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# Is there a role for regret minimisation in the patients' choices?

**Nicolas KRUCIEN**

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**Stated Preferences meeting**
**HERU, Univ of Aberdeen (UK)**

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# Discrete Choice Modelling

- Standard framework used to analyse choice data is based on explicit and implicit "behavioural" assumptions.
- **Explicit assumptions**:
  - Utility is gained from the products' features rather then the product itself (Lancaster, 1966)
  - Utility is partly random (Thurstone, 1927)
  - Individuals try to maximise their utility (Mill/Bentham)
- **Implicit assumptions** (cf form of the utility function):
  - Unlimited decision-making resources (e.g. no ANA)
  - Additive: Compensatory choice
  - Linear: No discount (e.g. no diminishing returns)

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# Random Utility Model

- The RUM is a direct translation of this framework in econometric terms.

- From a behavioural perspective, the RUM works in 3 steps:
  1. To compute the utility scores by combining tastes (preferences) and attributes' values
  2. To compare the alternatives on their utility score ("**Higher-order comparison**") [=> Independence of Irrelevant Alternatives (IIA) property]
  3. To select the alternative with the **highest utility score**

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# Random Utility Model

| Choice of a GP appointment | | | |
|---|---|---|---|
| **Attribute** | **Alt 1** | **Alt 2** | **Alt 3** |
| Consultation length | 0 | 30 | 45 |
| Waiting time | 40 | 20 | 10 |
| Cost (in £) | 20 | 12 | 0 |
| Easiness of access | Low (1) | High (3) | High (3) |

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# Random Utility Model

| Choice of a GP appointment | | | | |
|---|---|---|---|---|
| **Attribute** | **Tastes** | **Alt 1** | **Alt 2** | **Alt 3** |
| Consultation length | 0.006 | 0 | 0.18 | 0.27 |
| Waiting time | -0.011 | -0.44 | -0.22 | -0.11 |
| Cost (in £) | -0.092 | -1.84 | -1.104 | 0 |
| Easiness of access | 0.8 | 0.8 | 2.4 | 2.4 |

| | Alt 1 | Alt 2 | Alt 3 |
|---|---|---|---|
| **Utility score (Σ)** | **-1.48** | **1.256** | **2.56** |

**1/ Comparison only at the aggregated level (higher-order)**
**2/ Vertical reading/processing of the information**

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# Is the RUM realistic?

- People tend to display risk-seeking behaviour when facing losses (*Prospect theory* - Kahneman & Tversky, 1979)
- Individual choices can be better understood when seen as based on justifications for and against each alternative (Simonson, 1989)
- Individuals base their preferences not only on the anticipated performance of a considered option but also on that of other alternative (*Regret theory* – Loomes & Sugden, 1982)
- Individuals are likely to anticipate their regret when making choice (Zeelenberg, 1999)

# Regret Minimisation Model

- Introduced by G.Chorus (2008,2010,2012) in transportation research
- **Definition**: Regret arises when one or more non-chosen alternatives **perform better than the chosen** one in terms of one or more attributes
- Key notions:
  - **Regret minimisation** (max{Utility} ➔ min{Regret})
  - **Binary comparison** (e.g. A vs B and A vs C but not A vs {BC})
  - **Attributes-based regret** (i.e. "**lower-order comparison**")
- Empirical evidence
  - RRM performs better than RUM for some studies
  - RRM is close to RUM in terms of GoF but still leads to important differences especially in terms of predicted probabilities

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# Regret Minimisation Model

- From a behavioural perspective, the RRM works in 3 steps:
  1. To compute the utility scores by combining tastes (preferences) and **differences in attributes' values**

     => **Relative measure of attractiveness**

     => **Choice-set specific preferences**
  2. To compare the alternatives on the basis of their regret score ("Higher-order comparison") and attributes' values ("Lower-order comparison")

     => **Relaxing IIA property** (even under the assumption of IID EV1 errors)
  3. To select the alternative with the lowest regret score

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# Regret Minimisation Model

| Choice of a GP appointment | | | |
|---|---|---|---|
| **Attribute** | **Alt 1** | **Alt 2** | **Alt 3** |
| Consultation length | 0 | 30 | 45 |
| Waiting time | 40 | 20 | 10 |
| Cost (in £) | 20 | 12 | 0 |
| Easiness of access | Low (1) | High (3) | High (3) |

**Length**: Alt2-Alt1 = +30

**Time**: Alt2-Alt1 = -20

**Cost**: Alt2-Alt1 = -8

**Access**: Alt2-Alt1 = +2

| Tastes |
|---|
| 0.006 |
| -0.011 |
| -0.092 |
| 0.8 |

| Binary regret |
|---|
| 0.18 |
| 0.22 |
| 0.74 |
| 1.60 |

**Σ: R(A vs B) = 2.74**

**<u>Horizontal</u> reading/information processing**

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# Regret Minimisation Model

- We do the same for all the binary comparisons

$$\boldsymbol{Max}\ \{0; \boldsymbol{\beta}(\boldsymbol{Xj} - \boldsymbol{Xi})\}$$

| | [2-1] | [3-1] | [1-2] | [3-2] | [1-3] | [2-3] |
|---|---|---|---|---|---|---|
| Length | 0.18 | 0.27 | -0.18 | 0.09 | -0.27 | -0.09 |
| Time | 0.22 | 0.33 | -0.22 | 0.11 | -0.33 | -0.11 |
| Cost | 0.74 | 1.84 | -0.74 | 1.10 | -1.84 | -1.10 |
| Access | 1.60 | 1.60 | -1.60 | 0.00 | -1.60 | 0.00 |

| | [2-1] | [3-1] | [1-2] | [3-2] | [1-3] | [2-3] |
|---|---|---|---|---|---|---|
| Length | 0.18 | 0.27 | 0.00 | 0.09 | 0.00 | 0.00 |
| Time | 0.22 | 0.33 | 0.00 | 0.11 | 0.00 | 0.00 |
| Cost | 0.74 | 1.84 | 0.00 | 1.10 | 0.00 | 0.00 |
| Access | 1.60 | 1.60 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Binary regret | 2.74 | 4.04 | 0.00 | 1.30 | 0.00 | 0.00 |
| Total regret | 6.78 | | 1.30 | | 0.00 | |

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# Regret Minimisation Model

- Can be implemented in the same way than RUM

**Regret**

$$RR_i = R_i + \varepsilon_i$$

$$RR_i = \sum_j \sum_k \ln\left(1 + exp\left(\beta_k (X_j - X_i)\right)\right)$$

$$If\ \varepsilon \rightarrow iid\ EV1$$

$$Min\{RR_i\} = Max\{-RR_i\}$$

$$P_i = \frac{exp(-R_i)}{\sum_j exp(-R_j)}$$

**Utility**

$$U_i = V_i + \varepsilon_i$$

$$V_i = \sum_k \beta_k X_i$$

$$If\ \varepsilon \rightarrow iid\ EV1$$

$$P_i = \frac{exp(V_i)}{\sum_j exp(V_j)}$$

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# Regret Minimisation Model

- With this approach, regret depends on:
  - Weight (≈ importance) of the attributes in the decision-making
  - Magnitude of the difference between the alternatives in comparison
  - Number of alternatives in comparison (the RRM estimates are inversely related to the size of the choice sets)

- Behavioural implications of the RRM:
  - Relaxing IIA property => More realistic substitution patterns
  - Semi-compensatory decision-making
  - Compromise effect (i.e. market share "bonus" for *in-between* alternatives)

# RUM and RRM estimates

- **Not the same meaning**
  - **RUM**: $\beta_{cost}$= -0.058 => 1-unit increase in cost decreases the utility of the alternative from **0.058 unit**
  - **RRM**: $\beta_{cost}$= -0.058 => 1-unit increase in cost increases the regret of the alternative from **0.07 unit**

| Situation | Cost preference | Alt 1 | Alt 2 | Alt 3 | R[Alt 2] |
|---|---|---|---|---|---|
| **Before** | -0.058 | 0 | **30** | 45 | 2.26 |
| **After** | -0.058 | 0 | **31** | 45 | 2.33 |
| | | | | **Diff.** | **0.07** |

- **Not directly comparable**
  - Ratio of coefficients (e.g. WTP)
  - Choice elasticities

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# Application

***"Patients' preferences on the increasing role of the pharmacist in the management of drug therapy"***

- **List of the attributes**:
  - Travelling and waiting in the GP office (in min): 0; 30; 50
  - Travelling and waiting in the pharmacy (in min): 10; 20; 40
  - Chance of receiving the best treatment: Low [1]; Medium [2]; High [3]
  - Cost (in £): 3; 7; 12; 20
- **Study**:
  - 204 respondents

  + Socio-demo characteristics {Gender; Age; Health state; Income; DCE easiness}
  - 16 tasks per respondent
  - 3 alternatives per task

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# Application

**Which type of service would you choose? (Please tick one box below)**

| | *Prescribing & dispensing pharmacist* | *Dispensing pharmacist* | |
|---|---|---|---|
| *GP time* | 0 minutes | 15 minutes | |
| *Pharmacy time* | 30 minutes | 30 minutes | |
| *Chance of receiving the "best" treatment* | high | medium | |
| *How much do you have to pay* | £ 7 | £ 3 | |
| *Which situation would you prefer? (Tick one box only)* | *Prescribing & dispensing pharmacist* ✔ | *Dispensing pharmacist* ☐ | *Your current situation* ☐ |

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# Application: RUM

| Attribute | RUM estimates | | |
|---|---|---|---|
| | Beta | P-value | WTP |
| Travelling and waiting in the GP office (in min) | -0.006 | < 0.001 | -0.06 |
| Travelling and waiting in the pharmacy (in min) | -0.011 | < 0.001 | -0.12 |
| Cost (in £) | -0.092 | < 0.001 | - |
| Chance of receiving the best treatment - Ref. "Low": | | | |
| 1) Medium | 0.941 | < 0.001 | 10.26 |
| 2) High | 1.643 | < 0.001 | 17.92 |
| Observations | | 3,263 | |
| Log-Likelihood | | -2903.2 | |

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# Application: RRM

| Attribute | RRM estimates | | |
|---|---|---|---|
| | Beta | P-value | WTP |
| Travelling and waiting in the GP office (in min) | -0.004 | < 0.001 | -0.06 |
| Travelling and waiting in the pharmacy (in min) | -0.007 | < 0.001 | -0.13 |
| Cost (in £) | -0.058 | < 0.001 | - |
| Chance of receiving the best treatment - Ref. "Low": | | | |
| 1) Medium | 0.578 | < 0.001 | 9.91 |
| 2) High | 1.097 | < 0.001 | 18.82 |
| Observations | | 3,263 | |
| Log-Likelihood | | -2903.7 | |

**vs. 2903.2 in RUM**

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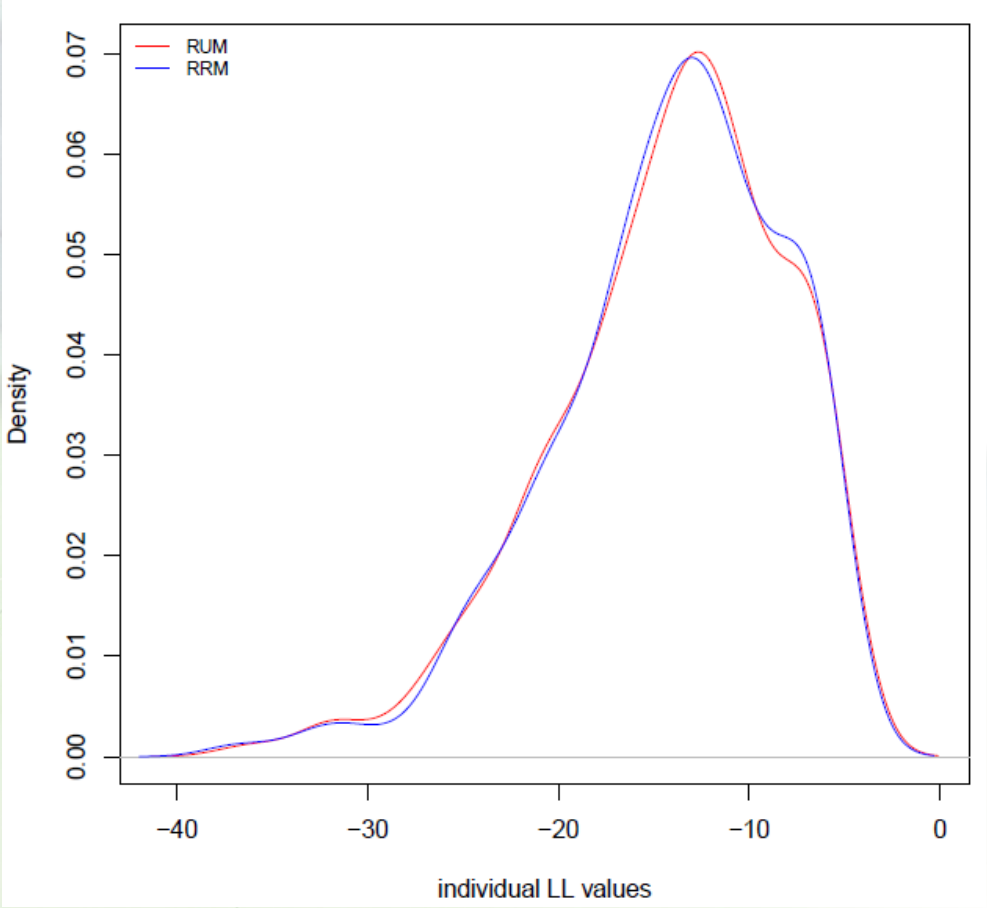
# Application: RUM vs RRM




| Attribute | RUM vs RRM [WTP] |
|---|---|
| GP time | 104.2% |
| Chance: Medium | 103.6% |
| Chance: High | 95.2% |
| Pharmacy time | 94.9% |
| Cost | - |

| Individual-level analysis | | |
|---|---|---|
| **Best model** | **N** | **%** |
| Both | 2 | 1 |
| RRM | 97 | 47.5 |
| RUM | 105 | 51.5 |

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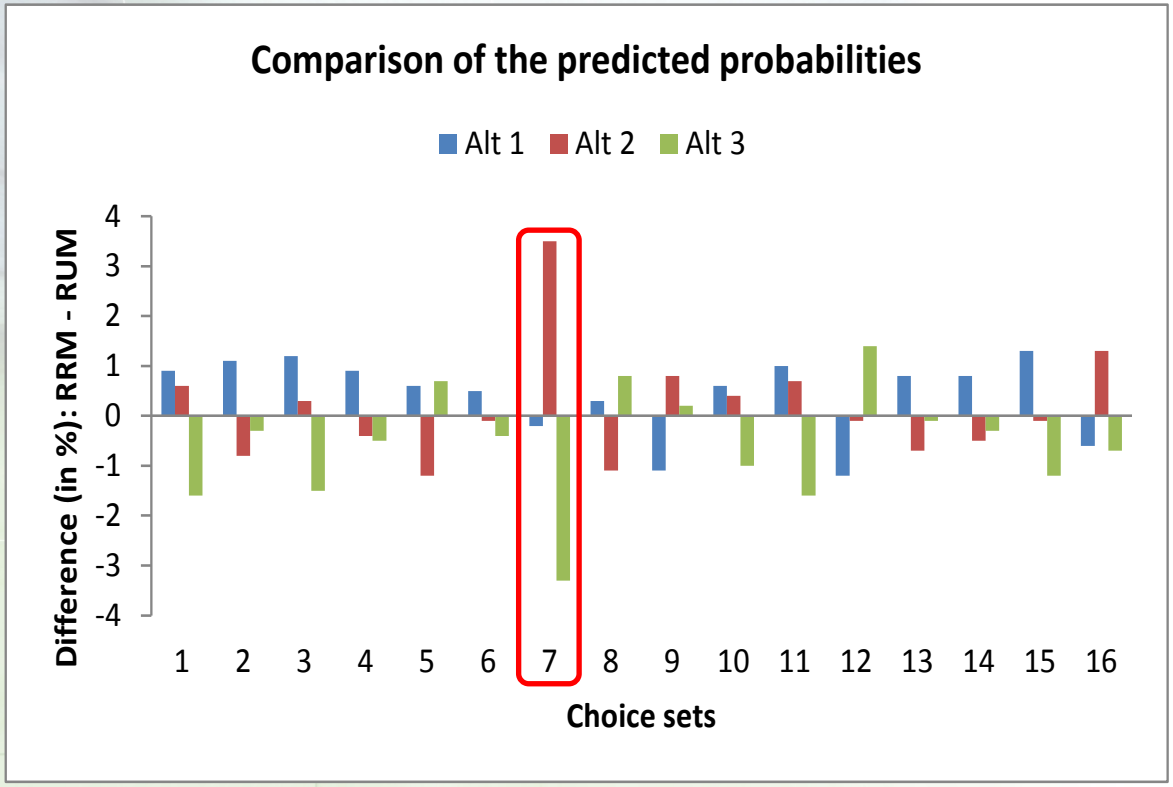
# Application: RUM vs RRM




| Choice set 7 | | | |
|---|---|---|---|
| **Attribute** | **Alt 1** | **Alt 2** | **Alt 3** |
| GP time | **0** | **30** | **45** |
| Pharma time | **40** | **20** | **10** |
| Cost (in £) | **20** | **12** | **0** |
| Chance | **Low** | **High** | **High** |

**≈ compromise effect**

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# Application: RUM vs RRM

**Table. Socio-demo analysis of the "best model" ***

| Level | Ref. | Beta | SE | P-value |
|---|---|---|---|---|
| **Gender** | | | | |
| Female | Male | -0.03 | 0.29 | 0.92 |
| **Age (in years)** | | | | |
| 30-40 | < 30 | 0.35 | 0.42 | 0.41 |
| 40-50 | < 30 | 0.23 | 0.43 | 0.59 |
| > 50 | < 30 | -0.68 | 0.35 | 0.05 |
| **Health score (visual scale 0-100)** | | | | |
| 80-90 | 90-100 | 0.15 | 0.35 | 0.67 |
| 50-80 | 90-100 | -0.28 | 0.39 | 0.47 |
| < 50 | 90-100 | -0.19 | 0.45 | 0.67 |
| **Annual income (in K£)** | | | | |
| 10-20 | < 10 | -0.09 | 0.45 | 0.85 |
| 20-30 | < 10 | 0.25 | 0.40 | 0.53 |
| > 30 | < 10 | -0.06 | 0.42 | 0.89 |
| **DCE task easiness** | | | | |
| Easy | Very easy | 0.37 | 0.37 | 0.31 |
| Moderate | Very easy | 0.09 | 0.37 | 0.80 |

** Depdent variable: RRM*

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# Discussion

- RRM: A *true* model of regret minimisation or an alternative model of information processing (vertical vs horizontal)?
- Is the RRM able to make predictions in line with regret theory? [Empirical issue]
- Is the RRM realistic? Lower-order comparisons => Increase in the number of comparisons => Increase in the cognitive load. Contradictions with bounded rationality theory? (Simon, 1955) [Theoretical issue]

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# *Thank you for your attention*

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