions people did not have access to a minimum banking service. With 2.9 millions people without a job in December 2005, the unemployment rate was just below 10% and around 3 millions of persons were depending upon social aid. At the same period, 4.4 millions of people used to benefit from a free medical care due to low income (CMU). Finally, according to the National Institute for Statistics and Economic Studies (INSEE), 3 millions households (representing more than 12% of the population) are considered as being poor (their income per consumption unit is lower than 50% of the median income).

Due to a lack of published and reliable statistics, water poverty in France is difficult to evaluate. However, according to Smets (2005), 300,000 households have accumulated important renting debts and at least 3 millions of people are late in paying water, electricity, gas or phones bills. Around 300,000 poor households receive a specific social aid in order to pay electricity bills and 700,000 households have asked for a reschedule of their water bills. These figures show that affordability of water is an important issue in France, at least for poor households.

Charitable and non-profit organisations offer an interesting point of view for assessing water affordability in France since those institutions deal with the poorest people. It is however clear that the figures reported by these organisations should not be viewed as representative of the total French population. In what follows, we discuss the water poverty related figures published by the

³ As it will be discussed in this article, we define a *water-poor* household as an household for which the share of income devoted to paying water charges is greater than 3% of its total income.

⁴ The number of poor people varies according to the definition of the poverty threshold (either 50% of the median income or 60%).

“Secours Catholique Français”.⁵ In 2003, 1.6 millions of people (2.5% of the French population) have gone through an office managed by the Secours Catholique in France. According to the Secours Catholique (2004), half of the people going through their offices lives below the poverty threshold (12.8% do not have any income and 41.7% exclusively rely on social aid). In 2003, 58% of the poverty cases analysed by the Secours Catholique present at least one type of unpaid charges (electricity, gas, water or baking services). The average debt per household in 2003 represents 1646 euros which corresponds to two months of income. For around 10% of the poverty cases analysed, the water bill has not been paid.

Another way allowing to assess the issue of water affordability in France is to analyse the disconnection policies of private firms in charge of water services. According to Fauquez-Avon (2005), the number of customers served in France by the Compagnie Générale des Eaux (CGE) was 6.3 millions in 2002. The CGE has granted 250,000 payment facilities to customers facing financial difficulties (representing 20‰ of the water bills or 40‰ of the customers). Normally, for 95% of the cases, unpaid water bills did not lead to a water disconnection. The number of disconnections realised by the CGE was however 80,000 (13‰ of the customers) in 2002, but for 90% of the cases, the disconnection lasted less than one day. According to the ministry of Sanitary and Social Affairs, the rate of disconnection due to serious financial difficulties is around 15% in France. Hence, the number of disconnections by the CGE due to serious financial difficulties is estimated to be 12,000. Among them 1,200 (0.2 ‰ of the total number of customers) disconnections last more than 24 hours. According to the CGE, the disconnection policy aims at limiting as much as possible the number of water disconnections because it affects its image by associating water disconnections to “harassing of poorest population by a capitalistic firm realising important profits”, see Billard et al. (2001).

A last way to assess the importance of water affordability for poor households in France is to analyse the social actions directly undertaken by municipalities through Social Action Centres (CCAS or CIAS). In 2002, a national survey has been realised in order to evaluate the social aid of these Social Action Centres. On average, 64% of the French municipalities offered in 2000 water debt payment programs oriented toward low-income household facing financial difficulties (compared to 35% and 49% respectively for the phone and the rental service). It is very interesting to notice that the share of municipalities having implemented household debt payment programs is significantly higher for water than for any other basic goods (phone, gas or electricity). This may reflect that, at the local level, water charge payment by low-income household used to appear to be a significant problem.

1.2 Private and public regulation of water affordability

1.2.1 A system of *ex-post* social help

In France, there is no specific water price, rebate or discount tariff for the poorest households, that is there is no formal social water pricing. Historically, the mechanism put in place by public authorities and private firms in order to guaranty an affordable access to water may be viewed as an *ex-post* financial aid to help poor households facing difficulties for paying the water bill. In case of financial difficulties, qualified low-income households can have access to a specific fund in order to write off water debts.

There are two main reasons explaining the choice of an *ex-post* help system in France. First, according to the definition of a public service, all customers having similar characteristics must face

⁵ The Secours Catholique is a non-profit association committed to assist the poor and to fight poverty, exclusion, intolerance and discrimination. The Secours Catholique has been created in France in 1946 and it belongs to the Caritas network.

the same price. As the level of income is not considered as a particular characteristic of a household, this implies that not specific tariff can be implemented for the poorest household. Of course, increasing block rate pricing may be used to favour small water consumers (poor household) but this is not an explicit social pricing system since all consumers face the same tariff.⁶ Second, it is clear that the size of the private water sector⁷ and the private water company preferences for an ex-post system may constitute a possible explanation of the French choice.

The recent Water Law proposition, presented in March 2005, has confirmed that social pricing was not an objective *per se* of the State and that maintaining water affordability to low-income households did not necessarily need to put in place a social water pricing in France. In the 2004 Water Law project presented by the French Ministry of Ecology, Environment and Durable Development (MEED), the creation of a water social pricing (as it is already the case for the electricity sector) was mentioned. However, the term social pricing has disappeared in the final Law project presented in March 2005. Even if the new Ministry of Ecology, Environment and Durable Development Lepeltier has declared at the Senate that « This text recognises the responsibility of mayors in fixing water prices. They may decide to use increasing block rate pricing, according to the social policy they have chosen », since the pricing cannot rely on the size or on the income of households, such a text cannot be used for implementing any form of social pricing in France, that is any form of income-based type of pricing.

1.2.2 An historic view of State social and regulatory mechanisms

One characteristic of the French water sector is that there is no specific tariff oriented toward poor consumers. However, the State has defined a set of regulatory instruments aiming at guaranteeing affordability of water for French households. We briefly describe and discuss the most important of them.

The first economic tool having created a formal solidarity between water users (from urban toward rural areas) is the National Fund for Rural Water Supply (FNDAE) created in 1954. The main objective of this fund is to finance water supply and sewage equipment in rural areas. The FNDAE levies a tax on all cubic metre of water supplied in France, and allocates subsidies for small rural communities to enable them to invest in potable water supply, storm and waste water collection and treatment. The FNDAE has been quite successful since, at the beginning of the 50ies, less than 40% of the rural population was connected to the water supply network. From 1954 to 1995, the connection rate has been multiplied by more than 2.5 to reach almost a full connection rate of rural population at the end of the 90ies.

One must wait until the beginning of the 90ies to find some social policies specifically dedicated to water. The main objective of the 29 July 1992 Law on the Minimum Income (RMI) was to guarantee each person (older than 25 years) a minimum income level. But some articles of this law were dedicated to basic human needs, including water. In particular, the article 43 stated that “*Mechanisms aiming at dealing with serious financial difficulties and social exclusion include financial aids for household unpaid water and energy bills*”. However, since no specific fund dedicated to

⁶ Duroy (1996) reports that the Conseil d’Etat (the highest French administrative jurisdiction) used to consider that any price discrimination based on customer income was not allowed by the administrative code. In 1982, the Conseil d’Etat published a decision stating that the rebate implemented in Charente-Maritime for the sewage service for low-income households and elderly people was illegal since any category of customers can benefit from a specific pricing.

⁷ According to Guérin-Schneider and Lorrain (2004), 80% of the population was supplied in water by private firms in 2001.

unpaid water bills was created, this law has not resulted in a significant help for poorest households in terms of water access.

Four years later, the Water Solidarity Charter was promulgated. The main specificity of this charter is that it is neither a Law nor a legislative text. The Water Solidarity Charter is a voluntary contractual agreement between the State, the Association of French Mayors (AMF), the Federation of local communities delegating public services (FNCCR) and the Professional syndicate of water and sewage operators (SPDE). The Charter is based on three general principles: the water access must not be disconnected in case of unpaid bill due to serious financial difficulties (up to 3 months while the case is put to a departmental Commission Solidarité-Eau), in case of payment default, the water and sewage bills can be paid, totally or partially, by local communities, private water operators or charitable associations; efficient water use education campaigns are put in place. Although this Charter has been a step towards a guaranteed access to water for low-income households, the impact of this Charter in terms of access to water services has been limited due to a complex system involving several institutions with divergent interests, an absence of clear definition and repartition of obligations and responsibilities between institutions and a lack of sanctions in case of non application of the Charter, see Billard et al. (2001). As a consequence, in the late 90ies 130,000 disconnections a year were still occurring. 20,000 used to affect poorly housed low-income households.

The main objective of 28 April 2000 National Water Solidarity Convention has been to clarify the 1996 water Charter. This Convention has been signed by the State, by the Association of French Mayors (AMF), by the Federation of local communities delegating public services (FNCCR) and by the Professional syndicate of water and sewage operators (SPDE). The Convention explicitly specifies that water access must not be disconnected in case of unpaid bill due to serious financial difficulties (up to 3 months while the case is put to a specialised commission), that disconnection of households with babies or old elderly people is not allowed and that households in serious financial difficulties must be identified by State social agencies (Commissions de l'action sociale d'urgence) at the local level. As a result, a financial fund was created (mainly from State resources, 4.6 millions euros and from the SPDE resources, 3 millions of euros in 2000⁸). For the first time, public and private institutions involved in the water sector have clearly defined their respective financial contribution to a social water fund.

Very recently, the Law Project on Housing presented on October 27th 2005 by the Minister Jean-Louis Borloo reinforces the protection of poor households in case of non-payment of water bills. This article 11 states that *"From November to 15 March, electricity, water and gas suppliers are not allowed to disconnect an household due to non-payment except if the social services are agree."* It follows that, according to this text, non-disconnection should be the rule for low-income households facing financial difficulties for paying water charges and disconnection should be the exception.

1.2.3 Private utilities water pricing practices

Pricing policies for public services are often used to satisfy several requirements and to pursue several objectives. In the specific context of urban water supply, some criteria have been emphasized, including efficiency, equity, financial aspects, and/or public acceptability and transparency. If many empirical studies have analysed efficiency issues only a few have approached the distributional aspects of water pricing. The interested reader may refer to García-Valiñas (2005) for a recent investigation of distributional impacts of water pricing in Spain. The author of this work advocates that, in spite of being frequently used, Ramsey pricing approach goes against the equity principle since low-consumption and low-income households are characterized by a more price inelastic water demand. As a consequence, García-Valiñas (2005) proposes to use for water

⁸ For instance, the financial participation of private operators belonging to the SPDE represents 0.2 euros per customer and per year.

consumption a pricing scheme derived from Feldstein's works where the Ramsey pricing rule is distorted in order to take into account some redistributive objectives of public authorities. It is interesting to notice that, based on Spanish data for year 2000, García-Valiñas (2005) conclude that implementing a more egalitarian pricing would not result in substantial welfare losses.

The type of pricing schemes implemented by water utilities will have in particular an important distributional effect on consumers. In particular, increasing block rates may favour small consumers (that is poor households). On contrary, large consumers (rich households) will benefit from decreasing block rates. In the same vein, a small fixed charge will reflect a more socially-oriented tariff policy. Hence, the choice of pricing schemes implemented by water utility (increasing or decreasing block rates, flat rates, constant unit rate, etc) has a significant distributional impact.

Last, Garcia and Reynaud (2004) have analysed private water utility pricing in France. They first show that the water utility pricing is in most cases inefficient: the marginal price differs from the marginal cost. On average, water utilities tend to price water under their marginal cost. The average marginal price on the whole sample is 0.35 euros par m³ with a standard deviation of 0.16. The average marginal cost is estimated at 0.41 euros per m³ with a standard deviation of 0.10. The gap between the marginal price and the marginal cost of water service is quite low but significantly different from zero. This result may be explained by the constant nature (on average) of returns to scale implying that average and marginal costs are very close, and by the utilities' practice of average-cost pricing. Moreover, this difference could be related to the level of the fixed charge. The average fixed charge (25.85 euros per user) is more than one half the average capital expenditures (16.12 euros per user). An interpretation of this result may be that water utilities try to secure their revenues through fixed charges. By recovering some variable costs through fixed charges, they reduce financial risks which may derive from the volatility of water consumption. A consequence of these high fixed charges is that poor households pay a too high average water price.

1.3 Measuring water affordability in France

To our best knowledge, there is currently no formal accepted definition of water affordability in France (or even elsewhere). The concept of social water pricing is moreover not adapted to the current French situation. Hence, although the recent 2004 Water Laws proposition had first confirmed that social pricing was an objective per se of the State, the term social pricing has finally disappeared from the Law project presented in March 2005. This explains that, in what follows, we define the concept of water affordability (by reference to the UK case).

1.3.1 A definition of water affordability

According to Sawkins and Dickie (2002), the term affordability has evolved to the point where *"it is now virtually synonymous with the notion of ability to pay"*. Clearly, it may be possible that consumers whose financial circumstances are similar may make different subjective assessments of their own ability to pay for an essential service such as water. British policymakers have however got around this problem by assuming a negative correlation between the proportion of a household's income or budget spent on the service and affordability or ability to pay. Hence, water affordability has been defined in the UK by reference to the share of income spent on water charges.⁹

⁹ Historically in the UK, the definition of water affordability is based on the fuel-poverty definition adopted by the UK public authorities: *"A fuel poor household is one that cannot afford to keep adequately warm at reasonable cost. The most widely accepted definition of a fuel poor household is one which needs to spend more than 10% of its income on all fuel use and to heat its home to an adequate standard of warmth. This is generally defined*

Fitch and Price (2002) have been the first to suggest a formal way of measuring water affordability and setting a water poverty standard in the UK. They conclude that “*The Office National of Statistics finding has enabled us to propose the standard of 3% to determine whether, in relation to their income, a household’s water charges are affordable, and thus whether or not the household is experiencing water poverty*”. The microeconomic data on which this analysis was based were drawn from the Family Resources Survey. The 3% threshold chosen by Fitch and Price (2002) corresponds to the percentage of income spent by households belonging to the three lowest deciles on water charges. Sawkins and Dickie (2002) conclude that “*calibration of water affordability by analysing the proportion of household income spent on the service is an important exercise. The analysis will, we believe, give an important insight into the budget choices facing the vast majority of consumers who undertake to meet all their financial obligations. It will also give us some purchase on the related questions of poverty and social inclusion.*”

Following Fitch and Price (2002) and Sawkins and Dickie (2002), we define water affordability as the share of income spent on water charges. Moreover, we define a “*water-poor*” household as an household spending 3% or more of its income for paying water charges. One should be however cautious with using the term *water-poor* in case of high income classes. For a rich household, being *water-poor* results by definition from a high water bill. It is likely that such a high water bill is the consequence of a large water consumption associated with water consuming equipments such as air conditioning, swimming-pool, garden, etc... Hence, being *water-poor* in the case of a high income class is the result of a voluntary decision of the household. On contrary, being *water-poor* in the case of a low-income class likely means that a significant part of the total income must be devoted to the water bill for insuring basic human needs.

1.3.2 Measuring water expenses and household income

Water affordability has been defined by reference to the share of income spent on water charges (*water income share*). Assessing the affordability of water for a household involves the straightforward comparison of their water bill with their income.¹⁰ Obviously, the definition of income is critical and we need to clarify our approach. But a clear definition of water charges taken into account is also necessary.

Water charges may be divided into three parts in France: water supply charges, sewage treatment charges and taxes and fees. The first and main component of water price corresponds to the supply process which involves extraction of water, treatment and distribution to customers. In 2003, according to the Professional Syndicate of Water and Sewage Companies (SPDE), the share of the supply used to represent 46% of total price paid by a consumer, see Bipe (2005). The second component of the price corresponding to the sewage service used to represent on average 37% of the total water price in 2003, see Bipe (2005). It is important to notice that all consumers do not necessary pay sewage charges. This is for instance not the case in small rural local communities, where no collective sewage service exists. The last component, which corresponds to taxes and fees, includes the river basin agency fees, the National Fund for the Development of Water Supply System fee and the Value Added Tax (VAT) at 5.5%. These taxes represent now more than 17% of the price.

as 21C in the living room and 18C in the other occupied rooms - the temperatures recommended by the World Health Organisation.”

¹⁰ Water affordability could also be defined by comparing the water expenses to the total household expenses. We prefer to use the household income for two reasons. First the statistical information is more reliable for income than for household expenses. Second, the intra-year variability of household expenses is higher than the income one (total expenses are registered for a given period of year, hence they may be subject to seasonality problems). It follows that a water affordability index based on household expenses will more heavily depend upon the date at which the survey is conducted than an index based on household income.

This component has registered during the last decade the quickest increase (+256% for the basin agency fees and +115% for other taxes from 1991 to 1998).

Since we focus exclusively in this article on the water service, we will exclude from the water charges those related to the sewage service. Hence, the water charges we will consider in the remaining of this article are those corresponding exclusively to the water supply service (extraction of water, treatment and distribution to customers) plus the taxes and fees that must be paid by each household. In order to avoid any seasonality problem, we will consider the annual water charges paid by each household. The source of data to measure water expenses at the household level is the *INSEE family income and expenditure surveys* conducted regularly by the National Institute for Statistics and Economic Studies (INSEE), see Appendix A for a presentation of the database. French households are asked in this survey to report each year their water expenses.

Concerning the income definition, Fitch and Price (2002) argue that since a majority of the applicants in the samples they have used were receiving the safety net benefits, income support or jobseekers' allowance, they have chosen to use a definition of income that reflects the budgeting reality of these consumers. Hence, they have used a definition of income that is net of tax and national insurance, and that includes neither council tax nor housing benefit nor housing costs. Sawkins and Dickie (2002) have decided to use the gross rather than 'disposable' income. They argue that "*Gross income figures are a more reliable and consistent foundation on which to build the analysis*". They however recognise that "*the effect of this will, however, be to reduce the numbers of households recorded as falling into the 3% and above this threshold compared with these other studies*".

As a definition of income, we have used the total annual household income directly computed by the National Institute for Statistics and Economic Studies (INSEE), see Appendix A. The total income is the sum of all household income from professional activities, from all social benefits and from all financial income. Hence, the definition we have used is similar to a gross annual income per household. Our results should be easily comparable with those reported by Sawkins and Dickie (2002).

1.3.3 An empirical assessment of water affordability in France

The water income shares have been computed using the INSEE Family budget and income surveys (1979, 1984, 1989, 1995 and 2005) by dividing the annual water bill paid by each household by the total net income. In the following table, we report the water income shares by income deciles (income classes).

-- TABLE 1, here --

In 2001, the average percentage of income spent on paying water charges is 1.20%. The average French household is not *water-poor* (3% of the total income devoted to paying water charges). From 1979 to 2001, the share of income devoted by French households to paying the water bills has significantly increased from 0.79% to 1.20%. For example, in 1979, the water expenses used to represent less than 1% of the total income for income class 3 to 10. In 2001, the share of the total income devoted to water bill payment is smaller than 1% only for income class 8 to 10. One may suspect that a significant part of this change is due to the water price increase observed during that period.

The percentage of income spent on paying water charges varies significantly according the income level. For the highest income decile, the water expenditures used to represent in 1979 only 0.335% of the total net income, compared to 2.256% for the lowest income class. For the 1% poorest households the water charges represent 4.80% of their total income in 2001 compared to 0.37% for the 1% richest ones.

The idea of affordability is important when it involves essential expenditure such as that on water, electricity, gas or even phone services. Yet it is difficult to say, categorically, whether a particular expenditure is affordable in an absolute sense or not because that involves value judgements about priorities.

-- TABLE 2, here --

From the 2001 INSEE Family budget and income survey, we have computed the share of household income spent on four basic commodities by income decile (water, electricity, gas, phone). For all income deciles, the percentage of income devoted to water charges ranks third, below electricity and gas but above the share of income spent on phone charges. The poorest households, that is households belonging to the first income decile, must spend on average around 14% of their total income on water, electricity, gas and phone. For households belonging to the higher income class, the share of income devoted to these basic expenses represents less than 3.3%.

All these questions lead us to further empirically investigate the issues of affordability of water in the French private and public sector. For this, we will use econometrical modelling.

2. An econometrical analysis of water affordability in France

2.1 Assessing the determinant of water affordability in France

2.1.1 The potential determinants of water affordability

Let's us denote by w_i the share of total household income spent on water charges (in short, *water income share*) with i indexing households. By definition, we have:

$$w_i = \frac{F_i + p_i \times c_i - A_i}{I_i}, \quad i \in \{1, \dots, I\} \quad (1)$$

where F_i is the fixed charge paid by the household (in euros), p_i is the unit water price (in euros per m³), c_i is the annual water consumption (in m³), A_i is the financial aid (social benefits) received by households for paying the water bill (in euros) and I_i is the total household income (in euros).¹¹

There are several potential determinants that may explain the level of the water income shares. Those determinants include in particular household characteristics, housing characteristics, the type of water pricing scheme implemented by the water service, the level of participation of the private sector into the management of the service or the State regulation (either social or economic).

Household characteristics

We know that the water consumption c_i depends upon the composition of the households (number of children, age of the household head). Such characteristics of the household should be introduced as potential determinants of the water income shares.

¹¹ As already mentioned, there are two main reasons explaining that we have used the total income in order to define the water income share. First the income data reported by household in the statistical surveys is a much reliable information than the total expenses (for instance total expenses may highly fluctuate from week to week). Second, the existing published studies on water affordability in developed countries have also used income. In order to get comparable measure, we have decided to follow this existing literature.

Housing characteristics

The water consumption of a given household also depends upon the housing characteristics (size of the house, garden, air-conditioning or swimming-pool...). In the same vein, the water consumption may depend upon the sanitary equipments installed.

Water pricing schemes

From the above definition of the water income share, it is clear that the higher is the water price (either the fixed or the unit price), the higher is the water income share. As discussed previously, the type of pricing schemes implemented by water utilities will also have an important distributional effect on consumers. In particular, increasing block rates may favour small consumers (that is poor households). On contrary, large consumers (rich households) will benefit from decreasing block rates. In the same vein, a small fixed charge will reflect a more socially-oriented tariff policy. Hence, the choice of pricing schemes implemented by water utility (increasing or decreasing block rates, flat rates, constant unit rate, etc) has a significant impact on the water income share.

Participation of the private sector

There are several canals through which the participation of the private sector into the water industry may have an impact on the water income shares of households, especially for poor households. First, as discussed in Carpentier et al. (2004), the water price for private water services is in France on average 30% higher than the price of water for services publicly managed.¹² It follows, that the private participation is expected to have a detrimental impact on the household income shares. Second, pricing schemes implemented by private utilities may differ from the ones chosen in the case of a public management of water services. It is possible that pricing schemes implemented by public utilities may more closely fit the social objectives of local communities. A private utilities may prefer using a decreasing block rate pricing in order to favour large consumers. On contrary, under a public management increasing block rates may be preferred to favour small (poor) households and to induce water conservation. As already mentioned, Garcia and Reynaud (2004) have shown that the water utility pricing in France is, in most cases, inefficient: the marginal price differs from the marginal cost. On average, water utilities tend to price water under their marginal cost. The gap between the marginal price and the marginal cost of water service is quite low but significantly different from zero. This result may be explained by the constant nature (on average) of returns to scale implying that average and marginal costs are very close, and by the utilities' practice of average-cost pricing. Moreover, this difference could be related to the level of the fixed charge. The average fixed charge is more than one half the average capital expenditures. An interpretation of this result may be that private French water utilities try to secure their revenues through fixed charges. By recovering some variable costs through fixed charges, they reduce financial risks which may derive from the volatility of water consumption. A consequence of these high fixed charges is that poor households pay a too high average water price. Last, the type of contract linking the local community to the private firm (affermage, concession...) may also be viewed as a potential determinant of household water income shares. For instance, the incentive power of delegation contract are very different according to the type of contract. Recent contracts are signed under the Sapin Law where the bidding process is much more transparent. It follows that having recently delegated or renegotiated their water service should be more easily able to regulate the private firms.

¹² However, taking into account the fact that the operational conditions of public and private services differ, the price difference between private and public service is on average 15%, see Carpentier et al (2004).

Public regulation

There are two important ways through which the public regulation may have an impact on the water income share of poor households. First, as discussed previously there is a system of social benefits or social aids aiming at helping poor household to pay the water bill. Second, in the case of private management of the water service, one may expect that a close monitoring of the firm by the local community will have a significant impact on household income shares.

2.1.2 Estimating the determinants of the water income shares

Econometric methods

For all households $i = 1, \dots, I$, we wish to estimate the parameters of the water income share demand function defined by the following equation:

$$w_i = \sum_{k=1}^K \alpha_i \cdot Z_{ik} + \varepsilon_i \quad (2)$$

where w_i is the share of the household total income spent on paying water charges. Z_i is a vector of exogenous variables assumed to influence share of the household total income spent on paying water charges and ε_i is the usual error term.

We are especially interested in understanding the impact of the private participation into the water industry on the water income shares, that is on the percentage income devoted to paying water charges. However, directly introducing a variable capturing the private participation in the water industry as a determinant of the water income share may raise a severe problem of regressor endogeneity. Hence, Carpentier et al. (2004) have shown that the technical characteristics of public and private water utilities are significantly different. The delegation choice by a local community is not random as it reflects an optimisation program by local communities. Carpentier et al. (2004) have demonstrated that the higher average price observed for private utilities could be explained, at least in part, by some specific technical characteristics of those water services (complexity of the network, use of elaborated water treatments, low quality of raw water, etc.). By introducing directly a variable capturing the private participation into the water industry as a determinant of the water income share, we may only capture the effect of these higher prices resulting from, at least in part, specific observed and unobserved technical characteristics.¹³

Hence, when the observed effects of a decision are mixed with the effects of a second decision involving voluntary self-selection into one of several treatment groups, a measurement problem emerges. This can be the case when considering the water saving decisions of households also facing an ex-ante choice between different types of tariffs. Of course, the delegation choice used by a local municipality does not directly result from a decision of water consumers. However, it is not

¹³ This is a very classical problem in econometric. In the field of water management, such a problem arises for instance when one tries to estimate the impact of different pricing schemes (increasing block rate, decreasing bloc rates or constant unit rates) on the residential water demand. Some studies have tried to assess the impact of the type of water pricing on water consumption by directly comparing water demand functions. This comparison is appropriate only if domestic users facing different pricing schemes are identical in all respects, except water prices. But, domestic users are likely to differ in observed economic and demographic characteristics, which in turn induce differences in unobserved preferences for water consumption and for the water tariff choice. Hence attribution of the observed difference in water consumption to the type of water pricing potentially ignores these other differences and leads to a selectivity bias, see Reynaud et al (2005) for further details on this issue.

a strong assumption to consider that the delegation carried out by the public authority maximizes the surplus of the representative consumers (this could be for example the consequence of necessity of political re-election of the majority in power).

There are two main ways for addressing this potential endogeneity problem of the private participation into the water income share equation. The first solution consists in specifying and estimating a model describing the delegation choice of each local municipality. Then, in a second step, we would estimate the water income share equation by correcting for the endogeneity of the delegation choice made by the municipality. However, since we do not observe for each household of our sample the delegation choice made by the local municipality (private versus public management of the water service), such econometric approach cannot be implemented. Another way to take into account the endogeneity issue consists in first regressing the variable representing the private participation into the water sector on a set of exogenous variables (i.e. instrumental variables which include all the determinants of the water income shares and a set of technical variables characterising the water service). Then, the instrumented private participation variable can be used as an exogenous variable in the water income share equation and we get an unbiased estimation of the water income share equation. This is the approach we have decided to follow.

Estimation of the water income share equation

The estimation of the water income share equation has been conducted using 2001 data since this year corresponds to the more recent household income and expenditures survey realised by the INSEE.¹⁴ The detailed definition for all variables appearing in the following table may be found in Table B.1 in Appendix B.

Two models will be considered in particular. First, a *parsimonious* model in which we simply introduce a variable capturing the share of the private sector. Second, a *full* model where the share of the private sector also interacts with dummy variables associated with income decile classes. The *full* model allows to take into account a potential differentiated impact of private participation across income decile classes. A private utility may, for instance, choose to implement a decreasing block rate pricing or a large fixed charge in order to favour large water consumers (high income households). Such a pricing behaviour would result in increasing the share of income spent on water charges for low water consumers (low-income households).

-- TABLE 3, here --

Columns 2-5 in the previous table give the estimates of the water income shares when the private participation variable is not instrumented by technical characteristics of the water utilities. On contrary, in columns 6-9 we use the instrumented private participation (IV model). The interested reader may refer to Appendix D.1 for the presentation of the instrumented equation.

First, we examine how the household characteristics impact on water affordability. Using "single adult" as the default case, the most clear-cut results are obtained for single parent families (*H_typ7* and *Hyp_typ8*). Being a single parent results in increasing the share of income spent on water charges by 0.2% if the head of the household is a man and by 0.4% in the case of a woman. Being elderly results in a small but significant decrease of the share of income devoted to paying water charges. However, it is difficult to assess for this category if this result comes from a voluntary or an involuntary consumption behaviour. Hence, previous studies (see for instance Reynaud and

¹⁴ Moreover, most of the determinants of the water cost shares comes from the IFEN-SCEES database which has been conducted in year 2001. A panel analysis cannot be conducted and we must rely on a cross-section approach.

Thomas (2005)), on residential water demand in France have shown that the consumption per capita tends to decrease with age of household head. Last, the larger the size of the household the greater the share of income spent on water charges. This reflects a positive relationship between household size and consumption levels.

Next, we discuss the impact of housing characteristics of water affordability. Living in an individual house results in a higher share of income spent on water charges. One possible explanation is that individual houses affect positively the average consumption per household, due for instance to a larger outdoor water use. The negative impact of renting may be attributed to the fact that, in some cases in collective housings, water charges are included in global housing charges. Hence, a household may in such a case underestimated their own water bill.

The relationship between water affordability and social aid is mixed. The most clear-cut result is however obtained for the share of total household income coming from social aid (*share_soc*). The higher is the share of income coming from social aid, the higher is the share of income spent on water charges. Households receiving a social aid while renting their housing (*rent_aid*) or owning their housing (*own_aid*) must allocate a slightly higher share of their income for paying water bills.

Concerning the regulation variables, the periodicity of water bills (*perfac1*) has a significant negative impact on the share of income spent on water charges. One may think that a higher bill periodicity result in a better monitoring of water consumption by households. The political variables appear to be significant. A high proportion of votes to the socialist (*left_soc*) or to the communist party (*left_ext*) at the last local election results in a lower share of income spent on water charges. It is possible that being in power results for those parties in more pro-poor social policies. The year of contract signature for the delegation contract between the local community and the private firm and the expected year of contract ending (*contract_end*) are significant but their impact on water affordability is very limited.

To summarize, single parent families (especially if the head of the household is a woman) or on contrary large families for which social aid represents a large proportion of the household total income should be considered as the most vulnerable groups in terms of water affordability.

2.1.3 The impact of the private participation on water affordability

Next, we focus on the impact of private participation on water affordability. The parsimonious model (either using a simple OLS method or the IV method) calls for a few comments. First the private participation variable (*private* or *private_iv*) is significant which means that the private sector has an impact on water affordability in France. Second, since the sign associated with the coefficients of these variables is positive, one may conclude that the private participation tends to increase the proportion of income devoted to paying water bills. In the next table, we more formally evaluate the impact of private participation on household water affordability.

-- TABLE 4, here --

With the *parsimonious* model, the marginal impact of increasing the share of household supplied by private firms on the water income share is directly given by the coefficient associated with the variable *private*. It follows that by increasing the private share by 10%, the share of income spent on water charges will increase by 0.03% on average (OLS method) or by 0.05% (IV method). These figures may appear quite low and one may conclude that the impact of the private sector of the water income share *per se* is quite limited. But, one implicit assumption of the *parsimonious* model is that the impact of the private sector is the same for all households. As discussed previously, this is a strong assumption.

More interesting are the results given by the *full* model where income class dummies interact with the private participation share. Increasing the private sector participation by 10% will result in a

significant increase of the water income shares for the lowest income classes, respectively equal to 0.24%, 0.14 and 0.11% for income classes 1, 2 and 3. These percentages may appear low in absolute value but compared to the water income share levels (respectively 2.3%, 1.7% and 1.6% for income classes 1, 2 and 3) they are quite significant. On contrary, the impact of the private participation on the water income shares is profitable for households belonging to the highest income decile classes. Increasing the private sector participation by 10% will result in a decrease in the water income shares equal to -0.01% , -0.02% and -0.02% for income classes 8, 9 and 10.

To conclude, the impact of private participation on water affordability appears to be very moderate *on average* (0.05%) but significantly different from zero. The picture is however quite different when we consider a model allowing a differentiated impact of private participation across income classes. Increasing the private sector participation by 10% results in a significant increase in the water income shares by 0.24%, 0.14% and 0.11% for income classes 1, 2 and 3 (low-income households). On contrary increasing the private participation seems to favour high income households since by increasing the private sector participation by 10%, the water income shares are reduced by -0.01% , -0.02% and -0.02% for income classes 8, 9 and 10.

2.1.4 Household water income shares and delegation contracts

A last question we wish to investigate deals with assessing the impact, on the share of income spent by households to pay the water charges, of the type of delegation contract existing between local communities and the private firms managing the water service.

In case of a private management, the relationship between the local municipality and the firm can take different forms. The three main types of contact are management contracts, affermage contract (which is in fact similar to a lease contract) where the municipality remains the owner of assets, and concession contract where the private operator is responsible for financing all new investments over the period of delegation.

Whatever the type of delegation contract chosen by local communities, water services must have the characteristics of a public service (equal access for all consumers, continuity, and adaptability to the general interest). It is however clear that the negotiation power of local communities vary according to the contract implemented. For instance, it is likely that the technical skills of a local community are greater under an affermage contract (were the municipality is the owner of the asset) than under a concession contract (were investments and the full management of the water service are delegated). Hence, one may expect a more effective regulation of private firms in the case of an affermage contract than is the case of a delegation contract. In particular, the social objectives of a municipality (affordability of water for poor households) may be more easily implemented under an affermage contract. This is the type of assumption we are going to test by introducing into the water income share equations the proportion of population served by a private firm under an affermage, a concession contract or an hybrid delegation contract.

In table C.1 in Appendix C, we have estimated the water income share equations by introducing as potential determinants the proportion of population served by a private firm under an affermage contract, under a concession contract or an hybrid delegation contract. As shown, the estimated coefficients associated with these three variables are significant at 1%. It follows that the type of delegation contract has an impact on affordability of water for households in France. The higher increasing impact on the water income share is found for local communities were delegation is made through a concession contract. Increasing the private participation by 10% and increasing the proportion of concession contracts by 10%, results in increasing the percentage of income spent to pay the water charges by 0.1% on average. One possible explanation is that concession contracts are usually long-term contract. Under a concession contract, the control of the private firm by the local community may be more difficult especially due to a lack of municipal technical skills. Increasing the proportion of affermage or hybrid contracts, results in increasing respectively by 0.05% and

0.04% the share of income devoted to paying water charges. The impact of the type of contract on the water income shares is *per se* limited although significant.

In the next table, we have simulated an increase of the private participation by 10% (either affermage, concession or hybrid contracts), and we have computed the average change in the water income shares by income classes.

-- TABLE 5, here --

First, the impact of hybrid and affermage contracts on the percentage of household income devoted to paying water charges is very similar. Being under an hybrid or an affermage contract results in increasing the water income shares for the lowest income deciles and in decreasing the water income shares for the highest income deciles.

A concession contract tends to increase the percentage of household income devoted to paying water charges for all income deciles. Moreover, the impact is higher for the low income groups than with an hybrid or affermage contract. One may think that the control of the delegated firm by the local community is more difficult under a concession contract than under an affermage contract.

2.2 Being “water-poor” in France

2.2.1 Being “water-poor” in France, a statistical analysis

As mentioned previously, for the French case, we have decided to follow Fitch and Price (2002) and Sawkins and Dickie (2002) by defining water affordability as the share of income spent on water charges. More precisely, we define a “*water-poor*” household as an household spending 3% or more of its total income for paying water charges.

In year 2001, 4.31% of households in France (representing around 11.6 millions of households) need to spend more than 3% of their income on water charges. The proportion of income these households are obliged to devote to water is on average more than four time that of the population as a whole (1.19%).

-- TABLE 6, here --

Households which are vulnerable to water poverty share a number of specific characteristics. First, the share of social income to the total income is higher the case of water-poor households. As expected, the average total income of water-poor household is significantly smaller than the average income for the whole French population. The most vulnerable groups to water poverty are the single adult families. 14.15% of the single adult families where the head of the household is a woman are water-poor (compared to 4.31% of the whole population). Unemployment of the household’s head is also a clear determinant of water poverty since 11.53% of the households where the head is unemployed are water-poor (compared to 4.31% of the whole population). Last the average number of persons per household is smaller in the case of water-poor household.

2.2.2 Being “water-poor” in France, an econometric analysis

We estimate a logit model to examine which characteristics of the households have a significant impact on the probability of being water-poor, that is on the probability of spending more

than 3% of the total income to pay water charges. We also try to assess if the private participation or the social policies implemented by public authorities have an impact on this probability. It is important to notice at this stage that the observations are unequally distributed between groups. By far the fewest households are in the water-poor class (4.31% of the households in our sample).

-- TABLE 7, here --

First, being a single parent family results in increasing the probability of being water-poor. This is especially true if the head of the household is a woman (*H_typ8*). Being elderly results in a small but significant increase of the probability of being water-poor. Last, the larger the size of the household the greater the probability of being water-poor. This reflects a positive relationship between household size and water consumption levels. Next, we discuss the impact of housing characteristics of water affordability. Living in an individual house results in a higher probability of being water-poor. The relationship between the probability of being water-poor and the level of social aid is mixed since all coefficients associated with social aid variables do not have the same sign. However, the higher is the share of social aid into the total income, the higher is the probability of being water-poor.

Concerning the regulation variables, the periodicity of water bills (*perfac1*) has a significant negative impact on the probability of being water-poor. The political variables appear to be significant. A high proportion of votes to the socialist (*left_soc*) or to the communist party (*left_ext*) at the last local election results in a lower the probability of being water-poor. It is possible that being in power results for those parties in more pro-poor social policies. The year of contract signature for the delegation contract between the local community and the private firm and the expected year of contract ending (*contract_end*) are not significant.

2.2.3 Private participation and probability of being “water-poor” in France

In the previous paragraph, we have identified the determinants of being water-poor. We now more formally explore the relationship between private participation into the water industry and the probability of spending more than 3% of the income for paying water charges.

The methodology used consists in modifying for each household the share of the private participation into the water sector (by -20%, -10%, +10% and +20%). Using the coefficients estimated by the logit model, we can then compute for each household the resulting probability of being water poor. Finally, we compute the average probability of spending more than three percent of the total income on the water charges by income class. These simulated probabilities of being water poor are reported in Table 8.

First and as expected, the predicted probability of being water poor significantly decreases with the income class. For a household belonging to the highest decile, the probability of being water poor is less than 1%. Belonging to the lowest income class results in a probability of being water poor more than 24 times higher (24.8%). However, one should be extremely cautious with using the term water poor in case of high income classes. A water poor household belonging to a high income class results by definition from a high water bill. It is likely that such a high water bill is the consequence of a large water consumption associated with water consuming equipments (air conditioning, swimming-pool, garden, number of bathrooms...). Hence, being water poor in the case of a high income class is the result of a voluntary decision of the household. On contrary, being water poor in the case of a low income class likely means that a significant part of the total income must be devoted to the water bill for a minimum water level.

-- TABLE 8, here --

For income class 4 to 10, the probability of being water poor is relatively small (from 0.9% to 3.6%). The three first income deciles seem to be much more vulnerable. Being in the third income decile is associated with a probability of being water poor equal to 7.4% and almost one household to ten belonging to the second income class is expected to spend more than 3% of its income on the water bill.

In columns 4-7 in Table 8, we have simulated the impact of changing the private participation into the water industry on the probability of being water poor. Let's first focus on a reduction by 10% of the private participation. The resulting reduction in the probability of being water poor is very significant in the income class 1 to 5 (from -10.9% in the fifth income class to -27.5% in the first income class). The water poor probability change is much more moderate in the highest income classes. In the 8th income class, the decrease in the private participation has even a small but positive impact on the probability of being water poor. Increasing the private participation into the water industry by 10% results on contrary in increasing the probability of being water poor for almost all income classes. In particular, for households belonging to income classes 1 to 3, the probability of spending more than 3% of the total income to pay the water bill increases by a bit less than one-third. On contrary, for households belonging to income class 8, the probability of spending more than 3% of the total income to pay the water bill decreases by 4.3%.

What are the main conclusions to be drawn from this econometric analysis? First, the impact of the private participation into the water industry on the probability of being water poor strongly differs according to the level of income. Second, the participation of the private sector into the water industry has a significant increasing impact on the probability of being water poor for households belonging to the lowest income classes. Third, the impact of the private participation into the water sector has a much more moderate impact on the probability of being water poor for households belonging to the highest income classes.

2.2.4 Type of delegation contract and probability of being “water-poor” in France

We are finally interested in assessing how the type of delegation contract may have an impact on the on the probability of being water-poor in France. The logit model presented in the previous paragraph has been estimated by introducing as a potential determinant three variables, *affermage*, *concession* and *hybrid* representing respectively the share of the population served by a private firm with an *affermage*, a *concession* or an *hybrid* contract. The estimation of the logit model is presented in Appendix C, section C.2, of this article. In what follows, we limit our discussion to the coefficients associated with the type of delegation contract.

First, the coefficients associated with the type of delegation contract are all significant at 1%. This indicates that the type of contract seems to be a determinant of the probability of being water poor in France. The marginal impact of increasing the share of *affermage*, *concession* and *hybrid* contracts is directly given by the coefficient associated with those variables. Since the sign of the coefficient is negative, this implies that increasing the proportion of *affermage*, *concession* and *hybrid* contracts (compared to direct management of the water service by the local community) will result, on average, in a higher probability of being water-poor.

Last, in Table 9, we have simulated a change in the private participation by changing the proportion of delegation contracts (either *affermage*, *concession* or *hybrid* contract). As previously, the methodology consists in modifying for each household the share of private participation into the water sector by -10% or +10% and in modifying in the same way the proportion of a given contract. Using the coefficients estimated by the logit model, we can then compute for each household the resulting probability of being water-poor. Finally, we compute the average probability of spending more than three percent of the total income on the water charges by income class.

-- TABLE 9, here --

First, increasing by 10% the share of *affermage*, *concession* or *hybrid* contracts results in an increase in the probability of being water-poor by respectively 27.2%, 33.1% and 33.5% for households belonging to the lower income decile. As previously found in the case of water income share equations, concession and hybrids contracts seem to have the higher negative impact on the probability of being water poor. One may suspect that the control of the delegated firm is more effective under an *affermage* contract than under an hybrid or concession one. It is possible that the local community is more easily able to impose on the private delegated firm some social objectives in the case of *affermage* contracts than in the case of concession or hybrid contracts.

For the median income class, the impact of changing the share of *affermage*, *concession* or *hybrid* contracts has a quite similar impact.

Conclusion and policy implications

Social water pricing in France

We have seen that one specificity of the French water sector is that there is currently no specific pricing scheme, rebate or discount tariff, for the poorest households. The mechanism put in place by public authorities and private firms in order to guaranty an affordable access to water corresponds to an *ex-post* financial aid to help qualified low-income households facing difficulties for paying the water bill. The main explanation on this situation is that, according to the French definition of a public service, all customers having similar characteristics must face the same price.

Very recently, the 8 April 2004 decree has however defined the way a social electricity pricing must be implemented. According to this decree, the eligible households (the eligibility criterion is based on household income per consumption unit) can benefit from a 30% to 50% price discount up to 100 kWh/month. Such a social pricing scheme has been implemented since January 1st 2005.

We believe that, since the French public authorities have decided that a social electricity tariff is allowed by the Law, there is a priori no reason to exclude these pro-poor tariffs from the water sector. Hence, there is a priori no reason to exclude the possibility to see some form of social water pricing in France in the next years.

Water access to the poor in France

In twenty years, the proportion of French households not connected has dropped from 0.4% in 1984 to 0.1% in 2002. For households belonging to the lower income decile, the change is also very significant (from 2.2% to 0.3%).

One may conclude that the population access to the water network is no more a relevant issue in France, except maybe in very specific areas (very small local rural communities) where building a water network is not possible or too costly to undertake.

However, a crucial challenge that will have to be solved by the French water sector will be to maintain the water access rate to the water network at the current level. Hence, according to Berlan and Juery (2002), 29% of the network pipe are 30 years old or more and 10% of the network is even 60 years old or more. The investment required to renew the network is estimated to be between 1.5 and 2 billion euro per year from now to 2015. Financing such investment necessary to maintain water access is a challenging issue for the French water sector. It is expected that this will reinforce the private public partnership in France.

Determinants of water affordability

The water affordability (defined as the percentage of income spent on paying water charges) depends upon a certain number of household characteristics. It has been for instance shown that being a single parent results in increasing the share of income spent on water charges by 0.2% if the head of the household is a man and by 0.4% in the case of a woman. Being elderly results in a small but significant decrease of the share of income devoted to paying water charges.

The relationship between water affordability and social aid is mixed. The most clear-cut result is however obtained for the share of total household income coming from social aid: The higher is the share of income coming from social aid, the higher is the share of income spent on water charges.

Concerning the regulation variables, the periodicity of water bills has a significant negative impact on the share of income spent on water charges. One may think that a higher bill periodicity result in a better monitoring of water consumption by households. The political variables appear to be significant. A high proportion of votes to the socialist or to the communist party at the last local election results in a lower share of income spent on water charges. It is possible that being in power results for those parties in more pro-poor social policies.

To summarize, single parent families (especially if the head of the household is a woman) or on contrary large families for which social aid represents a large proportion of the household total income should be considered as the most vulnerable groups in terms of water affordability.

On water affordability to the poor in France

In 2001, the average percentage of income spent on paying water charges by French households is 1.20%. Based on the average aggregated figure, one may say that water affordability does not seem to be an important issue. However, going into the details gives a very different picture.

First, the percentage of income spent on paying water charges strongly depends on the household income level. It varies from 2.32% for households belonging to the first income decile group to 0.61% if the household belongs to the highest income decile. For the 1% poorest households, the water charges even represent 4.80% of the total income. These figures clearly show that pro-poor policies are still required in France to maintain water affordability at an acceptable level for poor households.

Second, Charitable and non-profit organisations offer an interesting perspective for assessing water affordability since those institutions deal with the poorest people in France. For around 10% of the poverty cases analysed in 2003 by the Secours Catholique, the water bill has not been paid by households. Applying this rate to the total population going through the Secours Catholique means that 69,000 households have unpaid water bills in 2003. Moreover, the Secours Catholique notices that the frequency of unpaid charges related to housing tends to increase. For the poorest households, paying water bills still raises some affordability issues.

Last, on average, 64% of the French municipalities offer water debt payment programs oriented toward low-income household facing financial difficulties in 2000. Moreover the proportion of municipalities having implemented household debt payment programs is significantly higher for water than for any other basic goods (phone, gas or electricity). This may reflect that, at the local level, water charge payment by low-income households used to appear to be a significant problem in 2000.

Impact of the private sector on water affordability to the poor in France

The impact of private participation on water affordability appears to be very moderate *on average* (0.05%) but significantly different from zero.

The picture is however quite different when we consider a model allowing a differentiated impact of private participation across income classes. Increasing the private sector participation by 10% results in a significant increase in the water income shares by 0.24%, 0.14% and 0.11% for income classes 1, 2 and 3 (low-income households). On contrary increasing the share of the private sector in the water industry seems to favour high income households since by increasing the private sector participation by 10%, the water income shares are reduced by -0.01%, -0.02% and -0.02% for income classes 8, 9 and 10.

The type of delegation contract has an impact on affordability of water for households in France. The higher increasing impact on the water income share is found for local communities where delegation is made through a concession contract. Increasing the private participation by 10% and increasing the proportion of concession contracts by 10%, results in increasing the percentage of income spent to pay the water charges by 0.1% on average. Increasing the proportion of affermage or hybrid contracts, results in increasing respectively by 0.05% and 0.04% the share of income devoted to paying water charges. One possible explanation is that the concession contract are usually long-term contract. Hence, under a concession contract, the control of the private firm by the local community may be more difficult especially if the municipality lacks of technical skills. To conclude, notice that the impact of the type of contract on the water income shares is limited although significant.

Impact of the private sector on the probability of being water poor

By reference to Fitch and Price (2002) and Sawkins and Dickie (2002), we have defined a “*water-poor*” household as an household spending 3% or more of its income on paying water charges. The quantitative analysis of the probability of being water poor reveals the following results.

First, the impact of the private participation into the water industry on the probability of being water poor strongly differs according to the level of income. More precisely, the predicted probability of being water poor significantly decreases with the income class. For instance, for a household belonging to the highest decile, the probability of being water poor in 2001 represents less than 1%. Belonging to the lowest income class results in a probability of being water poor more than 24 times higher (24.8% on average).

Increasing the private participation into the water industry by 10% results, on average, in increasing the probability of being water poor for almost all income classes. In particular, for households belonging to income classes 1 to 3, the probability of spending more than 3% of the total income to pay the water bill increases by a bit less than one-third. On contrary, for households belonging to income class 8, the probability of spending more than 3% of the total income to pay the water bill decreases by 4.3%.

Last, the type of contract between the local municipality and the private firm has a significant impact on the probability of being water-poor. Being under a concession or an hybrid contract (compared to an affermage contract) seems to have an increasing impact on the probability of being water-poor. One may suspect that the control of the delegated firm is more effective under an affermage contract than under an hybrid or concession one. It is possible that the local community is more easily able to impose on the private delegated firm some social objectives in the case of affermage contracts than in the case of concession or hybrid contracts. Lowering the probability of being water-poor, especially for low-income households, calls for a reinforcement of delegated firm regulation.

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Appendixes

Appendix A. Description of surveys used in the French case study

A.1 The *INSEE* family income and expenditure surveys

The main objective of this survey realized by the National Institute for Statistics and Economic Studies (INSEE) is to report all income sources and expenditure of French households. The survey allow reconstructing all household expenses (including consumption of goods and services, taxes, etc) and all types of household resources (including income, social aid, intergenerational transfers, etc).

These surveys have been conducted every 5 years since 1978 (1978-79, 1984-85, 1989, 1994-95, 2000-01). The most recent surveys report household expenses using the Classification Of Individual Consumption by Purpose, COICP. The sampling of the population is based on the last available census. The database is representative at the national level.

A.2 The *INSEE* housing surveys

The main objective of this survey realized by the National Institute for Statistics and Economic Studies (INSEE) is analyse the characteristics of housing in France. The survey describes : the characteristics of permanent housings (size, sanitary equipments, heating, etc.), the quality of housing (date of construction, security, noises, etc.), the household housing occupation status and all charges related to housing (housing rent, water charges, etc).

These surveys have been conducted every 4 or 5 years since 1973 (1973, 1978, 1984, 1988, 1992, 1996, 2000).

The sampling of the population is based on the last available census. The database is representative at the national level.

A.3 The IFEN-SCEES water surveys

A survey focused on water services has been conducted by the French Institute for the Environment (IFEN) and the Ministry of Agriculture's Department of Statistics (SCEES) 1998 and 2001.

More than 5,000 services have been surveyed. The sampling is exhaustive for all local communities with more than 10,000 inhabitants. The sampling rate decreases with the local community size (1/20 for local community with less than 400 inhabitants). This survey is representative of the total population of French municipalities (e.g. all sizes of local communities are proportionally represented in the sample, with the exception of large municipalities that are all included in the sample).

The IFEN-SCEES water surveys conducted in 1998 and 2001 constitute the main source of water related information representative at the French national level. In particular, these surveys include data at the local community level on:

- the type organisation chosen by the local community: private versus public, type of delegation contract, inter-communal agreement...;
- the cost and price of the water services: investments realised by the water service, labour cost, average domestic water price, type of pricing schemes implemented...;

- the technical characteristics of the water service: network length, pumping capacity, number of residential or industrial users, water treatment facilities...

A.4 The political database

The political databases give the percentage of votes obtained by each party at the municipal election in 1989 and 1995. These databases are defined at the municipality level. We observe the political results on a randomly selected sub-sample made of respectively 927 municipalities in 1989 and 965 in 1995.

From these political databases, we have computed three variables of interest:

- *left_ext* gives the percentage of votes obtained by the communist party (and by the extreme left parties) at the local election in 1995;
- *left_soc* gives the percentage of votes obtained by the socialist party at the local election in 1995.
- *left_stable* is a dummy variable equal to one if the left parties (socialist party, communist party and green party) have obtained the majority of votes both at the 1989 and 1995 local elections.

A.5 Merging the databases

To assess the impact of the private sector participation on affordability of water in France, a crucial data management issue that must be overcome is to combine all databases (INSEE databases, IFEN-SCEES database and political database) into a single one. Hence, the INSEE databases contain all information required to compute the share of the water expenses to the total household income, but it does not allow to evaluate the impact of the private participation since no information is available on the type of water service organisation (private versus public). In the similar way, a complete technical / financial description of the water services in France is available in the IFEN-SCEES database however, there is no detailed information on household characteristics.

The master dataset is made of the INSEE databases (housing and family income and expenditures) defined at the household level. The IFEN-SCEES and the political databases are defined at the local community level. Unfortunately, in order to guaranty the statistical secret, the INSEE household-level databases do not contain any information allowing to allocate each household to a given municipality. However, there are two variables common to all databases:

- *Nuts1* gives the geographical region according to the Nuts 1 classification (Ile de France, Parisian Basin, North, East, West, South-West, Centre and Mediterranean)
- *Size* is a categorical variable equal to 0 for rural municipalities, 1 for urban municipalities with less than 20,000 inhabitants, 2 for urban municipalities with more than 20,000 inhabitants but less than 100,000, 3 for urban municipalities with more than 100,000 inhabitants and 4 for Paris.

We have used these two variable to merge all the databases. By crossing variables *Nuts1* and *Size*, we obtain 45 cells for which all variables of interest in the IFEN-SCESS database have been averaged.

Appendix B. Definition of variables

Table B.1: Definition of variables

Variable	Definition	Source
w_j	Water income share. Share of the total household income spent on the water charges for households belonging to income decile $j \in \{1, \dots, 10\}$.	INSEE
<u>Private participation into the water sector</u>		
<i>private</i>	Share of the population water supplied by a private firm	IFEN
<i>private_iv</i>	Share of the population water supplied by a private firm. Variable instrumentalised by the technical characteristics of the water service.	IFEN
<i>affermage</i>	Share of the population water supplied by a private firm with an <i>affermage</i> delegation contract	IFEN
<i>concession</i>	Share of the population water supplied by a private firm with a <i>concession</i> delegation contract	IFEN
<i>hybrid</i>	Share of the population water supplied by a private firm with an <i>hybrid</i> delegation contract	IFEN
<i>incj*private</i>	Cross-term between the <i>private</i> variable and a dummy variable equal to 1 if the household belongs to the income class $j \in \{1, \dots, 10\}$.	IFEN - INSEE
<u>Household characteristics</u>		
<i>H_typ1</i>	Single person.	INSEE
<i>H_typ2</i>	Couple without child.	INSEE
<i>H_typ3</i>	Couple with one child.	INSEE
<i>H_typ4</i>	Couple with two children.	INSEE
<i>H_typ5</i>	Couple with three children.	INSEE
<i>H_typ6</i>	Other.	INSEE
<i>H_typ7</i>	Single (man) with children.	INSEE
<i>H_typ8</i>	Single (woman) with children	INSEE
<i>d_comfort</i>	Dummy variable equal to one if the head of the household considers the financial situation as being comfortable.	INSEE
<i>d_old</i>	Dummy variable equal to one if the head of the household is 65 or more years old.	INSEE
<i>nbpers</i>	Number of persons.	INSEE
<u>Housing characteristics</u>		
<i>house</i>	Dummy variable equal to one if the household lives in a house.	INSEE

<i>year_built</i>	Year of housing building.	INSEE
<i>rent</i>	Dummy equal to one if the household rents the housing.	INSEE
<u>Social aid</u>		
<i>owner_aid</i>	Dummy variable equal to one if a housing owner get a social aid.	INSEE
<i>rent_aid</i>	Dummy variable equal to one if a household renting housing gets a social aid.	INSEE
<i>soc_aid</i>	Dummy variable equal to one if the household receives any form of social aid.	INSEE
<i>share_soc</i>	Share of total income made of social benefits.	INSEE
<u>Regulation</u>		
<i>left_ext</i>	Percentage of votes to the communist party (and to the extreme left parties) at the local election in 1995.	POL
<i>left_soc</i>	Percentage of votes to the socialist party at the local election in 1995.	POL
<i>left_stable</i>	Dummy variable equal to one if the left parties (socialist party, communist party and green party) have obtained the majority of votes both at the 1989 and 1995 local elections.	POL
<i>price_120</i>	Average residential water price for an annual consumption of 120 cubic meters.	IFEN
<i>price_fix</i>	Share of the fixed charge into the total water bill.	IFEN
<i>perfac1</i>	Periodicity of the water bill	IFEN
<i>contract_beg</i>	Year of contract signature for the delegation contract between the local community and the private firm.	IFEN
<i>contract_end</i>	Expected year of contract ending for the delegation contract between the local community and the private firm.	IFEN
<u>Technical variables</u> (used as instrumental variables)		
<i>vulnerable</i>	Share of classified as vulnerable area by the French public authorities (an area is classified as being vulnerable if it there is a risk of nitrate or pesticide contamination or if this risk has already happened).	IFEN
<i>river_bad</i>	Share of rivers with a bad water quality.	IFEN
<i>river_vbad</i>	Share of rivers with a very bad water quality.	IFEN
<i>noprotect</i>	Share of water intake points not protected.	IFEN
<i>treatment</i>	Share of water delivered to final users requiring an elaborated purification treatment	IFEN
<i>resid_sec</i>	Share of secondary housings.	IFEN
<i>wat_cons</i>	Average water consumption per household	IFEN

Appendix C. Delegation contract type and water affordability in France

C.1 Water income share equations and the type of delegation contract

In order to capture the impact of the type of delegation contract on the household affordability of water, three variables have been included in the water income share equations:

- *affermage* is the share of the population water supplied by a private firm under an affermage contract;
- *concession* is the share of the population water supplied by a private firm under a concession contract;
- *hybrid* is the share of the population water supplied by a private firm under a hybrid delegation contract (such a delegation contract mixes the specific characteristics of the two previous ones).

Table C.1: Econometric estimations of the water income shares equation (year 2001) with the type of delegation contract

Variable	Coef.	Stu.	Variable	Coef.	Stu.
<i>private_iv</i>	-0.010	-15.14	<i>d_comfort</i>	0.001	21.84
<i>inc1*private</i>	0.028	110.06	<i>d_old</i>	-0.001	-5.70
<i>inc2*private</i>	0.018	77.42	<i>nbpers</i>	0.001	24.27
<i>inc3*private</i>	0.016	84.68	<i>house</i>	0.001	8.78
<i>inc4*private</i>	0.011	87.20	<i>year_built</i>	0.000	1.28
<i>inc5*private</i>	0.009	78.54	<i>rent</i>	-0.001	-14.42
<i>inc6*private</i>	0.007	70.35	<i>owner_aid</i>	0.000	-6.94
<i>inc7*private</i>	0.006	64.14	<i>rent_aid</i>	0.001	9.34
<i>inc8*private</i>	0.004	47.62	<i>soc_aid</i>	-0.001	-14.69
<i>inc9*private</i>	0.002	34.27	<i>share_soc</i>	0.002	14.32
<u>affermage</u>	0.005	11.64	<i>left_ext</i>	0.002	1.40
<u>concession</u>	0.010	10.87	<i>left_soc</i>	-0.007	-7.55
<u>hybrid</u>	0.004	4.02	<i>left_stable</i>	0.001	2.26
<i>H_typ2</i>	0.002	19.87	<i>price_120</i>	-0.001	-1.37
<i>H_typ3</i>	0.002	16.00	<i>price_fix</i>	-0.007	-13.14
<i>H_typ4</i>	0.001	8.68	<i>perfac1</i>	0.000	-39.89
<i>H_typ5</i>	0.002	7.27	<i>contract_beg</i>	0.000	5.20
<i>H_typ6</i>	0.001	6.67	<i>contract_end</i>	0.000	7.87
<i>H_typ7</i>	0.002	6.45	<i>constant</i>	-0.496	-8.31
<i>H_typ8</i>	0.004	23.13			

Adj. R2: 0.25

C.2 Probability of being water-poor and the type of delegation contract

The logit model presented in section 4.4.3 has been estimated by introducing the variables *affermage*, *concession* and *hybrid* as potential determinants. The objective is to check if the type of contract linking the local community and the delegated firm has a significant impact on the probability of being water-poor in France.

Table C.2: Logit estimations of the probability of being water poor (year 2001) with the type of delegation contract

Variable	Coef.	Stu.	Variable	Coef.	Stu.
<i>private_iv</i>	1.467	3.76	<i>d_comfort</i>	0.247	11.61
<i>inc1*private</i>	6.842	49.89	<i>d_old</i>	0.155	3.77
<i>inc2*private</i>	4.913	37.00	<i>nbpers</i>	0.578	22.82
<i>inc3*private</i>	4.394	34.95	<i>house</i>	0.482	10.66
<i>inc4*private</i>	3.113	24.49	<i>year_built</i>	0.003	2.41
<i>inc5*private</i>	2.201	15.96	<i>rent</i>	-0.298	-7.47
<i>inc6*private</i>	0.758	4.99	<i>owner_aid</i>	-0.554	-6.64
<i>inc7*private</i>	0.700	4.33	<i>rent_aid</i>	0.243	5.75
<i>inc8*private</i>	-0.192	-0.96	<i>soc_aid</i>	-0.406	-7.10
<u>affermage</u>	-1.830	-10.51	<i>share_soc</i>	0.142	2.51
<u>concession</u>	-4.135	-8.97	<i>left_ext</i>	-3.534	-5.02
<u>hybrid</u>	-3.581	-5.82	<i>left_soc</i>	-6.289	-10.45
<i>H_typ2</i>	-0.058	-1.23	<i>left_stable</i>	0.840	4.48
<i>H_typ3</i>	0.111	1.34	<i>price_120</i>	-1.834	-7.27
<i>H_typ4</i>	-0.073	-0.78	<i>price_fix</i>	-1.360	-4.12
<i>H_typ5</i>	-0.594	-4.50	<i>perfac1</i>	-0.079	-15.78
<i>H_typ6</i>	-0.764	-7.73	<i>contract_beg</i>	-0.031	-7.46
<i>H_typ7</i>	0.251	1.66	<i>contract_end</i>	-0.041	-1.97
<i>H_typ8</i>	0.413	5.69	<i>constant</i>	142.645	3.19

Appendix D. Instrumental variable method for the private participation variable.

As mentioned previously, directly introducing a variable capturing the private participation into the water industry in the household water income share equation may result in a severe problem of regressor endogeneity.

A simple way to take into account this endogeneity issue consists in first regressing the *private* variable on a set of exogenous variables (i.e. instrumental variables which include all the determinants of the water income shares and a set of technical variables characterising the water service).

Table D.1: IV equation for the private participation (year 2001)

Variable	Coef.	Stu.	Variable	Coef.	Stu.
Ln(income)	-0.010	-9.83	<i>year_built</i>	0.000	6.44
<i>H_typ2</i>	-0.001	-1.69	<i>rent</i>	-0.001	-2.80
<i>H_typ3</i>	-0.002	-2.09	<i>owner_aid</i>	0.001	2.06
<i>H_typ4</i>	-0.003	-2.07	<i>rent_aid</i>	0.002	4.13
<i>H_typ5</i>	-0.007	-4.04	<i>soc_aid</i>	-0.003	-6.56
<i>H_typ6</i>	0.000	0.28	<i>share_soc</i>	0.002	3.42
<i>H_typ7</i>	-0.006	-3.00	<i>left_ext</i>	1.442	274.39
<i>H_typ8</i>	0.005	5.25	<i>left_soc</i>	1.020	272.36
<i>d_comfort</i>	0.000	0.17	<i>left_stable</i>	-0.291	-175.57
<i>d_old</i>	0.002	3.06	<i>price_120</i>	0.614	385.29
<i>nbpers</i>	0.000	0.35	<i>price_fix</i>	-0.398	-97.62
<i>inc1*private</i>	0.088	28.91	<i>perfac1</i>	-0.001	-13.50
<i>inc2*private</i>	0.092	34.01	<i>contract_beg</i>	0.010	198.47
<i>inc3*private</i>	0.096	37.34	<i>contract_end</i>	0.059	410.37
<i>inc4*private</i>	0.102	41.32	vulnerable	-0.004	-2.98
<i>inc5*private</i>	0.100	41.90	river_bad	-0.040	-30.12
<i>inc6*private</i>	0.102	43.66	river_vbad	0.563	168.45
<i>inc7*private</i>	0.107	46.64	noprotect	0.130	94.74
<i>inc8*private</i>	0.114	50.66	treatment	-0.475	-173.13
<i>inc9*private</i>	0.116	52.46	resid_sec	-0.065	-28.56
<i>inc10*private</i>	0.161	60.63	wat_cons	-1.945	-97.83
<i>house</i>	-0.024	-55.49	constant	-139.340	-460.34

Adj. R2 = 0.82

In this table, we present the OLS estimation of the private participation share. As it can be seen, the predictive power of the model is good since the adjusted R2 is 0.82. Most of the variables are significant and most of the estimated coefficients make sense.

Table 1: Water income shares from 1979 to 2001 by income classes

	1979	1984	1989	1995	2001
Total sample	0.79%	1.11%	1.05%	1.19%	1.20%
income class 1	2.256%	4.692%	3.915%	3.100%	2.311%
income class 2	1.079%	1.234%	1.252%	1.725%	1.663%
income class 3	0.736%	0.949%	0.994%	1.339%	1.588%
income class 4	0.699%	0.845%	0.941%	1.267%	1.292%
income class 5	0.647%	0.728%	0.774%	1.117%	1.166%
income class 6	0.598%	0.634%	0.769%	1.087%	1.041%
income class 7	0.546%	0.613%	0.618%	0.889%	1.002%
income class 8	0.474%	0.558%	0.609%	0.873%	0.873%
income class 9	0.412%	0.494%	0.524%	0.735%	0.742%
income class 10	0.335%	0.391%	0.407%	0.574%	0.607%
1% poorest households	9.70%	22.61%	22.65%	17.64%	4.80%
5% poorest households	3.25%	8.48%	6.47%	4.25%	2.69%
5% richest households	0.29%	0.34%	0.35%	0.47%	0.51%
1% richest households	0.19%	0.25%	0.27%	0.36%	0.37%

This tables gives the water income shares by income classes (deciles). Data sources: INSEE Family budget and income surveys and author's own calculation.

Table 2: Basic good income shares by income decile in 2001

Income decile	Water	Electricity	Gas	Phone
1	2.32%	6.45%	4.31%	1.04%
2	1.67%	4.04%	2.40%	0.61%
3	1.59%	3.77%	2.01%	0.60%
4	1.29%	3.14%	2.73%	0.55%
5	1.17%	2.75%	2.01%	0.45%
6	1.04%	2.52%	1.90%	0.40%
7	1.00%	2.32%	1.58%	0.33%
8	0.88%	2.03%	1.40%	0.31%
9	0.74%	1.86%	1.35%	0.29%
10	0.61%	1.42%	0.96%	0.20%

This tables gives the percentage of income spent on water, electricity, gas and telephone charges by income classes (deciles). Data sources: 2001 INSEE Family budget and income survey and author's own calculation.

Table 3: Econometric estimation of the water income share equation (year 2001)

	OLS method				IV method			
	Parsi. ^(a)		Full		Parsi. ^(a)		Full	
	Coef.	Stu.	Coef.	Stu.	Coef.	Stu.	Coef.	Stu.
<u>Private participation into the water sector</u>								
<i>private</i>	0.003	6.93	-0.004	-10.90	-	-	-	-
<i>private_iv</i>	-	-	-	-	0.005	7.96	-0.002	-4.19
<i>inc1*private</i>	-	-	0.028	109.95	-	-	0.028	98.00
<i>inc2*private</i>	-	-	0.018	70.15	-	-	0.018	57.61
<i>inc3*private</i>	-	-	0.015	83.70	-	-	0.015	80.71
<i>inc4*private</i>	-	-	0.011	90.01	-	-	0.011	69.66
<i>inc5*private</i>	-	-	0.009	81.80	-	-	0.008	62.98
<i>inc6*private</i>	-	-	0.007	73.95	-	-	0.006	53.97
<i>inc7*private</i>	-	-	0.006	65.35	-	-	0.006	47.65
<i>inc8*private</i>	-	-	0.004	48.99	-	-	0.004	32.61
<i>inc9*private</i>	-	-	0.002	34.16	-	-	0.002	20.67
<u>Household characteristics</u>								
<i>H_typ2</i>	-0.002	-14.64	0.002	19.36	-0.002	-14.63	0.002	19.18
<i>H_typ3</i>	-0.002	-13.45	0.002	15.58	-0.002	-13.43	0.002	15.40
<i>H_typ4</i>	-0.001	-7.84	0.001	8.58	-0.001	-7.81	0.001	8.56
<i>H_typ5</i>	-0.001	-6.78	0.002	7.21	-0.001	-6.71	0.002	7.28
<i>H_typ6</i>	-0.003	-24.30	0.001	6.34	-0.003	-24.27	0.001	6.16
<i>H_typ7</i>	0.000	0.69	0.002	6.35	0.000	0.66	0.002	6.35
<i>H_typ8</i>	0.003	13.04	0.004	23.08	0.003	13.01	0.004	23.03
<i>d_comfort</i>	0.003	77.76	0.001	22.79	0.003	77.34	0.001	24.00
<i>d_old</i>	-0.001	-5.38	-0.001	-5.71	-0.001	-5.39	-0.001	-5.71
<i>nbpers</i>	0.000	0.97	0.001	24.09	0.000	0.88	0.001	23.51
<u>Housing characteristics</u>								
<i>house</i>	0.001	8.19	0.001	8.96	0.001	8.17	0.001	8.90
<i>year_built</i>	0.000	0.53	0.000	1.20	0.000	0.32	0.000	0.95
<i>rent</i>	0.000	-1.06	-0.001	-14.15	0.000	-0.96	-0.001	-13.64
<u>Social aid</u>								
<i>owner_aid</i>	0.000	3.83	0.000	-6.64	0.000	3.93	0.000	-6.27
<i>rent_aid</i>	0.003	17.03	0.001	9.57	0.003	16.98	0.001	9.52
<i>soc_aid</i>	-0.001	-14.73	-0.001	-14.88	-0.001	-14.46	-0.001	-14.51
<i>share_soc</i>	0.005	45.94	0.002	14.41	0.005	46.13	0.002	14.26

Regulation

<i>left_ext</i>	-0.002	-1.68	-0.002	-1.49	-0.004	-3.62	-0.003	-3.69
<i>left_soc</i>	-0.008	-10.27	-0.008	-11.48	-0.009	-11.45	-0.010	-13.39
<i>left_stable</i>	0.001	5.99	0.001	4.98	0.002	7.75	0.002	7.08
<i>price_120</i>	-0.001	-4.87	-0.003	-11.28	-0.002	-6.22	-0.003	-11.29
<i>price_fix</i>	-0.001	-2.03	-0.007	-12.92	0.000	-0.29	-0.006	-10.31
<i>perfac1</i>	0.000	-37.33	0.000	-39.62	0.000	-38.03	0.000	-40.63
<i>contract_beg</i>	0.000	5.46	0.000	-1.52	0.000	4.49	0.000	-2.69
<i>contract_end</i>	0.000	1.63	0.000	8.98	0.000	-1.60	0.000	2.91
<i>constant</i>	-0.136	-2.40	-0.401	-7.62	0.086	1.06	-0.175	-2.32

<i>Adj. R2</i>	0.14	0.25	0.14	0.25
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^(a)Parsi. for parsimonious model were the *private* variable does not interact with the income deciles dummies

Table 4: Impact of increasing the private participation in the water industry by 10% on the water income share (by income class for year 2001)

Income class	OLS method		IV method	
	Parsi.	Full	Parsi.	Full
1	0.03%	0.24%	0.05%	0.26%
2	0.03%	0.14%	0.05%	0.15%
3	0.03%	0.11%	0.05%	0.13%
4	0.03%	0.07%	0.05%	0.08%
5	0.03%	0.04%	0.05%	0.06%
6	0.03%	0.02%	0.05%	0.04%
7	0.03%	0.02%	0.05%	0.03%
8	0.03%	-0.01%	0.05%	0.01%
9	0.03%	-0.02%	0.05%	-0.004%
10	0.03%	-0.02%	0.05%	-0.001%

Parsi. for parsimonious model.

Table 5: Impact of increasing the private participation in the water industry by 10% on the water income shares (by income class and by type of delegation contract for year 2001)

Income class	Affermage	Concession	Hybrid
1	0.23%	0.28%	0.22%
2	0.12%	0.18%	0.11%
3	0.10%	0.15%	0.09%
4	0.05%	0.11%	0.04%
5	0.03%	0.09%	0.02%
6	0.01%	0.07%	0.00%
7	0.00%	0.06%	-0.01%
8	-0.02%	0.04%	-0.03%
9	-0.04%	0.02%	-0.05%
10	-0.01%	0.04%	-0.02%

Table 6: Descriptive statistics for water-poor and non water-poor households for year 2001

	All households	Non water-poor households	Water-poor households
<i>Proportion of households</i>	-	95.69%	4.31%
<i>Total income (euros per year)</i>	27534	29108	12169
<i>Percentage of income spent on water charges</i>	1.19%	1.05%	4.50%
<i>Share of social income to total income</i>	41.08%	43.03%	66.88%
<i>Private participation</i>	72.75%	69.00%	72.79%
<i>Average water price (euros per cubic metres)</i>	1.32	1.31	1.33
<i>Share of the fixed water charge to the total bill</i>	16.40%	16.50%	16.09%
<i>Periodicity of the water bill (months)</i>	7.06	7.65	6.80
<i>Number of persons</i>	2.42	2.58	2.17
<i>1 Adult only</i>	-	92.32%	7.68%
<i>1 Adult (man) and children</i>	-	93.32%	6.68%
<i>1 Adult (woman) and children</i>	-	85.85%	14.15%
<i>Head of the household unemployed</i>	-	88.47%	11.53%
<i>Head of the household 65 years old or more</i>	-	93.65%	6.15%

Table 7: Logit estimations of the probability of being water poor (year 2001)

Variable	OLS method				IV method			
	Parsi. ^(a)		Full		Parsi. ^(a)		Full	
	Coef.	Stu.	Coef.	Stu.	Coef.	Stu.	Coef.	Stu.
<u>Private participation into the water sector</u>								
<i>private</i>	1.726	12.59	-2.677	-11.40	-	-	-	-
<i>private_iv</i>	-	-	-	-	0.154	0.11	-0.523	-1.57
<i>inc1*private</i>	-	-	7.316	37.99	-	-	6.084	56.69
<i>inc2*private</i>	-	-	5.374	28.53	-	-	4.156	41.13
<i>inc3*private</i>	-	-	4.869	26.43	-	-	3.691	38.73
<i>inc4*private</i>	-	-	3.574	19.52	-	-	2.433	24.57
<i>inc5*private</i>	-	-	2.635	13.95	-	-	1.568	13.68
<i>inc6*private</i>	-	-	1.165	5.85	-	-	0.161	1.24
<i>inc7*private</i>	-	-	1.113	5.44	-	-	0.116	0.82
<i>inc8*private</i>	-	-	0.258	1.10	-	-	-0.713	-3.93

Household characteristics

<i>H_typ2</i>	-0.871	-18.53	-0.074	-1.57	-0.959	-4.25	-0.060	-1.26
<i>H_typ3</i>	-0.829	-9.57	0.082	0.97	-0.823	-2.05	0.132	1.59
<i>H_typ4</i>	-0.566	-5.34	-0.094	-0.99	-0.741	-1.50	-0.044	-0.47
<i>H_typ5</i>	-1.290	-8.74	-0.620	-4.59	-1.508	-2.20	-0.557	-4.17
<i>H_typ6</i>	-1.549	-16.21	-0.755	-7.61	-1.588	-3.54	-0.755	-7.58
<i>H_typ7</i>	0.308	2.06	0.200	1.31	0.259	0.37	0.253	1.68
<i>H_typ8</i>	0.193	2.43	0.399	5.40	0.204	0.56	0.458	6.26
<i>d_comfort</i>	0.828	44.15	0.236	10.96	0.826	8.88	0.267	12.59
<i>d_old</i>	0.069	1.91	0.149	3.63	0.052	0.29	0.146	3.54
<i>nbpers</i>	0.122	4.05	0.589	22.46	0.171	1.24	0.543	21.58

Housing characteristics

<i>house</i>	0.392	10.00	0.440	10.04	0.430	2.20	0.429	9.71
<i>year_built</i>	0.004	2.83	0.004	3.33	0.003	0.50	0.003	2.63
<i>rent</i>	-0.030	-0.80	-0.318	-8.00	-0.016	-0.10	-0.296	-7.36

Social aid

<i>owner_aid</i>	-0.341	-4.53	-0.565	-6.82	-0.292	-0.84	-0.543	-6.47
<i>rent_aid</i>	0.401	11.35	0.241	5.73	0.430	2.87	0.218	4.95
<i>soc_aid</i>	-0.464	-8.74	-0.392	-6.78	-0.524	-2.08	-0.388	-6.86
<i>share_soc</i>	1.425	26.49	0.116	2.04	1.496	5.81	0.172	2.99

Regulation

<i>left_ext</i>	-1.964	-4.62	-1.369	-3.03	-0.213	-0.08	-1.858	-3.00
<i>left_soc</i>	-4.582	-13.65	-4.933	-13.33	-2.723	-1.24	-5.555	-11.52
<i>left_stable</i>	0.862	7.32	0.641	4.81	0.135	0.21	0.814	5.28
<i>price_120</i>	-0.542	-4.91	-0.817	-6.71	0.329	0.39	-1.332	-6.90
<i>price_fix</i>	0.092	0.34	-2.253	-7.51	-1.434	-1.08	-1.304	-3.98
<i>perfac1</i>	-0.071	-15.18	-0.081	-16.34	-0.078	-3.43	-0.078	-15.68
<i>contract_beg</i>	0.002	0.78	-0.004	-1.16	0.004	0.25	-0.005	-1.45
<i>contract_end</i>	-0.019	-1.70	0.041	3.09	0.046	0.47	-0.028	-1.41
<i>constant</i>	29.138	1.19	-77.342	-2.90	-105.034	-0.50	63.777	1.49

Pseudo R2	0.14	0.25	0.14	0.25
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^(a)Parsi. for parsimonious model were private does not interact with income decile.

Table 8: Impact of increasing the private participation in the water industry on the probability of being water poor (by income class for year 2001)

Income class	Empirical probability of being water poor	Predicted probability of being water poor	Simulated probability of being water poor			
			Change in private participation share			
			-20%	-10%	+10%	+20%
1	24.3%	24.8%	12.5% (-49.6%)	17.9% (-27.5%)	32.7% (31.9%)	41.2% (66.3%)
2	9.5%	9.4%	5.2% (-44.2%)	7.0% (-24.9%)	12.3% (31.3%)	15.9% (69.5%)
3	7.4%	7.4%	4.4% (-40.5%)	5.7% (-22.6%)	9.4% (28.1%)	12.0% (62.4%)
4	3.6%	3.6%	2.5% (-30.3%)	3.0% (-16.5%)	4.4% (19.6%)	5.2% (42.8%)
5	2.1%	2.2%	1.7% (-20.6%)	2.0% (-10.9%)	2.5% (12.3%)	2.8% (26.0%)
6	1.1%	0.9%	0.9% (-3.3%)	0.9% (-1.7%)	0.9% (1.7%)	1.0% (3.4%)
7	1.2%	1.2%	1.1% (-6.3%)	1.2% (-3.2%)	1.2% (3.3%)	1.3% (6.8%)
8	0.5%	0.6%	0.6% (9.2%)	0.6% (4.5%)	0.6% (-4.3%)	0.5% (-8.3%)
9	0%	na	na (na)	na (na)	na (na)	na (na)
10	0.3%	0.9%	0.9% (0.0%)	0.9% (0.0%)	0.9% (0.0%)	0.9% (0.0%)

The numbers in parentheses give the percentage change in the probability of being water poor following a change in private participation compared to the predicted probability without change. For instance, in the case of a reduction by 20% of the participation of the private sector, the probability of being water poor goes from 24.8% to 12.5% for households belonging to the first income class. The probability of being water poor falls by 49.6%.

Table 9: Impact of changing the private participation (affermage, concession or hybrid delegation contracts) in the water industry on the probability of being water-poor (by income class for year 2001)

Income class	Empirical probability of being water poor	Predicted probability of being water poor	Affermage		Concession		Hybrid	
			-10%	+10%	-10%	+10%	-10%	+10%
1	24.30%	24.8%	18.9%	31.6%	17.8%	33.0%	17.7%	33.1%
			(-24.0%)	(27.2%)	(-28.1%)	(33.0%)	(-28.8%)	(33.5%)
2	9.50%	9.4%	7.4%	11.7%	7.0%	12.4%	6.9%	12.6%
			(-20.6%)	(24.8%)	(-25.7%)	(32.7%)	(-26.9%)	(34.4%)
3	7.40%	8.0%	7.4%	11.7%	7.0%	12.4%	6.9%	12.6%
			(-20.6%)	(24.8%)	(-25.7%)	(32.7%)	(-26.9%)	(34.4%)
4	3.60%	3.8%	3.3%	4.3%	3.1%	4.6%	3.1%	4.6%
			(-11.5%)	(13.1%)	(-17.5%)	(21.1%)	(-18.8%)	(23.0%)
5	2.10%	2.3%	2.2%	2.5%	2.0%	2.6%	2.0%	2.7%
			(-5.7%)	(6.1%)	(-11.7%)	(13.3%)	(-13.2%)	(15.3%)
6	1.10%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
			(3.9%)	(-3.7%)	(-2.9%)	(3.0%)	(-4.2%)	(4.4%)
7	1.20%	1.1%	1.1%	1.0%	1.0%	1.1%	1.0%	1.1%
			(4.2%)	(-4.0%)	(-2.4%)	(2.6%)	(-3.9%)	(4.1%)
8	0.50%	0.6%	0.7%	0.6%	0.7%	0.6%	0.7%	0.6%
			(10.2%)	(-9.2%)	(3.2%)	(-3.0%)	(1.7%)	(-1.7%)
9	0%	0.0%	Na	na	na	na	na	na
			(na)	(na)	(na)	(na)	(na)	(na)
10	0.30%	0.7%	0.7%	0.6%	0.7%	0.6%	0.7%	0.7%
			(9.5%)	(-8.6%)	(4.1%)	(-3.8%)	(0.4%)	(-0.4%)

Numbers in parentheses give the percentage change in the probability of being water poor following a change in private participation (either affermage, concession or hybrid contract) compared to the predicted probability without change. For instance, in the case of a reduction by 10% of the participation of the private sector, the probability of being water poor goes from 24.8% to 18.9% in the case of affermage contracts for households belonging to the first income class. The probability of being water poor falls by 24.0%.