Modeling Longitudinal Count Data with Excess Zeros and Time-Dependent Covariates: Application to Drug Use

(1) EMA DATA

i Count Response

ii Longitudinal Data Collection

iii Excess Zeros Expected

iv Time-Dependent Covariates

(2) Subject-Specific Models

i Mixed Hurdle Model: Decompose TDC Effects

Random Component:

\[ Y_{ij} | u_i \sim HurrP(\pi(x_{it}, z_{it}; u_i), \lambda(x_{it}, z_{it}; u_i)) \]

\[ u_i \sim \mathcal{N}(0, \sigma_u^2) \]

\[ f_{ij}(y_{ij} | u_i; \pi_{it}, \lambda_{it}) = \begin{cases} 
\pi_{it} & y_{ij} = 0 \\
(1 - \pi_{it}) \frac{f(y_{ij} | u_i; \lambda_{it})}{1 - f(0; \lambda_{it})} & y_{ij} > 0
\end{cases} \]

Systematic Components:
\[
\logit(\pi_{it}) = x_{l, it} \alpha + z_{it} u \\
\ln(\lambda_{it}) = x_{c, it} \beta + z_{it} u
\]

(3) Population-Averaged Models

i Hurdle GEE: Independent Working Correlation Structure

\[
\sum_{i=1}^{N} \left( \frac{\partial \pi_i}{\partial \alpha} \right) V_{l, i}^{-1} (y_{\text{bin}} - \pi_i) = 0
\]

\[
\sum_{i=1}^{N} \left( \frac{\partial \mu_i}{\partial \beta} \right) V_{c, i}^{-1} (I_{(y_{it}>0)} (y_i - \mu_i)) = 0
\]

ii Hurdle GMM: Select Types of TDC

\[Q_l(\alpha) = (G_l(\alpha; Y, Z))^T W_{l}^{-1} (G_l(\alpha; Y, Z))\]

\[Q_c(\beta) = (G_c(\beta; Y, X))^T W_{c}^{-1} (G_c(\beta; Y, X))\]

\[g_{l, ij}(\alpha; Y_i, Z_i) = \frac{\partial \pi_i (z_{is})}{\partial \alpha_k} (I_{(Y_{it}=0)} - \pi(z_{it}))\]

\[g_{c, ij}(\beta; Y_i, X_i) = \frac{\partial \mu_i (\lambda(x_{is}))}{\partial \beta_k} (I_{(Y_{it}>0)} [Y_{it} - \mu(\lambda(x_{is}))])\]

(4) Results

<table>
<thead>
<tr>
<th></th>
<th>Mixed Hurdle</th>
<th>Hurdle IGEE</th>
<th>Hurdle GMM</th>
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<tbody>
<tr>
<td>Logistic</td>
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<tr>
<td>craving</td>
<td>0.223*** (W)</td>
<td>-0.170***</td>
<td>-0.169***</td>
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<td>-0.219* (B)</td>
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<tr>
<td>controls</td>
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<td>Count</td>
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<td>0.160 (B)</td>
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<td>cum GPA</td>
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<td>-0.056***</td>
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