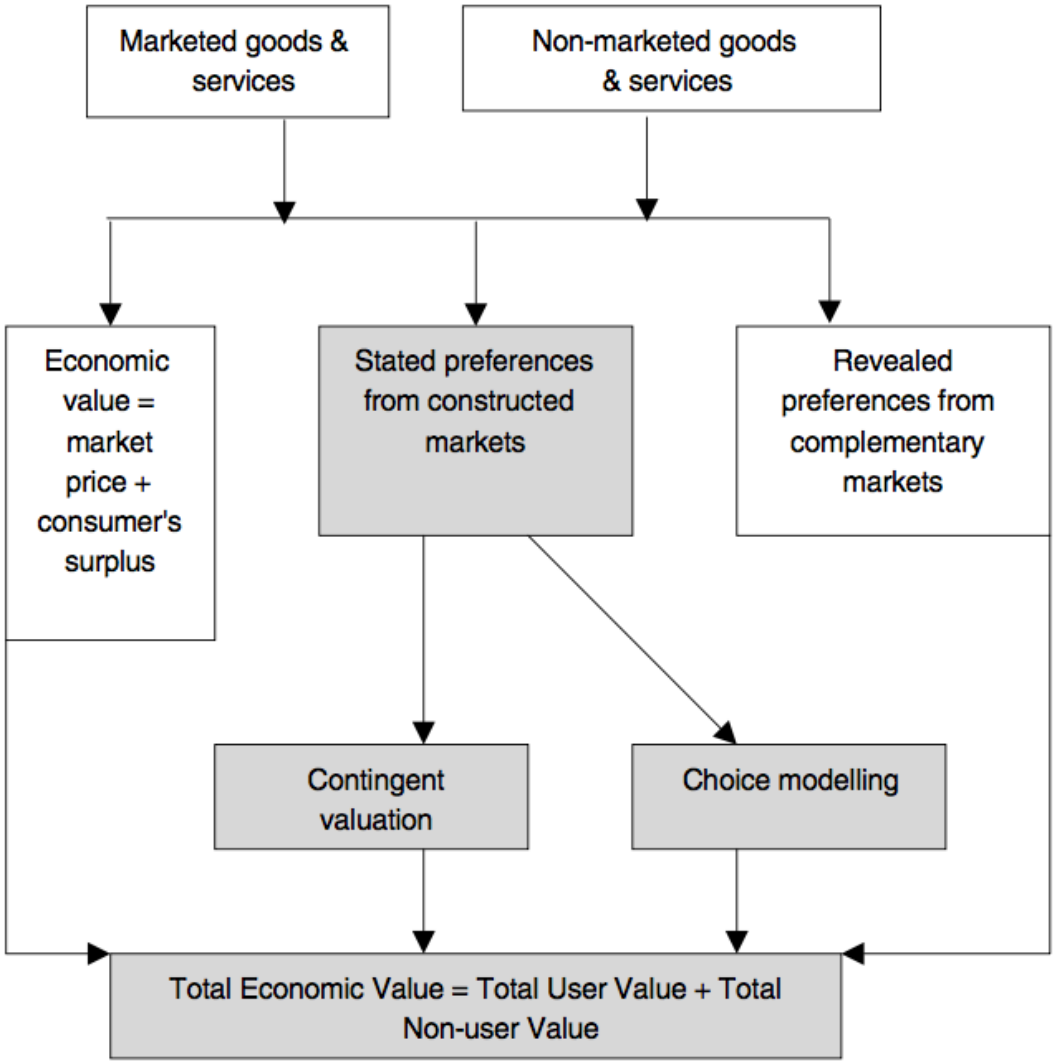
Economic evaluation of non-marketable goods

Gianfranco Atzeni

Environmental Economics

Introduction



...Introduction...

There are two ways of estimating the economic values attached to non-marketed goods and services

- Revealed preferences
- Stated preferences

Revealed preference approaches identify the ways in which a non-marketed good influences actual markets for some other good, i.e. value is revealed through a complementary (surrogate or proxy) market.

For example: economic value of noise nuisance as reflected in house prices.

...Introduction...

Stated preference approaches on the other hand are based on constructed markets, i.e. they ask people what economic value they attach to those goods and services.

In this case the economic value is revealed through a hypothetical or constructed market.

...Introduction

- Stated preference (SP) theory and methods has been of great interest in agricultural and food economics, environmental and resource economics and health economics since the mid-1990's.
- SP are used to elicit an individual's preferences for "alternatives" (goods, services, or courses of action) expressed in a survey context

Many ways to elicit stated preferences

- We concentrate on two general paradigms for preference elicitation that have evolved over the past thirty plus years:
- Conjoint analysis (CA) and Discrete choice experiments (DCE)
- We discuss differences in both paradigms and explain why one should be cautious about using CA in many economics applications

Reasons for economic valuation

- Any appraisal requires criteria for choosing between alternatives.
- Different criteria may entail trade-offs, such as between cost and quality or performance.
- Cost benefit analysis uses money values as weights, because they express people's willingness to pay (WTP) or willingness to accept compensation (WTA).

...Reasons for economic valuation

- Cost benefit analysis adopts various decision rules.
- First, a project or policy is potentially acceptable provided benefits are greater than costs.
- Benefits are measured by WTP to secure the benefits.
- Costs may comprise WTA compensation for losses, plus resource costs (e.g. costs of inputs such as labour, capital, raw materials).
- Since market prices also reflect WTP, resource costs are also linked to WTP.

Dose-response

- Valuation techniques are often applied to some outcome of a dose-response function, a relationship between an event (the ‘dose’) and its effects (the ‘response’).
- Dose response functions are scientific relationships which are observed or hypothesised, and are not themselves a valuation technique, but they produce an effect that can be valued, in this case the health effect.

Criteria-alternative matrix

Good decision-making involves:

- adopting criteria by which a policy, project or programme is judged to be 'good';
- an appraisal of how the alternative options compare.

Analysis usually begin with a performance matrix (also known as a criteria-alternatives matrix).

...Criteria-alternative matrix

For example: appropriate speed limit on a motorway.

Table 2.2 Criteria/alternatives matrix: original data

	Alternative speed limit options km/h			
Criteria	**70**	**80**	**90**	**100**
Serious injuries (number) per million vehicle km	5.0	5.4	5.9	6.5
Time spent travelling (years) per million vehicle km	3.3	3.1	2.9	2.7
Vehicle operating costs (£million) per million vehicle km	12.6	12.8	13.2	13.8

The alternative policy options (speed limits) are in the four right hand columns of the matrix, with 80 km/h being the base case (i.e., current position or status quo).

...Criteria-alternative matrix...

The following table uses the same information but shows the data for the options in terms of comparisons to show differences from the base case.

Table 2.3 Criteria/alternatives matrix: normalised on 80 km/h

	Alternative speed limit options			
Criteria	**70**	**80**	**90**	**100**
Serious injuries (number) per million vehicle km	−0.4	0	+0.5	+1.1
Time spent travelling (years) per million vehicle km	+0.2	0	−0.2	−0.4
Vehicle operating costs (£million) per million vehicle km	−0.2	0	+0.4	+1.0

...Criteria-alternative matrix

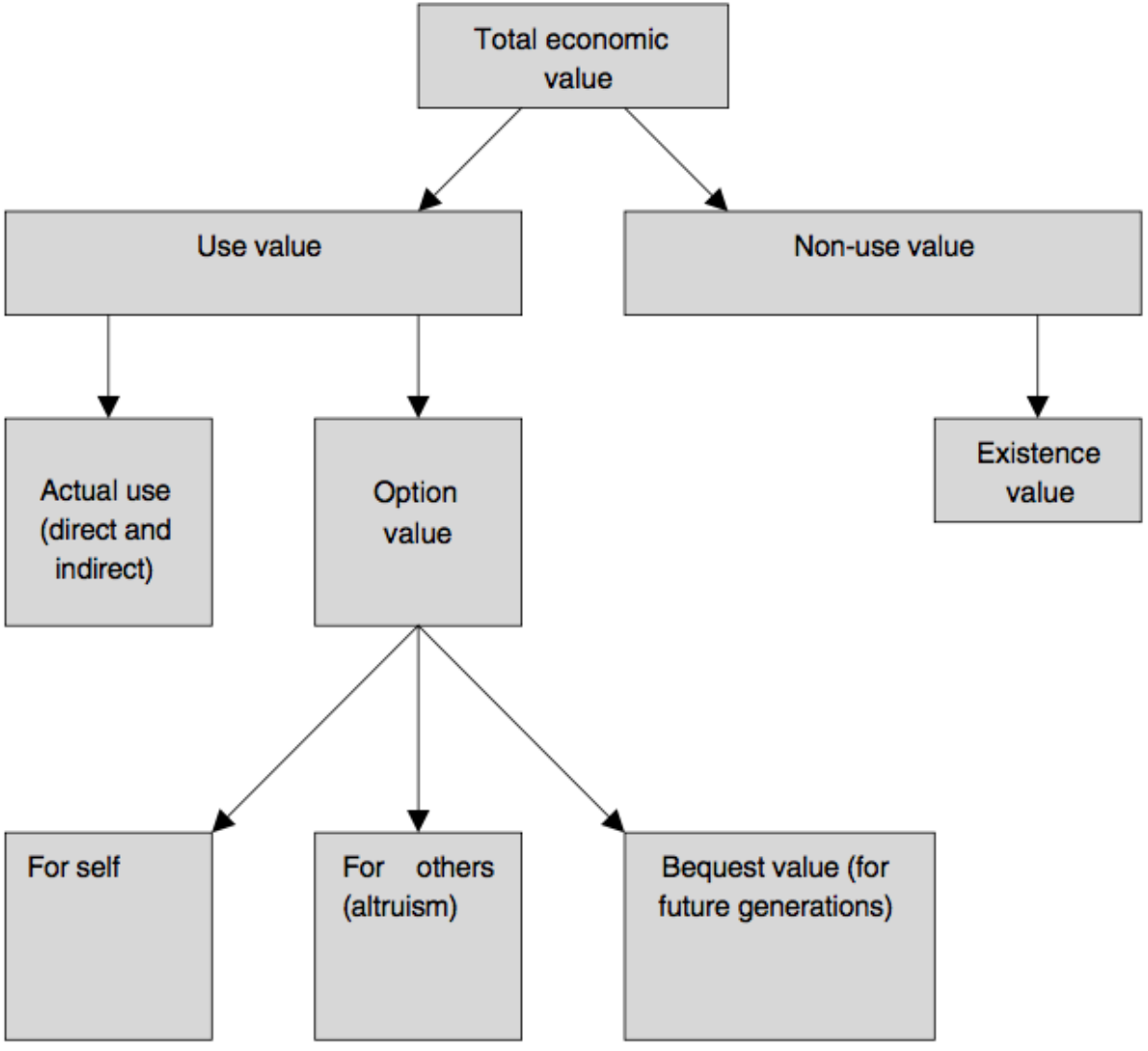
What happens if each injury is valued at £1 million and a year of saving time is also valued at £1 million? The computation for each option is simple, as the money values for each criterion are added together.

Table 2.4 Criteria/alternatives matrix: monetised outcome

	Alternative speed limit options			
Criteria	**70**	**80**	**90**	**100**
Money value of serious injuries (£million)	+0.4	0	−0.5	−1.1
Money value of time spent (£million)	−0.2	0	+0.2	+0.4
Money value of vehicle operating costs (£million)	+0.2	0	−0.4	−1.0
Aggregated net benefit (£million)	+0.4	0	−0.7	−1.7

The bottom line shows that the highest net benefit would be for a change in the speed limit downwards to 70 km/h.

Total economic value...



...Total economic value...

Total economic value comprises the sum of use and non-use values.

- Use values may be:
- direct (e.g. by consuming the good, visiting a site);
- indirect (e.g. by securing some benefit from the good). Example a lemon tree.
- Option value: individuals may be willing to pay to conserve the option of future use

...Total economic value...

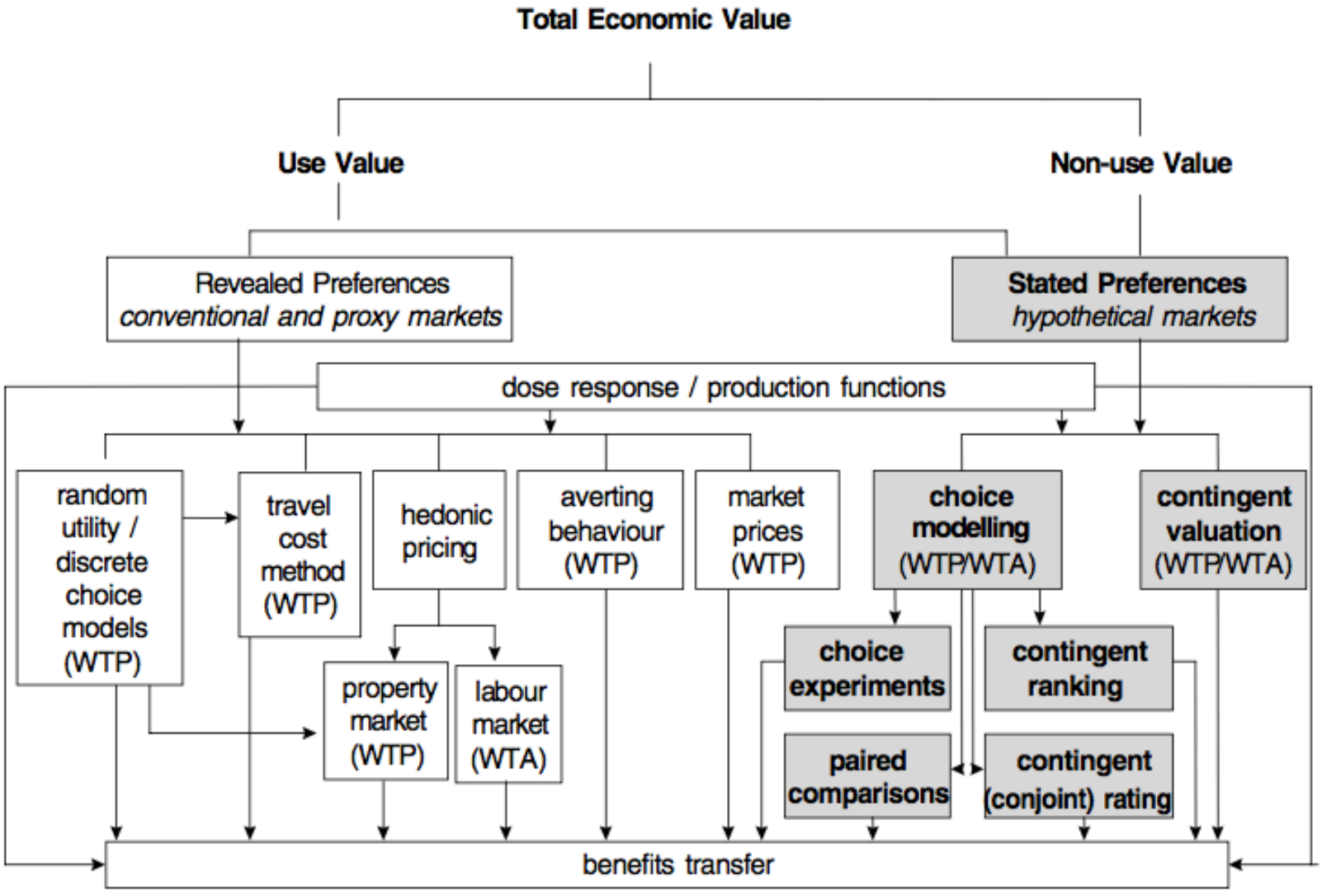
- Use values may be:
- direct (e.g. by consuming the good, visiting a site);
- indirect (e.g. by securing some benefit from the good).
- Example a lemon tree

...Total economic value...

Non-use values arise in contexts where an individual is willing to pay for a good even though he or she makes no direct use of it.

- May not benefit even indirectly from it.
- May not plan any future use for themselves or others.

Economic valuation techniques...



...Economic valuation techniques...

- Discrete choice models work on the basis that choices between alternative options reflect the wellbeing (utility) that accrues from those options.
- Choices expressed in probabilistic form, i.e. in terms of the probability of choosing one option rather than another, define the **random utility model** which underlies **travel cost** approaches.
- **Travel cost** approaches are used to value recreational assets via the expenditures on travelling to the site.
- **Hedonic pricing** refers to the measurement of effects which show up in labour markets or property markets (noise in house prices).
- **Averting** behaviour involves expenditures to avoid unwanted effects (e.g., smoke alarms, double-glazing, child-proof containers).

...Economic valuation techniques...

Stated preference techniques, asking people hypothetical questions, are classified into:

- Contingent valuation: seek measures of willingness to pay through direct questions such as ‘What are you willing to pay?’ and ‘Are you willing to pay £X’?
- Choice modelling: seeks to secure rankings and ratings of alternatives from which WTP can be inferred
  - Conjoint Analysis
  - Choice experiments

What is Conjoint Analysis?

- CA's origins are in psychology, principally associated with research dealing with ways to mathematically represent the behavior of rankings observed as an outcome of systematic, factorial manipulation ("factorial designs") of independent factors (“attributes”).
- Two important points:
  1. The axioms of CM have some very restrictive relationship to utility theory
  2. there is no error theory associated with CM, statistical or otherwise, which allow the theory to be represented as testable statistical models.

...What is Conjoint Analysis?

- CA theory originally was not a theory about the behavior of preferences or choices, but instead a theory about the behavior of sets of numbers in response to factorial manipulations of factor levels.
- CA theory tells us that one can represent the numbers “as if” the individual used a certain algebraic process to combine preferences for each level of each attribute into a preference combinations of attribute levels

...Example

- For example, suppose one describes a pecorino cheese by attributes like texture, aging and degree of creamy.
- CA can be applied if individuals have different degree of preference for each level of these attributes,
- and if they combine the preferences for each attribute level into an overall preference for each pecorino.

Summarizing

- CA provides a way to study how such preferences are formed and identify processes individuals use to form them
- difficult to use CA methods used to examine and model preference process(es) per se.
- CA collect data in ways that cannot be analyzed to be consistent with neoclassical economic theory,
- attribute importance measures do not readily translate into choice (e.g., direct expression of WTP), the base of utility theory.

What are Discrete Choice Experiments (DCE)

- DCEs are based on a long-standing, well-tested theory of choice behavior.
- The theory was proposed by Thurstone (1927), and is called random utility theory (RUT)
- McFadden extended Thurstone's original theory of paired comparisons (pairs of choice alternatives) to multiple comparisons
  - McFadden 1986; McFadden and Train 2000; McFadden 1974; Thurstone 1927

Random Utility Theory (RUT)

- RUT proposes that there is a latent construct called “utility” existing in a person’s head that cannot be observed by researchers
- A person has a “utility” for each choice alternative, but these utilities cannot be “seen” by researchers (latent)
- RUT assumes that the latent utilities can be summarized by two components, a systematic (explainable) component and a random (unexplainable) component:

$$U_{in} = V_{in} + \varepsilon_{in}$$

...Random Utility Theory (RUT)...

$$U_{in} = V_{in} + \varepsilon_{in}$$

- Systematic components are attributes explaining differences in choice alternatives and covariates explaining differences in individuals' choices
- Random components comprise all unidentified factors that impact choices.
- Psychologists assume that individuals are imperfect measurement devices: random components also can include factors reflecting variability and differences in choices associated with individuals.

...Random Utility Theory (RUT)

$$U_{in} = V_{in} + \varepsilon_{in} \tag{1}$$

- where U_{in} is the latent, unobservable utility that individual n associates with choice alternative i
- V_{in} is the systematic, explainable component of utility that individual n associates with alternative i
- ε_{in} is the random component associated with individual n and option i

Preferences are stochastic!

- As there is a random component, utilities (or “preferences”) are stochastic as viewed by researchers.
- So, researchers can predict the probability that individual *n* will choose alternative *i*,
- but not the exact alternative that individual *n* will choose.

Families of probabilistic DCM

RUT leads to families of probabilistic discrete choice models that describe how choice probabilities respond to changes in choice options (or equivalently, their attributes) and/or covariates representing differences in individuals.

The probability that individual n chooses option i from a set of competing options is:

$$P(i|C_n) = P[V_{in} + \varepsilon_{in}) > max(V_{jn} + \varepsilon_{jn})]$$

for all j options in choice set C_n

...Families of probabilistic DCM...

$$P(i|C_n) = P[V_{in} + \varepsilon_{in}) > max(V_{jn} + \varepsilon_{jn})] \quad (2)$$

Equation (2) says that the probability that individual n chooses option i from the choice set C_n equals the probability that the systematic and random components of option i for individual n are larger than the systematic and random components of all other options competing with option i

...Families of probabilistic DCM

Different probabilistic discrete choice models can be derived from equation (2) by making different assumptions about probability distributions for ε_{in}, as for example:

- distributed as non-independent, non-identically distributed normal random variates (Thurstone);
- Independent Identically Distributed (IID) Gumbel (McFadden).

The Gumbel distribution closely resembles the normal but is slightly asymmetric;

it has the advantage of yielding closed form expressions for the choice probabilities if random components are IID, i.e. multinomial logit (MNL) model (also known as a conditional logit model) used in practical applications.

Identification

- The distribution properties of random components are as general as desired, but there is an important identification restriction that must be imposed.
- Any vector of estimated choice model parameters (“betas”) is inversely proportional to the size of the variances of associated random components.
- We need to set the “scale” of the utility vector to some constant for identification purposes when making inference about the latent scale.

...Identification

- let λ, to be a scalar multiple of the true vector of utility parameters, then:

$$\lambda = k(1/\sigma_\varepsilon)$$

- where k is a constant of proportionality, and σ_ε is the standard deviation of the random component (error distribution)
- Due to the inverse relationship between error variance and scale, we say that λ scales" the estimated vector of beta parameters:

$$V_i = \lambda \beta_k X_{ki} + \varepsilon_i$$

where V_i is the systematic utility component, β_k is a $K = 1, 2, ..., K$ element vector of parameters, X_{ki} $(i = 1, 2, ..., I)$ is a $K \times I$ element matrix of attribute effects.

Formulation of RU model...

In formulating a random utility model, the researcher makes two decisions:

- The functional form of the indirect utility function: in the vast majority of applications the utility of an option is modelled as a simple linear combination of costs and attributes.
- The probability distribution of the random elements: typical distribution in this case is the Gumbel or extreme value distribution. The resulting probability that a particular choice is made can be expressed in terms of the logistic distribution.
  - When the choice is between two options the model is binary logit
  - When the dependent variable takes three or more values, as is usually the case in CE, the model is a conditional (or multinomial) logit model.

...Formulation of RU model...

The simplest model is the conditional logit model resulting from the assumption of Gumbel distributed error terms.

- This model is built upon the assumption of the 'independence of irrelevant alternatives' (IIA)
- IIA states that the ratio of the probabilities of choosing any two options will be unaffected by the attributes or availability of other options:
  - often violated in real world
  - the introduction of a third option will nearly always alter the relative probabilities of choosing the first two options.

...Formulation of RU model

- The nested logit model relaxes the IIA assumption by grouping more similar options together.
- The multinomial probit model is the most general model and makes no IIA assumption.
- Probabilistic models such as the binary or multinomial logit model or the binary probit model, can be estimated using maximum likelihood procedures.

WTP / WTA...

- Whatever Random Utility Model has been chosen is estimated by econometric analysis to provide the mean and median WTP/WTA information, via the estimation of indirect utility function.
- Welfare measurement:
  - assess how respondents' utility would change if the attributes of a non-marketed good were changed from their current level (the status quo) to some different level (the levels set by the policy option under review);
  - express this utility change in money terms.

...WTP / WTA

It is possibile to calculate marginal WTP for any one of the option attributes according to:

$$MWTP = -\frac{b_k}{\beta} \tag{3}$$

- where β is the coefficient on cost and b_k is the coefficient on attribute k.
- **Interpretation**: b_k is the utility from an extra unit of attribute k; β is the money value of an extra unit of utility.
- Their ratio: the monetary value of the utility coming from an extra unit of attribute k (**IMPLICIT PRICE** of the attribute).

Validity

The central problem in assessing the validity of WTP/WTA values obtained from any stated preference study is the absence of a definitive yardstick against which to compare those measures.

- Not necessary the case in all survey research (for example election opinion polls).
- It is generally a problem for non-market goods since, with very few exceptions, actual values are unobservable.

Residents and Tourist trade-offs

Nanni Concu, Gianfranco Atzeni (2012) **Conflicting preferences among tourists and residents**, Tourism Management.

The paper studies the complex relationship between tourism and host environments

- Tourism development depends on features and quality of natural, cultural, and heritage resources, among other things.
- Tourism also demands services and goods that could alter these environments, and hence it has the potential to degrade the resources on which its development is based.
- Comparing the benefits received and the costs incurred by host communities and tourists is then necessary to determine the optimal level of tourist development.

Benefits and costs

Benefits and costs of tourism development are difficult to quantify because of positive and negative externalities, non-market values, and opportunity costs.

- For instance, tourists incur costs by both purchasing the holiday package and suffering from overcrowding of tourist facilities.
- The host community could gain from tourism revenues and from revitalising of local traditions, and incur costs such as disruption of social relations and environmental degradation

Aim of the study

The aim is to provide a monetary estimation of residents' and tourists' perceptions of the impacts of recreational uses of resources in host communities

We use a stated preference technique, the Discrete Choice Experiments

- Study area: Alghero
- Coastal development policies have been the source of serious political debate in recent years
- Regulation: Sustainable Tourism Development Regional Plan (Piano Regionale di Sviluppo Turistico Sostenibile, PRSTS), and the Regional Landscape Plan (Piano Paesaggistico Regionale, PPR).

Regulation...

- The PRSTS represents the first strategic plan for the preservation and use of natural resources for tourism purposes in Sardinia
- Coastal development policies have been the source of serious political debate in recent years
- The PPR is the main instrument for implementing conservation and protection measures. Two principles guided the 2004 framework:
  - sustainable development;
  - homogeneity of planning processes.
- The major prescription of the PPR is the total ban of new buildings and infrastructures within 2 km from the seashore.

On one hand, this regulation aimed at protecting the coastal landscape and environment; on the other hand, it posed extensive limits on the use of this resource for tourism development.

...Regulation

Another important regulation of the 2004 reform includes a set of incentives for the renovation and restoration of old suburbs in tourist towns. This measure aimed at reducing the spread of tourist infrastructures, and making better use of the existing urban assets

- An unintended consequence of such a measure is the concentration of tourists in urban areas, with increased **congestion** affecting both residents' quality of life and the recreational experience.
- Alghero is an ideal place to investigate on communities and tourist preferences, and the potential conflicts between them.

Survey design and administration...

The choice modelling application was organized as follows.

1. preliminary questionnaire to interview a random sample of residents
   - open and Likert-type questions on the effects of tourism on natural resources, public services, resident's quality of life, and on other socio-economic indicators.
2. Out of this information, we defined four attributes to describe the main perceived effects of tourism and to create various scenarios of tourism development.
3. The preliminary questionnaire contained some questions on policies for promotion and management of tourist flows, and on how to fund these policies.
4. willingness to pay for the proposed policies. This aimed to provide a range of monetary values for the final questionnaire.

...Survey design and administration

We used this information to design the choice modelling questionnaire. This questionnaire has three parts.

1. contains a set of questions on respondents' attitudes, and some reminders of income constraints on individual and public choices.
2. contains the choice sets generated by combining five levels of the four attributes.
3. These combinations describe the claimed effects of PPR (the **status quo** at the time) and hypothetical alternatives.

Status quo

The status quo levels describe the expected effects of the PPR, based on the policy makers' claim and past trends of the tourism industry:

- there was still a great deal of uncertainty regarding the true impact of the PPR;
- the time frame proposed to residents was five years, that is, the proposed changes take place every year for five years.

Attributes and levels

Table 3
Choice attributes.

Attributes	Description	Label	Levels
Distance of new buildings from the seashore	Level of protection assigned to the coastal environment	DIST	• 150 m • 500 m • 1000 m • 2000 m (Status quo) • 3000 m
Number of new jobs in the tourist sector (per year in Alghero)	Economic impact of tourism	EMPL	• 0 • 20 • 40 (Status quo) • 60 • 80
Increase of time required by daily activities (in minutes)	Impact on residents' quality of life of increased tourist flows	TIME	• 5 • 10 • 15 (Status Quo) • 30 • over 30
Payment vehicle	Residents: • local tax increase (absolute value in euros per year) Tourists • increase of cost of holidaying in Alghero (absolute value in euros per day)	COST	• 0 (Status quo) • 10 • 20 • 30 • 40 • 0 (Status quo) • 2 • 4 • 6 • 8

Results

Table 5
Random parameter models with mean heterogeneity.

Variables	Residents		Tourists	
	Coeff.	Standard error	Coeff.	Standard error
Non-random parameters (*b*)				
Alternative specific constant	−0.6477***	0.101	−0.9290***	0.246
Random parameters of choice attributes (b_{ij})				
Distance of new building from the seashore (DIST)	5.17E−05	0.788E−04	3.67E−04***	0.000
Number of new jobs in the tourist sector (EMPL)	0.0796***	0.009	0.0910***	0.019
Increase of congestion (TIME)	−0.0452***	0.009	−0.0331	0.037
Local tax increase (in euro) (COST)	−0.0276***	0.006		
Increase of cost of the holiday (in euro) (COST)			−0.063	0.064

Results

Heterogeneity in mean (d_{ij})				
DIST:gender (female = 1)	0.0005***	0.000		
DIST:income from tourism (yes = 1)	−0.0004***	0.000		
DIST:# of dependants			−0.0002 ***	0.779976E−04
EMPL:age	−0.0006***	0.000		
EMPL:income			−6.01E−7***	0.283362E−06
TIME:income from tourism (yes = 1)	−0.0324***	0.014		
TIME:age			−0.0024***	0.001
COST:gender (female = 1)	−0.0096***	0.005		
COST:income from tourism (yes = 1)	0.0155***	0.002		
COST:# of dependants	−0.0048***	0.006		
COST:age			−0.0047***	0.002
Derived standard deviations of parameter distributions (w_{iz})				
NsDIST	0.0015***	0.000	0.0003	0.000
NsEMPL	0.0146	0.010	0.0791***	0.023
NsTIME	0.0639***	0.024	0.1299***	0.050
NsCOST	0.0450***	0.013	0.14	0.104
Pseudo *Rsq*	0.237		0.338	
Log likelihood	−3306.55		−997.75	
Observations	6264		2188	
% Correct predictions	72.9		77.7	

***Significant at 1%, **significant at 5%; *significant at 10%.

Implicit prices

Table 6
Implicit prices.

Attribute	Residents (income from tourism = no)	
	IP (€)	95% CI
Distance of new building from the seashore	0.013***	0.007–0.019
Number of new jobs in the tourist sector	1.95***	1.374–2.527
Increase of congestion	−1.11***	−1.576 to −0.642

***Significant at 1%, **significant at 5%; *significant at 10%.

Implicit prices

Residents (income from tourism = yes)		Tourists	
IP (€)	95% CI	IP (€)	95% CI
0.003	−0.009 to 0.015	0.005	−0.004 to 0.015
3.15***	1.539−4.753	1.28	−0.997 to 3.552
−3.07***	−4.838 to −1.303	−0.46	−1.631 to 0.702

Conflicting preferences

Results indicate that there are several conflicting preferences over tourism development:

- increasing the level of environmental conservation in Alghero provides welfare gains only to those residents that do not earn an income from tourism;
- both tourists and tourist service providers are not concerned about environmental protection.
- congestion seems to negatively affect Alghero residents e including those that earn their income from tourism.
- tourists do not indicate they are impacted by congestion.

jobs

- Increasing employment opportunities is very important for residents, while tourists have no concern for the impact of tourist development on local jobs.
- Our study shows that tourists are not sensitive to changes in the cost of their holidays in the price range used in the analysis (from 0 to 8 euros per day). Hence the local authorities could rise revenues at the cost of only a small reduction of the number of tourists and their length of stay.