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Modelling regret effects in route-choice with real-time and feedback information

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Outline

- Background
- Experiment setup
- Modelling approach
- Model specifications
- Results
- Conclusions

Background

- Like EUT and Prospect Theory, Regret Theory (RT) is a model of human decision making under uncertainty.
- The three theories explain situations where choices are based on information providing a description of the alternatives.
- RT postulates choices are influenced not only by the attractiveness of a considered alternative as EUT, but also by the regret associated with not choosing a foregone one [i.e. Regret Aversion].
- But..in order to compare 'what is' with 'what would have been..', the DM needs to learn from experience what the foregone alternative implies.
- The 'trigger' for regret is not that obvious.

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Experiment setup

- Choice between a faster and a slower route (5 min. mean dif.)
- 24 participants
- Panel: 100 repeated choice-trials in 3 scenarios.

Scen.	Description	Range FAST [mean±min]	Range SLOW [mean±min]
Fast and Safe	Low var. on FAST	25 ± 5	30 ± 15
Fast and Risky	High var. on FAST	25 ± 15	30 ± 5
Low Risk	Low var. on both	25 ± 5	30 ± 5

- **Information**: in each trial 2 sources are always available:

1. Descriptive: Travel time range expected on each route
2. Experiential: Feedback on actual travel times of chosen route

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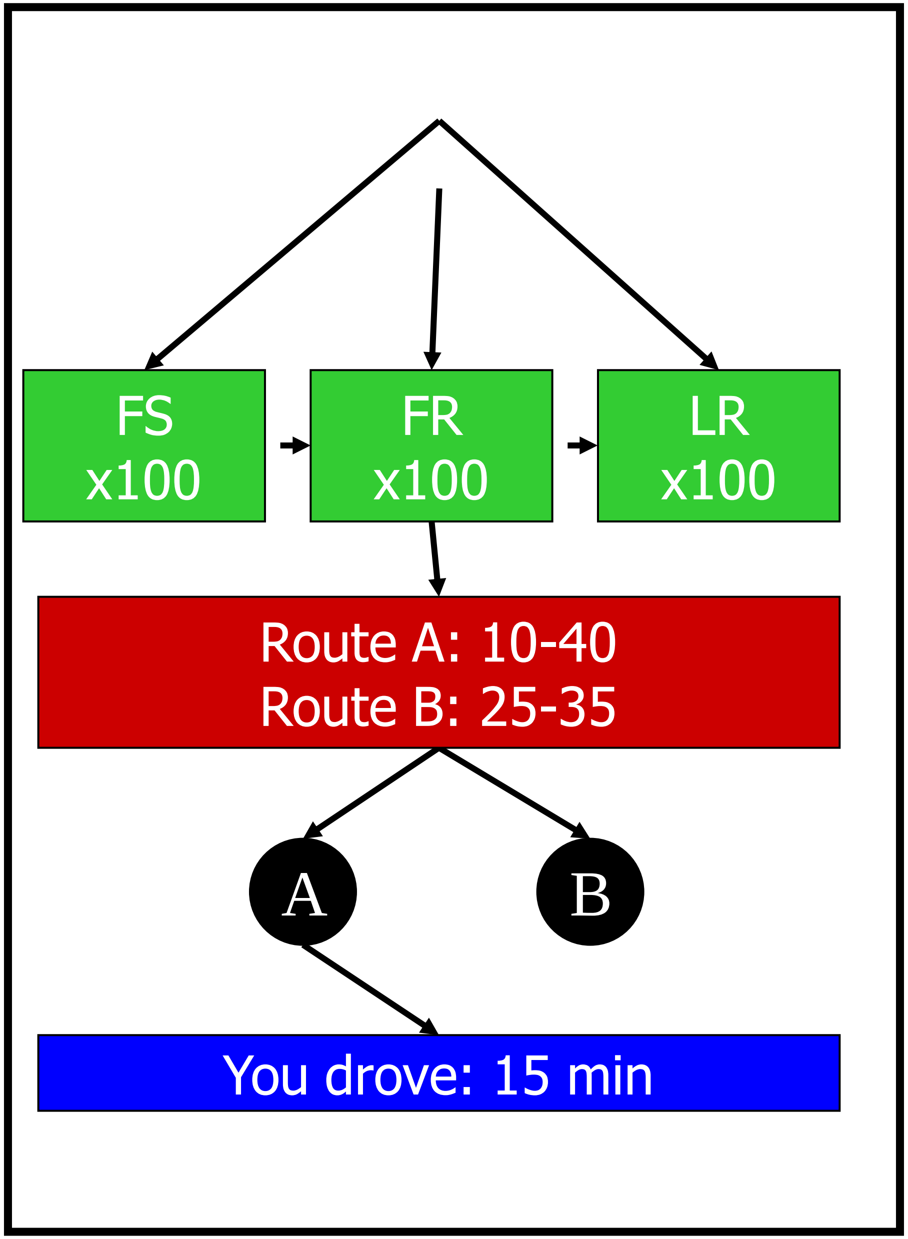

Data was not designed with the objective of testing RT.

If regret is a significant effect, this is a strong indication to the relevance of regret in similar experienced-based route-choice decisions

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Modelling approach

1. EU – expected utility
2. EMU – expected modified utilty

utility (*U*) of alternative *i* for person *m* in response *t* is:

$$U_{imt} = \alpha_{im} + \beta_{im} X_{imt}$$

β - fixed coefficients for alternatives' attributes - *X*;
α - random coefficients $\alpha \sim N(0, \sigma_{\alpha}^2)$

$$EU_{imt} = \left(\sum_{j=1, j \in S}^{J} p_{jt} U_{imjt} \right) + \varepsilon_{imt}$$

p_j [0,1] is the probability that state-of-the world *j* will occur at response *t* out of the set of J possible states of the world – *S*

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Modelling cont.

Modified Utility (MU) depends on both the considered (*i*) and foregone (*k*) alternatives. Following Chorus (2010), the modified utility (*MU*) is:

$$MU_{ikmt} = \alpha_{im} + \beta_{im} X_{imt}$$
$$+ \left\{1 - e^{[-\rho(\beta_{im} X_{imt} - \beta_{im} X_{kmt})]}\right\}$$

$\rho \in [0, +\infty]$ is a regret aversion parameter. Higher values imply that person *m* will become more and more sensitive to regret

$$EMU_{ikmt} = \left(\sum_{j=1, j \in S}^{J} p_{jt} MU_{ikmt}\right) + \varepsilon_{imt}$$

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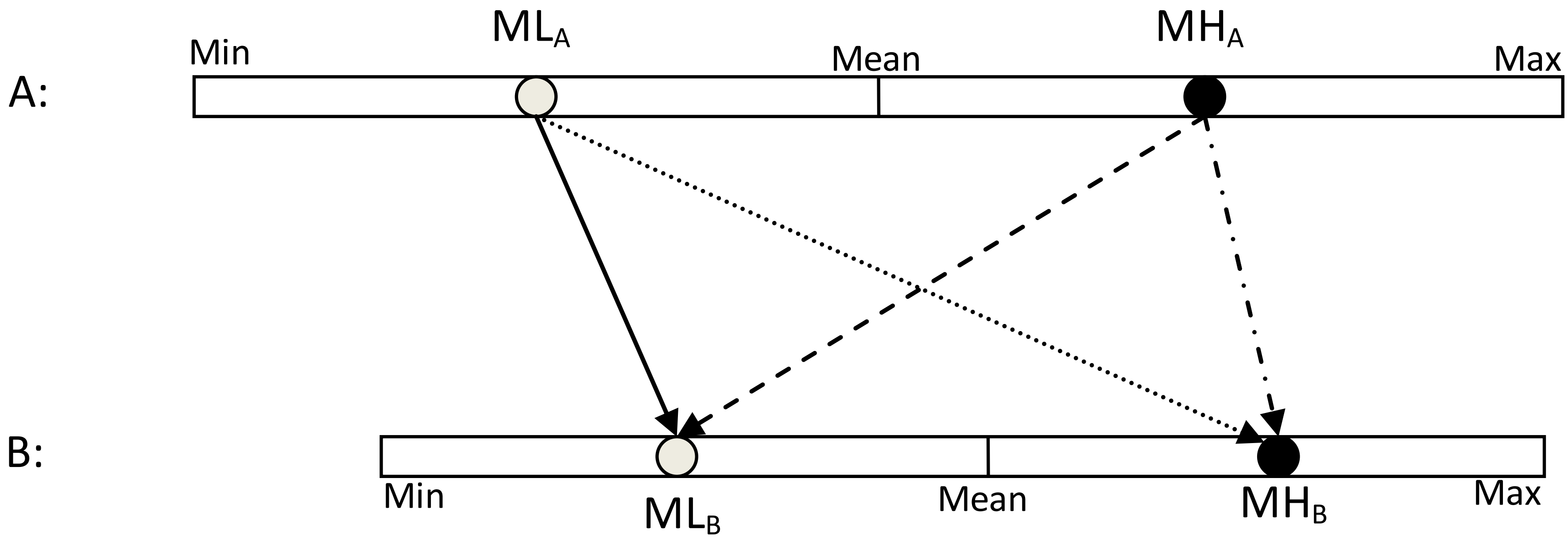
Specification



Assume that the DM regards two points on the TT range as being identified with the possible states of the world – one below (i.e. the first quarter) and the other above (i.e. the 3rd quarter) the mean value

Specification cont.

- Four models are specified.

1. **Simple EU model** (control)

$$EU_A = \alpha_A + 0.5(\beta MH_A + \beta ML_A) + \varepsilon$$

2. **Description-based RT model**

$$EMU_A = \alpha_A + 0.25\left(\beta MH_A + 1 - e^{[-\rho(\beta MH_A - \beta MH_B)]}\right) + 0.25\left(\beta MH_A + 1 - e^{[-\rho(\beta MH_A - \beta ML_B)]}\right) + 0.25\left(\beta ML_A + 1 - e^{[-\rho(\beta ML_A - \beta MH_B)]}\right) + 0.25\left(\beta ML_A + 1 - e^{[-\rho(\beta ML_A - \beta ML_B)]}\right) + \varepsilon$$

3. **Description and experienced-based RT model**

$$EMU_A = \alpha_A + 0.25\left(\beta MH_A + 1 - e^{\{-\rho[w(\beta MH_A - \beta MH_B)+(1-w)(\beta F_A - \beta F_B)]\}}\right) + 0.25\left(\beta MH_A + 1 - e^{\{-\rho[w(\beta MH_A - \beta ML_B)+(1-w)(\beta F_A - \beta F_B)]\}}\right) + 0.25\left(\beta ML_A + 1 - e^{\{-\rho[w(\beta ML_A - \beta MH_B)+(1-w)(\beta F_A - \beta F_B)]\}}\right) + 0.25\left(\beta ML_A + 1 - e^{\{-\rho[w(\beta ML_A - \beta ML_B)+(1-w)(\beta F_A - \beta F_B)]\}}\right) + \varepsilon$$

$0<w<1$ is a weight attributed to the descriptive information (MH_i, ML_i); ($1-w$) is the weight for feedbacks

F_i is the feedback received for Route i the last time i is chosen

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Specification cont.

w=1 means only descriptive information affects regret (the same as Model II).

w=0, means only feedbacks affect regret. The information provided ex-ante is not responsible for generating regret.

w is estimated exogenously (trial and error)

4. **Effect of risk on regret** : Regret coefficients specified for each scenario (*s*).

$$
\begin{aligned}
EMU_A = \alpha_A + \sum_{s=1}^{3} \Big[& 0.25\left(\beta MH_{As} + 1 - e^{\{-\rho_s[w(\beta MH_{As} - \beta MH_{Bs}) + (1-w)(\beta F_{As} - \beta F_{Bs})]\}}\right) \\
& + 0.25\left(\beta MH_{As} + 1 - e^{\{-\rho_s[w(\beta MH_{As} - \beta ML_{Bs}) + (1-w)(\beta F_{As} - \beta F_{Bs})]\}}\right) \\
& + 0.25\left(\beta ML_{As} + 1 - e^{\{-\rho_s[w(\beta ML_{As} - \beta MH_{Bs}) + (1-w)(\beta F_{As} - \beta F_{Bs})]\}}\right) \\
& + 0.25\left(\beta ML_{As} + 1 - e^{\{-\rho_s[w(\beta ML_{As} - \beta ML_{Bs}) + (1-w)(\beta F_{As} - \beta F_{Bs})]\}}\right) \Big] + \varepsilon
\end{aligned}
$$

Estimation

- Biogeme 2.0
- Mixed logit model with non linear utilities
- Log likelihood maximization:

$$LL(\beta,\rho,\sigma) = \sum_{m=1}^{M} log(P_{mi})$$

$$= \sum_{m=1}^{M} log\left\{\int_{\alpha} \left[\prod_{t=1}^{T} \left(\frac{e^{EMU_{it}}}{\sum_{k=1,i\in K}^{K} e^{EMU_{kt}}}\right)\right] d\alpha\right\}$$

M=24 participants, *T=300* trials, *K=2* alternative routes

- Simulated LL using 1000 Halton draws.

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Results

No	Coef.	Est.	Std err*	t-test	p-value
1	β	-0.545	0.055	-9.83	< 0.001
	σ_α	1.28	0.18	7.14	< 0.001
	LL_0	-4940.8			
	LL_β	-2086.3			
2	β	-1.24	0.148	-8.39	< 0.001
	σ_α	1.32	0.181	7.26	< 0.001
	ρ	-0.134	0.0073	-18.46	< 0.001
	LL_0	-4940.8			
	LL_β	-1969.2			
3	β	-0.471	0.055	-8.58	< 0.001
	σ_α	1.23	0.174	7.05	< 0.001
	ρ	0.0777	0.019	4.2	< 0.001
	w	0			
	LL_0	-4940.8			
	LL_β	-1985.6			

No	Coef.	Est.	Std err*	t-test	p-value
4	β	-0.45	0.0575	-7.82	< 0.001
	σ_α	1.27	0.173	7.31	< 0.001
	ρ_1	0.0359	0.0254	1.41	0.160
	ρ_2	0.0913	0.0208	4.39	< 0.001
	ρ_3	0.313	0.064	4.89	< 0.001
	w	0			
	LL_0	-4940.8			
	LL_β	-1869.4			

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Conclusions

- Effect of regret do occur in the observed data.
- Regret is associated more with experiential feedback than with the descriptional information regarding the expected travel time ranges.
- Accounting for effects of risk Regret is more apparent in situations involving less risk, whereas riskier situation seem to inhibit regret.
- More research in understanding the relations between Regret, learning and risk attitudes.

Thanks,
Merci.

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