0001Waste

MUNICIPAL WASTE STRATEGY AND HOUSEHOLDS' BEHAVIOUR AND ATTITUDES.

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Abstract. In the European Union and more specially in France, waste management is expected to change significantly in the coming years. The objective is to increase recycling and by 2002, to accept only ultimate waste in landfills. To achieve this, a number of new recycling facilities will be required and landfill-operating standards will also be tightened and enforced. The decrease in the number of incinerators and of landfill sites is expected to continue in the future since the closing of obsolete facilities is planned. Modernised and new installations will therefore operate on a larger scale.
There has been a public debate about the amount of local taxes including disposal fees, and people have felt uneasy about their increase during the eighties and nineties. The success of the waste policy will heavily depend on households' behaviour and attitudes. For that reason we carried out a survey in a densely populated area of 10 million inhabitants, Paris and its outskirts. To formulate the questionnaire, the focus group technique has been used to identify the main issues. The behaviour regarding waste collection and recycling was considered in the first part of the questionnaire. Then people were asked to state their maximum willingness-to-pay (*WTP*) for improving the present situation. Finally they had to vote for one of five incinerator types with different levels of pollution control and costs, the first one being the one currently used, with no tax increase. This questionnaire was administered in 403 face-to-face interviews at home.
Nobody refused to answer the *WTP* question, but 34% of the respondents gave a zero value. Low-income people and non-respondents to the income question are more likely to give a zero *WTP*. This point is corroborated by the influence of education, since the probability of a positive answer increases with the level of former education of the respondent. People suffering morbidity symptoms or people whose relatives suffer such symptoms are more inclined to state a positive *WTP*.
Several econometric procedures including a Tobit model have been used to estimate *WTP*. According to economic theory *WTP* increases with income. With respect to the influence of income, it must be noted that the non-response modality effect is close to the lowest-class of income effect. Formal education up to secondary school makes it less likely that respondents state a high bid. With respect to age, people under forty are willing to pay more than other respondents. Both education and age influences are non-linear. Finally, respondents suffering headache, sinus pain and throat irritation are willing to pay quite a large additional amount. The constant of the Tobit equation provides an estimate of *WTP* for a hypothetical respondent. It equals 181 FF[1] which is in the range defined by the median and the mean of the empirical distribution. Modelling the vote shows that most people prefer the best available technology and accept to pay for it. Actually municipalities do not implement this as they tend to choose the cheapest technology, thus meeting the minimum standards enforced by law.

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Suggested area of the paper: Valuation and Cost-Benefit Analysis/Environmental Regulation.

[1] FF: French Franc. 1 FF = 0.15245 €.

Introduction.

Waste from all sources has increased for years and their management has become an important environmental issue. Municipal solid waste (MSW) [2] amounts to 26 million tonnes in France in 1995, 80% arising from households (Ministry of the Environment, 1998). The average yearly production of MSW by households is now about 425 kilogram per capita, twice the amount of 1960. Similar figures are observed among the other European Union members (European Commission, 1999a).

The current Fifth Environmental Action Programme reinforces the European Union's strategy for waste management and places more emphasis on waste reduction and solving waste problems at their source. It calls for the promotion of recycling and re-use in order to limit the volume of waste requiring final treatment. Moreover, the Landfill Directive (European Commission, 1999b) of July 1999, aims to harmonise controls, throughout European Union, by setting common standards for the design, operation and aftercare of landfill sites. Since biodegradable waste breaks down to produce the greenhouse gas methane, the Landfill Directive sets progressive targets to reduce biodegradable waste going to landfill. Member States shall set up a national strategy complying with these targets. By 2016, biodegradable municipal waste [3] going to landfills must be reduced to 35% of the total amount (by weight) produced in 1995. Intermediate targets of 75% by 2006, and 50% by 2009 have also been set.

The Landfill Directive objectives are consistent with French law. Indeed, the 1992 Waste Disposal Act which became effective in April 1993, defines a comprehensive waste management policy whose objectives are to establish a hierarchy for waste disposal: recycling, then processing and finally landfilling. Only final waste should be received in landfill sites by the year 2002. France currently disposes of an important part of its MSW (Table 1) by sending it to the landfill, and meeting the targets presents a substantial challenge. Roughly 40% of MSW are incinerated, over 45% are dumped in 10000 landfills (but 6000 of them are not controlled), about 5% are recycled. The objective is to increase recycling up to 25%, and by 2002, to accept only ultimate wastes in landfills (ash from incinerators, toxic products, asbestos, etc.).

To achieve this, a number of new treatment or recycling facilities will be required to ensure that the waste is made inert, stabilised or solidified. Landfill-operating standards will also be tightened and enforced. The decrease in the number of incinerators and of landfill sites is expected to continue in the future since the closing of obsolete facilities is planned. Modernised and new installations will therefore operate on a larger scale.

Table 1. MSW management in France: share of the different options (%).

Years	1989	1993	1995
Composting & collecting methane	6	6	7
Re-use & recycling	4	6	6
Incineration with energy recovery	10	12	10
Incineration without energy recovery	27	28	30
Landfill	53	48	47

Source: Ministry of the Environment (1998).

Waste policy combines regulation, economic incentives and persuasion. Costs imposed on collection, transport, sorting, processing, recycling and disposal of wastes are likely to increase. A number of operators are involved among which households are key players. They

[2] MSW includes waste originating from households and from businesses that dispose of waste at the same facilities.

[3] The biodegradable content of municipal waste is around 60%.

will have to bear an increasing financial burden and they are expected to voluntarily participate in extensive sorting, using separate trash cans provided by municipalities.
Disposal fees are a separate component of the local taxes collected by municipalities and regional authorities. There is a public debate about the amount of local taxes and people feel uneasy about their increase during the eighties and nineties. The success of the waste policy will heavily depend on households' behaviour and attitudes. For that reason we have carried out a survey of 403 persons in a densely populated area of 10 million inhabitants, Paris and its outskirts. First the behaviour regarding waste collection and recycling is considered. Then people are asked to state their maximum willingness-to-pay (*WTP*) for improving the present situation. Finally they have to vote for one of five incinerator types with different levels of pollution control and costs, the first one being the one currently used, with no tax increase.

1. Questionnaire and survey.

To formulate the questionnaire it was necessary to understand how much the public knows about waste management. For this purpose the focus group technique has been used to identify the main issues. Two ten-person groups have been conducted by a psychologist familiar with contingent valuation (CV). Upper and lower middle class people living in an area close to a landfill or close to an incinerator were selected to participate in these groups. People were paid for their participation and sessions were video recorded.
The focus group exercise has led to a first version of the questionnaire which has been tested by using verbal protocols. A twenty-person sample have been asked to read aloud and to answer the questionnaire. It is an interactive survey approach which allows the questionnaire to be tailored to the specific application (McClelland *et al*., 1993). This process led to the final questionnaire which is divided into three sections.
In the first part of the questionnaire the usual socio-economic variables (sex, age, occupation) are considered in order to respect the quota method to construct a representative sample. Then people where asked to describe their current behaviour and attitudes about waste management. How many trash cans do they use? (These trash cans are provided by their municipality). What do they do with specific wastes like batteries or lubricating oil? Do they sort and bring specific wastes like paper or glass to collection points which can be far from their dwellings? Do they know the quantity of MSW they produce each year? According to their location (near a landfill, or an incinerator), people were asked in an open question, to state the harmful effects they spontaneously associate with the existence (if they are aware of it) of the landfill or the incinerator.
In the second part of the questionnaire (Box 1) we start to give them information on the waste management problem, and the objective of the government in the coming years. Specific information is given on the adverse effects of landfilling and incineration. Recycling 25% of the wastes is stated as an objective, but it will increase the cost of waste management. Then people are asked to participate in the implementation of a new waste policy in their community. At this stage of the questionnaire we ask them to express their maximum willingness to pay for an improvement in the municipal waste management. The question is voluntarily general, and the only information given is the tax bill paid, each year, by a couple with two children.
In the third part of the questionnaire people where asked to choose a type of incinerator. The more sophisticated the technology and less polluting the plant, the more expensive is the treatment of the waste (Box 2).
All the information given is true. The costs of waste treatment were provided by the industry, and the benefits of pollution control have been calculated specifically for the region of Paris during a European research project (Rabl *et al.,* 1999), using the impact pathways methodology of the ExternE project (ExternE, 1998).

The principal steps of the impact pathway methodology are the following:

- specification of the relevant technologies and the environmental burdens they impose (*e.g.* kg/s of particles emitted by a power plant);
- calculation of increased pollutant concentration in all affected regions (*e.g.* $\mu g/m^3$ of particles, using models of atmospheric dispersion and chemistry);
- calculation of the resulting dose and the physical impacts (*e.g.* number of cases of asthma due to these particles, using a dose-response function);
- economic valuation of these impacts (*e.g.* multiplication by the cost of a case of asthma).

If more information was requested by the interviewee, a copy of a paper (Rabl *et al.*, 1998) was given.

Box 1. Eliciting *WTP*.

Imagine that you are responsible for choosing the waste management policy of your community.
Suppose that until now your community has been putting the waste into a landfill, but the new legislation requires that after 2002 the environmental and health impacts of waste disposal be reduced. Suppose that 25% of the wastes will be recycled, and a destination must be found for the remaining 75%.

An ordinary landfill today costs 300 FF per ton. That is on top of 250 FF per ton for the collection. A Frenchman produces on the average 425 kg of wastes per year. An average family of 4 persons produces 1.7 tonne wastes per year. **Today an average family pays about 1000 FF per year for waste disposal, as part of its local tax.**

Incineration costs more than landfilling. But the regulations imposed by the European Commission are very strict and allow only technologies that entail negligible health risks.

Can-you to tell me what maximal increase of your tax per year you would accept for an improvement of the processing of your wastes? ____ FF

How much are you currently paying for your local taxes? ____ FF

Box 2. Choosing one large-scale type of incinerator.

An incinerator emits a certain amount of pollutants into the atmosphere (as do cars, furnaces, etc.). There is a variety of different technologies to that can greatly reduce the quantity of pollutants emitted by an incinerator, but the cleaner the technology the higher the cost. In particular, one tries to limit the emission of dust, sulfur oxides and nitrogen oxides (which increase respiratory health problems) and of dioxins (which cause cancer).
Suppose that there are the following four options for the incinerator that could be built for your community, presented in order of increasing pollution control:

Option 1: An incinerator that meets the new European regulation concerning dust and sulfur oxides.
This incinerator will emit 3 times less dust and 6 time less sulfur oxides than a typical incinerator today. The resulting benefit for the health of the population is estimated to be worth **80 FF** per ton of waste, compared to a typical incinerator today. However, it would increase the cost of incineration by **65 FF** per ton of waste (**111 FF per family per year**), beyond the 450 FF per ton of waste for a typical incinerator today.

Option 2: An incinerator that offers the advantages of Option 1 and in addition emits less dioxins.
This incinerator will emit 10 times less dioxins than a typical incinerator today. The resulting benefit for the health of the population is estimated to be worth **85 FF** per ton of waste, compared to a typical incinerator today. However, it would increase the cost of incineration by **73 FF** per ton of waste (**124 FF per family per year**), beyond the 450F per ton of waste for a typical incinerator today.

Option 3: An incinerator that offers the advantages of Option 2 and in addition emits less nitrogen oxides.
This incinerator corresponds to current regulations in **Germany**; it will emit approximately 2 times less nitrogen oxides than a typical incinerator today. The resulting benefit for the health of the population is estimated to be worth **118 FF** per ton of waste, compared to a typical incinerator today. However, it would increase the cost of incineration by **120 FF** per ton of waste (**204 FF per family per year**), beyond the 450F per ton of waste for a typical incinerator today.

Option 4: An incinerator that offers the advantages of Option 3 but emits even less nitrogen oxides.
This incinerator corresponds to current regulations in the **Netherlands**. The resulting benefit for the health of the population is estimated to be worth **160 FF** per ton of waste, compared to a typical incinerator today. However, it would increase the cost of incineration by **160 FF** per ton of waste (**272 FF per family per year**), beyond the 450 FF per ton of waste for a typical incinerator today.

To summarise:
Option 0: the current situation
Option 1: increased cost 111 FF per family per year
Option 2: increased cost 128 FF per family per year
Option 3: increased cost 204 FF per family per year
Option 4: increased cost 272 FF per family per year

For which solution would you vote? (you can prefer the current situation)

Do you accept therefore a voluntary increase of your taxes of ___ F *(cost of the chosen option)* per year?

The wording emphasises that the interviewees are free to prefer the present situation. And if they choose any other solution they accept to pay the stated amount (recalled by the interviewer).
Finally, people were asked if they, or a member of the family, is suffering of symptoms related to air pollution, and if they smoke or not. The last questions concern education and income, and the number of persons in the family.
This questionnaire was administered in 403 interviews face-to-face at home, distributed in the following communities:

- 100 in Paris 13th Arrondissement,
- 100 in Paris 15th Arrondissement,
- 203 in Villeparisis, 15 km North-East of Paris.

These communities were chosen because they are either close to an existing incinerator (Paris 13th and 15th) or close to an existing landfill (Villeparisis).

2. Sample characteristics

Based on the quota method the sample is representative of the three populations, in terms of age, sex and occupation.
The age ranges from 18 to 87 years, mean and median age are equal among the sub-samples, but statistical distributions show differences, with a higher percentage of respondents between 40 and 50 years in the Villeparisis sub-sample (Table 2). This is consistent with the relatively high number of couples with children in this area. Otherwise, there are more people over 70 years in Paris 15th sub-sample. 6.3% of the sample refused to situate their income in one of the 9 classes proposed. Retired people indicate their last occupation.

2.1. Basic statistics

In comparison with the Villeparisis sub-sample, the Paris 15th sub-sample is biased toward wealthy and highly educated people. Besides, the Paris 13th one is between these two extreme cases. This ranking is consistent with differences in the cost of living among these areas.

Table 2. Basic statistics

Variable	Sample	Number	Mean	Median	Standard Deviation
Sex (1 = men, 0 otherwise)	All	403	0.50		
Age (years)	All	403	48	47	0.82
Type of household (1 = couple with children, 0 otherwise)	Paris 13th	99	0.29		
	Paris 15th	100	0.34		
	Villeparisis	200	0.52		
	All	399	0.42		
Education (1 = over secondary school, 0 otherwise)	Paris 13th	100	0.48		
	Paris 15th	100	0.55		
	Villeparisis	202	0.15		
	All	402	0.39		
Active (1 = employed person, 0 otherwise)	Paris 13th	100	0.68		
	Paris 15th	100	0.66		
	Villeparisis	203	0.75		
	All	403	0.71		
Occupation (1 = high position[1], 0 otherwise)	Paris 13th	100	0.21		
	Paris 15th	100	0.33		
	Villeparisis	203	0.09		
	All	403	0.18		
Monthly income by household (FF) [2]	Paris 13th	93	15962	12500	8305
	Paris 15th	92	18353	17500	8989
	Villeparisis	189	14047	12500	6398
	All	374	15583	12500	7777

Note: [1] This category includes executives, managers and professionals.
[2] Available monthly income has been categorised into 9 classes and respondents were asked to indicate the relevant class for their household. Mid-points are used to calculate the various statistics but the four households in the highest income class are excluded.

2.2. Concerning symptoms related to air pollution

46.4% of the respondents reported at least one symptom of morbidity for themselves and 48.6% for one member of their family. There is no relationship between age and number of symptoms, but people reporting headaches are younger, and those reporting breathing difficulties are older. Moreover rhinitis are relatively more frequent in Paris and breathing difficulties in Villeparisis. Smokers did not report more symptoms than non-smokers.

Table 3. Data on respondents' morbidity

Symptoms	Number	%	Mean age (years)
Breathing difficulties : asthma, chronic bronchitis	67	35.8	51
Rhinitis (common cold)	50	26.7	52
Headaches	48	25.7	39
Throat irritation	22	11.8	46
Total	187	100	47

2.3. Concerning recycling behaviour

Waste separation at the source depends on the availability of several trash cans, offered by the municipality, in each dwelling. In Table 4 one can see that the 13th Arrondissement in Paris is engaged in the largest effort of sorting waste.

Table 4. Percentage of households that sort waste at the source

Number of trash cans	1	2	3 or more	Total
Paris 13th	34.0	17.0	49.0	100
Paris 15th	23.0	72.0	5.0	100
Villeparisis	96.0	1.5	2.5	100
All	62.6	22.8	14.6	100

Sorting and recycling strategy also relies on the use of central collection facilities which are available for glass and paper in most municipalities. There is no financial incentive to separate wastes and to bring them to the relevant collection centre. So, public policy is based on education and moral persuasion. People who regularly use collection centres act voluntarily and incur additional costs. As we can see in table 5, the distance from home to the nearest centre influence negatively the willingness to use them. Voluntarily use is quite popular since 59.2% of the respondents state that they use them always or often (but we must be careful with this assertion because of the well known tendency to overstate a "good" behaviour). Higher level of education and income are positively correlated with sorting, and retired people are relatively more involved in these programmes. It appears that both programmes (sorting at the source and bringing to a collection centre) are complements.

Table 5. Willingness to use collection centres

Type of use	Number	%	Distance from home (m)
Always	184	47.1	248
Often	47	12.1	214
Time to time	63	16.2	487
Never	96	24.6	472
Total	390	100	338

2.4. What people know about MSW production and management

It appears clearly that respondents are not well-informed. First of all they tend to underestimate the amount of waste their family produces, the underestimate increasing with the number of persons in the household. In the 15th and the 13th arrondissement 45 % of the interviewees know that their wastes are incinerated in the nearby incinerators of Issy les Moulineaux, or Ivry, and less than 40% of them consider that the incinerator generates air pollution. The rest state explicitly that the incinerators are not harmful.

Concerning Villeparisis, 75% of the respondents know that they are living near a landfill, 52% of them reporting nuisances : odours, noise (from the traffic), health effects, water pollution. It is interesting to mention that people living close to the landfill (one km or less) can have two opposite attitudes, either they suffer and they can be very precise in the description of the nuisances they attribute to the landfill, or they do not suffer at all. When they live further away the description of the nuisance become more general (odour, noise, health impact in general).

4. Modelling and estimating *WTP*.

Nobody refused to answer the *WTP* question, but 34% of the respondents gave a zero value (Table 6), 30% for the 15th Arrondissement, 25% for the 13th Arrondissement, and 41% for Villeparisis. The lowest value stated was 10 FF and the highest was 2000 F. Recall that before asking this question we gave information about the average MSW tax paid by a household with two children, 1000 FF. One-fourth of the respondents are willing to accept a rather high increase (over 300 FF) in disposal fee to improve the present situation

Table 6. Annually *WTP* (in FF) to improve the present situation.

	N	Mean	Standard-error	1st quartile	Median	3rd quartile	Min	Max	Mode
All *WTP*	403	244	340	0	150	300	0	2000	0
WTP > 0	266	370	359	150	250	500	10	2000	500

Note. N = number of observations.

If we observe the results by community:

- in the 15th Arrondissement the mean *WTP* is 371 FF for individuals with positive *WTP*, 260FF for all;
- in the 13th Arrondissement the mean *WTP* is 364 FF for individuals with positive *WTP*, 273FF for all;
- in Villeparisis the mean *WTP* is 379 FF for individuals with positive *WTP*, 222 FF for all.

It is surprising to see that the mean for individuals with positive *WTP* is so close for the three communities, when the general level of income is so different. Are they expressing a "cultural value", more than a transaction value ? If we take a closer look at the data we see that no income effect appears in the 15th Arrondissement. But in the 13th Arrondissement and in Villeparisis the 25% highest *WTP* (from 400 FF to 2000 FF) are offered by the households with high income. People, by a large majority seem to express a lump sum, not directly related to their income. This result is partly due to the way we phrased the *WTP* question, on purpose very general, with no information on a specific policy and its cost, in order to estimate the order of magnitude in tax increase acceptable to the general population. The principal limit of this phrasing is that the number of zeroes is high. And we were lucky that the highest *WTP* values are plausible.

If now we merge all the data, and we try to discriminate, with a probit model, the population in two categories, those who accept to pay something, and those who refuse, we find that the most significant variables are income, education, age and symptoms of morbidity (Table 7). Low-income people and non-respondents to the income question are more likely to give a zero *WTP*. This point is corroborated by the influence of education, since the probability of a positive answer increases with the level of former education of the respondent. Other things being equal, respondents whose age is between 40 and 60 are more ready to bid positively. A significant influence of morbidity symptoms of one member of the family is also observed. Symptoms of the respondent does not have a significant effect with the probit specification, but a significant one has been found with a logit specification. So people suffering morbidity symptoms or people whose relatives suffer such symptoms are more inclined to state a positive *WTP*. This result is consistent with prior expectation regarding the influence of morbidity on *WTP*. In addition, it is found with a logit model that where there is a couple with children, the respondent is more inclined to bid positively. This is consistent with a bequest behaviour.

Table 7. Probability to give a zero *WTP* (Probit procedure).

Variable	Estimate	Std Error	ChiSquare	Pr > Chi
Constant	-0.50	0.32	2.37	0.12
Income			10.08	0.04
< 10000 FF	0.43	0.23	3.42	0.06
10000-15000 FF	0.05	0.21	0.05	0.83
15000-20000 FF	0.03	0.22	0.02	0.90
NR	0.71	0.30	5.65	0.02
> 20000 FF (ref)	-	-		
Education			5.53	0.06
Primary	0.34	0.22	2.44	0.12
Secondary	0.39	0.17	5.37	0.02
High (ref)	-	-		
Age (years)			20.54	0.00
< 40	-0.70	0.18	15.40	0.00
> 60	0.13	0.20	0.44	0.51
40-60 (ref)	-	-		
Type of household			3.60	0.31
One person	0.02	0.22	0.01	0.93
Couple with children	0.36	0.21	3.09	0.08
Other	0.11	0.25	0.20	0.65
Couple without children (ref)	-	-		
Landfill disamenities?			1.18	0.55
NR	0.11	0.17	0.40	0.53
No	-0.09	0.23	0.15	0.70
Yes (ref)	-	-		
Respondent's symptoms			2.76	0.43
NR	-0.06	0.20	0.08	0.78
Sinus/throat	-0.35	0.24	2.05	0.15
Headache	0.00	0.27	0.00	0.99
Breathing difficulties (ref)	-	-		
Family's symptoms			9.50	0.02
NR	-0.37	0.18	4.44	0.04
Sinus/throat	-0.57	0.26	4.75	0.03
Headache	-0.72	0.31	5.31	0.02
Breathing difficulties (ref)	-	-		
χ^2 (a)	DF =19		43.99	0.00
Concordant predictions = 69.80%			N = 403	

Note. NR = non-response, ref = reference, N = number of observations, DF = degree of freedom. (a): likelihood ratio test statistic for joint significance of the covariates.

Probit and Logit models do not use all the information available. To go further, let us consider the dual programme of a respondent who minimises his expenditures providing his utility level U_0 and a vector p of prices (Mas Collel *et al*,.1995). The programme is written as follows:

$$\begin{cases} \underset{x}{Min}\, p'x \\ U(x, Q_0, m) \geq U_0 \end{cases}$$

x is the vector of market commodities while m describes the respondent's socio-economic characteristics (age, sex, income, education). Finally, Q_0 is the current waste management policy. This programme admits a solution which is the restricted expenditure function :

$e^r(p, Q_0, m, U_0)$

Its value is the minimum expenditure, given prices, respondent's characteristics, required utility level and waste management policy. But in addition, the respondent has to pay a certain amount of disposal fee equal to $V(Q_0)$. Therefore total expenditure is:

$$e_0 = e^r(p, Q_0, m, U_0) + V(Q_0)$$

Let us now imagine an improvement in waste management policy associated with an increase in disposal fees. The reference situation being defined by U_0 and by the current policy Q_0, this results into a welfare gain associated with an increase in compensating surplus. Indeed, the following relationship holds:

$$e^r(p, Q_0, m, U_0) + V(Q_0) = e^r(p, Q_1, m, U_0) + V(Q_1)$$

where Q_1 is the new policy and $V(Q_1)$ the new amount of disposal fees.
Given utility level and total expenditures, the respondent's *WTP* is defined as follows:

$$WTP = V(Q_1) - V(Q_0) = e^r(p,Q_0,m,U_0) - e^r(p,Q_1,m,U_0)$$

This is the classical definition of the compensating surplus in terms of a variation in the restricted expenditure function. This leads to:

$$\begin{cases} WTP^*(\Delta Q) = f(p,m,U_0,\Delta Q) + \varepsilon \\ \Delta Q = Q_1 - Q_0 \end{cases}$$

where ε is random variable, which allows to specify the econometric model. However, many observations are equal to zero, so least squares regression would be inappropriate. A censored regression model has been considered to deal with the data (Maddala, 1983). Besides, there is some evidence that some people feel they already pay too much for disposing wastes. Thus, for this category a negative *WTP* would have been logical. As they did not have the opportunity to state a negative amount they gave a zero value. Let us denote by *WTP* the given answer:

WTP = *WTP** if *WTP* > *0* and *WTP* = *0* otherwise.

Since the real bid is only observed when it is strictly positive, the Tobit procedure is relevant. It uses the observations associated with a strictly positive answer to derive what would have been the other bids if respondents had had the opportunity to state a negative value.
This procedure has been applied to the whole sample by considering the non-response answers to the income question as a specific modality and also to a restricted sample in which respondents refusing to fill the income question are omitted. In addition the Heckman procedure (Maddala, 1983) has also been used for both cases, but the results were not satisfactory.
Table 8 provides the outcome of the Tobit one. Otherwise, estimations based on a restricted sample in which observations with no answer to the income question have been omitted also lead to the same results. First of all the constant is significantly positive. Otherwise, a rapid inspection of the results shows a significant influence of income, education, age, opinion about landfill and the respondent's symptoms. However, symptoms of relatives do not significantly influence the bid level. According to economic theory *WTP* increases with income. With respect to the influence of income, it must be noted that the non-response modality effect is close to the lowest-class of income effect. Formal education up to secondary school makes it less likely that respondents state a high bid. With respect to age, people under forty are willing to pay more than other respondents. Both education and age influence are non-linear. Finally, respondents suffering headache, sinus pain and throat irritation are willing to pay a quite large additional amount.

Table 8. Estimation of *WTP*.

Variable	DF	Estimate	Std Error	t	ChiSquare	Pr > Chi
Constant	1	181	109	1.66	2.75	0.10
Income	4				24.82	0.00
< 10000 FF	1	-320	80	-4.03	16.22	0.00
10000-15000 FF	1	-144	71	-2.03	4.10	0.04
15000-20000 FF	1	-31	74	-0.42	0.18	0.67
NR		-343	112	-3.07	9.42	0.00
> 20000 FF (ref)	0	0	0			
Education	2				5.44	0.07
Primary	1	-53	77	-0.69	0.47	0.49
Secondary	1	-127	56	-2.29	5.22	0.02
High (ref)	0	0	0			
Age (years)	2				11.85	0.00
< 40	1	197	59	3.35	11.20	0.00
> 60	1	51	69	0.74	0.55	0.46
40-60 (ref)	0	0	0			
Type of household	3				3.39	0.34
One person	1	-90	74	-1.22	1.48	0.22
Couple with children	1	-118	68	-1.72	2.97	0.09
Other	1	-60	84	-0.71	0.51	0.48
Couple without children	0	0	0			
Landfill disamenities?	2				4.51	0.11
NR	1	-32	60	-0.53	0.28	0.59
No	1	104	76	1.37	1.87	0.17
Yes (ref)	0	0	0			
Respondent's symptoms	3				8.03	0.05
NR	1	54	70	0.77	0.60	0.44
Sinus/throat	1	210	82	2.55	6.51	0.01
Headache	1	141	92	1.53	2.34	0.13
Breathing difficulties (ref)	0	0	0			
Family's symptoms	3				3.49	0.32
NR	1	115	61	1.87	3.49	0.06
Sinus/throat	1	61	82	0.74	0.55	0.46
Headache	1	59	97	0.60	0.36	0.55
Breathing difficulties (ref)	0	0	0			
χ^2 (a)	19				29.78	0.05
N = 403						

Note. NR = non-response, ref = reference, N = number of observations, DF = degree of freedom. (a): likelihood ratio test statistic for joint significance of the covariates.

The constant of the Tobit equation (Table 8) provides an estimate of *WTP* for an hypothetical respondent defined by the reference level of each explanatory variable. Since, reference levels are associated with the most observed modalities, this constant corresponds to a kind of 'average'. The constant equals 181 FF which is in the range defined by the median and the mean of the empirical distribution.

5. Choosing the type of incinerator

In order to test if a precise information given to a person induce a modification in his behaviour, the vote for a type of incinerator was submitted to each interviewee, even if he had previously expressed a null *WTP*. The results are positive since 40 to 50% of those stating a null *WTP* accept a tax increase when a clear policy choice is offered. A second, unexpected result also appeared: people stating (generally) low *WTP*'s, after a second thought, either end with a null *WTP*, or accept to increase their *WTP*, due to the information. This result needs to be confirmed by new contingent valuation exercises.
Otherwise, those giving a positive *WTP* among people who voted for the *statu quo* option (Solution 1), revised their bid and finally stated a zero amount. More information regarding the votes for the other options (Solutions 2 to 5) are given in Table 9.

Table 9. Number of votes by community, expressed and confirmed.

Solution	Paris 13th		Paris 15th		Villeparisis		Total	
	Vote	Accept to pay	Vote	Accept to pay	Vote	Accept to pay	Vote	Accept to pay
2 (111 FF)	7	6	5	4	14	13	26	23
3 (124 FF)	6	6	5	5	13	12	24	23
4 (204 FF)	13	13	24	24	24	22	61	59
5 (272 FF)	66	58	57	49	126	92	249	199
2, 3, 4 & 5	92	83	91	82	177	139	360	304

The majority of the respondents voted for the best available technology. The increase in disposal fees induced by each choice may be interpreted as an estimator of a minimum acceptable *WTP*. So a mean *WTP* equal to 235 FF is derived for the 304 persons. If we add the zero *WTP* of 99 persons, we end with a mean *WTP* for the general population of 177 FF.
The votes made, and confirmed, by the population with a null *WTP* are informative. For the 15th Arrondissement, 15 persons modified their choice (50%), and accepted an increase in tax fees for the adoption of a less polluting incinerator (Solution 4 or 5). Concerning the 13th Arrondissement, 10 persons modified their choice (40%), mainly in favour of Solution 5, but also in favour of Solution 2 or 3. In Villeparisis, 33 persons (40%) modified their choice, preferably for Solution 4 or 5, but also Solution 2 or 3.
If we consider the votes made by people with a positive *WTP*, we can observe that if the large majority express stable preferences, a small part of the sample modify their preferences: 4% for the 15th and 13th Arrondissement, and 10% for Villeparisis, ending with a null *WTP*; 18% for the 15th Arrondissement, 24% for the 13th Arrondissement and 20% for Villeparisis ending with a *WTP* higher than the one stated in the open question. Except in two cases the values stated are small (150 francs or less).
Respondents' choices can be derived from a random utility model. So let us denote by *j (j=0,…4)* the outcome of the vote. The utility function is as follows:
$U_j = V_j + \varepsilon_j$
where V_j is a deterministic component and ε_j a random term. So the probability to choose solution *j* is:

$$P_j = proba(U_j \geq U_k) = proba(\varepsilon_k - \varepsilon_j \leq V_j - V_k)$$

Providing the random terms are independent and follow the same logistic distribution, then the multinomial logit model is derived (Maddala, 1983):

$$P_j = \exp(\beta_j x_i) / \sum_{j=1}^{4} \exp(\beta_k x_i)$$

$$P_0 = 1/(1 + \sum_{j=1}^{4} \exp(\beta_k x_j)$$

where x_i is the vector of socio-economic characteristics of the respondent and assuming $\beta_0=0$.
A smart interpretation is derived by differentiating the last equation. Indeed, the marginal effects of the regressors on the probabilities are obtained:

$$\delta P_j / \delta x_i = P_j \left[\beta_j - \sum_k P_k \beta_k \right]$$

The multinomial logit procedure has been applied separately to the Paris sample (Table 10) and the Villeparisis sample (Table 11). If we observe the coefficients of the variable we can see that:

- there is no "15th arrondissement effect", except for solution 3
- the significant variables are different for different solutions, but we can see that *WTP* is always significant but income is generally not.

The marginal effects of a characteristic on the probability to choose a specific solution are easier to explain. If we look to the last solution, the marginal effect of *WTP*, income and age is positive, and so is whether person suffers from symptoms related to air pollution. The effect '15th Arrondissement' appears negative here, as the number of years living in the same place.
As expected the marginal effects differ for different solutions.
The results are less significant for Villeparisis than for Paris. Only the *WTP* variable appears to be significant in the multinomial logit model, for solutions 2, 3 and 4, but the marginal effect is clearly significant only for the last solution. Income is never significant and education has a negative sign for solution 3 and 4.

Table 10. Modelling the vote for Paris.

Variables	Coefficient	t	Marginal effects	t
Solution 1				
WTP	8.52E-03	2.042	-1.04E-04	-1.644
AR15	3.18E-02	0.034	-3.11E-03	-0.197
AGE	2.38E-02	0.964	1.48E-04	0.355
YEARS	-8.74E-02	-1.565	-5.14E-04	-0.526
SEX	-0.98339089	-1.162	-8.21E-03	-0.544
EDUCATION	-0.27021428	-1.124	-2.65E-03	-0.566
CHILDREN	-2.08E-02	-0.057	1.57E-03	0.26
INCOME	-7.04E-02	-1.003	-2.22E-03	-1.369
RECYCLE	-2.01E-02	-0.049	6.46E-03	0.888
SUFFER	-0.77147251	-0.801	-2.47E-02	-1.297
NUISANCE	2.33494882	1.804	8.61E-03	0.445
TAXES	0.14985878	0.958	5.38E-03	1.3
Solution 2				
WTP	7.67E-03	1.908	-1.51E-04	-2.048
AR15	-0.47112575	-0.548	-1.59E-02	-0.851
AGE	5.00E-02	2.151	8.09E-04	1.368
YEARS	-0.16734033	-2.718	-2.55E-03	-1.562
SEX	-0.91552553	-1.142	-8.75E-03	-0.496
EDUCATION	-0.31892426	-1.436	-4.50E-03	-0.854
CHILDREN	0.20332399	0.642	7.30E-03	1.043
INCOME	3.57E-02	0.672	-2.84E-04	-0.258
RECYCLE	-0.65442995	-2.127	-6.91E-03	-0.992
SUFFER	0.59244441	0.753	1.23E-03	0.076
NUISANCE	0.80803956	0.545	-2.54E-02	-0.799
TAXES	0.1062569	0.689	5.76E-03	1.346
Solution 3				
WTP	1.20E-02	3.904	-4.74E-04	-2.429
AR15	0.93862159	1.594	0.17506554	2.289
AGE	-9.33E-03	-0.515	-5.95E-03	-2.215
YEARS	5.43E-03	0.184	1.55E-02	3.339
SEX	-0.10093782	-0.18	0.10529751	1.378
EDUCATION	-2.16E-02	-0.142	2.54E-02	1.246
CHILDREN	-6.82E-02	-0.257	8.49E-03	0.222
INCOME	1.95E-02	0.503	-6.64E-03	-1.343
RECYCLE	-0.32598016	-1.343	8.86E-03	0.288
SUFFER	-6.08E-02	-0.105	-0.14202643	-1.951
NUISANCE	1.78379278	1.8	-2.21E-02	-0.227
TAXES	-0.18542765	-1.681	-1.16E-02	-0.722
Solution 4				
WTP	1.56E-02	5.048	1.07E-03	4.706
AR15	-2.00E-02	-0.035	-0.15126949	-1.813
AGE	2.36E-02	1.379	5.39E-03	1.882
YEARS	-8.00E-02	-2.484	-1.39E-02	-2.683
SEX	-0.6929705	-1.291	-0.10174246	-1.231
EDUCATION	-0.16014507	-1.087	-2.15E-02	-0.97
CHILDREN	-0.13275713	-0.518	-1.99E-02	-0.486
INCOME	6.24E-02	1.679	1.03E-02	1.936
RECYCLE	-0.38835098	-1.655	-1.73E-02	-0.523
SUFFER	0.79730785	1.442	0.178745	2.289
NUISANCE	1.99914753	2.083	8.49E-02	0.803
TAXES	-0.14048942	-1.325	-2.89E-03	-0.165
LL function = - 179.26		Restricted LL = -250	R^2 McFaddeen = 0.28	

Note. Variables are defined in the Annex.

Table 11. Modelling the vote for Villeparisis

Variable	Coefficient	t	Marginal Effects	t
Solution 1				
WTP	-5.3E-03	-.940	-9.92E-05	-1.169
AGE	-3.6E-02	-1.375	-1.06E-04	-0.53
YEARS	7.9E-03	.247	-3.43E-05	-0.164
SEX	-7.6E-01	-1.063	-8.30E-03	-0.801
EDUCATION	-7.1E-02	-.293	1.12E-03	0.592
CHILDREN	1.9E-01	.592	1.41E-03	0.566
INCOME	2.1E-04	.004	-9.16E-05	-0.256
RECYCLE	6.8E-01	2.149	4.48E-03	0.896
SUFFER	-1.6E-01	-.263	2.37E-03	0.507
NUISANCE	4.3E-01	.616	1.19E-03	0.249
TAXES	-2.0E-01	-1.780	-1.17E-03	-0.858
Solution 2				
WTP	9.53E-03	3.658	-1.81E-05	-0.298
AGE	-1.03E-02	-0.563	3.17E-04	0.545
YEARS	2.25E-02	1.009	3.35E-04	0.469
SEX	-2.14403229	-1.925	-9.56E-02	-2.469
EDUCATION	-0.55242822	-1.821	-1.11E-02	-1.059
CHILDREN	9.37E-02	0.283	4.37E-03	0.414
INCOME	-7.44E-02	-0.935	-3.18E-03	-1.124
RECYCLE	0.20400441	0.722	7.87E-03	0.809
SUFFER	-0.77137051	-1.143	-8.65E-03	-0.382
NUISANCE	0.49837282	0.673	8.92E-03	0.373
TAXES	-2.44E-02	-0.243	-1.49E-04	-0.045
Solution 3				
WTP	1.11E-02	4.911	1.47E-04	1.362
AGE	-2.57E-02	-1.523	-9.39E-04	-0.52
YEARS	9.17E-03	0.406	-5.71E-04	-0.241
SEX	0.5594384	0.973	5.19E-03	0.086
EDUCATION	-0.53705578	-2.58	-4.20E-02	-2.003
CHILDREN	4.04E-02	0.151	9.83E-03	0.36
INCOME	1.89E-02	0.352	6.61E-04	0.115
RECYCLE	4.59E-02	0.212	8.82E-03	0.389
SUFFER	-1.43194354	-2.328	-0.1293025	-1.979
NUISANCE	-7.68E-02	-0.122	-4.68E-02	-0.696
TAXES	1.41E-03	0.021	3.10E-03	0.417
Solution 4				
WTP	1.19E-02	5.53	1.29E-03	6.333
AGE	-2.18E-02	-1.731	-1.80E-03	-0.759
YEARS	1.61E-02	0.965	2.01E-03	0.666
SEX	0.76921623	1.738	0.1678264	2.046
EDUCATION	-0.21489479	-1.534	1.98E-02	0.755
CHILDREN	-5.65E-02	-0.272	-1.93E-02	-0.533
INCOME	2.09E-02	0.531	4.50E-03	0.607
RECYCLE	-4.97E-02	-0.298	-2.32E-02	-0.775
SUFFER	-0.43402007	-1.067	6.56E-02	0.818
NUISANCE	0.3514899	0.777	6.96E-02	0.831
TAXES	-2.67E-02	-0.492	-4.45E-03	-0.428
LL function = -199.19		Restricted LL = -265.24	R^2 McFaddeen = 0.25	

Note. Variables are defined in the Annex.

6. Concluding comments.

What have we learned from this study concerning people's behaviour and attitude regarding MSW management ?

1) Asked about their maximum willingness to pay, the same mean value emerges from the three populations (15^{th} and 13^{th} Arrondissement, Villeparisis), even if their level of income or education is quite different. This result makes us wonder what type of good we try to value.
2) The number zero bids (25 à 40%) is lower than for other environmental problems (close to 50% generally).
3) When full information is given and people are asked to participate in a public policy choice, half of those stating a zero *WTP* revise their judgement and accept an increase in their taxes. They accept to buy a clearly stated good. They enter in the market and accept the transaction.
4) A small percentage (less than 10%) of persons who stated a positive *WTP*, after more information and on second thought, prefer not to buy the good.
5) Modelling the level of *WTP* is disappointing, perhaps because the main socio-economic characteristics are insufficient to express pure preferences. Did we ask the right questions?
6) Modelling the vote gives better results, but the most instructive finding is that people prefer by a large majority the best available technology and accept to pay for it. To put this result in context it is exactly what municipalities are not doing, because they tend to choose the least costly technology, just respecting the minimal standards imposed by law.

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Annex. Definition of the variables.

WTP : amount stated to the open question, in FF
AR15 : dummy variable, 1 = 15th Arrondissement
Age : age of the person
Years : number of years the person lived in the place
Sex : dummy, male = 1
Education : in 7 categories, increasing with higher education
Children : number of children in the family
Income : monthly income of the household, mid-point of class, 9 classes, in FF divided by 1000
Recycle : 1 for never, 2 for sometimes, 3 for always
Suffer : dummy, suffer from different symptoms related to air pollution = 1
Nuisance : dummy, associate nuisance with the existence of an incinerator or landfill = 1
Taxes : annual municipal taxes as renter or owner, in FF divided by 1000
FF: French Franc. 1 FF = 0.15245 €.