Investigating field effects on empirical countrywide data from Germany

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Outline

Research idea

German regional data

Background information empirical data

Mode choice games in detail

Implementing field effects

Future work and tasks
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- European national norms and regulations often use standardized values of time and thereby standardized mode and route choice models (e.g. Axhausen et al. 2015)
- Approach ignores regional differences in behavior, income and purchase power which all can influence an individual’s value of time
- Significant differences could lead to misallocation of (Federal) investments
- German VOT data allows empirical investigation of regional differences
- Individual decisions are influenced by other individuals
- *Field effects* try to capture social influences on decision makers in behavioral models
Research idea

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Background information empirical data

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Future work and tasks
NUTS regions Germany

Source: destatis.de

- Nomenclature des Units territoriales statistiques
- division of territory of the EU into hierarchical levels (0-3)
- NUTS regions Germany (NUTS 0 = DE)
  - NUTS 1 regions correspond to 16 Federal States (Bundeslaender)
  - NUTS 2 regions correspond to 38 governmental regions (Regierungsbezirke)
  - NUTS 3 regions correspond to 402 districts (Kreise and kreisfreie Staedte)
- data privacy in German VOT study permits Kreise and kreisfreie Staedte as lowest aggregation level
- Eurostat provides GDP and income data also on NUTS 3 level
NUTS levels Germany

NUTS 1

NUTS 2

NUTS 3

Source: Eurostat - GISCO
Example: German GDP NUTS 1 level
Research idea

German regional data

Background information empirical data

Mode choice games in detail

Implementing field effects

Future work and tasks
Background information German VOT and VOR study

- Commissioned by the German Federal Ministry of Transport and Digital Infrastructure (BMVI)
- Federal Transport Investment Plan 2015
  - Update of the overall methodology of the CBA
  - Values of Time (VOT) and Values of Reliability (VOR)
- Realisation by TNS Infratest and ETH Zurich
- Data collection
  - January 2012 — January 2013
  - Combined RP/SP survey
  - Business and non-business sample
  - representative sample (weighted)
Data collection process of the study

1. **Step: Collecting RP Data with CATI**
   - **Non-business**: dual frame population sample (land line 40%, mobile 60%)
   - **Business**: recruitment from previous online access panel

2. **Assigning SP Games per Respondent from RP Data**
   - Random selection of reference trip, construction of customized SP game sets

**2. Step: Collecting SP Data**
   - **Non-business**: paper pencil/online
   - **Business**: online

**Model Estimation**
- Estimation and validation discrete choice models

**VOT & VOR Determination**
### Types of questionnaires

<table>
<thead>
<tr>
<th>trip</th>
<th>reported mode</th>
<th>mode choice</th>
<th>route choice</th>
<th>reliability</th>
<th>long term</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
<td>walk</td>
<td>walk/put/mpt</td>
<td>--</td>
<td>--</td>
<td>workplace</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>walk</td>
<td>walk/put/mpt</td>
<td>--</td>
<td>--</td>
<td>residential</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>bike</td>
<td>bike/put/mpt</td>
<td>--</td>
<td>--</td>
<td>residential</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>bike</td>
<td>bike/put/mpt</td>
<td>--</td>
<td>--</td>
<td>workplace</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>put</td>
<td>bike/put/mpt</td>
<td>put 1</td>
<td></td>
<td>workplace</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>put</td>
<td>--</td>
<td>put 2</td>
<td></td>
<td>residential</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>mpt</td>
<td>walk/put/mpt</td>
<td>mpt 1</td>
<td></td>
<td>residential</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>mpt</td>
<td>--</td>
<td>mpt 2</td>
<td></td>
<td>workplace</td>
<td>8</td>
</tr>
<tr>
<td>journey</td>
<td>put</td>
<td>bus/put/mpt</td>
<td>put 3</td>
<td></td>
<td>workplace</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>put</td>
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<td>put 1</td>
<td></td>
<td>residential</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>mpt</td>
<td>bus/put/mpt</td>
<td>mpt 3</td>
<td></td>
<td>residential</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>mpt</td>
<td>--</td>
<td>mpt 1</td>
<td></td>
<td>workplace</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>put</td>
<td>put/mpt/plane</td>
<td>put 2</td>
<td></td>
<td>workplace</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>put</td>
<td>--</td>
<td>put 3</td>
<td></td>
<td>residential</td>
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</tr>
<tr>
<td></td>
<td>mpt</td>
<td>put/mpt/plane</td>
<td>mpt 2</td>
<td></td>
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<tr>
<td></td>
<td>mpt</td>
<td>--</td>
<td>mpt 3</td>
<td></td>
<td>workplace</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>plane</td>
<td>put/mpt/plane</td>
<td>plane 1</td>
<td></td>
<td>workplace</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>plane</td>
<td>--</td>
<td>plane 2</td>
<td></td>
<td>residential</td>
<td>18</td>
</tr>
</tbody>
</table>
Response

<table>
<thead>
<tr>
<th>Contacts</th>
<th>Non-business</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed computer assisted telephone interview (CATI)</td>
<td>3,151</td>
<td>848</td>
</tr>
<tr>
<td>Indicated willingness to participate written SC experiments</td>
<td>2,965</td>
<td>-</td>
</tr>
<tr>
<td>Indicated willingness to participate online SC experiments</td>
<td>186</td>
<td>848</td>
</tr>
<tr>
<td>Completed written SC experiments</td>
<td>2,187</td>
<td>-</td>
</tr>
<tr>
<td>Completed online SC experiments</td>
<td>98</td>
<td>786</td>
</tr>
</tbody>
</table>

- over 15,700 mode choice games (SP1)
- over 30,000 route choice games (SP2 9,000 & SP3 21,000)
- over 9,500 workplace choice games (SP4)
- over 8,500 residential choice games (SP5)
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Future work and tasks
Attributes mode choice experiments

- **walk**: walking time (min)
- **bike**: cycling time (min)
- **flight & public transport (bus, tram, train, long distance bus)**:
  - travel time (min): overall, in-vehicle, waiting, access & egress
  - travel cost (EUR): per trip, per month (# trips per month * 2)
  - number of transfers
  - headway
  - share of delayed trips

- **motorized private transport**:
  - travel time (min): overall, in-vehicle, congestion, access & egress
  - travel cost (EUR): per trip, per month (# trips per month * 2)
  - share of delayed trips
# Example mode choice questionnaire

<table>
<thead>
<tr>
<th>Bike</th>
<th>Public transport</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time 0:38 h</td>
<td>Travel time 0:27 h</td>
<td>Travel time 0:19 h</td>
</tr>
<tr>
<td>thereof</td>
<td>thereof</td>
<td>thereof</td>
</tr>
<tr>
<td>In-vehicle time 0:15 h</td>
<td>In-vehicle time 0:13 h</td>
<td>In-vehicle time 0:13 h</td>
</tr>
<tr>
<td>Waiting time 0:06 h</td>
<td>Waiting time 0:06 h</td>
<td>Waiting time 0:06 h</td>
</tr>
<tr>
<td>Access time 0:06 h</td>
<td>Access time 0:06 h</td>
<td>Access time 0:03 h</td>
</tr>
<tr>
<td>Change(s) 1 time(s)</td>
<td></td>
<td>Change(s) 1 time(s)</td>
</tr>
<tr>
<td>Costs 2,10 €</td>
<td>Costs 1,70 €</td>
<td>Costs 1,70 €</td>
</tr>
<tr>
<td>(17€/month for 4 trips)</td>
<td>(14€/month for 4 trips)</td>
<td>(14€/month for 4 trips)</td>
</tr>
<tr>
<td>Every 10 min</td>
<td>Every 10 min</td>
<td>Every 10 min</td>
</tr>
<tr>
<td>Share delayed 20 %</td>
<td>Share delayed 20 %</td>
<td>Share delayed 5 %</td>
</tr>
</tbody>
</table>

Choice: □ □ □
Utility function German VOT study (travel time & cost)

\[ U_i = \sum_j \left( \beta_{i,j} \ast x_{i,j} + \alpha_{i,j} \ast \ln(x_{i,j} + \gamma_{i,j}) \right) \ast \left( \frac{z_j}{\mu(z_j)} \right)^{\lambda_{ij} z_j} \]

\( U_i \) Utility of the alternative \( i = 1, \ldots, n \)
\( x_{ij} \) attribute \( j \) of alternative \( i \)
\( (\beta, \alpha, \gamma)_{ij} \) parameters associated with \( x_{i,j} \)
\( \lambda_{i,j,z_{i,j}} \) elasticity of the sensitivity to \( j \) for \( i \) with respect to \( z_j \)
\( \mu(z_j) \) mean of \( z_j \)
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Future work and tasks
Dugundji and Walker (2005), Walker et al. (2011)

- exact members of social network are unknown
- field effect variable to capture social influences by share of decision makers within a defined reference peer group (income class and postal code) that choose a particular alternative
- incorporating field effect

\[ U(ij) = V(x_{ij}, s_j, \beta) + \gamma F_{ij} + \epsilon_{ij} \]

- unobserved effects influence field effect and are captured in the error term
- field effect and error term may be correlated and the field effect an endogenous variable
- upward bias of field effect parameter
- difficult to define
Correcting for endogenity (Berry, Levinsohn and Pales (2004), Walker et al. (2011))

- decompose error in 2 parts (endogenous and random) and isolate endogenous-causing components

\[ U(ij) = [\gamma F_{ij} + \dot{\epsilon}_{ij}] + V(x_{ij}, s_j, \beta) + \dot{\epsilon}_{ij} \]

- replace the peer group effect with a market specific constant (endogeneity occurs at a market level)

\[ U(ij) = \alpha_{im} + V(x_{ijm}, s_{jm}, \beta) + \dot{\epsilon}_{ijm} \]

with

\[ \alpha_{im} = [\gamma F_{im} + \dot{\epsilon}_{im}] \]

- last include instrumental variable (correlated with endogenous variable and uncorrelated with the error) in two stage approach (first as explanatory variable for field effect, second as regression of fitted values from field effect from first step on market-specific constant)
Application on German VOT data

- remove income interaction in utility function
- 3 field effect variables
  - social reference group: income class
  - spatial reference group 1: NUTS 3 region
  - spatial reference group 2: German BIK_10 region (population density measure)
- share index of chosen alternative within peer group between -1 and 1 (representing 0 and 100 %)
- simple utility function: ASC, travel time, generic cost coefficient and field effect (probability of choosing a mode with respect to the share of choosing the mode in the peer group)
- preliminary result show highly significant positive field effect estimate of 1.4081 (robust t-value: 12.45) and a significant improvement of the LL from -11151.46 to -10764.27 with 1 DF
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Future work and tasks field effects

- include constants of all 3 NUTS levels (or at least on NUTS 1 and 2) and correct for endogeneity
- determine instrumental variables
- include GDP data and modal split on NUTS 3 level (MiD 2008) as reference groups (not SP data)
- control correlation (e.g. income interaction official utility function)
- implement field effect in long term experiments (workplace and residential choice)
- do field effects make sense in our route choice SPs?
- definition unobserved effect vs. field effect
- include purchase power (percentiles)
- investigate other regional differences
Thank you very much!

Questions?