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Perceived health status and environmental quality in the assessment of external cost of waste disposal facilities. An empirical investigation

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Perceived health status and environmental quality in the assessment of external cost of waste disposal facilities. An empirical investigation

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Abstract
The taxation for urban waste management has been reformed in Italy by the introduction of the environmental law in 2006. In the planning phase of waste management the externalities (social and environmental costs) generated by new facilities remain widely unaccounted, with a consequent distortion for prices, and the raise of local conflicts. In order to support the diffusion of cost-benefit application the paper presents a survey based on the choice modelling methodology, aimed to evaluate on a monetary scale the disamenity effect perceived by incinerator and landfills in an italian urban context: the city of Turin. The choice experiment and the survey data allowed to model in a random utility framework the behaviour of respondents, whose choices are found to be driven by the endowment of information about technological options, socio-economic characteristics as income, education, family composition, and also by their health status.
We propose choice modelling surveys as a way to improve the level of information about the preferences of citizens in a bottom-up sense. Furthermore, we found empirical evidence that the behaviour in residential location choices is affected by different aspects of the respondent life and in particular by the health status. Distinct estimates of *willingness to accept* compensation for disamenity effects of incinerator (€2670) and landfill (€3816) are elicited through the choice modelling aaproach. The effect of health status of the respondents, their level of information about the waste disposal infrastructure, the presence of a subjective strong aversion (NIMBY) and the actual endowment and concentration of infrastructures are demonstrated to be significant factors determining the choice behaviour, but differentiated and specific for incinerators and landfills.

Keywords:
Stated preferences; Choice modelling; externalities; waste disposal; Nimby effect; health.

JEL Classification: *C25, O13, O22, Q51.*

Introduction

The taxation for urban waste management has been reformed in Italy by the introduction of the environmental law in 2006. It updated the Ronchi Act, that implemented in 1997 the EC directives 91/156, 91/689 and 94/62. A goal of allocative efficiency inspires the new tariff system based on a polluter-pays principle. Still most of the externalities generated from the construction of facilities to the operational phase of waste management remain unaccounted, with a consequent distortion for prices (Basili et al, 2006; Ferrini et al, 2008). Either the siting decisions of disposal infrastructures or the programming of new plants should be supported, according to public investment law, by feasibility studies including cost-benefit tests to assess the socio-economic convenience of projects.

Despite some monetary values of externalities of infrastructures have been made available (as the Externe project, 1998), we point out the scarcity of available estimates for modern typologies of facilities, such as new incinerators or compost plants. The paper is twofold: first we propose a survey based on the choice experiments (CE) methodology, in order to evaluate on a monetary scale the disamenity effect perceived by incinerator and landfills in an Italian urban context. Secondly, we suggest CE surveys as a vector for information in a bottom-up sense. It may indirectly improve the component of public involvement in the choice of a location for a waste disposal facility. Our application has been conducted within the metropolitan area of Turin (north Italy), where the siting process of a new big incinerator and the programmed closure of an old landfill has been the core of a local debate (Bobbio 1999, 2002). In this context, some attempts to smooth the conflicts raising from NIMBY behaviours and the tradeoffs among land use changes have been based on a project aimed to build consensus through an experimental participative process: the NRDS experience[1]. The outcomes of the NRDS and the public involvement have been substantially ignored by the local administration, who supported in the final steps of the decision making process a top-down approach to the siting problem (Tipaldo, 2006). The NRDS experience implemented, as a way to synthesize public preferences, a multicriterial approach: the ELECTRE model (see for a detailed report Norese, 2006); the weights of the ELECTRE model conceptually correspond to the coefficients calibrated in the application of CE, that weight the effect of the choice variables in the utility space. Besides to more traditional variables, the set of choice determinants that we implemented in the model focuses on public belief, the perception of risk, and the aversion toward waste treatment plants: we test if and how these factors affect residential location choice of households. A first paragraph introduces the literature review on cases of monetary evaluation of waste facilities externalities. The second paragraph presents the methodology of the choice experiment, and the theoretical framework employed to model observed stated choices in a probabilistic way. The third and fourth paragraph describes the structure of the experiment and the sample design.

Literature Review

The literature on the evaluation of the externalities deriving from waste disposal facilities are mostly Hedonic Prices (HP) applications (see table 1 for a summary of the results of this group of assessments) . The number of studies based upon the HP approach grew during the seventies and eighties and is based on the simple idea that may exist price differentials among real estates due to the presence of environmental externalities (Griliches, 1971; Rosen, 1978).

Through econometric methods the *implicit (or "hedonic") prices* associated to each characteristics of the real estate, including the differences related to the presence of infrastructures can be derived through the market prices of the houses.

[1] The acronym NRDS stands for the Italian "Non Rifiutarti Di Scegliere" (Don't refuse to choose).

Furthermore the externalities from *disamenity* can be measured in monetary terms through the *implicit price* recovered from the revealed preferences of citizens on real estate markets.

We observe that the studies are mostly referred to waste disposal rather than to incineration plants. Another observation is related to the differences, also very high, in the estimates of the perceived damages plausibly due to the differences in the application of the method and in the aggregation of the results.

[Table 1 approximately here]

Probably one of the most interesting work aimed at the valuation of the externalities caused by incinerators is the paper written by Kiel and McClain (Kiel and McClain, 1995a). They sustain the idea that the preference structure is not stable in time, and they highlight the presence of transition periods identifiable in the life cycle of the infrastructure project:

- *pre-rumor stage,* the information about the future realization are not diffuse among the citizens;
- *rumor stage,* the information begin to circulate in the community. In this stage the real estate market has a first shock and the houses' prices decrease: the probability to have an incinerator close to the houses induces the owners to consider the idea that no one would be disposable to acquire their real estate;
- *building stage*, the presence of the infrastructure is now certain, in this stage the real estate market is mainly influenced by the expectations in terms of future pollution levels and health risks;
- *operating stage*, the citizens collect the information about the real effects of the infrastructure on the environment and health, this information will contribute in determining new variations in properties values, the sign of this variations is uncertain;
- *operating stage in the long-run,* this stage represents a sort of return to a situation of normality, as in the pre-rumor phase. If the presence of the incinerator is perceived as *disamenity* the equilibrium price for a house will be lower than in the first stage. Also in the case the infrastructure is no more perceived as dangerous for people's health, the authors expect a decrease in the properties values, even if smaller with respect to the first case, mostly related to the persistence of initial negative perceptions.

In a second work (Kiel and McClain, 1995b) the authors point out how rapid the prices adjust to the presence of the infrastructure in particular for houses very close to the incinerator. The differences in the growth rate could be interpreted as a sort of inertia in local markets in absorbing the presence of the source of *disamenities.* A first policy implication is to reduce at minimum the time passing through the different stages in order to minimize the reduction in properties prices.

The studies on landfills and incinerators externalities based on choice experiments or contingent valuations are more recent due to the development of the econometric technique in the last decades (Garrod and Willis, 1998; Sasao, 2008). The Stated Preferences (SP) analysis are in general considered as more flexible and able to better adapt to specific cases and to the valuation object. However the number of disposable studies is restrained, and our work, almost in the Italian context, is the first application of a CE to the specific case of waste disposal facilities. We mention two works on waste facilities in Italy using discrete choice models: a Contingent Valuation application on waste disposal (Basili, DiMatteo and Ferrini, 2006) and an application of the so-called Contingent Behaviour Method to the case of a composting plant (Baccheschi, Bimonte and Ferrini, 2008). Beyond revealed and stated preference studies that empirically obtain monetary estimates of the external costs of waste disposal plants, we find a group of other studies reporting and synthesizing the findings of other ad hoc evaluation of the impacts of these infrastructures. We refer to these as secondary studies, and we report a sample of relevant ones in Table 2.

[Table 2 approximately here]

Methodology

Choice experiments (CE) applied to environmental and disamenity effects may be considered as a generalization of the dichotomous close ended format of contingent valuation (Bennett et *al*., 2001). From an econometric point of view they extend to a multinomial structure the classical binomial response, as during the interview the respondents express their preferences choosing the favourite option among a set of alternative scenarios. The choice probability of each option is linked to the perceived level of satisfaction and to the attractiveness of each mutually exclusive option, through a Random Utility approach derive an utility measure based on the monetary attribute[2], in the choice experiment the scenarios to evaluate can be more than two (McFadden, 1974; Ben-Akiva and Lerman, 1985).

The attractiveness (utility) associated to each scenario depends on the attributes influencing the choice probability. The differences among alternatives are not referred to houses characteristics but only on the determinants of environmental quality of the area in which the house is located, in particular the presence of municipal solid waste facilities.

The utility associated at each scenario depends on the probability with which the scenario is preferred with respect to the others and is specified as function of the alternative and individual characteristics.

The decision behaviour of the population is approximated through an utility function. We built the experiment also taking into account the importance of maintaining simple the scenario proposed: an excessive complexity can become a cause of loss in the explicative power of the model and consequently a reduction in goodness of fits (among others Swait and Adamowicz, 2001).

The data analysis is based on a conditional logit model (McFadden, 1974), for which the general assumptions is rationality among agents who will maximize their utility level in presence of a budget constraint. According to Random Utility Models (RUMs), the utility function can be decomposed in two parts: a deterministic component, known to the econometrician, and a stochastic and unobservable component (error term) caused by the presence of heterogeneity among individuals. The usual form of this utility function is:

$$U_{iq} = V_{iq}(X_{iq}) + \varepsilon_{iq} \qquad [1]$$

where U_{iq} is total utility, V_{iq} is the deterministic component that is function of X_{iq} a vector of observables, ε_{iq} is the stochastic component; *i* identifies the alternative in each choice experiment and *q* is referred to the individuals.

If for individual *q* the utility associated to alternative *i* is grater than each other alternative *j*, he will choose *i*, in this sense the probability that individual *q* will choose among a set of *J* alternatives is:

$$P_{iq} = \Pr(U_{iq} > U_{jq} \forall j \in C, j \neq i) = \Pr(V_{iq} - V_{jq} > \varepsilon_{jq} - \varepsilon_{iq} \forall j \in C, j \neq i) \qquad [2]$$

2 The probability that the respondent is willing to pay a certain amount in order to obtain an increase in the environmental quality generally depend to the bid and a constant term representing the difference in attractiveness between two alternatives.

The terms ε_{jq} e ε_{iq} are random variables and we assume they have independent extreme value distributions. The relation between probability and the deterministic component *V* for each alternative becomes:

$$P_{iq} = \frac{e^{\lambda V_{iq}}}{\sum_{j=1}^{J} e^{\lambda V_{jq}}} \quad [3]$$

with λ a scale parameter conventionally normalized to 1.
The estimates of the parameters included in *V* are obtained using the maximum likelihood method: general speaking the method recover the set of parameters that maximize the conjoint probability to obtain the better representation of the preference structure observed in the data extensible to the whole population of reference. This probability expressed in its logarithmic transformation is called log-likelihood and is:

$$LogL = \sum_{q=1}^{Q} \sum_{j=1}^{J} d_{jq} \ln P_{jq} \quad [4]$$

Q is the number of respondents, d_{jq} is a dichotomous variable assuming value equal 1 when the alternative *j* is chosen and 0 otherwise.
If we define p the compensation (or in general the monetary attribute) and X the vector of all the *n* attributes, the utility function can be written in linear form (Ben-Akiva e Lerman, 1985; Louviere, 2000):

$$V(p, X) = \sum_{1}^{n} \beta_n X_n + \beta_p p \quad [5]$$

Design of the experiment

In 2007 we conducted a test interviewing almost 130 households, living in Brescia (Northern Italy) close to an incinerator for municipal solid waste, in order to calibrate our survey and to obtain useful information from "well-informed" citizens.
The test highlighted three relevant points:

- The citizens associate to the incinerator an high level of disamenities and almost the totality would choose a house far from this facility. However if we ask to compare the incinerator with a landfill we observe that the former is strongly preferred to the latter to which is associated the maximum level of disamenity.
- We observe a polarization of the preferences, the households are divided in two groups: one strongly adverse to the incinerator, in many cases participating in active opposition, and a second group claiming not to suffer its presence absolutely.
- Probably the most relevant result of the test for our purposes is the presence of a strong negative correlation between information and communication campaign and the perception of health risks caused by the infrastructure. This result suggests that augmenting the information distributed we can limit the aversion to the incinerator.

Therefore, using the information collected in the test, the survey presents an introductory section aiming at inform the respondents about the object of the valuation study. We provide information on: quantity of municipal solid waste burned, energy and materials flows, emissions and residuals. The second part of the survey introduces the choice experiment, after a brief set of instructions, we ask the respondent to think on the different alternatives, pointing out that the results of the survey would influence the decision of the policy makers involved in the process of facilities' localization. We have stressed the idea that the answers could condition the outcome of the decision process. This kind of incentive can, in most case, generate a positive behaviour during the survey and decrease the probability of protest responses and rejection of the hypothetical scenario. The design of the experiment has been driven by the objective to construct an utility function (the deterministic component) including determinants of the environmental quality and health risks perceptions. We ask the respondent to select the alternative in which they would willing to move in considering constants the houses characteristics, see the example of Table 3. The profiles proposed during the interviews are randomized, the combinations of the different attributes vary determining a pseudo-random set of possible comparisons among alternatives. The third option is a no-choice option, a sort of *status quo* alternative, characterized by the absence of waste facilities.

[Table 3 approximately here]

The interviews end with a section devoted to the collection of information on the households' characteristics, the perception of the environmental quality and the health risks associated to the two infrastructures for the municipal waste management.
The sample includes citizens living in a 2 km ray from the sites selected as possible locations for municipal solid waste facilities, in particular suburban areas in the north-west Turin (Figure 1). From the electoral rolls we extract a list of residents with more than 25 years from which we have carried out the random draw. Moreover the sample is stratified by age, as shown in table 4, and represents the urban active population in terms of residential choices. We contacted the households part of our sample by mail and we sent them the questionnaire with a letter presenting our research project and motivating our experiment.

[Table 4 approximately here]

Results
The aim of the analysis is to define a functional form for the indirect utility function, as in [5], able to model a decision rule as close as possible to that used by the respondents in their decision process. In our analysis we inserted a set of variables recovered during the survey as the risks' perception, the level of information on the localization process of an incinerator in Turin, the presence of aversion to the infrastructure, the so called NIMBY effect, and we complete the analysis using some individual characteristics. In table 5 we describe in details the variables used in the analysis.

[Table 5 approximately here]

[Figure 1 approximately here]

In Choice Experiments is possible to use the so called Alternative specific Constants (ASC), their coefficients represent the variations in utility, maintaining constant the others attributes , due to the sole presence of the infrastructure. In our case the indirect utility function is approximated to [8]:

$$V = \beta_{COMP} \cdot COMP + \beta_{DIST} \cdot DIST + \beta_{AIR} \cdot AIR + \beta_{ODOR} \cdot ODOR + \beta_{GREEN} \cdot GREEN + \beta_{HEAL} \cdot HEAL + \beta_{REDCO} \cdot REDCO + \beta_{INFR} \cdot INFR + \beta_{HIGHR} \cdot HRISK + \beta_{INFO} \cdot INFO + \beta_{NINBY} \cdot NIMBY + \beta_{C\_DIS} \cdot C\_DIS + \beta_{C\_INC} \cdot C\_INC \quad [8]$$

In discrete choice models the ACS are more often used in interaction (multiplied) with others attributes. In order to exploit the possibility to differentiate the utility function for each infrastructure [8] is enriched, as in [9], using the interactions with the ACS[3]:

$$V_{iq} = \beta_{Comp} \cdot COMP + \beta_{I\_DIST} \cdot I\_DIST + \beta_{L\_DIST} \cdot L\_DIST + \beta_{I\_AIR} \cdot I\_AIR + \beta_{L\_AIR} \cdot L\_AIR + \beta_{I\_ODOR} \cdot I\_ODOR + \beta_{L\_ODOR} \cdot L\_ODOR + \beta_{I\_GREEN} \cdot I\_GREEN + \beta_{L\_GREEN} \cdot L\_GREEN + \beta_{I\_HEAL} \cdot I\_HEAL + \beta_{L\_HEAL} \cdot L\_HEAL + \beta_{I\_REDCO} \cdot I\_REDCO + \beta_{L\_REDCO} \cdot L\_REDCO + \beta_{I\_INFRA} \cdot I\_INFRA + \beta_{I\_HRISK} \cdot I\_HRISK + \beta_{L\_HRISK} \cdot L\_HRISK + \beta_{I\_INFO} \cdot I\_INFO + \beta_{L\_INFO} \cdot L\_INFO + \beta_{I\_NIMBY} \cdot I\_NIMBY + \beta_{L\_NIMBY} \cdot L\_NIMBY + \sum \beta \cdot S_I + \sum \beta \cdot S_L \quad [9]$$

To each of the 168 respondents was asked to do the choice experiment twice and this allow us to collect a total of 336 observations. The estimates, obtained by statistical package NLOGIT, are presented in table 6.
Most of our expectations on the behaviour of the covariates are confirmed. In particular the variables indicating beliefs, attitudes and perception of the individual with respect to the incinerator show a high statistical significance, contributing in the improvement of the explanatory power of the model. In the following part of this section we will synthesize the results variable by variable.

[Table 6 approximately here]

The monetary compensation coefficient, consistently to our expectations, has a positive sign and its estimate results statistically significant at 0.01 level.
The main damage component is obtained through the variables indicating the proximity to incinerator and landfill (I_DIST and L_DIST). In the utility function these interaction variables measure the transition from a state in which the infrastructure, if present, is far from 2000m to 10000m, to a condition in which the infrastructure is close to the house (600 meters). These variables are highly statistically significant (p-value less than 0.05, last column in table 6) and both the coefficients present negative sign confirm the negative. Closer residents are requiring higher compensations. The marginal willingness to accept for the proximity of the two infrastructures, keeping constant the other variables, are €1901 for the incinerator and €1710 for the landfill.
The type of impacts associated to the information incorporated in the distance variables is not known, we propose to interpret these variables as a general loss of attractiveness of the site but not systematically associated with changes in other characteristics (pollution from particulates, odours, green areas, etc..).
The days of the PM10 concentrations affect the choice probability either when they are due to the landfill (L_AIR) or when they are due to the incinerator (I_AIR). The important, and relatively unexpected, outcome is that the sign of both L_AIR and I_AIR are negative; this

3 The letters *I* and *D* at the beginning of each code identify the ACS used for the interaction, *I* for incinerator and *L* for landfill

means that for each additional day with excessive air pollution the compensation for the presence of the infrastructure is reduced of respectively €19 and €14.
The attribute relative to the presence of odours differs explicitly between incinerator and landfill. While the number of days in which you perceive odours associated with the presence of waste does not have a statistically significant effect on the probability of choosing the site having an incinerator, it is particularly relevant for the choice of the site with the landfill. The implicit price of the variable L_ODOR constitutes a monetary value of this disamenity: the respondents require a compensation of €32 for each additional day in which bad odours are perceived, while for the incinerator is not possible to estimate a monetary value as the statistical significance of I_ODORE is not sufficient.
The attribute on the availability of green areas, expressed on a three level scale, play a positive role in the utility function of the individual in the case of the incinerator, while it is not significant and with a different sign for the landfill. The increase in the availability of public green areas generate a significant rise in the probability of choosing the incinerator: for the same other characteristics, the reduction in perceived damage (express with positive sign of the coefficient, remember that in order to calculate the marginal effect the formula requires to put a minus in front of the expression) amounts to an average annual household income of €1427.
The attractiveness of sites with waste disposal facilities also depends on the characteristics of the site where a respondent live at the moment of the experiment. It seems that people living in areas already heavily influenced by the presence of infrastructure with negative externalities are more likely to move from these sites. The variable INFRA (always interacted with the ASC of the incinerator and landfill) identify for this purpose the number of facilities present in the current respondent's residence, and is constructed as a score obtained by summing all the dichotomous variables indicating the presence of the following facilities:

- Landfill
- Incinerator
- Water Depurator
- Power lines
- Airport
- Railway
- Highway

The coefficients (I_INFRA and L_INFRA) are both statistical significant and the presence of an infrastructure more reduce the compensation required consistently €1672 for the incinerator and of €981 for the landfill.
The variable relative to the household income (REDCOM), as expected, has negative sign meaning that richer people want to be more compensated.
The last part of this section is devoted to the comment of the outcomes relative to the variables referred to attitudes, belief and health risks' perception.
Among the different protocols used to create a synthetic indicator of health status we have chosen the approach of "Healthy Days" used by the US Center for Disease Control and Prevention Ministry of Health, whose validity and reliability is tested in the literature from a large number of empirical studies (among others Andresen et al., 2001a, 2001b; Beatty et al., 1996; Brzenchek et al. 2001). The number of days in the last 30 days in which the respondent is sick of both emotional and physically is the numerical index used in our analysis. We derived a dichotomous variable (health) which is 1 if the respondent has had a number of days of well-being above average, and 0 otherwise. The two interactions I_HEAL and L_HEAL have different outcomes, significant the coefficient relative to I_HEAL with a marginal effect

of €1947. Healthy people want to be more compensated for the risks connected to the presence of an incinerator.
Three additional factors have a significant effect on how respondents considered the site incinerator, the same attributes are not significant for the landfill. The variable INFO refers to those who feel that their area has already been selected as possible location for new incinerators. These respondents more informed than the others are more likely to choose the site characterized by the presence of incinerator (I_INFOTO). The effect of this variable is likely to reduce the degree of hypothetical exercise of choice.
In the interview we asked if the respondent would be willing to accept the construction of an incinerator close to their house, knowing that this kind of infrastructure has a public utility for the entire province. Using this information we create NIMBY a dichotomous variable that identifies those who have absolutely refused to accept that prospective. The marginal value that represents the implicit price of the variable NIMBY is by far the highest (€6447) and a very low p-value (0,0002) indicating that this factor has good explanatory power in interpreting the preference structure.
The variable I_HIGHR quantifies the effect on the probability of choosing the incinerator site varying the level of health risk the people associate to this infrastructure. Other conditions being equal, the variation in the level of risk, here schematically built on two levels (low and high) causes an increase extremely high, almost , in the compensation required. This variable, as well as that related to the NIMBY effect refers to factors certainly less close to the traditional economic analysis and display a high degree of subjectivity, but significant as explanatory factors. The inclusion of these variables in the model allows us to conclude that these factors have a relevant and systematic effect in the choice process.

Conclusions

The paper presents results of a survey based on stated preferences of households, choosing hypothetical urban sites to live in. The choice behaviour is analysed through a discrete choice model implementing a monetary willingness to accept as compensation for the disamenities produced by the proximity to waste disposal facilities: a landfill and an incinerator.
The valuation exercise built on the specific context of Turin, in North-Western Italy, is aimed to obtain estimates of the citizens' perceptions of the externalities caused by the two waste disposal facilities. The differences among sites are not related to the house characteristics, considered as equivalent for the different options, but on specific aspects of the environmental context in which the site is located. The choice experiment and the survey data allowed to model in a random utility framework the behaviour of respondents, whose choices are found to be driven by the endowment of information about technological options, socio-economic characteristics as income, education, family composition and also by their health status.
The sample, stratified by age cohorts, was drawn through a random extraction among residents within a ray of 2 km from sites classified, by the local authorities, suitable for the localization of a facility for the treatment of municipal solid waste. The spatial proximity of the disposal facilities in the sites of the choice set has been modelled in the experiment in the form of a distance based scale, that points out to be statistically perceived as more relevant in the case of a landfill site, rather than a site with incineration plant.
We found empirical evidence as well that the choice behaviour is affected by different aspects of the respondent life and the health status, measured as a count variable by a healthy days index. Generally speaking, people with a poorer level of life quality, in particular suffering for the presence of health diseases, have a different perception of the externalities. The results of our choice experiment show how people, quite informed about the facilities features, are willing to live in areas in which are present the two facilities: the compensation for the presence of the incinerator is around €2670 and for the landfill is around €3816 for each

household. According to the structure of elicited preferences, landfills generate disamenity impacts quite stronger than incinerator plants.
Other impacts embedded in the estimated utility function refer to air pollution, bad odours, distance from the facility and presence of green areas. In the case of the incinerator, the compensation adjusted for the distance from the infrastructure stresses a negative decreasing impact of the distance on the preferences. For example at 600 meters the compensation is €2670 but at 2 km it decreases at €2161. These amounts assessed on the Italian context turn out to be interestingly higher than previous similar UK experiment (Garrod, Willis; 1998). The site-specificity may be a plausible explanation for these differences in the scale of *WTA* estimates. This divergence of results is also plausibly due to the different reference point in the lifetime of the infrastructure (a more adverse perspective with highest external costs in a pre-rumour phase, that is gradually shrinking in the construction and operational life (Kiel, McClain, 1995).
Moreover, the variable referred to the presence of green areas as a form of non-monetary compensation has a positive effect on the utility. In our model the increasing of the green areas endowment is a strong instrument in order to balance the perception of disamenities generated by the incinerator and waste disposal facilities. This argument may be a reference point for the policy-makers and in general for the stakeholders employed in the management of local conflicts. Furthermore, if we consider the case of the incinerator, the aversion for this facility is well explained in terms of "NIMBY" syndrome, stated by respondents through specific questions in the interview, and implemented in the model.
The field of empirical literature about discrete choice embraces now a wide series of applications, from the marketing of public services to land use planning. Nevertheless the methodology of choice experiments is now quite diffused in several sectors, it is still unexplored and not enough developed in the field of waste management. Our survey can be considered as a preliminary step in the attempt to deepen the analysis of public preferences as a support for the location of facilities. This pragmatic approach aimed to obtain monetary indicators and utility function has to be further followed by a methodological development of alternative solutions to the econometric analysis. Choice tasks could be alternatively treated through more recent approaches. Continuous or discrete mixture logit models, among others, are likely to better explain the heterogeneity in preferences, allowing for an improvement in the internalization of environmental costs of waste facilities.

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TABLES AND GRAPHS

Table 1: Hedonic price applications (source: DEFRA, 2003)

Year	Authors	Infrastructure	Method	Results
1971	Havlicek, Richardson Davies	5 Landfills (Fort Wayne, Indiana – US)	182 sales from 1962 to 1970 (residential)	Increase of 9800$ for each mile far to the landfill
1982	Adler et al.	Hazardous waste treatment plant (Pleasant Plains, New Jersey –US)	Survey before and after 1974 , year of public communication of a soil contamination	10% prices decrease at 1.5, 2, 2.5 miles from the landfill
1982	Gamble et al.	Landfill (Montgomery County, Pennsylvania – US)	¤ 137 sales from 1977 to 1979 (residential)	Reduction between 5% and 7% in the sale prices for houses enclosed in a one mile ray from the landfill
1982	Baker	Landfill (Dryden., New York – US)	Survey on supply prices	21% decrease in prices at 0.25 miles and 0.55% decrease at two miles from the landfill
1985	Havlicek	5 Landfills (Fort Wayne, Indiana – US)	Market study	5% increase in prices per mile of distance from landfill.
1989	Kohlhase	10 Landfills (Harris, Houston – US)	Sales of residential buildings in the years 1976, 1980 and 1985. In 1985 EPA has included the site among the environmental emergency	In 1976 and 1980 one mile of distance form the landfill caused an increase in the properties values of 906$ and 1215$. After EPA declaration the differential was 2435$.
1990	Michaels e Smith	11 Landfills in suburban contexts (Boston – US)	2182 sales in the period 1977-1981 (residential)	Decrease of 253$ for properties close to the infrastructure (1977 values)
1992	Mendelsohn et al.	Hazardous waste pollution and PCB (Port of New Bedford, Mass – US)	Survey on 1916 houses enclosed in a two miles ray from the port, period 1969-1988. Comparison of the price before and after 1982, year of contamination	5-8% decrease for properties interested by the contamination
1992	Hirshfield	Landfill (hypothetical scenario)	Survey conducted trough real estate operators	30% reduction at 0.5 miles, 13% at 1.25 miles.
1992	Genereux	Landfill (Ramsey, Minnesota – US)	708 sales in the period 1979-1989 (residential)	6.2% increase for each mile of distance
1995	Kiel e McClain	Incinerator (Boston – US)	2593 sales in the period 1974-1992 (residential)	Reduction in different stages: pre-rumor (0); rumor (0); building (2284$ per mile, 1.7%); operating (8100$ per mile, 3.2%); operating in the long-run (6607$ per mile, 2.7%).

Table 2: Secondary studies relative to externalities caused by waste disposal facilities (our elaboration from Heshet et al, 2005)

Author	Year	Area	Pollutant	Impacts evaluated
TELLUS INSTITUTE	1992	US	CO_2, NO_X, SO_2, TOC, PM_{10}	Morbidity and mortality
CSERGE	1993	UK	CO_2, NO_X, SO_2, PMT	Global warming, mortality,morbidity, buildings, agriculture
Powell and Brisson	1994	UK	CO_2, NO_X, SO_2, PMT	Global warming and health risks
ExternE	1995, 1998, 2000	UE	CO_2, NO_2, SO_2, TOC, PM_{10}, heavy metals, dioxins	Health, accidents, roads
ECON Energy	1995	N	NO_X, SO_2, TOC, PM_{10}, heavy metals, dioxins	Morbidity mortality, global warming, agriculture, forestry, buildings
Enosh	1996	IL	CO_2, NO_X, SO_2, CO, PM, HCl	Morbidity mortality, global warming, agriculture, forestry, buildings and roads
EMC	1996	IL	CO_2, PM, NO_X, SO_2	Morbidity mortality, global warming, agriculture, forestry, buildings, roads and accidents
Miranda and Hale	1997	S, D, UK, US	CO_2, NO_X, SO_2, CO, PM, HCl, HF	Morbidity mortality, global warming, agriculture, forestry, materials
Rabl	1998	EU	CO_2, NO_X, SO_2, CO, TOC, heavy metals, PM_{10}	Morbidity and mortality
Rabl	1998	F	PM_{10}, NO_2, SO_2	Health, buildings, agriculture, forestry
Eyre	1998	UK, UE_{12}	PM, NO_x, SO_2	Morbidity mortality, global warming, agriculture, forestry, water
COWI	2000	EU	CO_2, NO_2	Global warming
Eunomia	2002	EU	CO_2, NO_X, SO_X, TOC, CO, Pb, dioxins, PM_{10}, NO_2, dioxins	Global warming and health

Table 3: Choice Experiment Design

Which alternative you would choose?	**A □**	**B □**	**C □**
Waste disposal infrastructure	**Incinerator**	**Landfill**	
Distance from the infrastructure	**600 meters**	**2000meters**	
Air pollution level (days per year in which PM10 concentration overcome the EU limits)	**Low (15 days per year)**	**Low (15 days per year)**	
Disamenity derived from the presence of bad odours (days per year in which you fell bad odours)	**Low (15 days per year)**	**Medium (90 days per year)**	**None of the previous**
Yearly compensation (reduction in the cost of life for your family)	**0€**	**2000€**	
Green Areas	**Big park or garden**	**Small green area**	

Table 4: Sample strata

Age cohort	% of the total population of Turin	% of the reference population
25 – 34	14%	17%
35 – 44	17%	21%
45 – 54	13%	17%
55 – 64	13%	16%
65 – 74	13%	16%
More than 75	11%	14%

Table 5: Variables description

Code	Description
COMP	This is the monetary attribute, it represents the monetary compensation proposed for each alternative in the choice experiment.
DIST	Identifies the situation of high proximity to the facility, built as a dichotomous variable assuming value 1 when the infrastructure is at 600 meters or less and 0 when the distance indicated in the choice experiment is 2000 meters.
AIR	The value of this variable identifies situations of air pollution indicated as number of days in which occur exceeds in the limits, imposed by European directives, of particulate emissions.
ODOR	Number of days per year in which are perceptible bad odors.
GREEN	This variable indicates the presence of green areas close to the house. It can assume three different levels: absence, small urban garden, park or big urban garden.
INFRA	Number of infrastructures present close to the actual house of the respondent. We used it in order to identify the people more impacted by the presence of infrastructures to verify their willingness to move and to study their propensity to prefer sites with the incinerator or a landfill.
HIGHR	In the survey we ask the respondents to express their beliefs in term of the dangerousness of the presence o fan incinerator closet o their home. They could indicate a value in a scale from 1 to 6, then we decomposed this scale in two groups (from 1 to 3 the first, from 4 to 6 the second) and we built a dichotomous dummy to indicate the respondents most worried about the presence of the incinerator
NIMBY	This variable indicates the situation in which the respondents declare that in any case they would not willing to host an incinerator closet o their home. Regardless of the goodness of the project, the management and the public utility of the infrastructure they are strongly averse. We can interpret this behavior as an expression of the so called NIMBY effect. This variable signals the presence of this effect.
HEAL	This variable is an indicator of the health status of the respondents. It is modeled as dummy variable assuming value 1 if the interviewed has declared to suffer for physical or psychological disease, in terms of days per month of illness, grater than the average value.
INFO	This dummy variable assumes value 1 if the respondents declare to know the project for the realization of an incinerator in Turin, 0 otherwise.
REDCO	This variable is the sum of the households` annual gross income and the compensation obtainable for each profile.

Figure 1: Sample distribution in Turin's blocks.

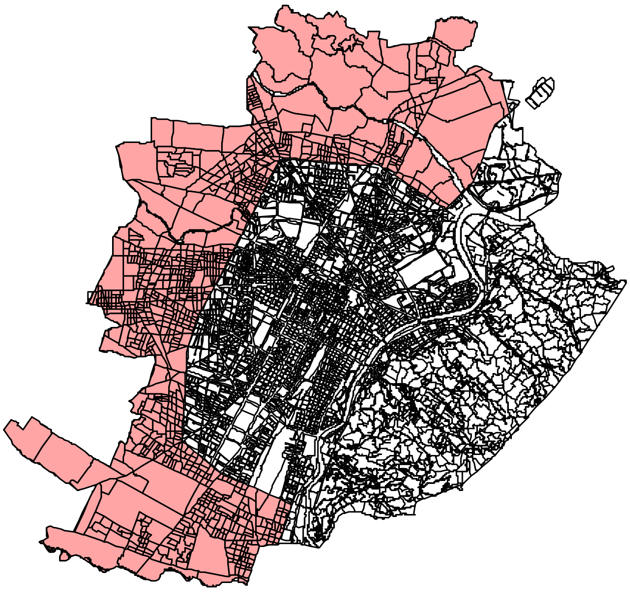

Table 6: Results

Variable	Coefficient	Standard Error	b/St.Er.	p-value
Log-likelihood: -256.8825				
Number of observations: 336				
McFadden Pseudo R^2: .27973				
COMP	0,00043801	0,00013764	3,182	0,0015
I_DIST	-0,83307117	0,31778317	-2.622	0,0088
D_DIST	-0,74884995	0,45740706	-1,637	0,1016
I_AIR	0,00623116	0,00276943	-2,250	0,0245
D_AIR	0,00840975	0,0036016	-2,335	0,0195
I_ODOR	-0,00170903	0,00275859	-0,620	0,5356
D_ODOR	-0,01394858	0,00377371	-3,696	0,0002
I_GREEN	0,62506139	0,20818482	3,002	0,0027
D_GREEN	-0,07459341	0,26186267	-0,285	0,7758
I_INFRA	0,73269743	0,1324709	5,531	0,0000
D_INFRA	0,43010840	0,15718767	2,736	0,0062
I_HEAL	-0,8529001	0,03751865	-2,273	0,0230
D_HEAL	-0,6252674	0,04427932	-1,412	0,1579
I_REDCOM	-0,127823D-7	0,402135D-08	-3,179	0,0015
D_REDCOM	-0,120801D-7	0,605427D-08	-1,995	0,0460
I_HRISK	-1,67376851	0,35388708	-4,730	0,0000
D_HRISK	-0,64663058	0,46378390	-1,394	0,1632
I_NIMBY	-2,82390021	0,75682678	-3,731	0,0002
D_NIMBY	-0,9247582	0,55531021	-0,167	0,8677
I_INFO	1,03018623	0,34493815	2,987	0,0028
D_INFO	0,35582851	0,42066209	0,846	0,3976