hEART

Destination choice with longitudinal data

Antonin Danalet, Loïc Tinguely, Matthieu de Lapparent, Michel Bierlaire

Lyngby,
September 10, 2015
Outline

Motivation: Activity-based model for pedestrian facilities

Correcting endogeneity for dynamic discrete choice models

Case study: Catering location choice on EPFL campus
Outline

Motivation: Activity-based model for pedestrian facilities

Correcting endogeneity for dynamic discrete choice models

Case study: Catering location choice on EPFL campus
Motivation:
Activity-based model for pedestrian facilities

- Where, when and for how long do pedestrians perform activities in public spaces?
- Based on WiFi traces from existing access points
Activity path approach

Raw data

Pre-processing

Activity-episode sequence detection [DFB14]

Modeling

Activity path choice model [DB15]

Location choice model with panel effect [Tin15]
Goal

- Model location choice conditional on an activity type
- Adapted to panel data
Outline

Motivation: Activity-based model for pedestrian facilities

Correcting endogeneity for dynamic discrete choice models

Case study: Catering location choice on EPFL campus
Static model

\[ U_{\text{int}} = V_{\text{int}} + \varepsilon_{\text{int}} \]

Ignores two aspects:

- Dynamics
- Serial correlation
Dynamic model without agent effect

\[ U_{int} = V_{int} + \rho y_{in(t-1)} + \varepsilon_{int} \]

Assumes
- Dynamic process of order one
- Location-specific dependence
- Previous choice \( y_{in(t-1)} \) independent of error term \( \varepsilon_{int} \)
Relaxing the independence assumption of error terms

- Agent effect $\alpha_{in}$: time-invariant factor ("between" individuals variability)
- Unobserved heterogeneity $\varepsilon'_{int}$: short-term variation of probabilities ("within" an individual variability)

\[
U_{int} = V_{int} + \rho y_{in(t-1)} + \alpha_{in} + \varepsilon'_{int}
\]

Endogeneity issue:
- $y_{in(t-1)}$ and $\alpha_{in}$ are correlated
Wooldridge approach

\[ \alpha_{in} = a + by_{in0} + c'\bar{x}_n + \xi_{in} \]

Endogeneity issue solved [Woo05]
Dynamic model with agent effect correction

\[ U_{int} = V_{int} + \rho y_{in(t-1)} + a + by_{in0} + c' \bar{x}_n + \xi_{in} + \varepsilon'_{int} \]
3 different models

<table>
<thead>
<tr>
<th>Static model</th>
<th>Dynamic model without agent effect</th>
<th>Dynamic model with agent effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho = 0$</td>
<td>$\rho \neq 0$</td>
<td>$\rho \neq 0$</td>
</tr>
<tr>
<td>$a, b, c, \sigma^2_{\alpha} = 0$</td>
<td>$a, b, c, \sigma^2_{\alpha} = 0$</td>
<td>$a, b, c, \sigma^2_{\alpha} \neq 0$</td>
</tr>
</tbody>
</table>
Outline

Motivation: Activity-based model for pedestrian facilities

Correcting endogeneity for dynamic discrete choice models

Case study: Catering location choice on EPFL campus
Sequences of activity episodes from WiFi traces

- Bayesian approach [DFB14]
  - detects stops
  - provide semantics
- merging data
  - map information
  - attractivity
  - time constraints
Two specifications for the agent effect

\[ \alpha_{in} = a + by_{in0} + \xi_n \]

\[ \alpha_{in} = a + by_{in0} + cy_{int}^{count} + \xi_n \]
4 models estimated

<table>
<thead>
<tr>
<th>Static model</th>
<th>Dynamic model without agent effect</th>
<th>Dynamic model with agent effect correction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First choice</td>
<td>First choice and frequency</td>
</tr>
<tr>
<td>$\rho = 0$</td>
<td>$\rho \neq 0$</td>
<td>$\rho \neq 0$</td>
</tr>
<tr>
<td>$a = 0$</td>
<td>$a = 0$</td>
<td>$a \neq 0$</td>
</tr>
<tr>
<td>$b = 0$</td>
<td>$b = 0$</td>
<td>$b \neq 0$</td>
</tr>
<tr>
<td>$c = 0$</td>
<td>$c = 0$</td>
<td>$c \neq 0$</td>
</tr>
<tr>
<td>$\sigma_\alpha^2 = 0$</td>
<td>$\sigma_\alpha^2 = 0$</td>
<td>$\sigma_\alpha^2 \neq 0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Estimation results

- Distance has a negative impact
- Yearly evaluation has a positive impact
- Beer after 14:00 has a positive impact
- Cost has a negative impact
- Dinner has a positive impact
- Capacity has a positive impact
## Likelihood ratio tests

<table>
<thead>
<tr>
<th>Static model</th>
<th>Dynamic model without agent effect</th>
<th>Dynamic model with agent effect correction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First choice</td>
<td>First choice and frequency</td>
</tr>
<tr>
<td>354.003 (&gt; 5.99)</td>
<td>920.354 (&gt; 58.12)</td>
<td>16.172 (&gt; 5.99)</td>
</tr>
</tbody>
</table>
Validation

<table>
<thead>
<tr>
<th>Predicting last observations based on past observations</th>
<th>Static model</th>
<th>Dynamic model without agent effect</th>
<th>Dynamic model with agent effect correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of the squares of the errors</td>
<td>232.95</td>
<td>204.01</td>
<td>184.16</td>
</tr>
<tr>
<td></td>
<td>First choice</td>
<td>First choice and frequency</td>
<td></td>
</tr>
</tbody>
</table>
Elasticities to price

- Static model
- Dynamic model without agent effect
- Dynamic model with agent effect correction: First choice
- Dynamic model with agent effect correction: First choice and frequency
Forecasting: opening a new catering location

Nesting structure with the most similar alternative
Forecasting: opening a new catering location

Frequency of visits for the new catering destination

Frequency of visits

Static model | Dynamic model without agent effect | Dynamic model with agent effect correction: First choice | Dynamic model with agent effect correction: First choice and frequency

θ = 1 | θ = 2 | θ = 5 | θ = 10

Point-of-sale data
Summary

• Location choice conditional on the choice of activity type
• From WiFi traces
• Including lagged variable
• Correcting for endogeneity
• Applied to case study
  – Cost, capacity, distance, beer, etc. have an impact
  – Validation
  – Elasticity of price
  – Forecasting with new element in the choice set
Conclusion

- WiFi traces allow to understand pedestrian destination choices;
- When having longitudinal data (GSM/GPS/WiFi traces), destination choice models must include Wooldridge correction.
Thank you

hEART:

**Destination choice with longitudinal data**
Antonin Danalet, Loïc Tinguely,
Matthieu de Lapparent, Michel Bierlaire

– antonin.danalet@epfl.ch
