Social networks and the dynamics of travel

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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
Acknowledgements

Most of the materials and more will be in:

Why the interest?
An agent-based model of travel demand: e.g. Singapore
Avg. daily distance travelled by income tercile (1980 – 2010)

Marmolejo and Ciari, 2013
Car always available (Switzerland 1980 – 2010)
Road based – Switzerland 1950 and 2000
Leisure travel in the 2000’s

<table>
<thead>
<tr>
<th>Trip purpose</th>
<th>Switzerland</th>
<th>Germany</th>
<th>UK</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leisure</td>
<td>40.2</td>
<td>17.4</td>
<td>41.0</td>
<td>9.4</td>
</tr>
<tr>
<td>Work/School</td>
<td>36.5</td>
<td>57.0</td>
<td>32.0</td>
<td>33.5</td>
</tr>
<tr>
<td>Shopping/Private business</td>
<td>12.8</td>
<td>15.9</td>
<td>12.0</td>
<td>11.9</td>
</tr>
<tr>
<td>Escorting others</td>
<td>4.8</td>
<td>9.7</td>
<td>15.0</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>5.7</td>
<td>-</td>
<td>-</td>
<td>45.2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
# 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: Required travel for leisure meetings of ego-alter

Distance between home locations [km]

Important contact

<table>
<thead>
<tr>
<th>Distance</th>
<th>Important Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10 km</td>
<td>No</td>
</tr>
<tr>
<td>10 - 20 km</td>
<td>Yes</td>
</tr>
<tr>
<td>20 - 30 km</td>
<td>Yes</td>
</tr>
<tr>
<td>30 - 50 km</td>
<td>Yes</td>
</tr>
<tr>
<td>50 - 60 km</td>
<td>Yes</td>
</tr>
<tr>
<td>60 - 250 km</td>
<td>Yes</td>
</tr>
<tr>
<td>Abroad</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Percent [%]

Schlich et al., 2002
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>Frequency weighted mean distance to friends</td>
<td>-8.16</td>
<td>*</td>
</tr>
<tr>
<td>Exponent (friends)</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>Exponent (distance to work)</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, rho² = 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

National Links

Friend always known
Phone weekly
Email daily
Text weekly
Meet up weekly
Walking distance

Mother
Phone everyday
Never email or text
Meet up weekly
Walking distance

Workmate
Known ‘04
Phone weekly
Email weekly
Text weekly
Meet up every day at work
Liverpool

Sister
Phone monthly
Email monthly
Text monthly
Meet up monthly
Train is £38, 4.29 hours, 4 changes,

School friend
Phone monthly
Email daily
Text weekly
Meet up every 3 months
Train is £32, 3 hr 12 min

International Ties

University friend
Phone every 3 months
Email daily
Never text
Meet up yearly
Flight is £90, 16 hr 45 min

Key To Symbols

Place of Residence
Most Significant People
Other Friends and Family
Former Places of Residence

Local Ties

University housemate
Phone weekly
Email monthly
Text weekly
Meet up monthly
Train is £30, 2 hr 22 min

Larsen, Urry and Axhausen, 2006
Number of contacts reported

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0</th>
<th>0.01</th>
<th>0.1</th>
<th>1</th>
<th>10</th>
<th>100</th>
<th>1000</th>
<th>10000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-dist</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

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
2010/11 Snowball survey
Response rate and response burden (IVT surveys)

Kowald and Axhausen, 2011
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
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

Great circle distance [km]

Zurich
Eindhoven
Switzerland
Concepcion

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
... 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
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 Conception 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
      - vtt et al.
- Specialisation
  - Tours
    - pkm
    - vkm
- Migration
- Professional and personal activity space
  - Number of networks
  - Network geography
  - Local anomie

Elasticity > 0
Elasticity < 0
Questions?

www.ivt.ethz.ch

www.matsim.org

www.futurecities.ethz.ch


