Modeling Uncertain Preferences in Contingent Valuation with a Mixture Model Approach

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Uncertainty in CVM

- Uncertainty of respondents may be caused by <u>multiple reasons</u>, among them:
  - Lack of knowledge or experience with the good or program being valued
  - Truly uncertain preferences: Not much thought about how much they value the good in monetary terms
  - Non-stable preferences: Due to a single payment without repetition or chance to experience

Approaches to deal with Uncertainty

- Polychotomous questions
  - Ready, Whitehead and Blomquist (1995) present respondents with six responses to choose from, "definitely yes," "probably yes," "maybe yes," "maybe no," "probably no," and "definitely no."

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  - Ready, Whitehead and Blomquist (1995) present respondents with six responses to choose from, “definitely yes,” “probably yes,” “maybe yes,” “maybe no,” “probably no,” and “definitely no.”
  - **Ready, Navrud, and Dubourg (2001) use a WTP question posed using the following choices: a) almost certain yes (95% sure yes), b) most likely yes, c) equally likely yes or no, d) more likely no, and e) almost certain no.**
  - **Welsh and Poe (1998) employ a multiple bounded uncertainty model (MBUM) with 13 bids, combining that with uncertain response options.**

Approaches to deal with Uncertainty

- <u>10 point follow-up certainty scale</u>
  - Champ et al. (1997) all “yes” respondents were recoded as a “no” if the respondent was not completely certain, i.e. providing a certainty score below 10.

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  - **Loomis and Ekstrand (1998) “asymmetric uncertainty models (ASUM): multiplies the Yes responses by the certainty score: Yes response with a 10 score assigned a 1 probability of paying the given amount; whereas an individual selecting a 1 will be assigned a 0.1 probability to its Yes response.**

Research Objectives

- Results coming from these popular DC recoding approaches outlined earlier will be compared with those from a finite mixture model developed here to deal with the uncertainty bias.
  - Advantage of proposed methodology: No recoding or interpretation of the certainty scale is needed

Finite Mixture Models

- Commonly used in the marketing literature
- Not too many applications in environmental economics (Boxall and Adamowicz,2002)
  - Advantages:
    - clustering individuals with respect to a latent or non-observable variable
    - Clusters or classes of individuals are modeled as a function of explanatory variables
    - No need of scaling of variables
    - Great flexibility with respect to possible selection of empirical forms

Finite Mixture Model

- Finite mixture model with K components of form:

$$h(y|x,w) = \sum_{k=1}^{K} \pi_k f\left(y|x,\theta_k\right)$$

$$\pi \geq 0, \quad \sum_{k=1}^{K} \pi_k = 1$$

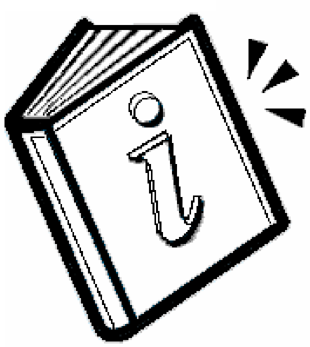
- Where *y*=dependent variable, with conditional density *h*,
x is a vector of explanatory variables, and θ_k
is the component specific parameter vector for the density function *f, and*
w is the vector for all parameters

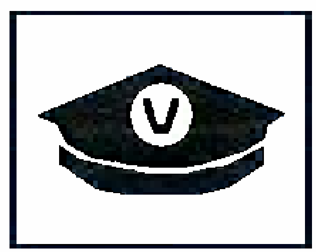
Data

- CVM survey conducted to quantify the passive use value lost in the Prestige oil spill
- Suvey structure followed previous surveys developed by Carson *et al.(2003)* for central California Oil Spills and Exxon Valdez Oil spill.
- Representative sample of Spanish households

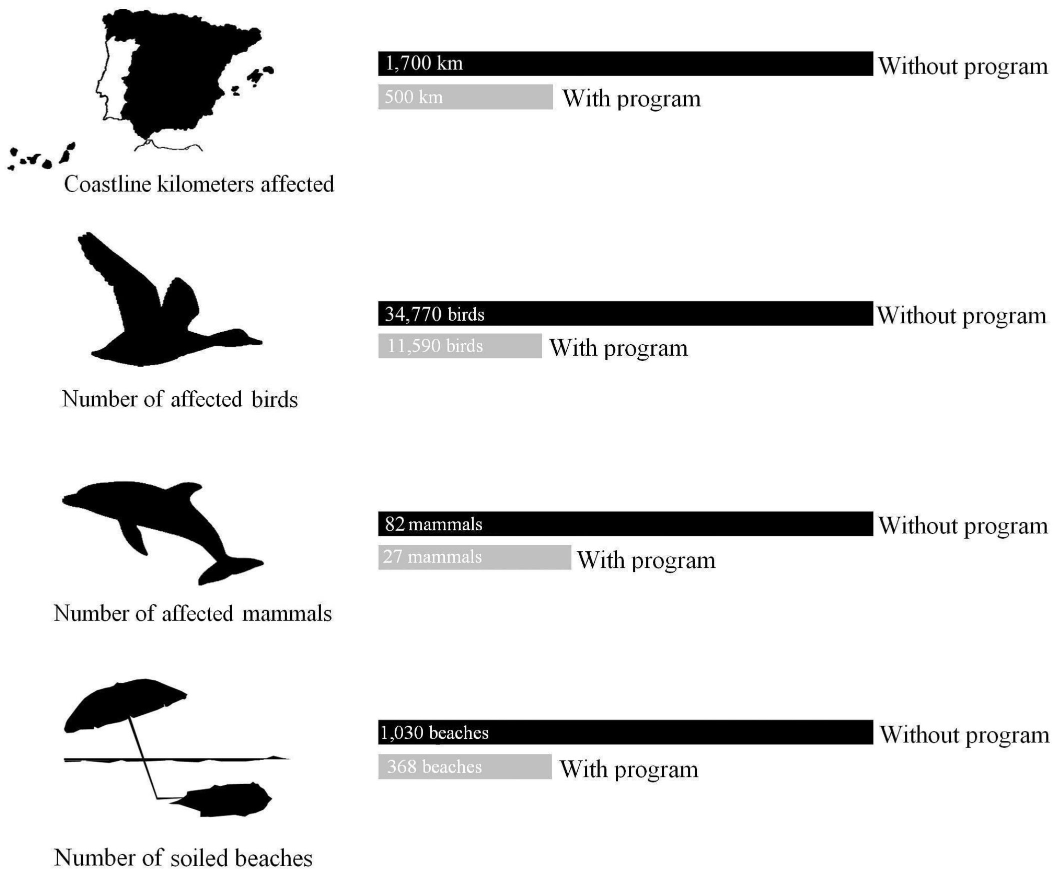
Rapid Response and Clean Up Program

- Training of personnel
- Surveillance
- Rapid and qualified response





Expected Damages every 7 years caused by oil spills



Data

- DC WTP valuation with a follow-up certainty scale from 1-10.
- Verbatim WTP question: *If the implementation of the escort ship and rapid response program described above will cost your household **€--,** would you vote in favor of paying this amount just <u>one single time (say in the next tax declaration)</u> to reduce the damages described to the nature and fauna by oil spills?*

  YES …..1 NO …..2
- *We are aware that there are many factors beyond your control that may affect the level of certainty of the response that you just stated above. Please circle the level of certainty you have regarding your previous response, meaning how sure you are about casting your vote in this way in a future referendum, given that*

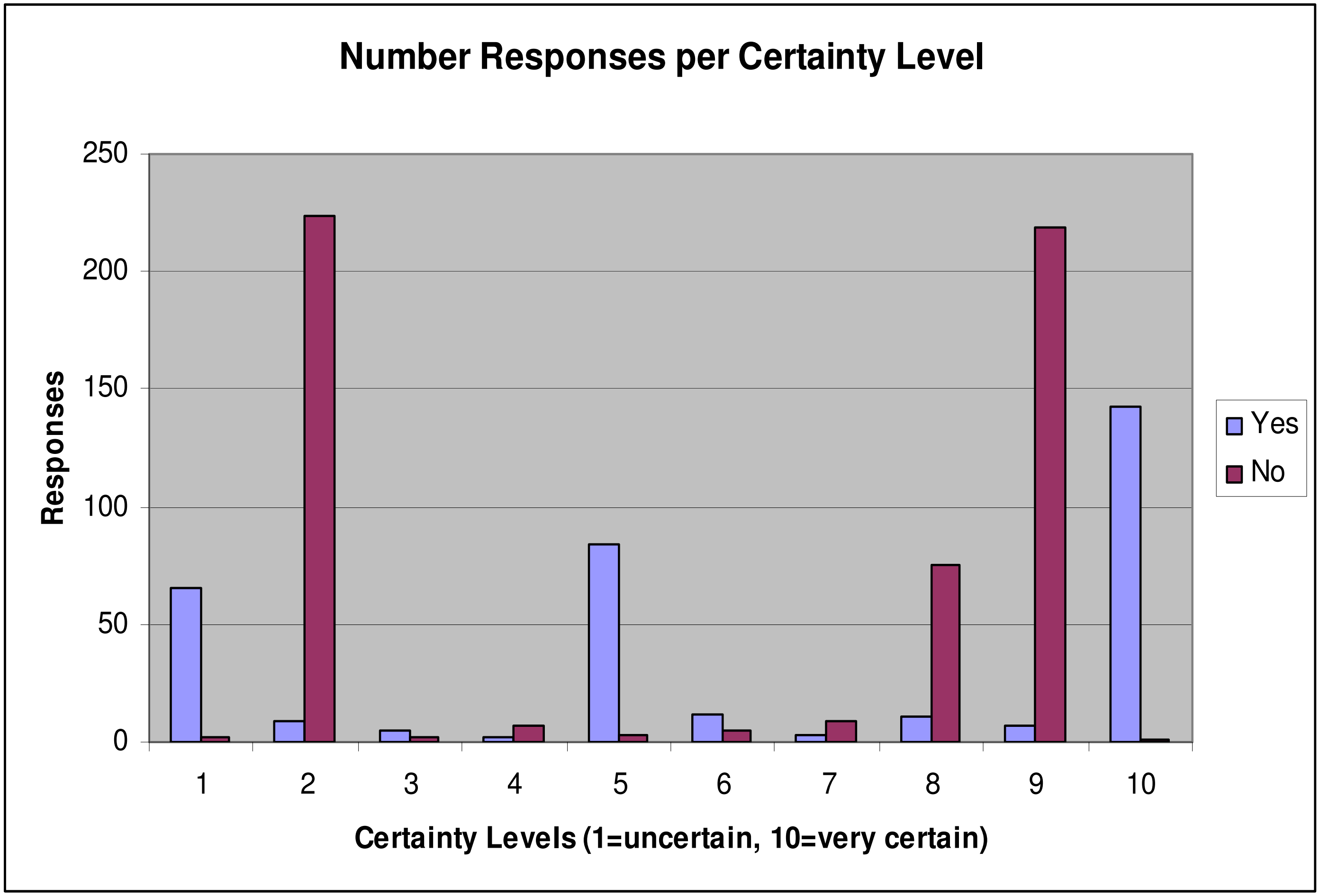
  1=not certain at all, and 10=absolutely certain.

1	2	3	4	5	6	7	8	9	10

Results

- 1140 surveys were collected in representative sample
- Multi-stage sampling procedure
- Surveys conducted during spring and early summer 2006
- 44.4 % response rate
- First approximation to uncertainty in responses employing and comparing:
    - RUM
    - Champ et al.(1997) recoding
    - ASUM model (Loomis and Ekstrand,1998)

Distribution of Responses



Explanatory Variables

Name	Definition	Mean
WTPbid	Bid offered	158.481
Age	Respondent's Age	44.913
Income-sources	=1 if income earners present	0.494
Primary-School	=1 if respondent completed primary school,	0.421
High-School	=1, if respondent completed high school	0.132
University	=1 if individual completed a College Degree	0.017
Certainty-scale	=1, not certain at all, 10=totally certain about response	6.070
Know- People	=1, if individual knew people affected by the Prestige oil spill, 0=otherwise	0.122
Visited-Area	=1, if individual have visited affected area, 0 otherwise	0.305
Male	=1 if respondent is a male, 0 otherwise	0.484

Logit Results

WTP	Standard Binary Logit Coef.	T-value	Champ et al. ,1997 RECODING Coef.	T-value	ASUM (Loomis & Ekstrand, 1998 Coef.	T-value
Bid	-0.007	-7.89	-0.007	-5.47	-0.001	-5.97
Age	-0.012	-2.51	-0.008	-1.09	-.0001	-0.05
Income Sources	0.022	0.21	0.181	1.08	.0001	0
Primary School	0.185	1.01	0.089	0.32	0.033	0.72
High School	0.686	2.68	0.373	0.94	0.115	1.75
UniversityDegree	1.407	2.17	0.395	0.44	0.308	1.93
Certainty Scale	0.092	3.73				
KnowA People	0.177	0.96	1.008	1.81	0.019	0.4
Visited Area	0.612	3.51	0.730	2.63	0.082	1.84
Male	-0.114	-0.69	-0.440	-1.71	-0.037	-0.9
Constant	0.122	0.35	0.847	1.7	0.270	3.32
Log-likelihood	-437.64		-181.81			

Mixture Model: Latent Class Results

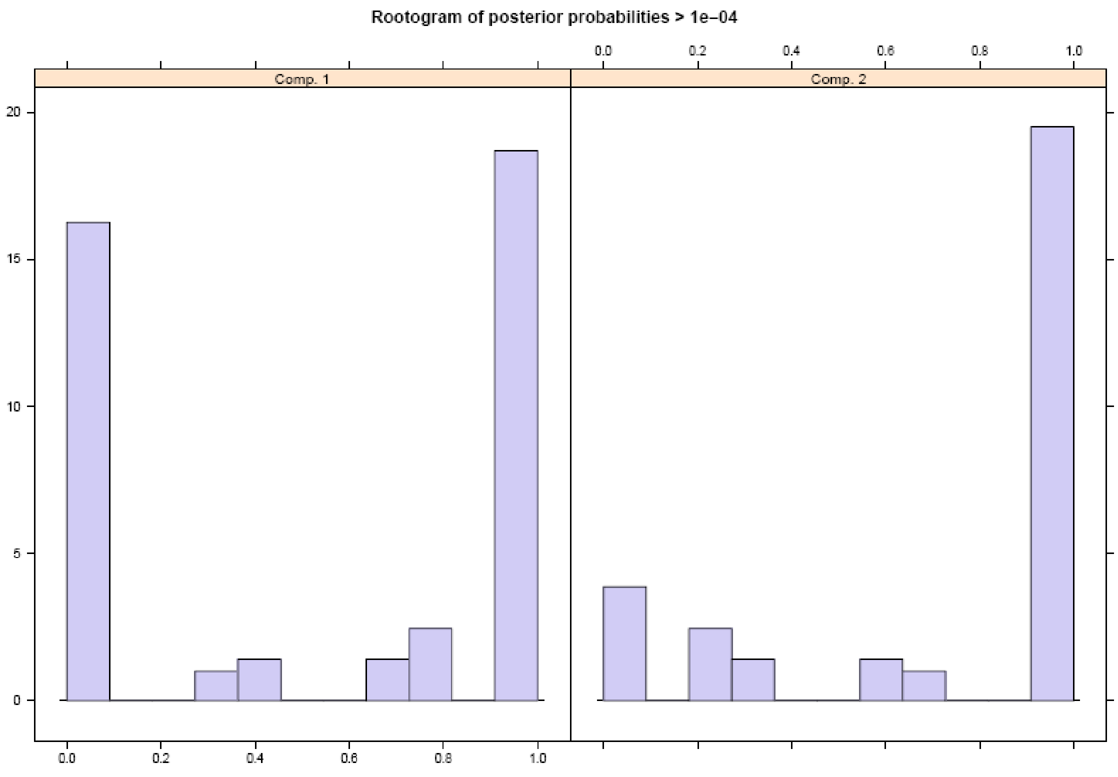
Table 4: Mixture Modeling Results for Class Assignment

	Estimate	T-value
Certain Class		
Constant	2.1467	8.8158
Bid	0.0026	4.1298
Coast	-0.0472	-0.3842
Know People	-0.2850	-2.4086
Income Sources	0.0102	0.1362
Age	-0.0012	-0.3519
Male	0.2061	1.7289
Visited Affected Area	0.5862	4.5507
Primary School	0.2705	1.9973
High School	-0.0449	-0.2423
University Degree	5.6460	13.8813
Uncertain Class		
Constant	9.4160	84.0588
Bid	-0.0007	-3.2047
Coast	-0.1066	-1.9058
Know People	0.2122	3.0357
Income Sources	-0.0005	-0.0129
Age	-0.0035	-2.1431
Male	-0.0636	-1.1913
Visited Affected Area	0.1725	2.9320
Primary School	-0.0677	-1.1523
High School	0.1039	1.2067
University Degree	-7.3962	-31.1752
Log Likelihood	-1597.209	

	Prior	Size	Post>0	Ratio
Certain Class	0.467	348	361	0.964
Not Certain Class	0.533	392	736	0.533

Rootgram of Posterior Probabilities

Graph 3: Rootogram of Posterior Probabilities



For K=3

	Prior	Size	Post	Ratio
Component 1	0.456	367	401	0.915
Component 2	0.218	125	734	0.170
Component 3	0.326	248	255	0.973

More evidence about the K-size

	Log-lik.	AIC	BIC
Cluster 1 (df=12)	-1938.82	3901.64	3956.92
Cluster 2 (df=25)	-1587.113	3224.226	3339.39
Cluster 3 (df=35)	-1436.989	2949.979	3125.032
Cluster 4 (df=51)	-1332.040	2766.080	3001.020

WTP Estimates in Euro's

WTP= $\frac{-\widehat{\alpha}}{\widehat{\beta}}$	**Mean WTP**	**95 % C.I.***
DC Standard Logit Model	72.59	(66.57, 78.66)
ASUM (Loomis& Ekstrand, 1998)	110.34	(110.30, 120.18)
Champ et al. Recoding, 1997	-439.05	(-432.46, -445.65)
Mixture-Model, **Uncertain Class**	54.08	(42.01, 66.15)
Mixture-Model, **Certain Class**	82.14	(76.07, 88.22)

C.I. were estimated with the Jacknife technique

WTP Estimates in Euro’s

WTP= $\frac{1}{-\hat{\beta}}\ln(1+\exp^{\alpha})$	**Mean WTP**
DC Standard Logit Model	141.18
ASUM (Loomis& Ekstrand, 1998)	502.95
Champ et al. Recoding, 1997	88.81
Mixture-Model, **Uncertain Class**	62.82
Mixture-Model, **Certain Class**	113.69

Conclusions

- Mixture models may be suitable to cluster individuals and within clusters may allow to model WTP for the public good or program
- Advantages over previous methods: non-recoding or interpretation of responses
- Clustering may be used to compute reliable WTP estimates
  - Ignoring non certain classes, given that certain respondents are more likely to behave as stated (Champ et al.)
  - Computing the social WTP, weighting each WTP estimate by the relative importance of each class