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Water Taxes and Consumer Behavior in France

Simon Porcher¹

Water taxes are employed to correct externalities associated with water pollution or resource scarcity and to raise government revenue. In this paper, using a dataset on more than 4,000 French municipalities, we directly examine how water taxes affect consumer behavior as distinct from tax-exclusive water prices. Our analysis shows that a 10-cent tax increase reduces water consumption by 0.26 percent, similarly to a 10-cent increase in the tax-exclusive water price. The responsiveness of consumers to tax and tax-exclusive price is important because it gives information about consumers' sensitivity to policy interventions versus market prices.

JEL Codes: H23-L95. Keywords: Externalities, Water Utilities.

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1 Introduction

Local governments around the world struggle to manage water resources in the face of increasing consumer demand and growing environmental costs. Since Pigou [1920], the conventional wisdom in economics is that environmental taxes are the best way to deal with externalities, i.e. costs imposed on others that are not taken into account by the agent taking the action. Water taxes are an important policy tool to deal with externalities such as local water pollution, but also to reduce water consumption and mitigate concerns regarding the scarcity of water, thereby facilitating the renewal of water sources. As the price-elasticity of water is supposedly low, water taxes are also a common source of local government revenue.

Despite the fact that water taxes constitute a primary subject of interest with respect to water consumption, little research examines their impact on consumer behavior. A common assumption in previous studies on the effectiveness of higher environmental taxes and the optimal level to ensure durable consumption is that consumers react to tax changes similarly to water price changes. However, recent papers point out that agents might react more strongly to permanent or policy-driven changes than to temporary or market-driven price changes, especially when they are rational (Scott [2012]). Consumers can be myopic and adjust their consumption to changing market conditions or they can be rational and adjust their consumption to what they interpret as permanent price increases. These changes in consumption are worthwhile only if they yield a benefit period after period, agents might ignore changes in the tax-inclusive price because they have limited time or attention (Chetty et al. [2009]).

Our analysis is an attempt to disentangle consumer responses to water taxes and prices. To assess the impact of water taxes on consumption, we use a unique dataset of more than 4,000 municipalities in France in 2008. We do not take into account taxes such as the VAT which is unique at the national level but we consider taxes that are used to clean the polluted basins or to reduce water usage in response to scarcity. We find that both tax-exclusive prices and taxes have a significant and negative impact on consumption and that consumers do not make the difference between tax-exclusive prices and taxes and are thus not more sensitive to an increase in the tax to struggle against water pollution for example.

2 The French Water Industry

In France, as in most European countries, municipalities provide local public services that have certain public-good characteristics. Water provision is one of these public services. If the responsibility for public services provision is public, its management can be either public or private. Although some municipalities provide direct public management and undertake all operations and investments needed for the service, the dominating contractual form is delegated management². In this case, a private operator, independent of the local government, is hired to manage the service and operate facilities, through one of the four different private-public arrangements.

Moreover, in France, negative externalities and resource protection are considered in the water tariff structure, namely to internalize externalities, as the polluter-pays and user-pays principles are clearly stated in the law. Two taxes have been implemented to finance Basin Agencies for the purpose of subsidizing projects to address pollution and protect resources. The per-unit rates of these fees are fixed by the Agencies and depend on the geological characteristics of the Basin. These characteristics are the origin of water and the condition of the sources, for the resource protection fee, and pollution intensity for the pollution fee. On average, the pollution fee is a 0.21 euro tax per unit while the resource protection rate is a 0.52 euro tax per unit. The level of taxes is computed using a simple formula at the municipal level: inhabitants are added to seasonal visitors (weighted by a coefficient of 0.4) and multiplied by an agglomeration coefficient going from 0.5 to 1.4 depending on the size of the city. A pre-determined cost of pollution per capita which is differentiated from city to city is then multiplied by the artificially computed number of inhabitants. The result is the corresponding amount of pollution charges that is to be paid by the municipality to the basin agency. It is then divided by the billed units to determine the level of tax per unit. To the best of our knowledge, France has been the first country to implement water taxes (in the 1960s) but similar taxes exist in the Netherlands (since the 1970s), Germany (1981) and Denmark (1997). These taxes are also designed as incentives to consumer less water, especially in water-stressed regions. France is characterized by some highly resource-stressed regions as the South of France. In our dataset, 5% of municipalities are characterized by state limitations on the maximum amount of water that can be consumed. The product of taxes is collected by the utilities and transferred to the Basin Agencies. The total amount of

² In our database, more than 60% of the municipalities are managed by private operators. Three major companies share with their subsidiaries more than 90% of the private market while other private companies operate mainly in small cities.

water taxes is equivalent to 2 billion euros per year. Our dataset, which covers taxes on consumers for a representative set of municipalities in 2008, the total amount of water taxes equals 1.45 billion euros.

3 Model Specification and Data

3.1 Model Specification

To measure how consumers react to changes in water price and tax, our empirical approach breaks down the tax-inclusive unit price into a tax-exclusive component and per-unit tax:

$$\ln(Q)_i = \alpha \ln(P)_i + \beta \ln\left(1 + \frac{T}{P}\right)_i + \gamma X_i + \lambda_i + \varepsilon_i. \quad (1)$$

with Q the dependent variable, water consumption per household, by municipality (i); P_i is the tax-exclusive per unit water price and T_i is the total per-unit tax; X_i is a vector of municipality-level observables and λ_i is the regional fixed effects for the 100 French *départements*. In this model, the coefficients of interest are α and β because they are useful to compute the price and tax elasticities of water demand. Our approach allows us to derive the semi-elasticities, which are defined as the demand change in percent associated with a unit increase in either the tax-exclusive or water tax:

$$\frac{\delta \ln(Q)}{\delta P} = \frac{1}{P}(\alpha - \beta \frac{T}{P+T}) \quad \frac{\delta \ln(Q)}{\delta T} = \beta \frac{1}{P+T} \quad (2)$$

This approach provides a direct test of whether taxes are more strongly correlated with behavior than are tax-exclusive water prices. If consumers respond equally to a similar change in the water tax and tax-exclusive water prices then α equals β and the two semi-elasticities depicted in equation (2) would be the same. In alternative specifications, we run the same model but using the tax-inclusive water price as the main independent variable, the tax-exclusive water price and $1 + \frac{T}{P}$ alone.

3.2 Descriptive Statistics

The IFEN-SOeS, collected by the French Environment Institute and the Environment Ministry, is a nationally-representative municipal survey of water public services. This sample is representative of the total French population and their local public authorities: all sizes of local authorities are proportionally represented and municipalities with more than 5,000 inhabitants are all included. The

database includes a lot of information at the municipal level about water consumption by domestic customers and municipalities' characteristics that can drive water consumption. We know for example whether the city is located in a touristic area or not or in which region the city is located. An important feature of the IFEN-SOeS dataset is that, in addition to characteristics of the contract such as ownership structure, it provides high-quality information about water bill structure. At the baseline consumption level, we know the amount of the fixed-part and we can compute the marginal price per unit and differentiate taxes from non-inclusive tax prices. Table 1 reports the descriptive statistics for our sample of observations in France in 2008.

4 Results

Table 2 presents the coefficient estimates and standard errors from the OLS specifications. In all specifications, the dependent variable is the consumption per household in log. Column (1) reports the estimates using the tax-inclusive water price, column (2) reports the estimates using the tax-exclusive price alone, column (3) reports the estimates using $1 + \frac{T}{P}$ alone, for comparison with the results when the water price is used as a single regressor. The estimated price elasticity of water in column (1) is -0.33, an estimation that is close to the results of various studies using different samples in France (Porcher [2014]). The result in column (2) is not surprising but the results in column (3) is noteworthy. Indeed, it appears that the elasticity of tax measured as a ratio reported in column (3) is higher than the elasticity of tax-exclusive prices. Column (4) shows the main specification of interest as depicted in equation 1. Here coefficients are slightly different of those observed in columns (2) and (3) where the two interest variables are taken separately because the ratio includes the two variables. The interpretation of elasticity is nevertheless straightforward : elasticities might not be the same, but if both coefficients are equal, semi-elasticities are equal and, then, a tax increase of 1 cent of the tax has the same impact as an increase of one cent. In column (4), coefficients in front of the tax-exclusive price and the tax are almost equal (respectively -0.374 and -0.394).

Table 3 reports the computed semi-elasticities of the specification in column (4). An increase of 10 cents of the per-unit water price would decrease consumption by 2.7% while a similar increase in the level of taxes decreases consumption by 2.6%. The effects are thus rather similar. The p -value of an equal effect shows that we cannot reject the probability of an equal effect for the semi-elasticities.

5 Discussion and conclusion

There are two potential explanations for the elasticity of water taxes. First, consumers might not make the differences between the net prices and the share of the tax. For example, Chetty et al. [2009] propose a simple model in which agents have bounded rationality and consequently face a small cognitive cost of computing tax-inclusive prices. Small cognitive costs can lead agents to ignore a large range of taxes because the utility gain from computing the tax-inclusive price is often quite small. Individuals prefer not to compute tax-inclusive prices for small goods because it is costly for them to take time or attention to do it. This should be the case for water: even if the tax makes up a large proportion of the tax-inclusive price, water bills do not represent a significant share of households spendings (Porcher [2014]).

Nevertheless water taxes can have large impacts on social welfare and tax revenue. When there are no externalities on the market, increasing taxes can raise a significant amount of revenue and could create significant deadweight losses. In markets like water, there are negative externalities due to consumption and when tax is not neutral as in competitive markets. Our results are consistent with the mechanism described in Finkelstein [2009]. A decline in tax salience reduces the proportion of individuals who directly observe tax changes, then it is associated with an increase in tax rates, since individuals are less responsive to any given tax increase. By the same token, the share of individuals who observe the magnitude of the tax change declines..

Moreover, in the standard view of externalities, a Pigouvian tax reflects marginal damages. In this case, current tariffs³ reflect the socially optimal level of exchange on the market because marginal prices equal the sum of private marginal costs and the costs of marginal damages. Under this assumption, inserting tax reflecting marginal damages into firms' cost functions or consumers' utility functions might be the best way to internalize externalities under the assumption that, in the absence

³ To the best of our knowledge, there are few studies evaluating the price of scarce resources. Moncur and Pollock [1988] consider for example the change in marginal cost that would occur at the complete use of the current water source. In their study, they consider that water demand would be satisfied through a desalination technology or a trans-basins diversion, leading to a marginal cost twice as high as than the current one.

of the tax, prices would be equal to private marginal costs. However, while this assumption is reasonable in competitive markets, they are less reasonable for regulated markets such as water in France. As noticed by Davis and Muehlegger [2010], in regulated markets, the standard Pigouvian solution is only verified and thus not distortionary if prices are set equal to marginal cost, which is not the case in the water industry (Porcher [2014]). Although we do not discuss the margins of the industry in this article, evidence of mark-ups in the water industry means that imposing a Pigouvian tax would shift consumption in the wrong direction, further potentially reducing consumption below the efficient level. Estimating the inefficiency costs of the current water taxes is beyond the scope of the paper but we however discuss the potential impact of such taxes and how they can be used to manage scarce resources and the trade-off between the local authority and the firm exploiting the public water service in who should bear the cost of the externality.

Even if our analysis makes full use of the available data, there are at least two limitations to our approach. Firstly, we exploit cross-sectional data but do not observe time-series changes in consumption when taxes vary. Secondly, our approach does not quantify the potential efficiency losses of water taxes due to the existing margins in the water industries. Further work is needed to disentangle and quantify the effects of these factors.

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Table 1: Descriptive Statistics

Statistics	Mean	Std. Dev.
Consumption per household	80.8739	37.5382
Price per unit (in euros)	1.09	0.33
Tax per unit (in euros)	0.44	0.22
Touristic Area (=1)	0.137	0.344
Household Size	1.78	0.155
Share of population under 14 YO	0.186	0.033
Share of population above 60 YO	0.236	0.0678
Linear Consumption Index (Billed units Pipes' length)	15.96	15.42

Table 2: OLS Estimates of the Effect of Price and Water Taxes on Water Demand

Variables	(1)	(2)	(3)	(4)
Tax-inclusive price	-0.332*** (0.0519)			
Tax-exclusive price		-0.163*** (0.0486)		-0.374*** (0.0596)
$1 + \frac{T}{P}$			-0.213*** (0.0445)	-0.394*** (0.0524)
Touristic area	0.117*** (0.0207)	0.109*** (0.0214)	0.127*** (0.0219)	0.133*** (0.0210)
Household size	0.362*** (0.0473)	0.360*** (0.0472)	0.363*** (0.0483)	0.364*** (0.0481)
Population < 14	0.335 (0.274)	0.422 (0.278)	0.318 (0.280)	0.238 (0.275)
Population > 60	0.785*** (0.134)	0.813*** (0.137)	0.779*** (0.137)	0.752*** (0.134)
LCI	0.00444*** (0.000988)	0.00404*** (0.000933)	0.00486*** (0.00101)	0.00509*** (0.00107)
Constant	3.934*** (0.125)	3.757*** (0.122)	3.740*** (0.118)	4.055*** (0.131)
Observations	4,529	4,529	4,529	4,529
R-squared	0.272	0.258	0.262	0.280

Note: The dependent variable is the log of water consumption per household. This table reports how consumers respond to changes in unit price and tax level. Price, tax and consumption are in log to allow the coefficients to be interpreted as elasticities. All regressions include *département* fixed-effects. *Département*-clustered robust standard errors are presented in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Computed Semi-Elasticities

Variables	Semi-elasticities
Water price	-0.269*** (0.053)
Water tax	-0.258*** (0.034)
<i>p</i>-value equal effects	0.14

Note: This table reports estimated semi-elasticities for water consumption from a 0.10 euros per unit increase from either the tax-exclusive price or tax for the specification in column (6) in Table 2. The calculation is based on column (6) of the specifications in Table 2. The estimates use the average tax and tax-exclusive price in 2008. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.