Smart cards and social networks: Results and familiar strangers

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Acknowledgements

Social networks:

- Timo Ohnmacht
- Andreas Frei
- Matthias Kowald
- Lijun Sun
- Andreas Diekmann, ETH Zürich
- Jonas Larsen, Roskilde/John Urry, Lancaster

Agent-based models

- Thibaut Dubernet
- Pieter Fourie

Social network generation

- Theo Arentze, TU Eindhoven
Further acknowledgements

Most of the materials and more will be in:

Why the interest?
An agent-based model of travel demand: e.g. Singapore
Road based – Switzerland 1950 and 2000

Scherer, 2004
Long distance journeys (100km+) in Germany, 2010’s

<table>
<thead>
<tr>
<th>Type</th>
<th>Number/year</th>
<th>km/journey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacation (5 days plus)</td>
<td>1.0</td>
<td>1600</td>
</tr>
<tr>
<td>Short vacation (2-4 days)</td>
<td>1.2</td>
<td>410</td>
</tr>
<tr>
<td>Other journeys with overnight stays</td>
<td>0.3</td>
<td>410</td>
</tr>
<tr>
<td>Day excursions</td>
<td>6.0</td>
<td>200</td>
</tr>
<tr>
<td>Business trip with overnight stay</td>
<td>1.2</td>
<td>500</td>
</tr>
<tr>
<td>Business trip without overnight stay</td>
<td>1.2</td>
<td>150</td>
</tr>
<tr>
<td>Long-distance commuting and other trips</td>
<td>5.0</td>
<td>150</td>
</tr>
</tbody>
</table>
Why social networks in transport/spatial planning?
Example: Number of accompanying travellers

Axhausen et al., 2007
Example: Heterogenity in choice

Location choice

- WTP
- Taste
- Joint choice with family, friends, persons to meet
- Schedule constraints
- Social constraints

For mode choice in addition

- Luggage
- Company
- Weather
- Temperature
**Example: Residential location choice in Kt. Zürich**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>t-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent/Income</td>
<td>-5.51</td>
<td>***</td>
</tr>
<tr>
<td>log(m²/head)</td>
<td>0.98</td>
<td>***</td>
</tr>
<tr>
<td><strong>Frequency weighted mean distance to friends</strong></td>
<td>-8.16</td>
<td>*</td>
</tr>
<tr>
<td><strong>Exponent (friends)</strong></td>
<td>0.22</td>
<td>**</td>
</tr>
<tr>
<td>Mean distance to work/school</td>
<td>-1.59</td>
<td>**</td>
</tr>
<tr>
<td><strong>Exponent (distance to work)</strong></td>
<td>0.37</td>
<td>**</td>
</tr>
<tr>
<td>Travel time to Bürkliplatz</td>
<td>0.02</td>
<td>**</td>
</tr>
<tr>
<td>log(transit accessibility) * &quot;No car&quot;</td>
<td>0.41</td>
<td>**</td>
</tr>
<tr>
<td>log(car accessibility) * “Car”</td>
<td>-0.30</td>
<td>**</td>
</tr>
<tr>
<td>Share of equally sized HH within 1 km</td>
<td>0.02</td>
<td>*</td>
</tr>
<tr>
<td>Population density within 1 km</td>
<td>0.01</td>
<td>**</td>
</tr>
<tr>
<td>Share of empty flats in municipality</td>
<td>-0.11</td>
<td></td>
</tr>
</tbody>
</table>

\[ N = 683, \rho^2 = 0.2128; \; * > 0.1; \; ** > 0.05; \; *** > 0.01 \]
Travel and social networks
Benchmarking the current state

• Numbers of contacts
• Distance distributions
• Geographies
• Frequency and mode of contact

• “Productivity”
• Levels of local anomie
• Levels of local trust
• Level of place attachment
Empirical strategy

- Surveys of social geographies & mobility biographies
  - Egocentric
  - Snowball

- Travel diaries
  - One-Day
  - Multiple days

- With/without information about the presence of others
- With/without named co-travellers, co-present persons
Social network surveys @ IVT

- Ohnmacht: 50 egos qualitative/quantitative in Zürich
- Larsen/Urry: 24 egos qualitative/quantitative in NE England
- Frei: 300 egos quantitative in Zürich
- Kowald: snowball; 750 egos quantitative worldwide (starting with 40 egos in Kanton Zürich)(12000 alters in total) (8 day diary included)
- Kowald/Diekmann: 2000 respondents of the Swiss Environment Survey – 5 core alters
- Sun: Smart card use on busses in Singapore
Biography of an architect, about thirty
Number of contacts reported

Number of contacts named

Percent

Frei and Axhausen, 2007
Great circle distances between “leisure” contacts: Zürich
Great circle distances between “leisure” contacts: Snowball

Daten: Schneeballbefragung IVT, Siehe Kowald et al. 2012
Example of a social network geography
Size of network geometries

95%-confidence ellipse of the social network geography

Frei and Axhausen, 2007
Interactions by mode and distance between homes

Frei and Axhausen, 2007
Behind egos’ horizons: The connected ‘snowball’-graph

<table>
<thead>
<tr>
<th></th>
<th>Vertices</th>
<th>Edges</th>
<th>Density</th>
<th>Components</th>
<th>Triangles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without sociogram</td>
<td>6’584</td>
<td>7’349</td>
<td>0.000</td>
<td>19</td>
<td>0.017</td>
</tr>
<tr>
<td>With sociogram</td>
<td>6’584</td>
<td>32’671</td>
<td>0.002</td>
<td>19</td>
<td>0.518</td>
</tr>
</tbody>
</table>

Kowald and Axhausen, 2011
Comparisons
Transport motivated social network surveys

- East York, Ontario (Wellman, Carrasco et al.)
- Eindhoven, Netherlands (Arentze, Van der Berg)
- Concepcion, Chile (Carrasco)
- City of Zürich (Frei)
- Kanton Zürich snowball (Kowald)
Contact “density” – shares by distance class

Kowald et al., forthcoming
Shares of contact by mode

**Face-to-face**

**Telephone**

**Internet**

- Zurich
- Eindhoven
- Switzerland
- Concepcion

Great circle distance [km]

Kowald et al., forthcoming
Low level networks as a building block
Smart card records as a source

- Boarding Stop ID
- Card ID, Passenger Type, Travel Mode,
- Bus
  Service Number, Ride Start Time (Date), Bus Registration No. Direction
- Alighting Stop ID, Ride Duration, Ride Distance, Fare Paid,
- Metro
  Transfer Number, Boarding Station ID, Ride Start Time (Date), Ö
Arrival distribution along a line
Number of contacts versus usage frequency

Sun et al., 2013
Monday
... Friday
... the weekly summary
A small world network in Singapore‘s busses

• One component by Wednesday

• Diameter: 6

• Characteristic path length: 2.95
  • (random: 2.63)

• Average clustering coefficient: 0.19
  • (random: 4.5x10^{-4})

• Small-world
A small world network in Singapore’s busses, but uneven

median degrees in quintiles
- <= 267.00
- 267.01 - 350.50
- 350.51 - 415.00
- 415.01 - 477.00
- 477.01+
Integration
Integration and future work

• Generation of artificial social networks (Arentze et al., 2012) (degree, clustering, distances)

• Repeat of Switzerland Snowball

• Measurement of network size (leisure, work, civic engagement)

• Measurement of network dynamics (Timmerman’s ERC project, Carrasco’s Concepcion survey)

• Measurement of anomie, trust and social network geography

• Integration of network choice/decision making model (Dubernet)
Integration, again
Some hypotheses for travel behaviour and more

- Wages
- Fleet comfort
- Housing consumption
- Activities
- Tours
- pkm
- vkm
- Energy costs
- Energy costs
- vtts et al.
- Specialisation
- Migration
- Professional and personal activity space
- Network geography
- Local anomie

Elasticity > 0
Elasticity < 0
Questions?

www.ivt.ethz.ch
www.matsim.org
www.futurecities.ethz.ch


