# Are Italians Willing to Pay For Agricultural Environmental Safety? A Stated Choice Approach

**Chiara M. Travisi, Peter Nijkamp**
Department of Management Economics and Industrial Engineering, Polytechnic of Milan, Italy, and Fondazione Eni Enrico Mattei (FEEM), Milan, Italy
Department of Spatial Economics, Free University, Amsterdam, The Netherlands, and Tinbergen Institute Amsterdam, The Netherlands

**Paper prepared for presentation at the 84th EAAE Seminar**
**'Food Safety in a Dynamic World'**
**Zeist, The Netherlands, February 8 - 11, 2004**

# ARE ITALIANS WILLING TO PAY FOR AGRICULTURAL ENVIRONMENTAL SAFETY? A STATED CHOICE APPROACH


1 Chiara M. Travisi

2 Peter Nijkamp

1 Department of Management Economics and Industrial Engineering, Polytechnic of Milan, Italy, and Fondazione Eni Enrico Mattei (FEEM), Milan, Italy

2 Department of Spatial Economics, Free University, Amsterdam, The Netherlands, and Tinbergen Institute Amsterdam, The Netherlands



**Abstract**

The widespread use of pesticides in agriculture provides a particularly complex pattern of multidimensional negative side-effects, ranging from food safety related effects to the deterioration of farmland ecosystems. The assessment of the economic implications of such negative processes is fraught with many uncertainties. This paper presents results of an empirical study recently conducted in the North of Italy aimed at estimating the value of reducing the multiple impacts of pesticide use. This type of analysis is rather novel in Italy. A statistical technique known as *choice modelling* is used here in combination with *contingent valuation* techniques. The experimental design of choice modelling provides a natural tool for tackling simultaneously the economic dimensions of several negative environmental effects associated with agrochemicals use. In particular, the paper addresses the reduction of farmland biodiversity, groundwater contamination and human intoxication. The resulting estimates show that, on average, Italians consumers are prone to accept substantial price mark-ups for agricultural goods (in particular, foodstuff) produced in environmentally benign ways.



**Keywords**: pesticide risks, food safety, willingness-to-pay, choice modeling, contingent valuation


## 1. Introduction

It is noteworthy that conventional agriculture produces non-negligible negative side-effects which have been broadly scientifically documented in the scientific literature (Pimentel et al., 1992; Pimentel and Greiner, 1997). The order of magnitude of these externalities justifies the theoretical and political significance of the literature on agro-environmental regulations, pesticide and fertiliser reduction, and the assessment of the associated economic costs. The numerous results of these research efforts are widely used to set regulatory standards for pesticide exposure, to design appropriate environmental protection and food safety strategies, to guide the assessment of environmental impacts and to measure the willingness-to-pay (WTP) for the improvement of agricultural safety. In the European Union, the increasing awareness of governments and consumers for pesticide-related food safety and the changing social preferences towards improving the environmental sustainability of agriculture have culminated in a number of valuable studies on the estimation of consumers' willingness-to-pay (WTP) for reducing the potential impact of pesticide use on human health and the environment (Swanson, 1998; Mourato et al., 2000; Foster and Mourato, 2000; Schou et al., 2002). In the framework of many studies providing quantitative WTP estimates, the availability of detailed monetary estimates on individual's WTP for pesticide risk reduction has been demonstrated to be pivotal to design and implement appropriate pesticide policy measures (such as pesticide taxation, design of eco-labelling) or to plan national incentive programmes for the dissemination of more environmental benign agricultural practices. In this context, the Italian agricultural policy aims to decrease the risks attached to the use of pesticides by providing economic incentives for organic farming and Integrated Pest Management (IPM) [1]. Economic theory suggests that a non-disturbing incentive requires the eco-incentive to be set equal to the marginal value of the negative externalities associated with pesticide usage. In this perspective, a proper incentive programme would require a precise estimation of the Italians' WTP for pesticide risk reduction. This paper presents novel results of a study recently conducted in Italy with the aim of providing estimates of the WTP of Italian consumers to gain improvements in the environmental and health safety of agriculture.

Our study has combined Choice Modelling (CM) and Contingent Valuation (CV) techniques to estimate the value of reducing the multiple impacts of pesticide use. Examples of previous studies using CV methods for pesticide risk valuation can be found in Higley and Wintersteen (1992); Bubzy et al. (1995); Mullen et al. (1997); Fu et al., (1999); Brethour and Weersink (2001); Cuyno et al. (2001); Wilson (2002). Recently, Foster and Mourato (2000) and Schou et al. (2002) have applied Contingent Ranking techniques to value multiple pesticide impacts, while several examples of Conjoint Analysis -applied to the valuation of various pesticide risks for consumers- can be found in Baker and Crosbie (1993), Eom (1994) and Baker (1999).

The CM application was designed to estimate the non-use value of some important pesticide-related environmental attributes, using a 'green shopping' payment vehicle. Respondents were asked to view the various environmental impacts of pesticide use in the agricultural production as foodstuff attributes to be taken into account in the purchase decision. The relevant environmental attributes taken into considerations here were: the reduction in farmlands' biodiversity, the contamination of soil and groundwater in the agricultural land, and the health effects of pesticides on the general public. The monetary attribute used was the monthly food expense through which it is possible to estimate the marginal value of the other non-market characteristics. The CV experiment then asked the respondents in a rather straightforward manner to indicate a maximum WTP for eliminating all the negative environmental impacts under consideration. Using a CV approach, it was then possible to infer the overall WTP for preventing all the environmental impacts of pesticide use.

The reminder of the present paper is organised as follows. In Section 2 the survey design is briefly detailed. Section 3 discusses the theoretical framework used for the analysis. Section 4 presents and discusses our main results.

## 2. The survey questionnaire: design and formulation

The questionnaire used in our Stated Choice experiment was developed and handled by using the results from one focus group and one pre-test [2]. The focus group and the pre-test were necessary to test the effectiveness of the attributes included in the questionnaire, to select a proper payment package of the WTP experiment, and to refine the initial draft questionnaire. On the basis of the results provided by the pilot study some minor modifications in the draft questionnaire were included [3]. The final survey was carried out in Milan between May and June 2003. The interviews were conducted using drop-off pick-up questionnaires by three interviewers across the main areas of the city. Overall, 484 questionnaires were distributed by three interviewers, 302 of which were returned in a completed form. The non-participation rate is therefore only about 28 percent. **Error! Reference source not found.** shows the survey statistics and the socio-demographics of the sample.

Table 1. Survey statistics and socio-demographics of the sample

| Survey Statistics | |
|---|---|
| N° questionnaires distributed | 484 |
| Final data-set | 302 |
| Response rate (%) | 62,4 |
| N° choice sets presented | 1358 |
| N° observations (CM) | 4074 |
| N° observations (CV) | 302 |
| **Variable** | **Sample average** |
| Age | 33.90 |
| Sex (% female) | 61.60 |
| Children (% household with children) | 15,1 |
| Household size | 3,5 |
| Education (% upper school) | 89,4 |
| Income (€/household per month) | 2098,1 |
| Food expense incidence (%) | 35,3 |

The questionnaire comprised three sections. The first part introduced the subject of the environmental side-effects of pesticides use in modern agriculture, *via* a costs-benefit perspective, which emphasized existing trade-offs between positive and negative externalities associated with agricultural production based on the use of synthetic inputs. The second section contained a Choice Modelling/Contingent Valuation (CM/CV) exercise, while the third one requested information on a variety of socio-economic and attitudinal characteristics. The design of the CM survey was inspired by recent literature on pesticide risk valuation, which extends the estimation of the social costs of pesticide applications in agriculture to both environmental and human well-being, modelled as different attributes of a common phenomenon (Mourato et al., 2000; Foster and Mourato, 2000; Schou et al., 2002).

Respondents were asked to view the various side-effects of pesticide usage due to conventional agricultural practices as food attributes to be taken into account in daily purchase decisions. The alternatives were differentiated in terms of food expense and environmental sustainability, which described the range of environmental externalities attached to the underlying production process.

In the pesticide risk valuation literature, the simulation of markets for green produce is well-established to minimize the problem of hypothetical bias. The hypothetical bias is reduced in our case, because respondents are more likely to correctly understand a market scenario they are already familiar with, like for agricultural foodstuff. However, the results of the pre-test showed that respondents were disturbed by a “single-green produce” perspective, and felt more comfortable with choices related to the whole shopping basket for foodstuff. Therefore, a “green shopping” payment package was preferred.

Since the range of the environmental impacts associated with pesticide use is potentially very wide, the selection of the relevant environmental attributes to be included in the questionnaire was a particularly delicate step. Thanks to close cooperation with a group of Italian eco-toxicologists, we first identified the main environmental category spoilt by pesticides, and next we selected the indicator variables appropriate to quantify each environmental category. The indicators were selected to describe, as accurately as possible, the main areas of well-documented environmental damage in Italy. As a result, the relevant environmental categories considered were: biodiversity, soil and groundwater (groundwater contamination is here considered intimately linked to soil contamination) and human health. In contrast to Foster and Mourato (2000), who only considered human health and biodiversity, we added an additional environmental dimension, via soil and groundwater, which emerged as a relevant attribute in discussion with both the panel of ecotoxicologists and the focus group. The impact on biodiversity was quantified in terms of the number of endangered farmland bird species, while the impact on soil and groundwater was measured using the percentage of farmland areas contaminated by pesticides. The impact on human health was measured in terms of cases per year of acute intoxication, both as a result of work and domestic exposure. Each attribute was considered at three different levels [5], as shown in Table 2.

Table 2. Attributes and levels

| *ATTRIBUTE* | *LEVEL-1 STATUS QUO* | *LEVEL-2* | *LEVEL-3* | *LEVEL-4* |
|---|---|---|---|---|
| *Food expense* [€/household month] | current (*) | +50 | +100 | +200 |
| *Human health* [N° cases intoxication/year] | 250 | 150 | 100 | 50 |
| *Soil and groundwater* [% contaminated agricultural land] | 65% | 45% | 25% | 15% |
| *Biodiversity* [N° endangered farmland bird species] | 15 | 9 | 6 | 3 |

(*)The current level of food expense is indicated by respondents before starting the CM exercise.

The *status quo* scenario was represented by the conventional scenario of agricultural practices, priced at the household monthly food expense level (indicated by respondents), for which each of the aforementioned environmental attributes were set at their estimated current position (i.e., respectively, 250 cases of acute intoxication per year, 15 endangered bird species and 65% of farmland areas contaminated).

Each respondent was presented with 4 or 5 choice sets developed using an experimental design technique [6]. Each choice set required respondents to make a choice among three alternative agricultural scenarios: the *status quo* scenario and two alternative ones (see Table 3).

Table 3. Example of choice set.

| Characteristics | Option A: Current Situation | Option B: Alternative agricultural practices | Option C: Alternative agricultural practices |
|---|---|---|---|
| **Food expense** (€/household month) | current | + 50 € | + 100 € |
| **Biodiversity:** N° of endangered bird species | 15 species | 10 species | 5 species |
| **Soil and groundwater:** % of contaminated farm land | 65% | 30% | 40% |
| **Human Health:** cases of intoxication per year | 250 cases/year | 160 cases/year | 90 cases/year |

☐ I would choose option A, obtained with conventional agricultural practices

☐ I would choose option B, obtained with more environmental benign agricultural practices

☐ I would choose option C, obtained with more environmental benign agricultural practices

A CV question followed next the CM exercise. In this part, a dichotomous choice format was used to elicit the respondents' maximum WTP for eliminating all the negative effects of pesticide use on the environment and human health.

## 3. Modelling consumers preferences

### 3.1 The Choice Modelling exercise

The underlying assumption in assessing the economic value of alternative agricultural practices that induce different levels of risk to human health and environmental well-being is that its monetary value reflects consumers' behaviour. In other words, our valuation exercise analyses consumer's preferences regarding the choice of alternative scenarios of agricultural practices, seen from the perspective of consumers making daily shopping decisions.

Let *W* represent a set of alternative agricultural practices, and *T* the set of vectors of measured attributes. The choice for a consumer can be defined as a draw from a multinomial distribution with a probability:

$$\Pr(x|t,A) \qquad \forall x \in A \qquad \text{with } A \subseteq W \qquad (1)$$

where $\Pr(x|t,A)$ is the probability of selecting agricultural practice x, given the vector of observed attributes *t* and the set of agricultural practices *A*, for each alternative contained in the choice set *A*. To operationalize the previous condition, we deployed a Random Utility model formulation (see e.g. McFadden, 1986).

The behavioural basis of stated choice data emerges from Random Utility Theory (RUT). RUT models estimate the probability that a respondent will select an alternative based on the attributes of each possible alternative. Let $U_{iq}$ be the utility of the *i*th agricultural scenario for the *q*th consumer. Under the RUT framework, $U_{iq}$ is assumed to be partioned into two components: a systematic component $V_{iq}$, and a random component, $\varepsilon_{iq}$ (see (2)). This means that it is assumed that one part of the utility is common to all individuals, and that the other part is individual-specific (Ben-Akiva and Lerman, 1997). Under the assumption that the error terms are independently and identically distributed (Gumbell distribution), a multinomial logit model results:

$$U_{iq} = V_{iq} + \varepsilon_{iq} \qquad (2)$$

The utility function $V_{iq}$, which represents the utility of the different options in the multinomial logit model, can have different functional forms. The simplest form assumes that $V_{iq}$ has an additive structure and is homogeneous across the population in terms of the relative importance of the attribute ($x_k$). The additive structure only includes the $k$ attributes from the choice set $i$, as follows:

$$V_{iq} = \sum_{k=1}^{K} \beta_{kiq} x_k \qquad (3)$$

The utility $V_{iq}$ of the $i$th alterative for the $q$th respondent consists of the sum of the values of the different attributes $k$. In addition, utility maximisation theory assumes that consumers will choose the agricultural scenario that yields the highest utility. Then, the individual consumer $q$ will choose the $i$th agricultural scenario if and only if:

$$U_{iq} > U_{jq} \qquad \forall \text{i,j} \in A \ \text{ with } i \neq j \qquad (4)$$

where $U_{iq}$ is the utility level of all non-selected alternatives, and $A$ is the set of possible choice alternatives. Combining (3) and (4), we know that an agricultural scenario $i$ is chosen if and only if:

$$(V_{iq} + \varepsilon_{iq}) > (V_{jq} + \varepsilon_{jq}) \ \text{ or } \ (V_{iq} - V_{jq}) > (\varepsilon_{jq} - \varepsilon_{iq}) \qquad (5)$$

Since $(\varepsilon_{jq} - \varepsilon_{iq})$ cannot be observed, it is not possible to assess exactly whether $(V_{iq} - V_{jq}) > (\varepsilon_{jq} - \varepsilon_{iq})$. Therefore, the aim of this choice model is to calculate the probability that $V_{iq} - V_{jq}$ will be larger than $(\varepsilon_{jq} - \varepsilon_{iq})$, i.e.,

$$\Pr(x_{iq} | t_q, A) = \Pr_{iq} = \Pr\{[\varepsilon_{jq} - \varepsilon_{iq}] < [V_{iq} - V_{jq}]\} \qquad \forall i,j \ \text{ with } i \neq j$$

This means that the probability that a consumer will choose the agricultural scenario $x_i$ equals the probability than the difference between the random component of the utility function is smaller than the systematic component of the utility function across the two alternative agricultural practices under consideration. The purpose of the choice model is to estimate the value and statistical significance of the determinants of the utility function. The basic model assumes a linear, additive form of the attributes as specified in (2).

In our questionnaire, the CM exercise implies a choice between three alternative agricultural scenarios, including the *status quo*. The agricultural scenarios differ with respect to food expense, effects on farmland birds' biodiversity, contamination of soil and aquifers in farmland areas and threats to human health. The utility of alternative $i$ for respondent $q$ is assumed to depend on:

- the food expense of the $q$th respondent related to the $i$th agricultural scenario ($x_{fiq}$);
- the effects of the $i$th agricultural scenario on birds' biodiversity for the $q$th respondent ($x_{biq}$);
- the contamination of soil and groundwater related to the $i$th agricultural scenario for the $q$th respondent ($x_{siq}$);
- the effects of the $i$th agricultural scenario on the health of the general public for the $q$th respondent ($x_{hiq}$).

This leads to the following utility expression:

$$V_{iq} = \beta_{fq} x_{fq} + \beta_{bq} x_{bq} + \beta_{sq} x_{sq} + \beta_{hq} x_{hq} \qquad (6)$$

To make this model tractable, it is necessary to assume that the probability that respondent $q$ chooses alternative $i$ falls between 0 and 1. In other words, we assume that the error terms of the resulting utility function are independently and identically distributed (IID, Gumbell distribution). A non-trivial consequence of using this error assumption is the property of independence of irrelevant alternatives (IIA). This property requires that the probability of choosing one alternative over a second one depends only on the utility of the respective alternatives [7]. In other words, the probability ratio of two options should be unaffected by including or omitting other alternatives.

Under this assumption, a multinomial logit model (also known as conditional) results. The multinomial logit model is structured, so that the probability of choosing an option $i$ depends on the utility of that option relative to the utility of the other options:

$$P_{iq} = \frac{\exp(V_{iq})}{\sum_{j=1}^{J} \exp(V_{jq})} \qquad (7)$$

and:

$$V_{iq} = \sum_{k=1}^{K} \beta_{iq} x_{ikq} \qquad (8)$$

This model can be estimated using the maximum likelihood estimation method.

After estimating the model, we can infer the marginal rate of substitution between any of the attributes in our choice set. The marginal rate of substitution between the food expense coefficient and the biodiversity coefficient gives the implicit WTP to protect farmland bird biodiversity (see (9)):

$$WTP_b = (\beta_b / \beta_f) \qquad (9)$$

Similarly, the marginal rate of substitution between the food expense coefficient and the soil contamination one gives the implicit WTP to reduce soil contamination (see (10)):

$$WTP_s = (\beta_s / \beta_f) \qquad (10)$$

And finally, the marginal rate of substitution between the food expense coefficient and the human health one gives the implicit WTP to prevent cases of human illness (see (11)):

$$WTP_h = (\beta_f / \beta_h) \qquad 11$$

In a CM exercise it is possible to determine the alternatives in such a way that all heterogeneities across alternatives are captured by the attributes, as in (6). Nevertheless, it is likely that respondents to express their preferences for alternatives by considering reasons beyond the attributes specified.

An alternative-specific constant term, *C*, can be added to the model to capture the effect of some systematic but unobserved factors on the respondents' choices. In other words, while the *x* variables show the effect of deterministic variables in explaining choices (i.e., attributes in the choice sets), the constant *C* captures the unobserved factors that explain choices (seeequation 12). Technically, they reflect the mean of the differences in the error terms (Ben-Akiva and Lerman, 1985). In a multinomial logit model it is possible to have (*a*-1) alternative specific constants, where *a* is the number of options. This is because the constants are based on differences between the alternative options and the current situation.

In the present context, though we do not use labelled options, it may be that consumers attach a value to the *status quo* or to one of the two safer agricultural options as such. To test whether this is indeed the case, one can add an alternative specific constant to the utility function:

$$V_{iq} = \delta_{iq} C_{iq} + \sum_{k=1}^{K} \beta_{kiq} x_k \qquad 12$$

More complex specifications are possible which include socioeconomic and attitudinal variables [8].

### 3.2 The Contingent Valuation exercise

In CV surveys, one of the most widely used approaches to elicit information about the respondent's WTP is the so-called dichotomous-choice format (Hanemann 1985, Carson 1985). In the follow-up of our CM part, we use this type of elicitation question to infer the respondents' WTP for eliminating all risks, both to human health and the environment, associated with pesticide applications in agriculture. The dichotomous-choice format mimics behaviour in regular markets, where people usually buy, or decline to buy, a certain good at the proposed retail price. Besides, similarly to the CM technique, this CV format is consistent with the incentive comparability property and is also credited with reducing the cognitive burden placed on the respondent.

The dichotomous-choice “double-bounded” payment question asked the respondent if he/she would be willing to pay $B_1$ percent extra on household monthly food expense to gain the proposed improvement in agricultural safety. In a follow-up question respondents who answered “yes” to the first bid value were asked if they would pay $B_2^+$ percent extra on household monthly food expense, with $B_2^+ > B_1$, while respondents who answered “no” were faced with a $B_2^-$ amount, with $B_2^- < B_1$. The bid value $B_1$ varied randomly across respondents and the amount of the second bid $B_2$ depends on the amount of the first one [9].

Four response sequences were possible in our exercise: both answers are positive (yes/yes); both answers are negative (no/no); refuse the first bid but accept the second (no/yes); or accept the first but refuse the second (yes/no). Therefore, for any given underlying WTP distribution $F(B_i;\theta)$, the probability of response is given by:

$$\Pr\{yes/yes\} \equiv P^{yy} = 1 - F(B_2^+;\theta) \qquad (13)$$

$$\Pr\{no/no\} \equiv P^{nn} = 1 - F(B_2^-;\theta) \qquad (14)$$

$$\Pr\{yes/no\} \equiv P^{yn} = F(B_2^+;\theta) - F(B_1;\theta) \qquad (15)$$

$$\Pr\{no/yes\} \equiv P^{ny} = F(B_1;\theta) - F(B_2^-;\theta) \qquad (16)$$

Given these expressions, the log-likelihood function for the double-bounded model can be written as:

$$\log L = \sum_{i=1}^{n} \left[ I_{yy} \log P_i^{yy} + I_{yn} \log P_i^{yn} + I_{ny} \log P_i^{ny} + I_{nn} \log P_i^{nn} \right] \qquad (17)$$

Since the follow-up bid amount is greater (lower) than the first for those who answer “yes” (“no”) to the initial payment question, the four pairs above identify intervals in which the respondents’ WTP amount is assume to fall. Specifically, the respondent’s WTP is greater than $B_2$ for (yes/yes) sequences; WTP falls between $B_2$ and $B_1$ for (no/yes) pairs; it falls between $B_1$ and $B_2$ for (yes/no); and it is lower than $B_2$ for (no/no). This yields the following log-likelihood function:

$$\log L = \sum_{i=1}^{n} \log\left[ F(WTP^H;\theta) - F(WTP^L;\theta) \right] \qquad (18)$$

where $WTP^H$ and $WTP^L$ are the higher and the lower bound of the interval around *WTP* as explained above [10]. Our results are based on the assumption that WTP follows a Weibull distribution.

## 4. Survey valuation results

### 4.1 Results of the Choice Modelling question

*Estimates of the basic logit model*

Two different multinomial logit models were estimated using the data from our Milan survey. The first one is a basic logit model which shows the importance of the four attributes used in the choice set to explain the respondents’ choices; the second one introduces alternative specific constants (ASC) to test the presence of hidden values attached to the choice options *per se*. In other words, in the basic model we assume that all the differences between the choice possibilities are reflected by the attributes, while in the second case we argue that respondents might follow a lexicographic behaviour and thus show response patterns where they always prefer the alternative that is better in one of the attributes. This might be the case, even though we used unlabelled options. Rizzi and Ortùzar (2003) identify three main reasons for lexicographic response patterns. One is related to a weak experimental design in which the differences in the attribute levels are simply not large enough to enable respondents to trade-off the choice attributes. A second reason could be simplification. If the cognitive effort required to answer is excessive for the respondent, he or she might choose the option that is the best in terms of just one attribute. Finally, lexicographic answers might come from respondents with random response patterns. The estimated results of the two models are summarized in Table 4.

Table 4: Estimates of the basic multinomial logit model

| *Variable* | *Model without ASC*(a,b) | *Model with ASC*(a,b) |
|---|---|---|
| Household food expense(c,d) | -0.0153*** (-17.439) | -0.0149*** (-17.495) |
| Bird biodiversity(c,d) | -0.0968*** (-5.768) | -0.0575*** (-3.086) |
| Soil and aquifer contamination(c,d) | -0.0356*** (-10.413) | -0.0345*** (-8.329) |
| Human health(c,d) | -0.0113*** (-9.059) | -0.0101*** (-5.921) |
| Intercept option A (*status-quo scenario*) (c,d) | – | -0.749*** (-2.205) |
| Intercept option B (*alternative scenario*) (c,d) | – | -0.419*** (-5.015) |
| Log-likelihood | -833.190 | -803.819 |
| $R^{2}$ (e) | 0.442 | 0.461 |
| $R^2$-adjusted(e) | 0.440 | 0.460 |
| WTP to protect bird biodiversity(f) | 3.850 | 6.310 |
| WTP to reduce soil and aquifer contamination(f) | 2.310 | 2.320 |
| WTP to protect human health(f) | 0.675 | 0.737 |

Notes:
(a) We use data from 302 questionnaires that provide, overall, 1358 observations.
(b) Calculations are performed using the Multinomial Logit procedure in *LIMDEP®*.
(c) The values listed in each case are coefficient and t-ratio.
(d) Statistically significance is indicated by (***), (**) and (*) referring respectively to 0.01, 0.05 and 0.1 percent level.
(e) $R^2 = R^2$ McFadden = 1-LogL/LogL*Log-L (Louviere et al., 2000).
(f) The WTP is expressed in units of € per household per month.

All coefficients for both models have the expected *a priori* sign and are highly statistically significant. The explanatory power of the two models is rather high, with an R-square higher than 0.4 [11]. These results indicate that positive-use values exist for all environmental dimensions considered in the survey, i.e, respondents are prone to accept price marks-up in foodstuff to gain improvements in the agricultural production safety. Moreover, from these outcomes it is possible to conclude that the respondents experience some kind of lexicographic behaviour thus paying for the concept of "safer" -or the idea of "feeling safer"- as such. The utility attached to the *status quo* scenario is indeed lower than the utility attached to the alternative agricultural scenario B. The results of the log-likelihood ratio test of the two models confirm that these differences are statistically significant (see Table 5).

Table 5. Log-likelihood ratio test

| *Unrestricted model* | *Restricted model* | *Test statistics* | *Test value* | *p-value* |
|---|---|---|---|---|
| Without ASC | With ASC | 58.74 | 5.99 | 0.000 |

*Capturing observed heterogeneity*

In order to examine whether socio-demographic and attitudinal differences across the sample might have an effect on the WTP estimation, we split the sample into subgroups according with the following variables: gender, income and education level, presence of children's in the household, concern about the topic proposed in the questionnaire and environmental attitude. The estimates of the different sub-samples are presented jointly with their 95 percent confidence intervals calculated using the asymptotic t-test method (Armstrong et al., 2001) in Figure 1-6. The resulting model for each of the cuts indicates substantial variations in coefficients across sample segments, particularly as regards the biodiversity and human health coefficients (see Table 6 and Table 7).

Table 6. Comparison of models estimated on different sample segments

| Variable Attitude | *Gender* (a,b) | | *Child* (a,b) | | *Education* (a,b) | | *Attitude*(a,b) | | *Concern*(a,b) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Female* | *Male* | *Yes* | *No* | *Secondary* | *Tertiary* | *I-III* | *IV-V* | *I-III* | *IV-V* |
| Household food expense(c,d) | -0.017***<br>(-14.41) | -0.012***<br>(-9.72) | -0.0151***<br>(-6.99) | -0.015***<br>(-15.99) | -0.023***<br>(-5.57) | -0.014***<br>(-16.41) | -0.014***<br>(-9.84) | -0.016***<br>(-14.11) | -0.014***<br>(-10.62) | -0.016***<br>(-13.70) |
| Birds biodiversity(c,d) | -0.041<br>(-1.63)** | -0.080***<br>(-2.85) | -0.031*<br>(-0.721) | -0.065***<br>(-3.08) | -0.109**<br>(-1.21) | -0.055***<br>(-2.87) | -0.043*<br>(1.25) | -0.059***<br>(2.58) | -0.039*<br>(-1.42) | -0.070***<br>(-2.75) |
| Soil and aquifer contamination(c,d) | -0.038***<br>(-6.55) | -0.034***<br>(-5.72) | -0.028***<br>(-2.79) | -0.036<br>(-7.91)*** | -0.075***<br>(-3.48) | -0.032***<br>(-7.62) | -0.039***<br>(-5.60) | -0.034***<br>(-6.35) | -0.042***<br>(-6.24) | -0.030***<br>(-5.46) |
| Human health(c,d) | -0.0127***<br>(-5.26) | -0.0072***<br>(-3-05) | -0.015***<br>(-3.33) | -0.009<br>(-4.90)*** | -0.015**<br>(-1.79) | -0.009***<br>(-5.72) | -0.0031*<br>(-1.16) | -0.014***<br>(-6.05) | -0.012***<br>(-4.18) | -0.0091***<br>(-4.17) |
| Intercept option A (*status-quo scenario*) (c,d) | -0.53**<br>(-1.18) | -0.88**<br>(-1.68) | -2.02***<br>(-1.99) | -0.591**<br>(-1.59) | 0.628*<br>(0.40) | -0.788***<br>(-2.26) | -0.944*<br>(-1.64) | -0.811*<br>(-1.80) | -0.701*<br>(-1.26) | -0.859*<br>(-1.96) |
| Intercept option B (*alternative scenario*) (c,d) | 0.055***<br>(4.87) | 0.22**<br>(1.79) | -0.30**<br>(1.49) | 0.453***<br>(4.89) | 1.02***<br>(2.62) | 0.386***<br>(4.48) | 0.406***<br>(2.75) | 0.44***<br>(4.147) | 0.59***<br>(4.47) | 0.28***<br>(2.57) |
| Log-likelihood | -506.49 | -295.55 | -132.01 | -665.47 | -65.43 | -734.07 | -268.20 | -520.09 | -327.11 | -470.62 |
| N° of observations | 889 | 482 | 251 | 1107 | 145 | 1213 | 402 | 956 | 580 | 778 |
| $R^{2}$ (e) | 0.481 | 0.442 | 0.521 | 0.452 | 0.589 | 0.449 | 0.393 | 0.505 | 0.487 | 0.449 |
| $R^2$-adjusted(e) | 0.479 | 0.438 | 0.515 | 0.451 | 0.580 | 0.447 | 0.388 | 0.503 | 0.484 | 0.447 |
| LR test statistics | *75.5* | | *12.68* | | *8.65* | | *31.06* | | *12.19* | |
| WTP to protect birds' biodiversity(f) | 2.375 | 6.616 | 2.052 | 4.333 | 4.641 | 3.835 | 3.071 | 3.687 | 2.786 | 4.375 |
| WTP to reduce soil and aquifer contamination(f) | 2.850 | 2.198 | 1.854 | 2.400 | 3.160 | 2.240 | 2.786 | 2.125 | 3.000 | 1.875 |
| WTP to protect human health(f) | 0.594 | 0.743 | 0.993 | 0.600 | 0.610 | 0.692 | 0.221 | 0.875 | 0.857 | 0.643 |

Notes:
(a) We use data from 302 questionnaires that provide, overall, 1358 observations.
(b) Calculations are performed using the Multinomial Logit procedure in *LIMDEP*®.
(c) The values listed in each case are coefficient and t-ratio.
(d) Statistically significance is indicated by (***), (**) and (*) referring respectively to a 0.01, 0.05 and 0.1 percent level.
(e) R2 = R2 McFadden = 1-LogL/LogL*Log-L (Louviere et al., 2000).
(f) The WTP is expressed in units of € per household per month.

Table 7. Comparison of models estimated on different income classes

| *Variable* | *Income class* (a,b) | | | |
|---|---|---|---|---|
| | *I*(g) | *II*(g) | *III*(g) | *IV*(g) |
| Household food expense(c,d) | -0.024***<br>(-4.165) | -0.0149***<br>(-10.175) | -0.0147***<br>(-11.85) | -0.0149***<br>(-6.39) |
| Birds biodiversity(c,d) | 0.052*<br>(0.56) | -0.053*<br>(-1.65) | -0.088***<br>(-3.03) | 0.004<br>(0.82) |
| Soil and aquifer contamination(c,d) | -0.046**<br>(-1.95) | -0.038***<br>(-5.28) | -0.029***<br>(-4.97) | -0.042***<br>(-3.83) |
| Human health(c,d) | -0.029***<br>(-2.59) | -0.0087***<br>(-2.99) | -0.0077***<br>(-3.17) | -0.016***<br>(-3.22) |
| Intercept option A (*status-quo scenario*) (c,d) | 1.663**<br>(1.01) | -0.639**<br>(-1.10) | -1.485***<br>(-2.82) | 0.129<br>(0.15) |
| Intercept option B (*alternative scenario*) (c,d) | 1.162***<br>(2.37) | 0.595***<br>(4.06) | 0.210**<br>(1.732) | 0.574***<br>(2.54) |
| Log-likelihood | -43.461 | -263.002 | -353.889 | -132.072 |
| N° of observations | 77 | 449 | 621 | 211 |
| $R^{2}$ (e) | 0.486 | 0.467 | 0.481 | 0.430 |
| $R^2$-adjusted(e) | 0.465 | 0.463 | 0.479 | 0.422 |
| LR test statistics | *22,8* | | | |

| Variable | Income class (a,b) | | | |
|---|---|---|---|---|
| | I(g) | II(g) | III(g) | IV(g) |
| WTP to protect birds' biodiversity(f) | -2.167 | 3.557 | 5.986 | -0.268 |
| WTP to reduce soil and aquifer contamination(f) | 1.916 | 2.550 | 1.973 | 2.819 |
| WTP to protect human health(f) | 1.208 | 0.584 | 0.524 | 1.074 |

Notes:
(a) We use data from 302 questionnaires that provide, overall, 1358 observations.
(b) Calculations are performed using the Multinomial Logit procedure in *LIMDEP*®.
(c) The values listed in each case are coefficient and t-ratio.
(d) Statistically significance is indicated by (***), (**) and (*) referring respectively to a 0.01, 0.05 and 0.1 percent level.
(e) $R^2 = R^2$ McFadden = 1-LogL/LogL*Log-L (Louviere et al., 2000).
(f) The WTP is expressed in units of € per household per month.
(g) Income: class '1' corresponds to respondents declaring a monthly household income between 500 and 750 €; class '2' corresponds to an income between 750 and 1.625 €; class '3' corresponds to an income between 1.625 and 3.000 € and class '4' corresponds to an income over 3.000 €.

To test whether these differences are overall statistically significant, Ben-Akiva and Lerman (1985) propose a likelihood ratio test based on the comparison of the log-likelihood functions for the model estimated on the pooled sample and the sum of the log-likelihoods estimated on a series of exhaustive and mutually exclusive segments of the population [12]. The test statistics for this likelihood ratio test are also reported in Tables 6 and 7, and can be compared against the corresponding critical value at the 95 percent confidence level [13]. This result suggests that all socio-economic and attitudinal variables considered have a significant impact on the coefficients estimates, since the test-statistics is larger than the critical value.

Notwithstanding the statistical relevance of the aforementioned socio-economic variables, the observed variations in the magnitude of WTP estimates according to different respondents' profiles satisfy only partially our *a priori* theoretical expectations (see also Hammitt, 1990). Women exhibit a lower willingness to pay for bird's biodiversity and groundwater quality than men, while they are prone to pay up to 79 percent more to reduce the negative effect of pesticide usage on the general public (see Figures 1-3). The same pattern can be observed for respondents with children, who exhibit lower WTPs to gain a reduction of pesticides threats to the environment but, on the other hand, are willing to pay even 62 percent more than those without children to safeguard human health. These results are consistent with the findings of previous studies that indicate that women have a more altruistic attitude and that motherhood or fatherhood is positively correlated with the magnitude of WTPs for improvements in environmental quality (Govindasamy *et al.*, 1998a, 1998b, Foster and Mourato, 2000). Those with only secondary education exhibit higher WTP for biodiversity and groundwater quality, while, in respect of higher educated respondents, they seem to underestimate human health risks. A satisfactory interpretation can be offered for results obtained for sub-models capturing differences in environmental attitude and concern. Using a five-point Likert scale, respondents were asked to reveal their environmental attitude choosing between two extreme positions: a *pro economic growth* against a *pro environmental quality* option. Then, they were asked to declare their level of concern on the topic proposed in the questionnaire choosing between a *not at all informed* and a *very well informed* position. The two issues captured by the attitude and concern variables are strictly interlinked. We therefore, expect to observe the same WTP pattern for both concern and attitudinal profiles. This is in fact the case for all environmental dimensions considered, except for the human health one for which we observe, respectively, a positive and a negative correlation of attitude and concern items in respect to the magnitude of WTP. In other words, the higher the attitude variable, the higher the WTP for human health; and, the higher the concern, the lower the WTP. Finally, those declaring a higher environmental sensitivity and a higher concern about pesticides risks exhibit a higher WTP for birds' biodiversity, while they are less prone to pay for improvements in soil and aquifer quality.

An important prediction of economic theory is that WTP is an increasing function in the individuals' income level. The results detailed in **Error! Reference source not found.** and shown in Figures 4 to 6 point at conflicting evidence to such an assumption. For birds' biodiversity, the WTP estimates increase as the income level increases; nevertheless, for very high household incomes the WTP becomes even negative (see Figure 4). Similarly, fluctuations over and below the WTP value estimated for the whole sample can be observed in the case of groundwater and human health related results (Figure5-6). In the first case, an WTP pattern increasing with the income level is visible, though the WTP decreases for household income between 1625 and 3000 euro per month, and reaches he highest level for an income over 3000 euro per month. In the latter case, the highest WTP values correspond to the lowest and highest income classes, respectively.

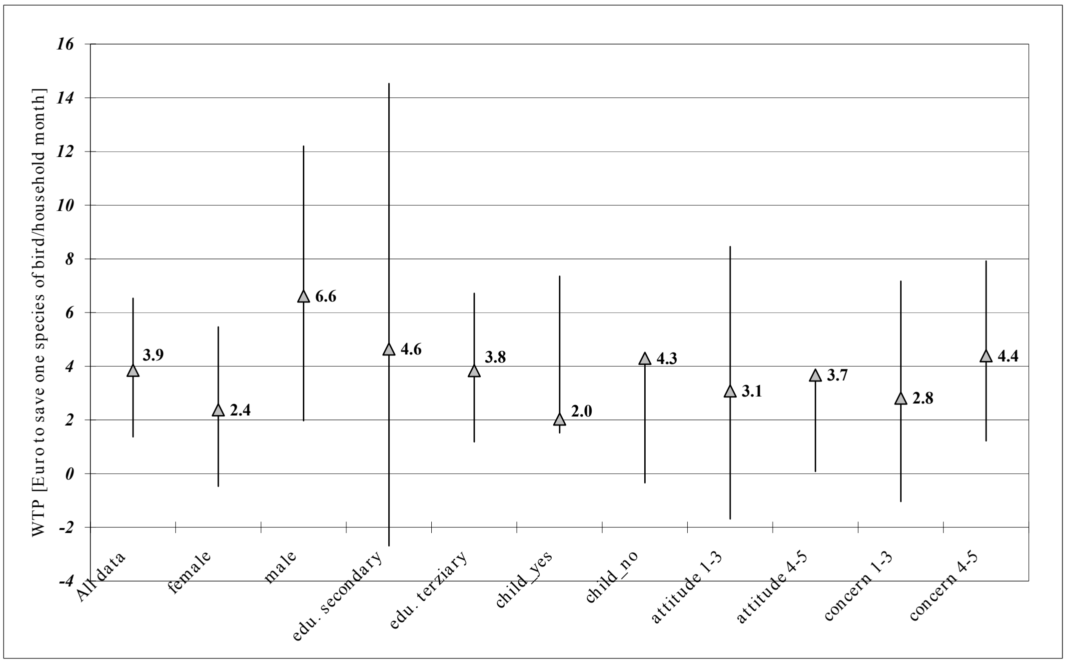


Figure1. WTP for birds' biodiversity: point estimates and 95 percent confidence interval for various sub-samples.

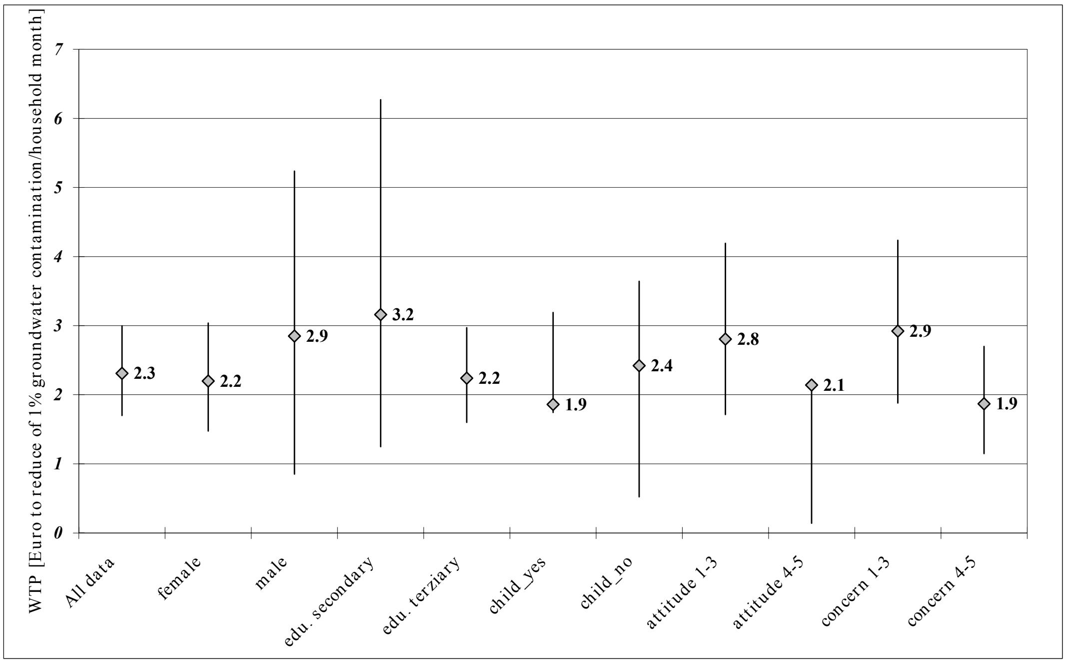


Figure 2. WTP for soil and groundwater: point estimates and 95 percent confidence interval for various sub-samples.

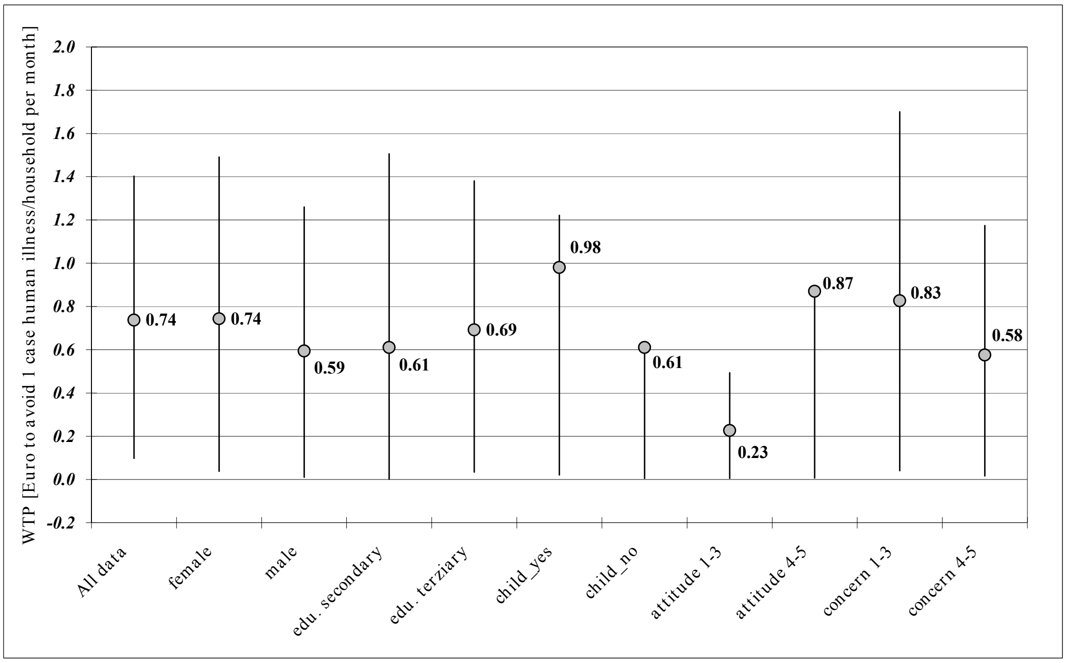


Figure 3. WTP for human health: point estimates and 95 percent confidence interval for various sub-samples.

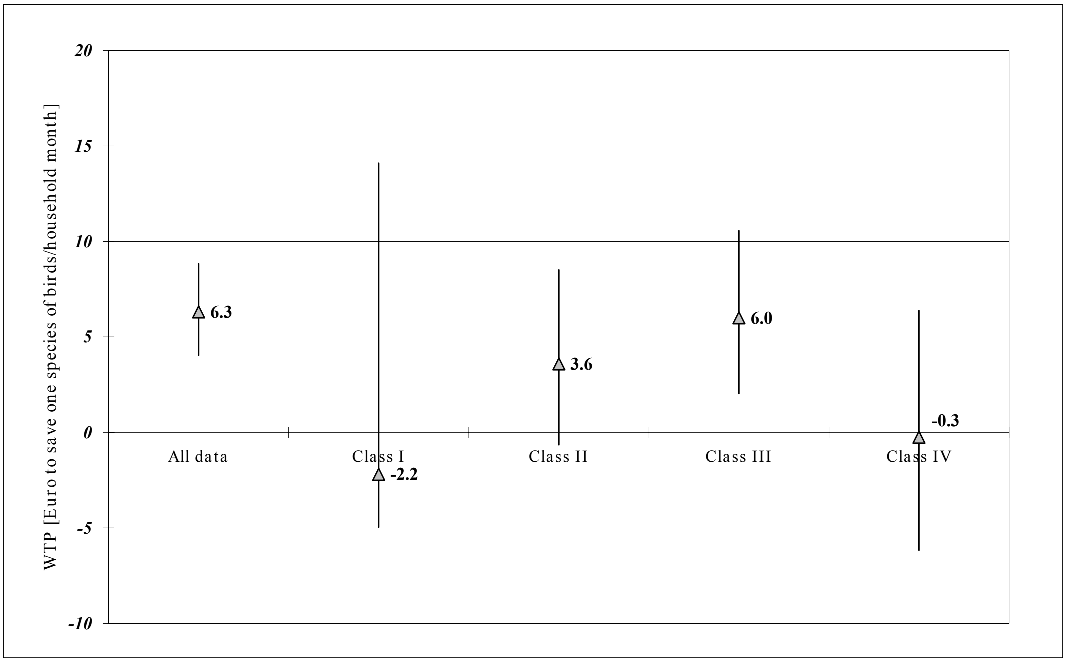


Figure 4. WTP for birds' biodiversity: point estimates and 95 percent confidence interval for income classes.

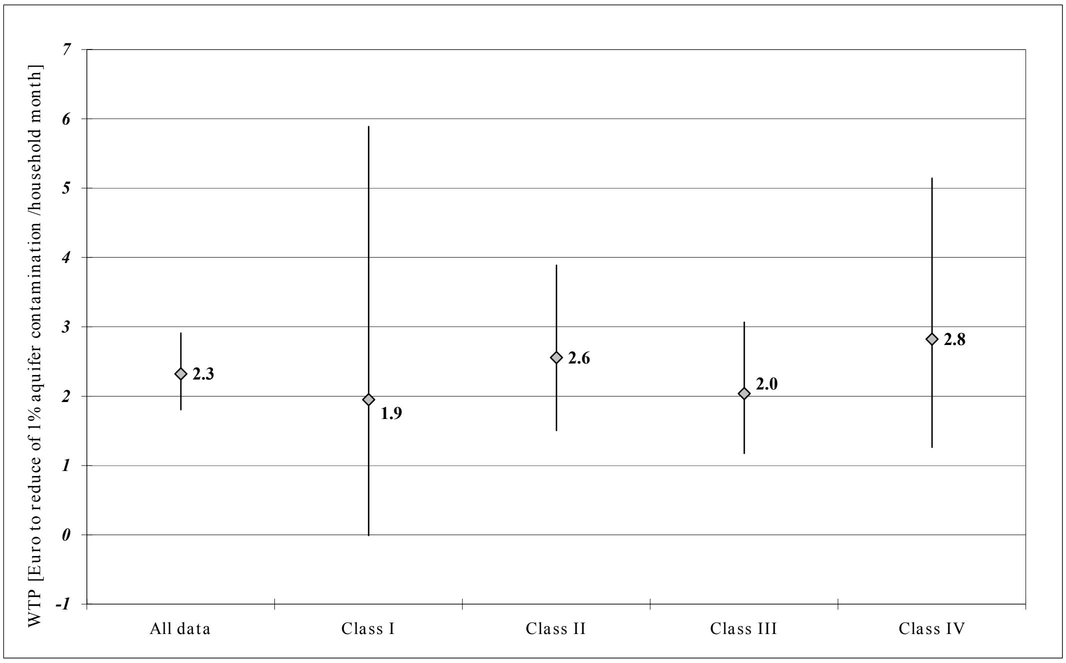


Figure 5. WTP for soil and groundwater: point estimates and 95 percent confidence interval for income classes.

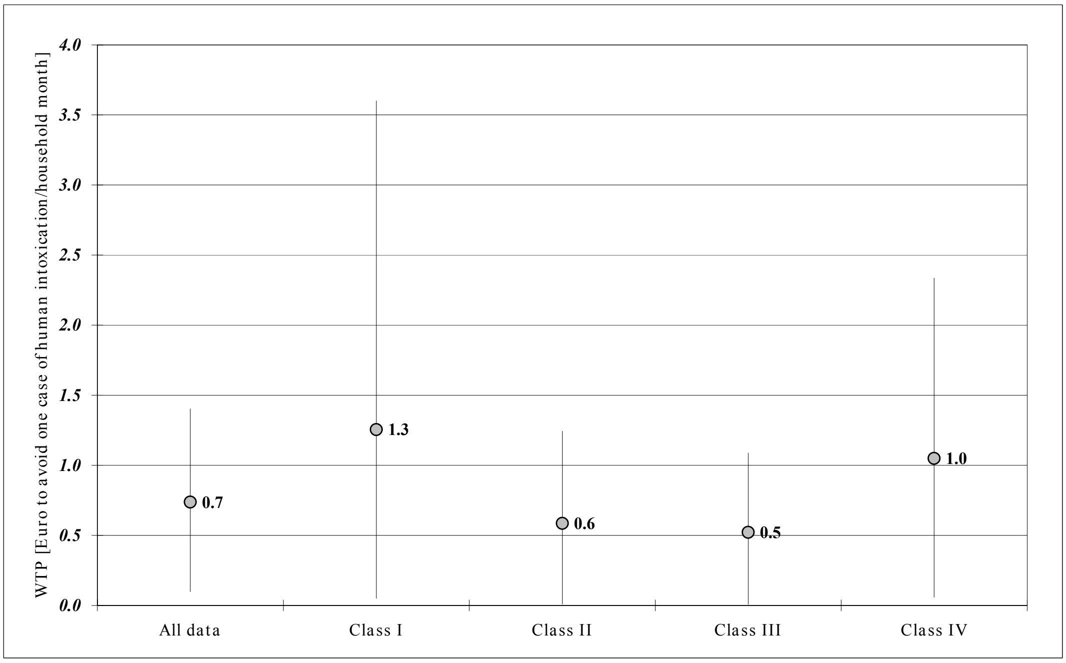


Figure 6. WTP for human health: point estimates and 95 percent confidence interval for income classes.

*Attributes trade-offs*

As suggested in the previous discussion, the WTP is found to be substantially larger for environmental dimensions than for human health. Nevertheless, it is not possible to make direct comparisons across different pesticide risks and the related WTPs, since the unit of measurement used to quantify risks in the experimental design varies. A more rigorous way of making direct comparisons is to observe unit trade-offs across choice attributes (see Table 8). From this simple exercise we can see that, on average, respondents are only willing to tolerate about 6 cases of human illness to save an entire species of farmland birds, and 3 cases of human intoxication to reduce soil and ground water contamination with 1 percent. Trade-offs between biodiversity protection and ground water quality show that the respondents were willing to accept only about 2 percent of soil and aquifer contamination to save an entire farmland bird's species. This indicates the importance that the sample attached to both the preservation of human health and the protection of farmland soil and ground water resources. Clearly, the issue of farmland biodiversity decrease is still weakly perceived by Italian households.

Table 8. Unit trade-offs across choice attributes

| | *Human health* | *Soil and groundwater* | *Birds biodiversity* |
|---|---|---|---|
| *Human health* | 1 | 0.3 | 0.1 |
| *Soil and groundwater* | 3.2 | 1 | 0.6 |
| *Birds biodiversity* | 6.2 | 2.7 | 1 |

### 4.2 Results of the Contingent Valuation experiment

After having responded to the series of choice modelling questions, respondents were exposed to a CV question with a dichotomous choice double-bounded format (see above). Respondents were asked to indicate whether they would have be willing to accept an increase in their household food expense to eliminate all risks related to pesticide use in agricultural production, i.e. related to both human health and the environment. This exercise allows us to calculate an "overall" WTP estimate for reducing all pesticides negative side-effects, compared to a "target specific" WTP to be inferred by means of the CM questions. What we estimate, using a dichotomous choice format, is the mean WTP for an overall increase in agricultural safety. The density functions of the WTP with a Weibull distribution are plotted in Figure 7. The mean and median WTP estimates appeared to be, respectively, a 19.78 and 15.01 percent increase in the household food expense (see Table 9).

Table 9 - Contingent Valuation WTP estimate

| *WTP*[(a)] | |
|---|---|
| Mean | 19.797 |
| Median | 15.009 |
| Lower bound | 14.544 |
| Upper bound | 15.475 |

Notes:
(a) WTP are measured as percentage of increase in the household food expense

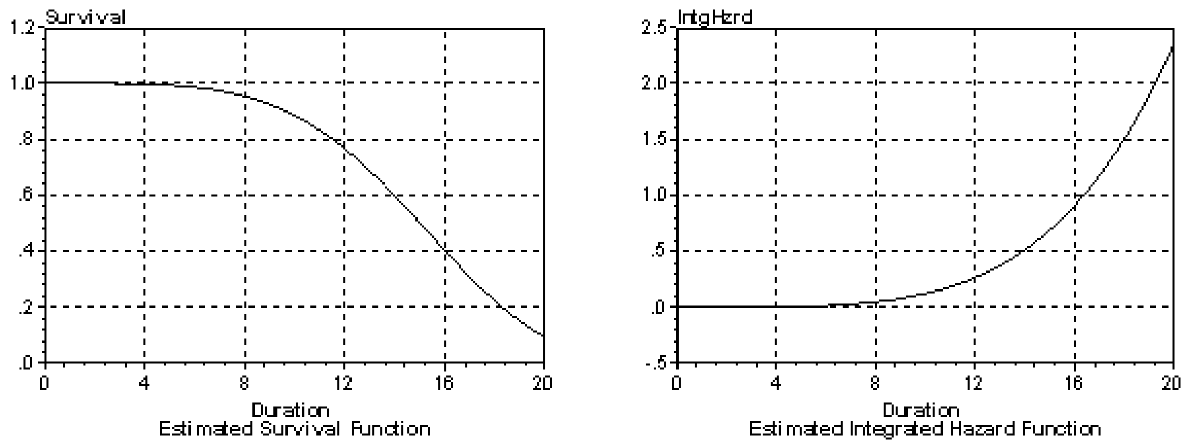


Figure 7 - Density and hazard function of WTP inferred from the CV question

### 4.3 Validity testing

For several years already it is considered good practice to subject the results of stated preference studies to a process of validity testing (Mitchell and Carson, 1989). One important procedure to test the theoretical validity of a stated choice experiment requires establishing whether or not the WTP varies systematically with variations in the respondents' socio-economic and attitudinal characteristics, in ways that might be suggested by economic theory or psychological and sociological evidence. As indicated above, we seek to explain the variation in WTP across respondents in terms of their underlying socio-economic and attitudinal profiles. The estimation of WTP for a series of exhaustive and mutually exclusive groupings of the sample showed that our *a priori* pattern of expectations was only partially satisfied, suggesting the presence of deficiencies in the experimental design, attributable -in particular- to some bias in the sampling process.

A second type of validity testing concerns the comparison of WTP estimates with those obtained in other studies and, where possible, with equivalent real payments. These tests are known as convergent and criterion validity testing, respectively. The former assesses the degree of consistency of our CM experiment results with estimates from other valuation techniques applied to similar environmental resources. The latter warrants the proximity of WTP estimates to values of real payments made in comparable circumstances. Table 10 summarizes the studies that are available to perform the convergent validity test, where WTP estimates are approximated in Euros per household per year. Specifically, the results from our basic multinomial logit model are translated into values of 46.2 Euros per household per year to avoid the loss of one farmland bird species, 27.7 Euros per household per year to avoid the contamination of 1 percent of farmland soil and groundwater, and 8.1 Euros per household per year to avoid one case of human intoxication due to pesticides usage. The value obtained in the present study for bird biodiversity falls well within the range of studies used as terms of comparison. This suggests, on the one hand, that our model performs well in term of convergent validity, and, on the other hand, it is also encouraging that our estimates –referring to multiple species- are higher than estimates drawn from single species CV surveys. For the value obtained for soil and ground water protection, we used as comparator a CV study performed in Milan, Italy. In this case, our estimate is much lower than the one obtained by Press and Soderqvist (1998), even though they refer to indirect threats. Finally, the value obtained in our study for human health converges towards estimates from similar studies assessing the value of reducing risks for consumers due to the use of pesticides in foodstuff agricultural production. All this provides some reassurance about the goodness-fit of our estimates.

Next, the criterion of validity test is used here to verify whether the results obtained from our simple CV exercise are plausible. The real price differential between foodstuffs from conventional or biological agriculture in Italy ranges between 10 and 200 percent, though for the most common products it is about 20 percent. Therefore, the CV estimate of the WTP for reducing all detrimental effects of pesticides on aggregate natural well-beings, which has mean and median values of respectively 19.8 and 15 percent of increment of the household food expense (see Table 9), performs very well in terms of criterion validity.

Table 10 – Comparison values for convergent and criterion validity testing

| ***Convergent Validity*** | |
|---|---|
| *Bird biodiversity* | *WTP*[(a)] |
| ▪ *WTP to avoid the loss of one species of farmland bird species* (in the present study) | 46.2 |
| ▪ WTP to avoid the loss of one species of farmland bird species in the UK (Foster and Mourato, 2000) | 19.4 |
| ▪ WTP to preserve the white-backed woodpecker in Norway (Veisten et al., 1993) | 47.5 |
| ▪ WTP to preserve the wild turkey in the US (Stevens et al., 1991) | 17.3 |
| *Soil and ground water* | |
| ▪ WTP to avoid contamination of 1 percent of farmland soil and groundwater (in the present study) | 27.7 |
| ▪ WTP for ground water protection in Italy (Press and Soderqvist, 1998) | 333.1 |
| *Human health* | |
| ▪ WTP to avoid one case of human intoxication (in the present study) | 8.1 |
| ▪ WTP to avoid one case of human ill-health in the UK (Foster and Mourato, 2000) | 2.5 |
| ▪ WTP to reduce pesticide related illnesses in the US (Misra et al., 1991) | 15.2 |
| ▪ WTP to reduce pesticide related illnesses in the US (Ravenswaay and Hoehn, 1991) | 9.2 |
| ***Criterion Validity*** | |
| ▪ WTP to avoid all the negative effects of pesticides (in the present study)[(b)] | 15 |
| ▪ Price differential among conventional and biological foodstuff in Italy[(c)] | 20 |

Notes:
(a) WTP approximated into Euros per household per year.
(b) WTP expressed as percentage of increment in the household food expense.
(c) Official statistics by Coldiretti.

## 5. Conclusion

This study has presented the results of a stated choice approach combining choice experiment and contingent valuation techniques to isolate the willingness to pay for improvements in agricultural safety for human health and environmental concerns, namely farmland biodiversity, soil and ground water. A rather more interesting part appears to be the choice experiment in which we have used a “green” food expense payment package to elicit the respondents’ preferences for alternative agri-environmental scenarios, proposing them a series of four or five choice sets made up of three possible options of agricultural practices, including the *status quo*. The biggest advantage of this methodology in respect to contingent valuation is that respondents were forced to make trade-offs -not only between environmental issues and money- but also among different aspects of environmental safety. These are important and typical features of environmental decision-making and, therefore, it is easy to appreciate the merits of these kinds of results.

From a statistical point of view, the results of the choice modelling experiment were shown to perform well in terms of theoretical, convergent and criterion validity, though we are aware of some limits inherent to the experimental design. Our *a priori* expectation on the effect of differences in the respondents’ socio-economic profile on attribute coefficients was only partially confirmed by the statistical analysis. This suggests that some degree of bias might be present to be investigated in a following experiment.

The basic findings from the survey were very interesting and demonstrated that consumer were on average willing to pay 3.8 Euros per household per month to avoid the loss of one species of farmland bird biodiversity, 2.3 Euros per household per month to avoid the contamination of one percent of farmland soil and aquifer, and 0.68 Euros per household per month to prevent one case per year of human ill-health. Though one might be surprised by the fact that biodiversity and groundwater got a higher value compared to human health, a comparison of unit trade-offs reveals that Italian consumers perceive strongly the possible risks for human health related to pesticides use, while there is much less concern about the rather vague concept of biodiversity.

## References


Adamowicz, W., Louviere, J.J., Williams, M. (1994). "Combining Revealed and Stated Preference Mehtods for Valuing Environmental Amenities", *Journal of Environmental Economics and Management*, 26:271-292.

Adamowicz, W., Swait, J., Boxall, P., Louviere, J.J., Williams, M. (1996). "Perceptions versus Objective Measurement of Environmental Valuation", *Journal of Environmental Economics and Management*, 32: 65-84.

Armstrong P., Garrido, R., Ortùzar (2001). Confidence intervals to bound the value of time. *Transportation Research, Part E* 37(2-3): 143-161.

Baker, G. (1999). "Consumer preferences for food safety attributes in fresh apples: market segments, consumer characteristics and marketing opportunities." *Journal of Agricultural and Resource Economics*, 24(1): 80-97.

Baker, G.A.C., Crosbie, P.J. (1993). "Measuring food safety preferences: identifying consumers segments." *Journal of Agricultural and Resource Economics*, 18: 277-287.

Ben-Akiva, M., Lerman, S.R. (1986). *Discrete Choice Analisi: Theory and Application to Travel Demand*, The MIT Press, Cambridge.

Blamey, R.K., Common, M.S., Quiggin, J. (1995). "Respondents to Contingent Valuation Surveys: Consumers or Citizens?", *Australian Journal of Agricultural Economics*, 39(3):263-288.

Brethour, C. A., Weersink, A. (2001). "An Economic evaluation of the environmental benefits from pesticide reduction." *Agricultural Economics*, 25: 219-226.

Bunch, D.S., Louviere, J.J., Anderson, D. (1993). A Comparison of Experimental Design Strategies for Multinomial Logit Models: The Case of Generic Attributes. Working Paper.

Buzby J.C., Ready R.C., Skees, J.R. (1995). "Contingent Valuation in Food Policy Analysis: A Case Study of a Pesticide Residue Risk Reduction", *Journal of Agricultural and Applied Economics*, 27(2): 613-625.

Cuyno, L. C. M., Norton, G. W., Rola A. (2001). "Economic analysis of environmental benefits of integrated pest management: a Philippine case study." *Agricultural Economics*, 25: 227-233.

Diamond, P.A., Hausman, J.A. (1994). "Contingent Valuation: Is Some Number Better than Non Number?", *Journal of Economics Perspectives*, 8(4): 45-64.

Eom, Y. S. (1994). "Pesticide Residue Risk and food Safety Valuation: A Random Utility Approach." *American Journal of Agricultural Economics*, 76: 760-771.

Foster V., Mourato, S. (2000). "Valuing the Multiple Impacts of Pesticides Use in the UK: A Contingent Ranking Approach." *Journal of Agricultural Economics*, 51: 1-21.

Fu T-T, Liu J-T, Hammitt, J.K. (1999). "Consumer willingness to pay for low-pesticide fresh produce in Taiwan", *Journal of Agricultural Economics*, 50(2): 220-233.

Govindasamy, R., Italia, J., Rabin, J. (1998b). Predicting Consumer Risk Aversion to Synthetic Pesticide Residues: A Logistic Analysis. New Brunswick, Department of Agricultural Economics, The State University of New Jersey, Rutgers.

Govindasamy, R., Italia, J., Rabin, J.. (1998a). Consumer response and perceptions of integrated pest managenet produce. New Brunswick, Department of Agricultural Economics, The State University of New Jersey, Rutgers.

Hammitt, J. K. (1990). "Risk Perceptions and Food Choice: An Exploraty Analysis of Organic-Versus Conventional - Produce Buyers", *Risk Analysis*, 10: 367-374.

Hensher, D. A., Jonhnson, L. W. (1981). *Applied Discrete Choice Modelling*. John Wiley and Sons, New York.

Higley, L. G., Wintersteen, W.K. (1992). "A novel approach to environmental risk assessment of pesticides as a basis for incorporating environmental costs into economic injury level." *American Entomologist*, 38: 34-39.

Lancaster, K. (1966). "A new approach to consumer theory", *Journal of Political Economy*, 74: 132-157.

Lazari, A.G., Anderson, D.A. (1994). "Design of Discrete Choice Set Experiments for Estimating Both Attribute and Availability Cross Effects", *Journal of Marketing Research*, 31: 375-383.

Louvier, J.J., Hensher, D.A. (1982). "On the Design and Analysis od Simulated Choice or Alocation Experiments in Travel Choice Modelling", *Transportation Research Record*, 890:11-17.

Louvier, J.J., Woodworth, G. (1983). "Design and Analysis of Simulated Choice or Allocation Experiments: An Approach Based on Aggregate Data", *Journal of Marketing Research*, 20: 350-367.

Louviere J. J., Hensher, D.A., Swait, J.D. (2000). *Stated choice methods; analysis and applications*, Cambridge University Press, Cambridge.

Maler, K.G. (1974). *Environmental Economics: A Theoretical Inquiry*, The Johns Hopkins University Press, Baltimore.

McFadden, D. (1986). "The Choice Theory Approach to Market Research", *Marketing Science*, 5: 275-297.

McFadden, D. (1994). "Contingent Valuation and Social Choice", *American Journal of Agricultural Economics*, 76: 689-708.

McFadden, D. Train, K., Tye, W.B. (1977). "An Application of Diangostinc Tests for the Independence from Irrelevant Alternatives Property of the Multinomial Logit Model", *Transportation Research Record*, 637: 39-45.

Misra, S.K., Huang, C.L., Ott, S.L. (1991). "Consumer Willingness to Pay for Pesticide-Free Fresh Produce", *Western Journal of Agricultural Economics*, 16: 218-227.

Mitchell, R. and Carson, R. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resources for the Future, John Hopkins Press, Baltimore.

Morrison, M.D., Bennett, J.W. (1997). *Water Use Trade-offs in the Macquarie and Gwydir Valleys*. Choice Modelling Research Report No.2, School of Economics and Management, University College, The University of New South Wales.

Mourato, S., Ozdemiroglu, E., Foster, V. (2000). "Evaluating health and environmental impacts of pesticide use: implications for the design of ecolabels and taxes", *Environmental Science & Technology*, 34(8), 1456-1461.

Mullen J.D., Norton G.W., Reaves, D.W. (1997). "Economic Analysis of Environmental benefits of Integrated Pest Management", *Journal of Agricultural and Applied Economics*, 29(2): 243-253.

Opaluch, J.J., Swallow, S.K., Weaver, T., Wessells, W. Wichelns, D. (1993). "Evaluating Impacts from Noxious Facilities: Including Public Preferences in Current Siting Mechanisms", *Journal of Environmental Economics and Management*, 24: 41-59.

Pimentel, D., Acquay, H., Biltonen, M., Rice, P., Silve, M., Nelson, J., Lipner, V., Giordano, S., Horowitz, A., D'amore, M. (1992). Environmental and human costs of pesticide use. *Bioscience* 42: 750-760.

Pimentel, D., Greiner, A. (1997). Environmental and socio-economic costs of pesticide use. In Pimentel, D. (eds), *Techniques for reducing pesticide use: economics and environmental benefits*. Chinchester: John Wiley and Sons, 51-78.

Press J., S., SÖderqvist, T. (1998). On estimating the benefits of groundwater protection: a contingent valuation study in Milan. In Swanson T., Vighi M. (Eds), *Regulating Chemical Accumulation in the Environment*, Cambridge University Press, Cambridge.

Ravenswaay van , E.O., Hoehn, J.P. (1991a). Contingent Valuation and Food Safety: the case of pesticides residues. Dept. of Agricultural Economics, Staff Paper N. 91-13. East Lansing, MI: Michigan State University.

Rizzi, L. I., Ortùzar, J. D. (2003). Stated preferences in the valuation of interurban road safety. *Accident Analysis and Prevention* 25(1): 9-22.

Schou, J. S., Hasler, B., Kaltoft, P. (2002). "Valuing biodiversity effects of pesticide use. What does perception of uncertainty mean for survey design?", Conference Proceedings. Risk and Uncertainty in Environmental and Resource Economics, Wageningen, The Netherlands.

Stevens, T. H., Echevarria, J., Glass, R. J., Hager, T. and More, T. A. (1991). Measuring the Existence Value of Wildlife: What Do CVM Estimates Really Show?, *Land Economics*, 67(4), 390-400.

Vestein, K., Hoen, H., Navriud, S.and Strand, S. (1993). Valuing Biodiversity in Norwegian Forests: A Contingent Valuation Study with Multiple Bias Testing. Memorandum No. /, Department of Economics, University of Oslo.

## Notes

1. Italy has the third highest level of pesticide consumption with the 13 percent of total purchases, and a rate of consumption of about 7.7 kg of pesticide per hectare of agricultural land treated (OECD, 1991).
2. A pre-test on 40 respondents was undertaken in April 2003 in Milan.
3. A draft version of the questionnaire asked respondents to choose among a conventional package of spaghetti and spaghetti produced with wheat from more environmentally benign agricultural practices. The pilot survey showed that respondents were disturbed by a "single-green produce" perspective, being more comfortable with choices related to the whole shopping basket for foodstuff (a "green food expense" payment portfolio).
4. University campuses and shopping centers were considered to be privileged locations to maximize the visibility of our questionnaire and the sampling size, curbing the generally high costs of surveys. In university campuses interviewers asked people to pick up the questionnaire, bring it home and make it compiled by the member of the family responsible for the daily food shopping. In shopping centers, people were asked to pick up the questionnaire before shopping, compile it and drop it off to the interviewer after shopping.
5. The attribute levels used in the choice sets were: monthly food expense (actual; +50€; +100€; +200€); number of endangered bird species (15, 9, 3); % of farmland contaminated (65, 45, 15); cases of acute pesticide intoxication per year (250; 100; 50).
6. The design of the 9 choice sets is consistent with modern principles of experimental design (Bunch et al., 1993; Lazari and Anderson, 1994). In particular, we used a shifted or cyclic design, which generally has a superior efficiency compared to other strategies for generating main effects designs (Bunch et al., 1993). These shifted designs use an orthogonal fractional factorial to provide the basic alternatives for each choice set. Subsequently, the alternatives within a choice set are cyclically generated. The attribute levels of the new alternatives add one to the general level of the previous alternative, until it is at its maximum. At this point, the assignment returns to the lowest level. We started, therefore, from a set of 81 possible permutations of the hypothetical agricultural scenario (3 levels4 attributes). Then, we generated the 'fractional factorial' using a simple routine in the software package SPSS®. Subsequently, we used a cyclic designed to generate 9 choice sets. These choice sets satisfy the principle of orthogonality, level balance, and minimal overlap (see Huber and Zwerina, 1996).
7. Violation of the IIA assumption may occur for various reasons, such as the inclusion of close substitutes in choice sets or the existence of random taste variations, i.e. heterogeneous preferences. Various tests have been proposed for detecting violations of the assumption of identically and independently distributed error terms, including the estimation of a mother logit (McFadden et al., 1977; McFadden, 1986). If an IIA violation is found, it may be possible to modify the existing MNL model to remove the violation, for instance by including individual characteristics in the model, or by estimating more complex models that relax part or all of the IIA assumption.
8. It is not possible to include socioeconomic and attitudinal variables directly into utility functions, as these are invariant across the alternatives in a choice set. Hence, their coefficient cannot be estimated. Instead, they have to be estimated interactively, either with the alternative-specific constant (C), or with one of the attributes from a choice set (X) (see Swallow et al. 1994):

   $$V_i = C + \sum_h CS_h + \sum_k \beta_k X_k + \sum_{h,k} \beta_k S_h X_k$$

   where i=1,....$N$; $k$=1,...,$K$; $h$=1,..., $H$; $C$ is an alternative-specific constant, $\beta$ is a coefficient, $X$ is a variable representing an attribute from a choice set, and $S$ represents socioeconomic or attitudinal variables.
9. Three different initial bid values $B$, randomly distributed among respondents, were used in our survey: plus 10 percent; plus 15 percent, plus 20 percent of the monthly household food expense. Those respondents who accepted the first bid were then faced with increments of, respectively, 20 percent, 30 percent and 40 percent; while respondents answering "no" where faced with increments of, respectively, 5 percent, 10 percent and 10 percent.
10. One should bear in mind that for respondents who give two positive responses, the upper bound of WTP might be infinity, $+\infty$ (or the respondent's income); while for those who give two negative answers, the lower bound is either zero (if the distribution of WTP admits only positive values) or negative infinity, $-\infty$, if the WTP distribution is a normal or a logistic one.
11. Hensher and Johnson (1981) comment that "the value of $R$-square between 0.2 and 0.4 are considered extremely good fits, so that the analysis should not be looking for values in excess of 0.9, as it is often the case for when using R2 in ordinary regression".
12. Coefficients across all segments of the population are implicitly restricted to be equal to $\log_{LR}$, while coefficients of sub-models are allowed to vary ($\Sigma M\log_{LM}$). The test statistics is $2[(\Sigma M\log_{LM})-\log_{LR}]$ and is distributed as a chi-squared variable with degrees of freedom equal to ($dof_{LR}-dof_{LM}$).

13. The critical value for a chi-squared distribution with one degree of freedom (3.841) is considered for sub-models based on: sex, motherhood, education, attitude and concern. For sub-models based on income level we consider the critical value for a chi-squared distribution with three degrees of freedom (7.815).