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RESEARCH IN ECONOMICS AND RURAL SOCIOLOGY

To drink or not to drink (tap water)? The impact of environmental quality on consumer's choices.

Surveys regularly report that a large share of the French population declares not to drink tap water. However, tap water has a very good sanitary quality, is regularly and strictly controlled, and is approximately one hundred times cheaper than bottled water. We attempt here to identify which factors are affecting households' decision to drink (or not) tap water. Using a sample of French households, we show that both the socioeconomic characteristics of the household (income, education, rural or urban residence), and the surrounding quality of the environment (measured here by the raw water quality) are important in the households' decision process to drink tap water.

Bottled or tap water?

In France, drinking tap water is a hundred times less costly than drinking bottled water. The tap water is regularly and very strictly checked insuring a good sanitary quality, baring accidental pollution. However, surveys regularly made upon representative samples of the French population show that around 40% of the respondents declare not to drink tap water. The reasons for not drinking tap water are by order of importance, its "bad taste" (the chlorine taste is the most often mentioned), its hardness (calcium content), and the fear of diseases and other sanitary risks.

These surveys also reveal differences in households' behaviour depending on their socioeconomic, demographic characteristics and their cultural habits: age, income, size and composition of the household, occupation as well as geographic location.

The datasets used here exhibit the same pattern as we observe similar socioeconomic and geographic heterogeneity in the households' decision to drink or not tap water (cf. frame 1).

Table 1 presents some summary statistics illustrating the difference in the share of "tap water drinker" households and some other features of households varying by French region.

Furthermore, the Sofres/CI.EAU study mentions a possible link between the surrounding environment quality perceived by households and their confidence in the tap water quality. People qualifying their surrounding environment as "quite damaged" or "damaged" seem to have less confidence in tap water quality. According to some experts, households' choices could be influenced by advertising campaigns made by major mineral water brands. In those campaigns, bottled water is indeed most of the time associated with images of "purity" and preserved environment. In Map 1 (resp. 2), we present the average non-alcoholic beverage consumption (resp. the poor raw water quality index) for each French *département* (see Frame 2). These two maps partially illustrate the potential link mentioned above.

Frame 1: dataset used

The dataset used is based on two main sources. First, data on French households' purchases are provided by TNS Worldpanel (Secodip), for the year 2001. This database contains information on French households' purchases of food items (of particular interest here, it includes drinks) as well as households' socioeconomic and demographic information. Second we use data on water distribution networks of 4880 French municipalities (IFEN-SCEES-Agences de l'eau, 2001), and data on raw water quality (Ministry of Health, 2001), both collected at the municipality level. Finally, we merge this information with the households' panel through the residential address of each household. The final sample consists of 4623 households spread all over the French territory.

Table 1: Summary statistics by region (4623 households)

French region by Secodip	Households	Tap water drinkers (%)	Monthly income (€)	Households in rural areas (%)	Households with retired head (%)
Paris and surrounding	867	67	2479	0.40	24
East	433	67	2102	6.00	27
North	467	48	1899	3.40	22
West	860	66	1923	12.40	29
Centre-West	402	67	1844	7.20	24
Centre-East	696	80	2081	5.30	22
South-East	483	72	1916	3.10	29
South-West	415	77	1854	5.50	27
All	4623	68	2052	5.50	26

Source: Secodip (2001).

Frame 2: Computation of the poor raw water quality index

Carpentier *et alii* (2006) showed that the water price paid by households in a municipality (P) depends on various factors:
- technical factors (T) such as size, complexity and shape of the distribution network,
- geographical factors (G): plain versus mountain,
- human factors (H): population density (rural or urban area),
- organisational factors (O): public or private management,
- and factors linked to raw water quality (Q): water origin (groundwater, surface water), raw water quality class (good, average and poor), protected or unprotected catchment.

We estimate here a water price equation using appropriate econometric methods. The parameter a_t, a_g, a_h, a_o and a_q associated with each of the above factors reflect their importance in the water price construction. The model is as follows:

$$P = a_0 + a_t T + a_g G + a_h H + a_O O + a_q Q$$

The impact of the raw water poor quality is measured by the vector of the estimated parameters $\widehat{a_q}$, so the Poor Raw Water Quality (PRWQ) index is defined by $IMQ = \widehat{a_q} Q$

The index defined here is constant within each municipality. The average index is equal to 0.93. It varies from 0.87 in the North up to 0.97 in Paris and surroundings and in the West, both regions being particularly affected by nitrate pollution (see map 2).

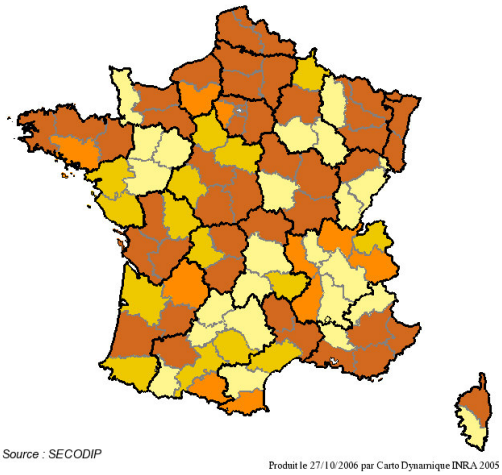
Water drinkers influenced by their environment

We estimate a so-called Probit decision model in order to measure the impact environmental, socioeconomic and cultural factors may have on households' decision to drink (or not) tap water. This econometric model uses households' consumption data merged, at the municipality level, with the poor raw water quality index. It is estimated using the Maximum Likelihood method (see Frame 3). Estimated coefficients may be read as marginal effects measuring the positive or negative impact (depending on the estimated coefficient sign) of each factor on the probability for households to drink tap water.

We introduce cross-effect variables in the decision model in addition to socioeconomic and demographic information and to the PRWQ index – obtained by estimating the "purification" cost of tap water at the municipality level. Those variables aim at testing whether or not the environmental quality effect depends upon households' characteristics.

The marginal effect of the "poor raw water quality" index is estimated at -0.638, and it is statistically significant (at a level of 1%), confirming the influence of the environment quality on the households' choice regarding tap water consumption. The negative effect of this "poor quality" index on the probability to drink tap water is however mitigated for high income households (significant cross-effect at the 1% level), and for households with a retired head (significant cross-effect at the 10% level). The bottled water price being much greater than tap water price, less wealthy households are therefore more affected by the (perceived) bad quality of tap water. Moreover, a high income decreases the probability to drink tap water, *ceteris paribus*. A household whose head is retired would have, all things being equal, a lower probability of drinking tap water. This may be resulting from the poor confidence elderly people have in tap water. Note that retired, and more generally elderly people, are the target of bottled water advertising campaigns. Elderly people also have advices given by their doctor to drink such highly mineralized waters, in order to compensate some specific deficiencies.

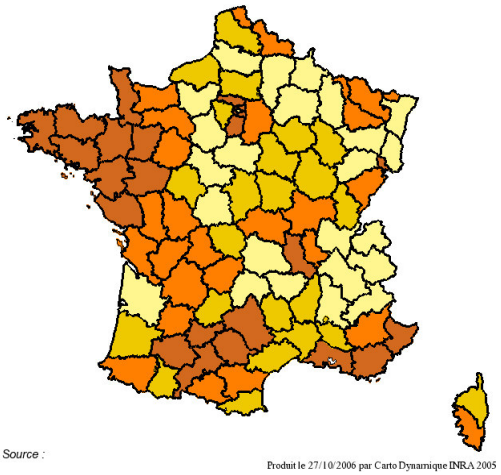
Map 1: Soft drink consumption in France.



Key:

- < 9 liters/pers/month
-] 9; 10.5] liters/pers/month
-] 10.5; 12] liters/pers/month
- > 12 liters/pers/month

Map 2: Average value of the "poor raw water quality" index.



Key:

- < 0.848 (1st quartile)
-] 0.848; 0.874] (2nd quartile)
-] 0.874; 0.923] (3rd quartile)
- >0.923 (4th quartile)

Living in a rural area (i.e., in a municipality of less than 2000 inhabitants) does not seem to play a significant role in this model. It is quite difficult to have a clear idea of the expected impact of rural *versus* urban residence in our model since many (opposite) effects interact. On the one hand, people living in rural areas can easily store bottled water (contrary to households living in cities, in particular in an apartment), and own most often a car, facilitating bottled water transport. These elements act in favour of a negative effect (negative coefficient) due to rural living on the probability to drink tap water. On the other hand however, the average distance to the closest super or hypermarket is higher for people living in rural areas than for city dwellers (positive effect).

In our model, the average marginal effect associated to the PRWQ index measures the specific effect of the raw water quality for each region (see Table 2). Marginal effects must be compared to the reference region (i.e. Centre-East) marginal effect. The marginal effects are all negative and vary from -0.721 for the North to -0.544 for the South-West.

The small marginal effect observed in both southern French regions may be explained by the presence of two mountain chains (the Alps and the Pyrenees), where the quality of raw water and the environment are globally better than in other regions with plains. The North and West face groundwater contamination due to nitrates. These regions are also characterized by a high population density and industrial activity (particularly in the North) causing the presence of mineral micro-contaminants (aluminium, arsenic and chrome, copper, etc.) in groundwater.

Table 2: Marginal effects of the "poor raw water quality" index computed at the regional mean

Paris and surroundings	-0.654
East	-0.650
North	-0.721
West	-0.663
Centre-West	-0.652
Centre-East	.
South-East	-0.600
South-west	-0.544

Frame 3: The "decision model" of the water drinker

We developed an econometric model in order to assess the relative weight of the factors influencing the households' decision to drink tap water. Each household is defined as a tap-water drinker or not based on the observation of its (average) soft drink consumption. We consider here all soft drinks (i.e., bottled water and sodas) since it has been shown from French data that bottled water and other soft drinks are substitutable goods (Boizot, 1999). Assuming that an agent consumes 0.5 litres of drink per day, 68% of our households are classified as tap water drinkers. We use previous studies, survey results and economic theory for the choice of explanatory factors. Even if we do not have information on the objective quality of each household's tap water, we have a lot of information on their socio-demographic characteristics and their place of residence. In the model, we consider the following factors: (i) The education level of the household head. We split that information in 4 categories: non-graduated, qualification lower than *baccalauréat*, graduated from high school or college, those for which we have no information. (ii) The household's level of income. (iii) The rural or urban residence of the household. We create a dummy equal to 1 if the household lives in a municipality of less than 2000 inhabitants and 0 otherwise. (iv) If the household head is retired or not. We create a dummy equal to 1 if the household head is retired and 0 otherwise. (v) The household's region of residence. We follow here the regional classification made by TNS (Secodip). We distinguish eight regions: Paris and surroundings, the East, the North, the West, the Centre-West, the Centre-East, the South-East and the South-West.

The impact of a change in environmental quality on water consumption

An alternative way to interpret the results is to estimate the impact of a variation in the "poor quality" index on the probability to drink tap water within two scenarios:
- Scenario A (deterioration in raw water quality): Within each region, the municipality raw water quality indexes are set to the minimum value of the PRWQ index observed within the region.
- Scenario B (improvement in raw water quality): Within each region, the municipality raw water quality indexes are set to the maximum value of the PRWQ index observed within the region.

In each scenario, we compute the models predictions for the probability to drink tap water and compare it with the original, in each region. In these predictions, all the variables but the PRWQ index, are set to their regional mean. Results are presented in Table 3.

Table 3: Probability to drink tap water in both scenarios

Region	Probability	Scenario A 'deterioration' (a)	Scenario B 'improvement' (a)
Paris and the surroundings	0.67	-0.021	0.108
East	0.67	-0.101	0.088
North	0.48	-0.113	0.085
West	0.66	-0.070	0.089
West-Centre	0.67	-0.096	0.089
Centre-East-	0.80	-0.088	0.060
South-East	0.73	-0.211	0.095
South-West	0.77	-0.053	0.092
All	0.68	-0.086	0.088

(a): Figures represent the probability variation predicted by the model.

On average, raw water deterioration [resp. improvement], would lead to a decrease [resp. increase] in households' probability to drink tap water of around 0.09. The deterioration of the raw water quality would lead to a more important substitution for bottled water in the South-East (-0.211), and in the North (-0.113). The predicted effect would be of less importance in Paris and surroundings (-0.021). The model helps also predicting that an improvement in the raw water quality would increase the probability to drink tap water in the Centre-East by 0.06 and by 0.11 in Paris and surroundings.

Conclusion

The households' decisions to drink tap water are influenced by the quality of their environment and particularly by the raw water quality. This influence varies according to households' own characteristics (income level, education level, type of dwelling, etc.) and according to specific regional effects. The confidence a household has in official standards or in compliance with them, as well as the level of information it has on the sanitary quality of tap water, plays a crucial role in its consumption choice.

To improve the welfare of French consumers, better information on the sanitary quality of tap water as well as improvements in the quality of raw water are necessary. This is particularly important for the poorest consumers for whom the expected impact of poor raw water quality on the decision to drink tap water is high. If a household drinks tap water rather than bottled water, its expenditure will be indeed a hundred times lower for the same consumption level.

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