Regret minimization and utility maximization: the approach and four case studies

Marco Boeri

Gibson Institute for Land, Food and the Environment,

Queens University Belfast

T.: +44(0)28 9097 2102, F: +44(0)28 9097 5877

E: mboeri01@qub.ac.uk

FEEM Seminar - Monday 13 February 2012 - h. 12.00 - Milan

Milan: FEEM, Sala Consiglio

Venice: FEEM, Sala Riunioni (videoconference)

Outline of the Presentation

- The approach
  - Random Utility Model
  - Random Regret Model
- Case study 1: the Natural Park of Regole d'Ampezzo (SP)
- Case study 2: kayakers' site choice in Ireland (RP)
- Case study 3: freight transport in Switzerland (SP)
- Case study 4: dietary choices, physical activity and cardiovascular disease risk (SP)
- Conclusions

The Random Utility Model

RUM’s basic assumption is that in making their choices respondents **maximize their utility**.

RUM advantages

- strong econometric foundations
- conceptual elegance
- formal tractability

BUT

- IIA assumption
  => fully compensatory decision rules

People may aim to minimize regret when choosing (Chorus et al., 2006, 2008, Chorus, 2010, Chorus and de Jong, 2011, Thiene et al, 2011)

A Model of Regret

Regret is defined as what one experiences when a non-chosen alternative performs better than a chosen one, on one or more attributes

(marketing, psychology, management science and transport, medical decision making, insurance policies, etc.)

The Random Regret Minimization Model

Semi-compensatory behaviour:

Improving an alternative in terms of an attribute on which it already performs well relative to other alternatives generates only small decreases in regret, whereas deteriorating to a similar extent the performance on another equally important attribute on which the alternative has a poor performance relative to other alternatives may generate substantial increases in regret.

Compromise effect:

Alternatives with an 'in-between' performance on all attributes relative to the other alternatives in the choice set, are generally favoured by choice-makers over alternatives with a poor performance on some attributes and a strong performance on others.

Random Utility Multinomial Logit Model (RU-MNL)

1) $$U_{ni} = V(\beta, X_{ni}) + \varepsilon_{ni}$$

2) $$Pr_{n(i)} = \frac{e^{V_{in}}}{\sum_{j=1}^{J} e^{V_{jn}}},$$

$$\text{where } V_{nit} = \beta' x_{nit}.$$

n = respondent
i = alternative in the choice set *j*
X = vector of *m* attributes,
β = vector of parameters to be estimated
ε = i.i.d. error term

Random Regret Multinomial Logit Model (RR-MNL)

3a) $$R_i = max_{j\,\neq\,i}\left\{\sum_{m=1\ldots M} max\left\{0, \gamma_{m(x_{jm}-x_{im})}\right\}\right\}$$ (Chorus, 2008)

Random Regret Multinomial Logit Model (RR-MNL)

3a) $$R_i = max_{j \neq i}\left\{ \sum_{m=1...M} max\left\{0, \gamma_{m(x_{jm}-x_{im})}\right\}\right\}$$ (Chorus, 2008)

3b) $$R_i = \sum_{j \neq i} \sum_{m=1..,M} \ln\left(1 + e^{\gamma_{m(x_{jm}-x_{im})}}\right)$$ (Chorus, 2010)

Confused?
An intuitive explanation

	Option 1	Option 2	Option 3
Attribute 1	1	3	2
Attribute 2	2	0	1
Cost	20	10	15

Regret associated with Option 1 (2008):

$R_{option2}=\gamma_{Attribute1}*\max(0,(3-1))+ \gamma_{Attribute2}*\max(0,(0-2))+ \gamma_{Cost}*\max(0,(10-20))$

$R_{option3}=\gamma_{Attribute1}*\max(0,(2-1))+ \gamma_{Attribute2}*\max(0,(1-2))+ \gamma_{Cost}*\max(0,(15-20))$

Regret associated with Option 1 (2010):

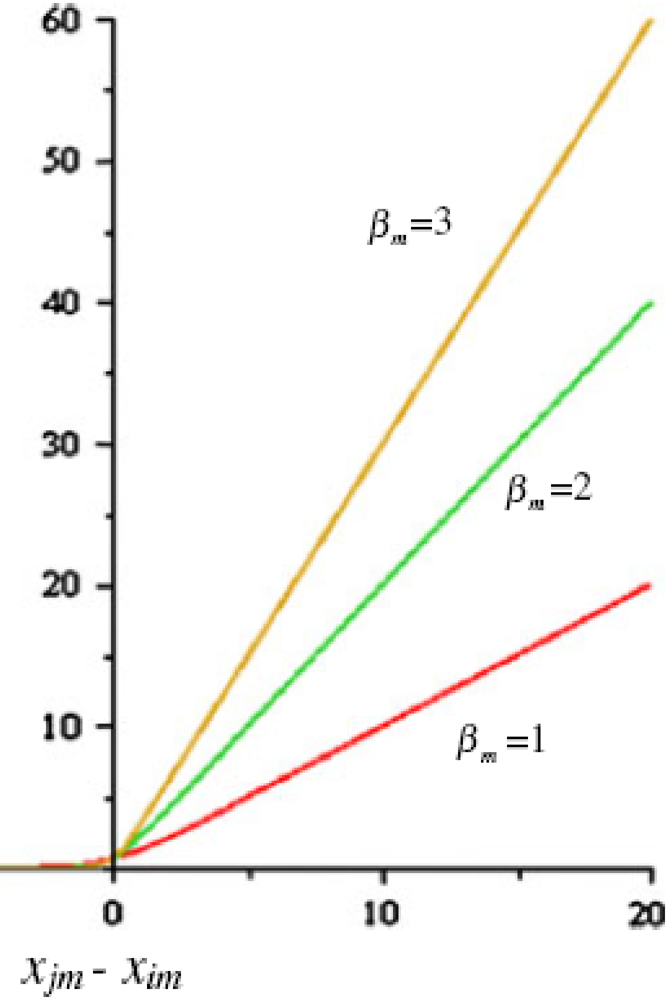
$Ln(1+\exp(\gamma_{Attribute1}*(3-1))+ Ln(1+\exp(\gamma_{Attribute1}*(2-1))+$

$Ln(1+\exp(\gamma_{Attribute2}*(0-2))+Ln(1+\exp(\gamma_{Attribute2}*(1-2))+$

$Ln(1+\exp(\gamma_{Cost}*(10-20)) + Ln(1+\exp(\gamma_{Cost}(15-20))$

A visualization of attribute level-regret

$$R^m_{i \leftrightarrow j} = \ln\left(1 + \exp\left[\beta_m \cdot \left(x_{jm} - x_{im}\right)\right]\right)$$



Random Regret Multinomial Logit Model (RR-MNL)

3a) $$R_i = max_{j \neq i}\left\{ \sum_{m=1 \ldots M} max\left\{0, \gamma_{m(x_{jm}-x_{im})}\right\}\right\}$$ (Chorus, 2008)

3b) $$R_i = \sum_{j \neq i} \sum_{m=1..,M} \ln\left(1 + e^{\gamma_{m(x_{jm}-x_{im})}}\right)$$ (Chorus, 2010)

4) $$Pr_{n(i)} = \frac{e^{(-R_i)}}{\sum_{j=1}^{J} e^{(-R_j)}}$$

γ reflects the **potential** contribution of an attribute to the regret associated with that alternative

The idea:

- Both RUM and RRM have strengths and weaknesses
- Both RUM and RRM represent **a** choice paradigm, but **not the only one,** as some choices are better described by RUM and others by RRM

The idea:

- Both RUM and RRM have strengths and weaknesses
- Both RUM and RRM represent **a** choice paradigm, but **not the only one,** as some choices are better described by RUM and others by RRM

- Applying both modelling approaches would capture the behavioural influences on choices more accurately than assuming in all instances RUM

4 case studies

Random Regret Minimization: Exploration of a New Choice Model for Environmental and Resource Economics

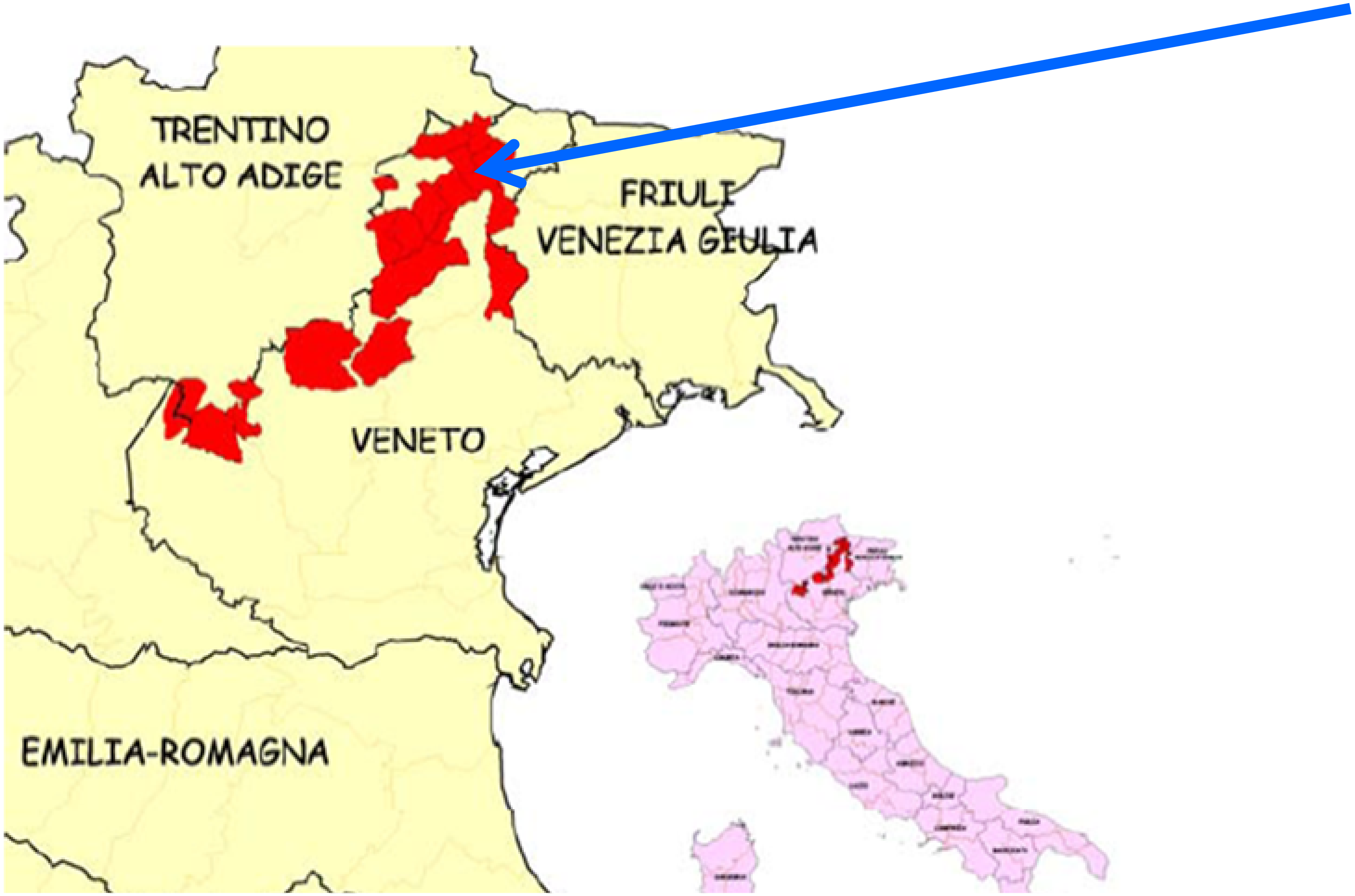
Mara Thiene[a], Marco Boeri[b], Caspar Chorus[c]

a) Dep. TESAF, University of Padua 35020 Legnaro, Padua

b) Gibson Institute for Land, Food and the Environment, Queens University Belfast

c) Delft University of Technology, Jaffalaan 5, Delft

The site: the Natural Park of Regole d'Ampezzo



World Heritage List


The Dolomites

The Survey

The data collection took place in summer 2008.

Respondents were selected from the population of visitors, surveyed on-site at the end of their outdoor experience.

They were randomly sampled within five strata based on the main purpose of the visit of the day.

Visitor types:

1. hikers,
2. climbers,
3. mountain bikers,
4. visitors who use via-ferratas,
5. visitors engaged in short walks and/or picnicking.

The experimental design

A sequential Bayesian design was used.

The survey design involved four separate waves for each of the five categories of visitors.

At the end of each wave the data was coded and MNL models were estimated to:

- make decisions about inclusion in subsequent waves;
- provide priors for the subsequent design.

First wave: all attributes and identical designs for all visitors.

Subsequent waves: 7, 5 and 3 non-monetary attributes.

The attributes discarded in each subsequent wave were those for which highest level of significance had been obtained.

Attribute	Attribute levels	Attribute	Attribute levels
Thematic itineraries (n)	2[a]	Via ferrata	Iron cable along part of the path[a]
	5		Iron cable along the whole path
	7		Iron cable plus artificial holds
Network of trails (km)	300	Shelters (n)	17
	350[a]		20[a]
	400		23
Trail signs	Vertical signs[a]	Congestion (n)	<20[a]
	Vertical signs plus horizontal painted signs 200		20–50 >50
	Vertical signs plus horizontal painted signs 50		
Managed trails excursions (h)	1[a]	Information	Leaflet[a]
	3		Brochure
	6		Book
Climbing routes (n)	20[a]	Entrance fee (€)	0[a]
	40		2
	60		5
			7
			10

[a] Status quo level

The experimental design

- Each respondent was presented with 12 choice-tasks, within each wave-group 24 visitors were surveyed
- Balanced total sub-sample of 120 surveys for each wave

- 480 completed surveys
- 5,760 usable choices

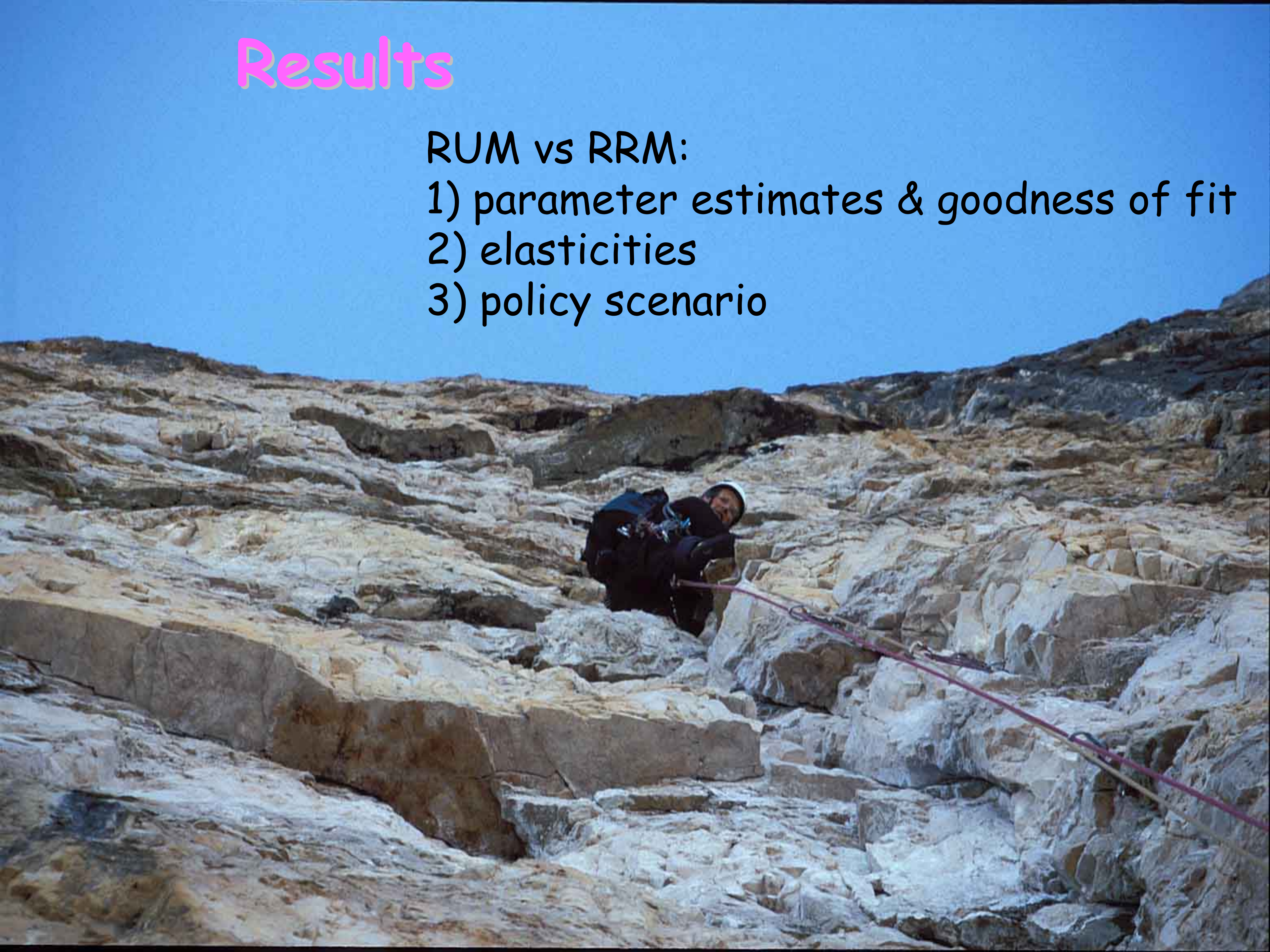
Example of choice task in CE of the first wave

Which of the following alternative would you choose?	Alternative A	Alternative B	Neither
Thematic itineraries (n.)	5 in addition	5 in addition	
Trails (km)	350 (baseline)	300 (1/7 less)	
Trail signs	vertical + horiz. 200m	vertical only	
Excursions (hours)	6	1	
Climbing routes (n.)	40 in addition	20 in addition	
Vie-ferrate	Complete iron cable	Complete iron cable + artif. holds	
Alpine huts (n.)	23 (3 in addition)	17 (3 in addition)	
Congestion (n. of people)	between 20 e 50	more than 50	
Information	leaflet	brochure	
Entrance fee (€)	2	2	
Choice			

Results

RUM vs RRM:

1) parameter estimates & goodness of fit
2) elasticities
3) policy scenario



Models' Results

	RUM			RRM	
Attribute	**Coeff**	**|t-stat|**		**Coeff**	**|t-stat|**
COST	-0.1931	24.84		-0.1181	28.54
ITINERARIES	0.0674	6.38		0.0436	6.27
TRAILS	0.0048	7.02		0.0033	7.54
TRAIL SIGNS	0.0007	3.57		0.0005	3.70
MNGD_TRAILS_EXCURSIONS	0.0181	1.66		0.0120	1.70
CLIMBS	0.0003	0.17		0.0002	0.19
FERRATA_N1	-0.1564	2.26		-0.0982	2.22
FERRATA_N2	-0.1044	1.47		-0.0651	1.44
SHELTERS	0.0242	2.44		0.0162	2.53
CROWD	-0.0082	13.46		-0.0054	14.32
INFO1	0.0071	0.14		0.0033	0.10
INFO2	0.0061	0.12		0.0035	0.11
SQ	-1.4106	18.7		-0.7787	24.02
LL at zero			*-6320.5*		
LL at conv.	*-5791.10*			*-5808.04*	
# Obs.			*5760*		

Direct elasticities and relative differences

	RUM	RRM	abs(RUM) / abs(RRM)
Attribute	Avg. Alt. A-B	Avg. Alt. A-B	Avg. Alt. A-B
ITINERARIES	0.1913	0.1970	0.943
TRAILS	0.4886	0.5244	0.871
TRAIL SIGNS	0.0676	0.0707	0.914
MNGD_TRAILS_EXCURSIONS	0.0213	0.0221	0.914
FERRATA_N1	-0.0180	-0.0150	1.500
SHELTERS	0.2263	0.2370	0.913
CROWD	-0.2045	-0.2048	0.947
COST	-0.6267	-0.6608	1.189

POLICY SCENARIO:

Predicted change in choice probabilities due to an increase of entrance fee by 15 %

	RUM		RRM	
	Change in choice probability	Total change	Change in choice probability	Total change
Alternative affected (Average effect)	-3.10%	-100.00%	-2.06%	-100.00%
Other Alternative (Average effect)	1.52%	48.81%	0.98%	47.53%
Status Quo (Average effect)	1.58%	51.19%	1.08%	52.47%

Site Choices in Recreational Demand: A Matter of Utility Maximization or Regret Minimization?

Marco Boeri,* Alberto Longo,*
Edel Doherty, Stephen Hynes****

*Gibson Institute for Land, Food and the Environment,
Queens University Belfast

**National University of Ireland, Galway

Kayakers' site choice in Ireland

Multi-site travel cost model. Respondents were asked to indicate how many trips they had made to each of the **eleven whitewater sites** in the previous year.

Attributes used:

- Quality of parking at the site
- Degree of expected crowding at the site
- Quality of the kayaking experience as measured by the star rating system used in the Irish Whitewater Guidebook
- Water quality
- Scenic quality
- Reliability of water information
- Travel cost

Sample

- Kayakers were surveyed from lists obtained from the Irish Kayakers Association, from the Outdoor Adventure Store, and the Irish kayaking instruction company H2O Extreme

- 279 useable responses from kayakers
- 3,466 usable choices

RU-MNL vs. RR-MNL

	RU-MNL	
Attribute	Coeff	|t-stat|
Quality of parking	0.0702	3.36
Crowding	-0.0882	4.37
Star quality rating of the whitewater site	0.241	8.77
Water quality	-0.206	9.96
Scenic quality	-0.0728	3.23
Availability of information on water levels prior to visiting the site	0.372	17.24
Travel Cost	-0.047	40.48
Log-likelihood	-6899.976	
Rho2	0.167	

RU-MNL vs. RR-MNL

	RU-MNL		RR-MNL	
Attribute	Coeff	|t-stat|	Coeff	|t-stat|
Quality of parking	0.0702	3.36	0.0121	3.27
Crowding	-0.0882	4.37	-0.0161	4.43
Star quality rating of the whitewater site	0.241	8.77	0.0433	8.8
Water quality	-0.206	9.96	-0.0358	9.4
Scenic quality	-0.0728	3.23	-0.0134	3.29
Availability of information on water levels prior to visiting the site	0.372	17.24	0.0668	16.94
Travel Cost	-0.047	40.48	-0.0086	38.59
Log-likelihood	-6899.976		-6929.67	
Rho2	0.167		0.165	

RU-MNL vs. RR-MNL

	RU-MNL		RR-MNL	
Attribute	Coeff	|t-stat|	Coeff	|t-stat|
Quality of parking	0.0702	3.36	0.0121	3.27
Crowding	-0.0882	4.37	-0.0161	4.43
Star quality rating of the whitewater site	0.241	8.77	0.0433	8.8
Water quality	-0.206	9.96	-0.0358	9.4
Scenic quality	-0.0728	3.23	-0.0134	3.29
Availability of information on water levels prior to visiting the site	0.372	17.24	0.0668	16.94
Travel Cost	-0.047	40.48	-0.0086	38.59
Log-likelihood	-6899.976		-6929.67	
Rho2	0.167		0.165	

RU-MNL vs. RR-MNL

	RU-MNL		RR-MNL	
Attribute	Coeff	|t-stat|	Coeff	|t-stat|
Quality of parking	0.0702	3.36	0.0121	3.27
Crowding	-0.0882	4.37	-0.0161	4.43
Star quality rating of the whitewater site	0.241	8.77	0.0433	8.8
Water quality	-0.206	9.96	-0.0358	9.4
Scenic quality	-0.0728	3.23	-0.0134	3.29
Availability of information on water levels prior to visiting the site	0.372	17.24	0.0668	16.94
Travel Cost	-0.047	40.48	-0.0086	38.59
Log-likelihood	-6899.976		-6929.67	
Rho2	0.167		0.165	

RU-MNL vs. RR-MNL

	RU-MNL		RR-MNL	
Attribute	Coeff	|t-stat|	Coeff	|t-stat|
Quality of parking	0.0702	3.36	0.0121	3.27
Crowding	-0.0882	4.37	-0.0161	4.43
Star quality rating of the whitewater site	0.241	8.77	0.0433	8.8
Water quality	-0.206	9.96	-0.0358	9.4
Scenic quality	-0.0728	3.23	-0.0134	3.29
Availability of information on water levels prior to visiting the site	0.372	17.24	0.0668	16.94
Travel Cost	-0.047	40.48	-0.0086	38.59
Log-likelihood	-6899.976		-6929.67	
Rho2	0.167		0.165	

Which model is better?

…difficult question…

We compute the contribution to the value of the Log-likelihood function for each choice under both the RU-MNL and the RR-MNL.

We create a dummy variable equal to 1 when the Log-likelihood of the RU-MNL outperforms the Log-likelihood of the RR-MNL, and 0 otherwise.

We run a logit regression on this variable where the characteristics of the choice, respondent and chosen site are used as explanatory variables:

5) $$P(d)_{nti} = 1/(1+\exp(-\alpha+\gamma' Z_{nti}))$$

Binary Logit on better prediction at choice level

	Value	t-stat
Intercept	0.109368	0.859
Frequency of visits to a particular site	0.034630	16.818
Self-reported intermediate or advanced skill level (dummy variable)	-0.303432	-3.669
Cliften Play Hole (dummy variable)	-1.797546	-12.181
Curragower Wave (dummy variable)	-0.988211	-7.113
The Boyne (dummy variable)	-0.381868	-2.788
The Roughty (dummy variable)	0.709026	2.972
The Clare Glens (dummy variable)	-1.42574	-6.879
The Annemoe (dummy variable)	-1.686707	-11.699
The Barrow (dummy variable)	-1.352322	-5.928
The Dargle (dummy variable)	0.657316	2.971
The Inny (dummy variable)	-2.510303	-10.921
The Boluisce (dummy variable)	0.439686	2.155

† The dependent variable is equal to 1 if RU-MNL outperforms RR-MNL, and 0 otherwise.

Binary Logit on better prediction at choice level

	Value	t-stat
Intercept	0.109368	0.859
Frequency of visits to a particular site	0.034630	16.818
Self-reported intermediate or advanced skill level (dummy variable)	-0.303432	-3.669
Cliften Play Hole (dummy variable)	-1.797546	-12.181
Curragower Wave (dummy variable)	-0.988211	-7.113
The Boyne (dummy variable)	-0.381868	-2.788
The Roughty (dummy variable)	0.709026	2.972
The Clare Glens (dummy variable)	-1.42574	-6.879
The Annemoe (dummy variable)	-1.686707	-11.699
The Barrow (dummy variable)	-1.352322	-5.928
The Dargle (dummy variable)	0.657316	2.971
The Inny (dummy variable)	-2.510303	-10.921
The Boluisce (dummy variable)	0.439686	2.155

† The dependent variable is equal to 1 if RU-MNL outperforms RR-MNL, and 0 otherwise.

Binary Logit on better prediction at choice level

	Value	t-stat
Intercept	0.109368	0.859
Frequency of visits to a particular site	0.034630	16.818
Self-reported intermediate or advanced skill level (dummy variable)	-0.303432	-3.669
Cliften Play Hole (dummy variable)	-1.797546	-12.181
Curragower Wave (dummy variable)	-0.988211	-7.113
The Boyne (dummy variable)	-0.381868	-2.788
The Roughty (dummy variable)	0.709026	2.972
The Clare Glens (dummy variable)	-1.42574	-6.879
The Annemoe (dummy variable)	-1.686707	-11.699
The Barrow (dummy variable)	-1.352322	-5.928
The Dargle (dummy variable)	0.657316	2.971
The Inny (dummy variable)	-2.510303	-10.921
The Boluisce (dummy variable)	0.439686	2.155

† The dependent variable is equal to 1 if RU-MNL outperforms RR-MNL, and 0 otherwise.

Binary Logit on better prediction at choice level

	Value	t-stat
Intercept	0.109368	0.859
Frequency of visits to a particular site	0.034630	16.818
Self-reported intermediate or advanced skill level (dummy variable)	-0.303432	-3.669
Cliften Play Hole (dummy variable)	-1.797546	-12.181
Curragower Wave (dummy variable)	-0.988211	-7.113
The Boyne (dummy variable)	-0.381868	-2.788
The Roughty (dummy variable)	0.709026	2.972
The Clare Glens (dummy variable)	-1.42574	-6.879
The Annemoe (dummy variable)	-1.686707	-11.699
The Barrow (dummy variable)	-1.352322	-5.928
The Dargle (dummy variable)	0.657316	2.971
The Inny (dummy variable)	-2.510303	-10.921
The Boluisce (dummy variable)	0.439686	2.155

† The dependent variable is equal to 1 if RU-MNL outperforms RR-MNL, and 0 otherwise.

Binary Logit on better prediction at choice level

	Value	t-stat
Intercept	0.109368	0.859
Frequency of visits to a particular site	0.034630	16.818
Self-reported intermediate or advanced skill level (dummy variable)	-0.303432	-3.669
Cliften Play Hole (dummy variable)	-1.797546	-12.181
Curragower Wave (dummy variable)	-0.988211	-7.113
The Boyne (dummy variable)	-0.381868	-2.788
The Roughty (dummy variable)	0.709026	2.972
The Clare Glens (dummy variable)	-1.42574	-6.879
The Annemoe (dummy variable)	-1.686707	-11.699
The Barrow (dummy variable)	-1.352322	-5.928
The Dargle (dummy variable)	0.657316	2.971
The Inny (dummy variable)	-2.510303	-10.921
The Boluisce (dummy variable)	0.439686	2.155

† The dependent variable is equal to 1 if RU-MNL outperforms RR-MNL, and 0 otherwise.

Policy analysis: Logsum

The Logsum is a widely used measure for assessing user's benefits and for retrieving post estimation welfare analysis.
The RU-MNL Logsum is the expected value of the maximum utility in the choice situation:

6) $$LS_{RU} = E\left[max_{j=1\ldots J}\{U_j\}\right] = \int_{\varepsilon}\left[max_{j=1\ldots J}\{U_j\}\cdot f(\varepsilon)\right]d\varepsilon = ln\left[\sum_{j=1\ldots J}\exp(V_j)\right]$$

The RR-MNL Logsum is the expected value of the minimum regret in the choice situation Chorus (2011):

7) $$LS_{RR} = E\left[min_{j=1\ldots J}\{RR_j\}\right] = \int_{\varepsilon}\left[min_{j=1\ldots J}\{RR_j\}\cdot f(\varepsilon)\right]d\varepsilon = -ln\left[\sum_{j=1\ldots J}\exp(-R_j)\right]$$

To assess the impacts of a policy change we calculate the logsums before and after the policy change for both RR and RU models.

Policy analysis: Logsum difference results

Scenario: Introduction of a €5 parking fee at the Liffey River

	RU-MNL $LS_{RU}{}^{1}\text{-}LS_{RU}{}^{0}$	**RR-MNL** $LS_{RR}{}^{1}\text{-}LS_{RR}{}^{0}$
1st Quarter	-0.04699	-0.004482
Median	-0.024982	0.004871
Mean	-0.032935	0.010995
3rd Quarter	-0.014168	0.023733

Policy analysis: Logsum difference results

Scenario: Introduction of a €5 parking fee at the Liffey River

	RU-MNL $LS_{RU}{}^{1}\text{-}LS_{RU}{}^{0}$	**RR-MNL** $LS_{RR}{}^{1}\text{-}LS_{RR}{}^{0}$
1st Quarter	-0.04699	-0.004482
Median	-0.024982	0.004871
Mean	-0.032935	0.010995
3rd Quarter	-0.014168	0.023733

Policy analysis: Logsum difference results

Scenario: Introduction of a €5 parking fee at the Liffey River

	RU-MNL $LS_{RU}{}^{1}\text{-}LS_{RU}{}^{0}$	**RR-MNL** $LS_{RR}{}^{1}\text{-}LS_{RR}{}^{0}$
1st Quarter	-0.04699	-0.004482
Median	-0.024982	0.004871
Mean	-0.032935	0.010995
3rd Quarter	-0.014168	0.023733

Policy analysis: Logsum difference results

Scenario: Introduction of a €5 parking fee at the Liffey River

	RU-MNL $LS_{RU}^{1}-LS_{RU}^{0}$	**RR-MNL** $LS_{RR}^{1}-LS_{RR}^{0}$
1st Quarter	-0.04699	-0.004482
Median	-0.024982	0.004871
Mean	-0.032935	0.010995
3rd Quarter	-0.014168	0.023733

Policy analysis: Logsum difference results

Scenario: Introduction of a €5 parking fee at the Liffey River

	RU-MNL $LS_{RU}{}^{1}$-$LS_{RU}{}^{0}$	**RR-MNL** $LS_{RR}{}^{1}$-$LS_{RR}{}^{0}$
1st Quarter	-0.04699	-0.004482
Median	-0.024982	0.004871
Mean	-0.032935	0.010995
3rd Quarter	-0.014168	0.023733

Regret minimization and utility maximization in a freight transport context: an application from two stated choice experiments

Marco Boeri*, Lorenzo Masiero**

*Gibson Institute for Land, Food and the Environment, Queens University Belfast

**Istituto Ricerche Economiche (IRE), Faculty of Economics, University of Lugano

An application to freight transport

- Two stated preference experiments conducted in 2008
- Labelled alternatives describing freight transport services in terms of **transportation mode**, **transport time**, **transport cost** and **punctuality**
- The main difference between the two experiments is in the reference values used for the setting of the scenarios
  - the first experiment (base scenario) is created around the actual values stated by logistics managers for the typical transport service
  - the second experiment (shock scenario) is created around transitional values reflecting a temporary and worsening manipulation of the stated values

Sample

In total, 60 medium to large firms were contacted and asked for their participation in the survey.

The final sample is composed by 27 firms (18 medium and 9 large in size).

The entire sample successfully completed both experiments proposed, resulting in 405 choice observations for each scenario.

Description of the stated preference experiments

	First experiment (base scenario)			Second experiment (shock scenario)		
	Cost	Time	Punctuality	Cost	Time	Punctuality
Level 1	-10 %	-10 %	100 %	-10 %	-10 %	100 %
Level 2	-5 %	-5 %	98 %	-5 %	-5 %	98 %
Level 3	Reference cost	Reference time	96 %	Transitional cost	Transitional time	96 %
Level 4	+5 %	+5 %		+5 %	+5 %	
Level 5	+10 %	+10 %		+10 %	+10 %	
	Transportation mode			**Transportation mode**		
	Piggyback, Combined transport, Road (reference)			Regulated road, Piggyback, Combined transport, Second best road (transitional reference)		
Reference transport		**Mean**	**Median**	**SD**	**Min**	**Max**
Cost (CHF)		1,300	1000	1,152	136	5400
Time (hr)		33.35	24	27.30	2	96
Punctuality (%)		96.52	98	3.04	90	100
Transitional transport						
Cost (CHF)	Reference cost + 500 CHF					
Time (hr)	Reference time + 5 hr					
Punctuality (hr)	min[(reference punctuality-2); 96]					

RU-MNL vs. RR-MNL (base scenario)

	RU-MNL		RR-MNL	
	Value	|t-stat|	Value	|t-stat|
Time	-0.069	2.74	-0.046	2.82
Punt	0.248	7.53	0.171	8.11
Cost	-0.005	6.09	-0.004	6.01
ASC_PB	-0.964	6.7	-0.608	7.46
ASC_TC	-0.757	5.53	-0.482	6.19
LL	-375.984		-374.717	
rho^2	0.134		0.137	

RU-MNL vs. RR-MNL (shock scenario)

	RU-MNL		RR-MNL	
	Value	**|t-stat|**	**Value**	**|t-stat|**
Time	-0.113	5.44	-0.060	6.08
Punt	0.347	8.81	0.187	9.01
Cost	-0.005	8.75	-0.004	9.24
ASC_PB	-0.32	2.12	-0.158	2.35
ASC_TC	-0.384	2.55	-0.19	2.83
ASC_SR	-0.116	0.62	-0.065	0.76
LL	-442.976		-438.664	
rho^2	0.188		0.196	

Direct elasticities: base scenario

elasticities for RU-MNL model			
change in:	Piggyback	Combined transport	Road
cost	**-5.1**	**-4.32**	**-3.79**
stdev	5.01	4.4	4.21
time	**-1.73**	**-1.52**	**-1.43**
stdev	1.45	1.34	1.4
punt	**18.38**	**16.29**	**13.54**
stdev	3.67	4.46	4.06
elasticities for RR-MNL model			
change in:	Piggyback	Combined transport	Road
cost	**-7.41**	**-2.78**	**-3.78**
stdev	7.2	2.71	3.82
time	**-1.81**	**-1.45**	**-1.42**
stdev	1.48	1.23	1.29
punt	**15.21**	**18.06**	**16.22**
stdev	2.42	3.76	3.1

Direct elasticities: shock scenario

Elasticities for RU-MNL model				
Change in	Regulated road	Piggyback	Combined transport	Second best road
cost	**-6.47**	**-6.6**	**-6.71**	**-7.83**
stdev	5.88	5.83	5.56	5.94
time	**-3.12**	**-3.23**	**-3.29**	**-3.83**
stdev	2.55	2.6	2.55	2.68
punt	**24.18**	**25.32**	**25.9**	**29.43**
stdev	7.73	7.56	6.9	2.27
Elasticities for RR-MNL model				
Change in	Regulated road	Piggyback	Combined transport	Second best road
cost	**-7.55**	**-9.71**	**-5.47**	**-8.36**
stdev	6.23	7.88	4.18	6.27
time	**-4.07**	**-3.52**	**-2.94**	**-3.88**
stdev	3.01	2.6	2.13	2.68
punt	**34.22**	**20.84**	**28.17**	**30.11**
stdev	6.33	3.68	4.55	1.63

POLICY SCENARIO:

(base scenario)

Predicted change in choice probabilities due to an increase of time in by 15% in road (first experiment)

RU-MNL:						
Choice	Baseline		Scenario		Change Scenario - Baseline	
	% share	Abs val.	% share	Abs val.	% share	Abs val.
Piggyback	24.20%	98	27.00%	109	2.80%	11
Combined transport	32.84%	133	36.51%	148	3.67%	15
Road	42.96%	174	36.49%	148	-6.47%	-26

RR-MNL:						
Choice	Baseline		Scenario		Change Scenario - Baseline	
	% share	Abs val.	% share	Abs val.	% share	Abs val.
Piggyback	27.17%	110	29.26%	119	2.09%	9
Combined transport	33.56%	136	36.11%	146	2.55%	10
Road	39.27%	159	34.64%	140	-4.64%	-19

POLICY SCENARIO:

(shock scenario)

Predicted change in choice probabilities due to an increase of time in by 15% in second best road

RU-MNL:						
Choice	Baseline		Scenario		change Scenario - Baseline	
	% share	Abs val.	% share	Abs val.	% share	Abs val.
Regulated road	31.85%	129	33.83%	137	1.97%	8
Piggyback	27.90%	113	29.60%	120	1.70%	7
Combined transport	26.17%	106	27.86%	113	1.69%	7
Second best road	14.07%	57	8.72%	35	-5.36%	-22
RR-MNL:						
Choice	Baseline		Scenario		Change Scenario - Baseline	
	% share	Abs val.	% share	Abs val.	% share	Abs val.
Regulated road	28.62%	115	30.21%	121	1.59%	6
Piggyback	26.65%	108	28.11%	114	1.46%	6
Combined transport	25.83%	105	27.27%	110	1.44%	5
Second best road	18.91%	77	14.41%	60	-4.49%	-17

Utility maximizes vs. Regret minimizers in trading-off between dietary choices, physical activity and cardiovascular disease risk

Marco Boeri, Alberto Longo*

*Gibson Institute for Land, Food and the Environment,
Queens University Belfast

The study

- Data from a discrete choice experiment to study the trade-off people are willing to make between dietary choices, physical activity and cardiovascular disease risk
- Data collected from a representative sample of the Northern Irish adult (40-65)
- Bayesian D_b-error efficient design (Ferrini and Scarpa, 2007), in two waves
- A total of 5,090 observations from 509 respondents used for the analysis

The study

Attribute	Levels
Diet (reduction of the consumption of unhealthy food items – grams of fat)	Current, light, medium, high and restricted diet
Cost (GBP per week)	0,2,5,7,10,15,18
Physical activity (increase in daily minutes)	0,10,20,30,40
Percentage risk reduction from respondent's actual risk	10, 15, 25, 40, 60

An example of choice card

amárach research

CHOICE 3 of 10 - Which option would you choose?

	Current Choice	Option A	Option B
Diet			
Boiled, mashed, instant or jacket potatoes	1-2 times week	1 per month	2-3 times a month
Beef: roast, steak, mince, stew or casserole	1-2 times week	1 per month	2-3 times a month
Savoury pies, eg. Meat pie, pork pie, pasties, steak & kidney pie, sausage rolls	2-3 times a month	1 per month	1 per month
Whole milk	Whole Milk	Skimmed Milk	Semi Skimmed Milk
Spread fat (different from butter) but not low-fat	2-3 times a month	1 per month	1 per month
Expenditure Increase in weekly expenditure in food(£)	No changes	£15 more	£5 more
Exercise Increase in moderate exercise(daily)	No changes	40 minutes	20 minutes
Cardio-vascular risk Your risk of a heart attack in the next 10 years(chances over 100%)	5.00 %	2.50 %	3.75 %
	Current Choice	Option A	Option B
I would choose			

RU-MNL vs. RR-MNL

	RUM	
Attribute	**Coeff**	**|t-stat|**
Cost	-0.0985	-15.48
Physical Activity	0.00134	9.34
Fat	0.0027	5.63
Risk	-0.0783	-5.34
Log-likelihood	-5,280.37	
Observations	4,930	

RU-MNL vs. RR-MNL

	RUM		RRM	
Attribute	**Coeff**	**|t-stat|**	**Coeff**	**|t-stat|**
Cost	-0.0985	-15.48	-0.0616	-17.66
Physical Activity	0.00134	9.34	0.000816	9.91
Fat	0.0027	5.63	0.0017	5.32
Risk	-0.0783	-5.34	-0.0537	-5.27
Log-likelihood	-5,280.37		-5,275.37	
Observations	4,930		4,930	

Who are the regret minimisers?

…difficult question…

We compute the contribution to the value of the Log-likelihood function for each **respondent** under both the RU-MNL and the RR-MNL.

We create a dummy variable equal to 1 when the Log-likelihood of the RR-MNL outperforms the Log-likelihood of the RU-MNL.

We run a logit regression on this variable where the characteristics of the characteristics of the respondents are used as explanatory variables:

5) $$P(d)_{nti} = 1/(1+\exp(-\alpha+\gamma' Z_{nti}))$$

Binary Logit to understand who are the regret minimisers

	Value	t-stat
(Intercept)	9.75883	6.741
Male (dummy variable)	-0.09729	-1.555
Underweight (dummy variable)	-0.15718	-1.065
Overweight (dummy variable)	-0.30836	-4.167
Obese (dummy variable)	-0.25177	-3.158
Good and very good health (dummy variable)	0.52703	12.224
High education (dummy variable)	0.04144	3.731
Sport person (dummy variable)	-0.30782	-4.813
smoker (dummy variable)	-0.33195	-4.419
Age	-0.43642	-7.694
Age^2	0.004569	8.366

† The dependent variable is equal to 1 if RR-MNL outperforms RU-MNL, and 0 otherwise.

Binary Logit to understand who are the regret minimisers

	Value	t-stat
(Intercept)	9.75883	6.741
Male (dummy variable)	-0.09729	-1.555
Underweight (dummy variable)	-0.15718	-1.065
Overweight (dummy variable)	-0.30836	-4.167
Obese (dummy variable)	-0.25177	-3.158
Good and very good health (dummy variable)	0.52703	12.224
High education (dummy variable)	0.04144	3.731
Sport person (dummy variable)	-0.30782	-4.813
smoker (dummy variable)	-0.33195	-4.419
Age	-0.43642	-7.694
Age^2	0.004569	8.366

† The dependent variable is equal to 1 if RR-MNL outperforms RU-MNL, and 0 otherwise.

Binary Logit to understand who are the regret minimisers

	Value	t-stat
(Intercept)	9.75883	6.741
Male (dummy variable)	-0.09729	-1.555
Underweight (dummy variable)	-0.15718	-1.065
Overweight (dummy variable)	-0.30836	-4.167
Obese (dummy variable)	-0.25177	-3.158
Good and very good health (dummy variable)	0.52703	12.224
High education (dummy variable)	0.04144	3.731
Sport person (dummy variable)	-0.30782	-4.813
smoker (dummy variable)	-0.33195	-4.419
Age	-0.43642	-7.694
Age^2	0.004569	8.366

† The dependent variable is equal to 1 if RR-MNL outperforms RU-MNL, and 0 otherwise.

Conclusions

Conclusions

Is RRM better than RUM?

Similar fit. In some cases RU-MNL (Natural parks and Kayakers) outperforms RR-MNL, in some others RR-MNL outperforms RU-MNL (freight transport and risk of CVD).

Conclusions

Is RRM better than RUM?

Similar fit. In some cases RU-MNL (Natural parks and Kayakers) outperforms RR-MNL, in some others RR-MNL outperforms RU-MNL (freight transport and risk of CVD).

Regret-minimization has been found to be particularly important when:

a) choices are perceived as important and difficult and
b) the decision-maker expects to receive feedback about chosen and non-chosen options

(psychology literature Zeelenberg and Pieters, 2007).

Conclusions

RRM allows to explore interesting aspects of choice behaviour:

- Equally parsimonious as linear-additive MNL
- Displays semi-compensatory choice-behaviour
  - Compromising effect
- Allows to analyse choices from a different prospective

- Elasticities and choice probability forecasts differ substantially between the two choice-modelling paradigms

- One can test managerial implications obtained from RU-MNL model comparing with conclusions from RR-MNL model

Conclusions and future research

… there is still a lot of work in progress on it!

1. Hybrid approach allows to test how decision-context result in behaviour is differently captured by RRM (work in progress)
2. WTP measures in RRM: the translation of regret into monetary values is not as intuitive as in the utility context
3. Need for analysis in Experimental economics
4. Need for Simulated data analysis

Take away message…

The analyst should consider applying both modelling approaches to their data.

Take away message…

The analyst should consider applying both modelling approaches to their data.

The results suggest that since some choices are better described by utility maximization and some by regret minimization, then it may be prudent to apply the model that best reflects the particular choice behaviour. This approach would capture the behavioural influences on choices more accurately than assuming in all instances that individuals always make choices within a utility maximization framework.

It would also allow for more robust policy appraisals.

Thank you

Any Question?

Marco Boeri
Email: mboeri01@qub.ac.uk

More on modelling Regret…

Random Regret Multinomial Logit Model (RR-MNL)

3a) $$R_i = max_{j \neq i}\left\{ \sum_{m=1 \ldots M} max\left\{0, \gamma_{m(x_{jm} - x_{im})}\right\}\right\}$$ (Chorus, 2008)

Confused?
An intuitive explanation

	Option 1	Option 2	Option 3
Attribute 1	1	3	2
Attribute 2	2	0	1
Cost	20	10	15

Regret associated with Option 1:

$R_{option2}=\gamma_{Attribute1}{}^{*}max(0,(3-1))+\ \gamma_{Attribute2}{}^{*}max(0,(0-2))+\ \gamma_{Cost}{}^{*}max(0,(10-20))$

$R_{option3}=\gamma_{Attribute1}{}^{*}max(0,(2-1))+\ \gamma_{Attribute2}{}^{*}max(0,(1-2))+\ \gamma_{Cost}{}^{*}max(0,(15-20))$

Confused?
An intuitive explanation

	Option 1	Option 2	Option 3
Attribute 1	1 => 0	3	2
Attribute 2	2 => 3	0	1
Cost	20	10	15

Regret associated with Option 1:

$R_{option2}=\gamma_{Attribute1}{}^{*}max(0,(\mathbf{3\text{-}0}))+\gamma_{Attribute2}{}^{*}max(0,(0-3))+\gamma_{Cost}{}^{*}max(0,(10-20))$

$R_{option3}=\gamma_{Attribute1}{}^{*}max(0,(\mathbf{2\text{-}0}))+\gamma_{Attribute2}{}^{*}max(0,(1-3))+\gamma_{Cost}{}^{*}max(0,(15-20))$

Confused?
An intuitive explanation

	Option 1	Option 2	Option 3
Attribute 1	1 => 0	3	2
Attribute 2	2 => 3	0	1
Cost	20	10	15

Regret associated with Option 1:

$R_{option2}=\gamma_{Attribute1}{}^{*}max(0,(3-0))+\gamma_{Attribute2}{}^{*}max(0,(\mathbf{0-3}))+\gamma_{Cost}{}^{*}max(0,(10-20))$

$R_{option3}=\gamma_{Attribute1}{}^{*}max(0,(2-0))+\gamma_{Attribute2}{}^{*}max(0,(\mathbf{1-3}))+\gamma_{Cost}{}^{*}max(0,(15-20))$

Random Regret Multinomial Logit Model (RR-MNL)

3a) $$R_i = max_{j \neq i}\left\{ \sum_{m=1 \ldots M} max\left\{0, \gamma_{m(x_{jm}-x_{im})}\right\}\right\}$$ (Chorus, 2008)

3b) $$R_i = \sum_{j \neq i} \sum_{m=1..,M} \ln\left(1 + e^{\gamma_{m(x_{jm}-x_{im})}}\right)$$ (Chorus, 2010)

Confused?
An intuitive explanation

	Option 1	Option 2	Option 3
Attribute 1	1	3	2
Attribute 2	2	0	1
Cost	20	10	15

Regret associated with Option 1:

$Ln(1+exp(\gamma_{Attribute1}*(3-1))+ Ln(1+exp(\gamma_{Attribute1}*(2-1))+$

$Ln(1+exp(\gamma_{Attribute2}*(0-2))+Ln(1+exp(\gamma_{Attribute2}*(1-2))+$

$Ln(1+exp(\gamma_{Cost}*(10-20)) + Ln(1+exp(\gamma_{Cost}(15-20))$

Random Regret Multinomial Logit Model (RR-MNL)

3a) $$R_i = max_{j \neq i}\left\{ \sum_{m=1...M} max\left\{0, \gamma_{m(x_{jm}-x_{im})}\right\}\right\}$$ (Chorus, 2008)

3b) $$R_i = \sum_{j \neq i} \sum_{m=1..,M} \ln\left(1 + e^{\gamma_{m(x_{jm}-x_{im})}}\right)$$ (Chorus, 2010)

4) $$Pr_{n(i)} = \frac{e^{(-R_i)}}{\sum_{j=1}^{J} e^{(-R_j)}}$$

γ reflect the potential contribution of an attribute to the regret associated with that alternative

"An attribute's actual contribution to regret depends on (i) whether the considered alternative performs better or worse on the attribute than the alternative it is compared with and (ii) whether regret caused by comparing the alternatives is surpassed or not by comparing the considered alternative with another alternative." (Chorus, 2008)