A Review of Latent Variable Models
for Discrete Choice

Cam Rungie

A paper for the Internal Choice Modelling Conference 2013

www.linkedin/in/rungiecm
ARC Discovery Project
DP0880074
2008 - 2010

Jordan Louviere
CenSoc, University of Technology, Sydney

Cam Rungie
EBI, University of South Australia

Len Coote
University of Queensland
Literature

Structural Choice Modelling


Hybrid Choice Modelling


Start with an example of structural choice modelling

- Choice task: Preference for postdoctoral employment in a university
  - Sample: 797 post graduate candidates in US universities
  - Choice set size: 2
  - Choice sets per decision maker: 8
  - Coding: Continuous

- Attributes:
  - Work/life balance
  - Tenure possibilities
  - Geographic location
  - Rating of department
  - Rating of institution
  - Salary
  - Length of contract
<table>
<thead>
<tr>
<th></th>
<th>Fixed</th>
<th>Random</th>
<th>Latent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of parameters</td>
<td>7</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-2326</td>
<td>-2212</td>
<td>-2185</td>
</tr>
<tr>
<td>AIC</td>
<td>4665</td>
<td>4452</td>
<td>4417</td>
</tr>
<tr>
<td>BIC</td>
<td>4698</td>
<td>4517</td>
<td>4525</td>
</tr>
<tr>
<td>LR Test c.f. Fixed</td>
<td></td>
<td></td>
<td>$p = 2E-45$</td>
</tr>
<tr>
<td>LR Test c.f. Random</td>
<td></td>
<td></td>
<td>$p = 3E-08$</td>
</tr>
</tbody>
</table>
Random Coefficient Model

\[ V_n = X_{n,1}(\beta_{n,1}) + X_{n,2}(\beta_{n,2}) + X_{n,3}(\beta_{n,3}) + X_{n,4}(\beta_{n,4}) + X_{n,5}(\beta_{n,5}) + X_{n,6}(\beta_{n,6}) + X_{n,7}(\beta_{n,7}) \]

Work/Life
Tenure
Geographic
Department
Institute
Salary
Contract
Structural Choice Modelling

\[ V_n = X_{n,1}(\beta_{n,1} + f_{1,1}\xi_{n,1}) + X_{n,2}(\beta_{n,2} + f_{2,1}\xi_{n,1}) + X_{n,3}(\beta_{n,3} + f_{3,1}\xi_{n,1}) + X_{n,4}(\beta_{n,4} + f_{4,2}\xi_{n,2}) + X_{n,5}(\beta_{n,5} + f_{5,2}\xi_{n,2}) + X_{n,6}(\beta_{n,6} + \xi_{n,3}) + X_{n,7}(\beta_{n,7} + f_{7,1}\xi_{n,1}) \]

\[ \xi_{n,1} = \zeta_{n,1} \]
\[ \xi_{n,2} = \zeta_{n,2} \]
\[ \xi_{n,3} = a_{3,1}\xi_{n,1} + a_{3,2}\xi_{n,2} \]

Work/Life
Tenure
Geographic
Department
Institute
Salary
Contract

'Conditions'
'Rating'
'Salary'
\[ \eta_1 \sim \text{Work/Life} \]
\[ \eta_2 \sim \text{Tenure} \]
\[ \eta_3 \sim \text{Geographic} \]
\[ \eta_4 \sim \text{Contract} \]

\[ \xi_1 \sim \text{Conditions} \]
\[ \zeta_1 \sim N(0,1) \]
\[ a = 0.47 \]
\[ \phi = -0.1 \]
\[ \zeta_2 \sim N(0,1) \]
\[ a = 0.46 \]
\[ f = 1.03 \]
\[ f = 0.07 \]

\[ \xi_2 \sim \text{Rating} \]

\[ \xi_3 \sim \text{Salary} \]
\[ \beta_1 \sim N(0.6, 0.3) \]
\[ \beta_2 \sim N(1, 0.5) \]
\[ \beta_3 \sim N(2.2, 0) \]
\[ \beta_4 \sim N(1.1, 0) \]
\[ \beta_5 \sim N(0.6, 0.6) \]
\[ \beta_6 \sim N(1.1, 0.7) \]

\[ \xi_1 \sim N(0,1) \]
\[ f = 0.21 \]
\[ f = 0.19 \]
\[ f = 1.51 \]
\[ f = -0.15 \]
The systematic component of utility, $V$, has covariates, $X$, with coefficients, $\eta$.

The coefficients, $\eta$, are random with the usual component and a factors/latent component $\xi$.

The factors/latent variables regress on each other.

Solve

Random Components

Parameters

Matrices

Means, st dev and cor of
### Papers using structural choice modelling to link data sets

<table>
<thead>
<tr>
<th>Name</th>
<th>Topic</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mara Thiene</td>
<td>joint/family</td>
<td>Bridge</td>
</tr>
<tr>
<td>Jasha Bowe</td>
<td>categories</td>
<td>Dawes Point 4</td>
</tr>
<tr>
<td>Abou Bakar</td>
<td>categories</td>
<td>Dawes Point 2</td>
</tr>
<tr>
<td>Ann Wallin</td>
<td>designs</td>
<td>Dawes Point 2</td>
</tr>
</tbody>
</table>

**Thursday 9.00 to 10.00.**

<table>
<thead>
<tr>
<th>Name</th>
<th>Topic</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Sampson</td>
<td>designs</td>
<td>Dawes Point 4/5</td>
</tr>
<tr>
<td>Thomas Magor</td>
<td>designs</td>
<td>Dawes Point 4/5</td>
</tr>
<tr>
<td>Len Coote</td>
<td>categories</td>
<td>Dawes Point 4/5</td>
</tr>
</tbody>
</table>

**Friday 11.00 to 12.30.**
Decision Maker ID Number | Choice Set ID Number | Choice | Covariates Data Set 1 | Covariates Data Set 2
---|---|---|---|---
DCE 1 | not same as DCE 1 | | | |
DCE 2 | same as DCE 1 | | | |
Latent Variables

• Hybrid Choice Modelling
  • Covariates for the latent variables are characteristics

• Structural Choice Modelling
  • Covariates for the latent variables are attributes
  • Can have 2 or more choice data sets with the same decision maker

• Software
  – MPlus
  – Discrete Choice Software - DisCoS
Papers using hybrid choice modelling

Stephane Hess
David Hoyos
Petr Mariel
Wednesday 1.30 to 3.00 Dawes Point 3

George Chryssochoidis
A.H.M. Mehbub Anwar
Thursday 9.00 to 10.00 Dawes Point 5

Thijs Dekker
Friday 1.30 to 2.30 Dawes Point 4/5
Discussion Points

- Identification
- Prediction
- The scale issues
- Latent class versus latent variable modelling
- Hybrid choice versus structural choice modelling
- Measurement using ‘attitude’ scale versus choice
Support for structural choice modelling and DisCoS

- Conference DisCoS demonstration
  Len Coote and Thomas Magor
  Thursday 6.00 pm, Dawes 4/5

- DUG The DisCoS User Group
  Len Coote, University of Queensland
  February 2014

- DisCoS software, manuals and blog
  www.linkedin/in/rungiecm