# MICROECONOMETRICS
## CLASS 5

**Wiktor Budziński**
Marek Giergiczny

# NESTED LOGIT

The nested multinomial logit is an extension of the basic model that allows us to introduce some dependence in the error term structure

We group the alternatives into several "*nests*"

- IIA still holds within a given nest, but does not have to between the nests
- For example, public transport vs. private car

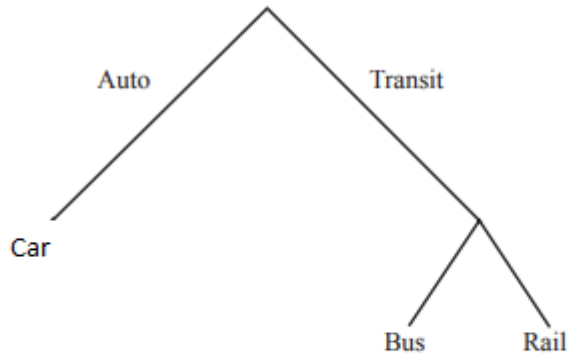


Figure 4.1: Tree diagram for mode choice.

# NESTED LOGIT

You can think about it as a two step process

- More steps needed for larger "tree structure"

First consumer chooses k'th nest $P\left(y_i \in N_k\right) = \dfrac{\exp\left(\lambda_k I_k\right)}{\sum_{m=1}^{K} \exp\left(\lambda_m I_m\right)}$

It is a multinomial logit function with inclusive value of a given nest as independent variable

- Expected utility from the given nest

$$I_k = \log\left(\sum_{l=1}^{J_k} \exp\left(\frac{\mathbf{X}_{il}\boldsymbol{\beta} + \mathbf{Z}_i\boldsymbol{\gamma}_l}{\lambda_k}\right)\right)$$

# NESTED LOGIT

In the 2nd step respondent chooses alternative *j* from this nest

$$P(y_i = j \mid N_k) = \frac{\exp\left(\frac{\mathbf{X}_{ij}\boldsymbol{\beta} + \mathbf{Z}_i\boldsymbol{\gamma}_j}{\lambda_k}\right)}{\sum_{l=1}^{J_k} \exp\left(\frac{\mathbf{X}_{il}\boldsymbol{\beta} + \mathbf{Z}_i\boldsymbol{\gamma}_l}{\lambda_k}\right)}$$

Probability of choosing the alternative is given as a product of these two probabilities

- Lambdas are coefficients that need to be estimated, which should be smaller than 1
- Nested logit can be also formulated as error terms following a generalized extreme value distribution

# EXERCISE 1: MULTINOMIAL DATA

1. Estimate a Nested MNL on the fishmode data, consider two different grouping of alternatives
    1. Fishing from land vs. fishing from boat
    2. Fishing with private resources vs. fishing with chartered boat

# NON-RUM BASED MODEL

Random utility model has been very useful for applied choice analysis

- Easy to estimate
- Rooted in microeconomic theory
- Allows for straightforward inference: calculating WTP, predicting market shares or price elasticities
- In use for almost 50 years now
- Several extensions of standard MNL allowed for better representation of individuals' choice behavior

On the other hand, extensive research from psychology and behavioral economics suggests that utility maximization is not a good description of individuals' behavior

# NON-RUM BASED MODEL

In choice modelling literature it has been recognized for a while now that there is a room for improvement in behavioral realism of the modelling

- Nonetheless applications are somewhat limited by the practical consideration

Some examples of more "behavioral" models (some of them are RUM based):

- Random regret minimization
- Attribute non-attendance
- Elimination by aspect
- Choice set formation
- Satisficing
- Decision field theory
- Hybrid choice models

# RANDOM REGRET MINIMIZATION

Regret minimization is relatively popular decision process in the choice modeling, especially in the transportation literature

- Chorus, C. G., Arentze, T. A., & Timmermans, H. J. (2008). A random regret-minimization model of travel choice. *Transportation Research Part B: Methodological*, 42(1), 1-18.

Employs regret theory developed in the 80's for the lottery choices

It assumes that decision-makers are afraid of the regret associated with non-chosen alternative occurring better than the chosen one

Decision is driven by the decision-maker trying to avoid this feeling of regret

- In the travel context: trying to avoid regret associated with being late, stuck in traffic etc.

# RANDOM REGRET MINIMIZATION

For multinomial choice with multiple attributes, regret for alternative *j* is given by:

$$R_j = \max\left\{R_{j1}, \ldots, R_{jJ}\right\}$$

and

$$R_{ji} = \sum_{k=1}^{K} \max\left\{0, \beta_k \left(X_{ki} - X_{kj}\right)\right\}$$

Only comparison with the best alternative matters

Regret is summed over all attributes

Not compensatory – there is no rejoice if given attribute is the best for the current alternative

Alternatives are evaluated in the context of the choice task

# RANDOM REGRET MINIMIZATION

This specification of RRM is not differentiable, and therefore it is not straightforward to optimize a choice model like that

In 2010 a new RRM was proposed utilizing a different definition of regret

$$R_{ji} = \sum_{k=1}^{K} \ln\left(1+\exp\left(\beta_k \left(X_{ki} - X_{kj}\right)\right)\right)$$

And then simply summing it over alternatives

$$R_j = \sum_{i \neq k} R_{ji}$$

Comparison is now made with all outcomes, not only the best one

# RANDOM REGRET MINIMIZATION

The model is operationalized by adding error component to the regret function

$$RR_{ji} = R_{ji} + \varepsilon_{ij}$$

Assuming that individuals are trying to minimize regret probability of choosing given alternative is given by MNL-like formula

$$P\left(y_i = j \mid \mathbf{X}_i\right) = \frac{\exp\left(-R_{ij}\right)}{\sum_l \exp\left(-R_{il}\right)}$$

# RANDOM REGRET MINIMIZATION

For this model IIA property does not hold

Alternatives with an "*in-between*" performance on all attributes, relative to the other alternatives in the choice set, receive a "*market share bonus*"

All the extensions of standard MNL can be also applied to RRM model

WTP cannot be really estimated, there is no economic theory which would allow for interpretation of the derived welfare measures

# EXERCISE 2: MULTINOMIAL DATA

1. Look in RRM.xlsx for some illustrative examples of RRM's properties
2. Estimate a random regret model on the fishmode data
    1. Test whether it provides improvement over MNL

# WORKBOOK 5

Now try to conduct a similar analysis for the exercises in Workbook5a.R

- Exercises 1 & 2