Preferred citation style

Catchment areas, social network geographies and travel: A conceptual model

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Time-scaled “road”-Switzerland (1950 and 2000)

Scherer, 2004
Quality – adjusted prices for cars

Quality-adjusted price index (2004 = 100) [%]

Jahr

Frei, 2004
Raff und Trajtenberg, 1990
Price deflation for telecommunication

![Graph showing price deflation for telecommunication revenue per minute from 1930 to 2000.](chart)

- **US International and interstate average revenue per minute**

  - **Index [1995 = 100]**
  - **Year**

Nach FCC (2001)
Size of goods markets and productivity: A hypothesis

Economies of scale
Economies of scope

Capital/Wages

Prices

GDP

Monopolies

Transport system and demand

Market size

Innovation

k: Generalised costs of travel

Energy costs

Elasticity > 0

Elasticity < 0 (excluding externalities)
Size of goods markets and productivity: A hypothesis

Economies of scale
Economies of scope

Activity
Tours
slots
vtts et al.

GDP
Market size
Energy costs

Elasticity > 0  Slots: possibilities to move goods or people
Elasticity < 0  For a given infrastructure and commercial and private fleet
Response: VTTS (free-flow)
Response: Swiss commuting speeds since 1970
First summary

- On-going reduction in the generalised cost of travel
- Expanded market areas and improved economic productivity
Social networks
Definition of a social network

The topology of a social network describes:

- Which person/firm (node) is linked to which other persons/firms
- By contacts (links) of a certain quality (impedance or cost)

Closeness $\sim 1/\text{Impedance}$
Spatial density and social connectivity

Dense/tight

Dense/loose

Sparse/tight

Sparse/loose
Travel and social networks

Maintenance of the networks requires:

• Face to face contacts
• Balanced by other forms of contacts

• Travel ~ Physical spread of the contacts

• Trade-off between loosing contacts and “social” capital and investing in new contacts closer to home
Average size of travel party (2003 Thurgau)

- Short vacation
- Excursion: nature
- Other
- Excursion: culture
- Meeting friends
- Further education (leisure)
- Garden/ cottage
- Voluntary work
- Disco, pub, restaurant, cinema
- Meeting relatives/family
- Window shopping
- Pick up/drop off/attendance
- Group/club meeting
- Family duty
- Cemetery
- Active sports
- Education
- Long-term shopping
- Walk or stroll
- Daily shopping
- Private business
- Private business (doctor,...)
- Work

Mean

- Household members travelling along
- Other persons travelling along
- Dog travelling along
In-commuter sheds of the ten largest Swiss towns

Nach Botte, 2003
Example of a social network geography

Female, 28, 4 moves, Public transport user
Example geography of a 35 old female
How to measure?

Team:

• S. Schönfelder, IVT
• M. Balmer, IVT
• R.K. Rai and V.S. Vaze, IIT interns

Funding: ETH research fund
How to measure?

Parametric:
  • 95% confidence ellipse (form and type of distribution)

Semiparametric:
  • Inclusion geometries (form of geometry)
  • (Weighted) shortest path networks (structure of path)
  • (Percentage) Minimum convex polygons (convexity)
  • Kernel density estimator (form of estimator)
  • Mean harmonic home ranges (form of estimator)

Non-parametric
  • Observed path geometries
Measures: Confidence ellipse

Schönhofler, 2006
Measures: Kernel densities

Workplace

Main shopping locations
Measures: Inclusion geometries

Find:

$$\min A_i(\beta_{i1} \ldots \beta_{in})$$

s.t.

Area $A_i$ covering $p\%$ of all observed points

with:

- $i$ : Type of geometry (Ellipse, bean, Cassini ...)
- $p$ : Predetermined share, e.g. 95%
Measures: Inclusion geometries
Measures: Minimum convex polygons (MCP)
Measures: Shortest path network
Measures: Weighted shortest path network
Survey work

Team:

- A. Frei, IVT
- T. Ohnmacht, Universität Basel/FH Zentralschweiz, Lucerne
- J. Larsen, Roskilde University
- J. Urry, Lancaster University

Funding: ifmo, DfT, BBW/Cost, SNF
Items to capture the social network geographies

• Name generators

• Name interpreters
  • Type and length of contact
  • Frequency by mode of contact
  • Home location
  • Second homes

• Detailed descriptions of face-to-face contacts
Items to characterise the mobility biography

- Home and second home locations
- Work and school locations
- Household composition
- Mobility tools
- Main mode (to work/school)
- (Major holidays)
- Personal income
- Household income
## Response behaviour in the Cost/ifmo surveys

<table>
<thead>
<tr>
<th>Phase</th>
<th>Pretest</th>
<th>Main study</th>
<th>Share of total</th>
<th>Share of reached by phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>150</td>
<td>4'200</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Wrong address</td>
<td>0</td>
<td>56</td>
<td>1.3%</td>
<td></td>
</tr>
<tr>
<td>Not reachable by phone</td>
<td>36</td>
<td>1'486</td>
<td>35.3%</td>
<td></td>
</tr>
<tr>
<td>Reached by phone</td>
<td>113</td>
<td>2'714</td>
<td>64.6%</td>
<td>100%</td>
</tr>
<tr>
<td>Recruited</td>
<td>14</td>
<td>318</td>
<td>7.5%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Interviewed</td>
<td>13</td>
<td>305</td>
<td>7.3%</td>
<td>11.2%</td>
</tr>
<tr>
<td>Post-interview questionnaire returned</td>
<td>13</td>
<td>294</td>
<td>7.0%</td>
<td>10.8%</td>
</tr>
</tbody>
</table>
Distance distribution

![Histogram of Distance Distribution](image-url)
Contact frequency by mode

![Graph showing contact frequency by mean distance in the decile (km)].

- **Electronic contacts**
- **Face-to-face contacts**

**Axes:**
- **Y-axis:** Mean annual frequency
- **X-axis:** Mean distance in the decile [km]
Market share by contact mode

Average contacts per year vs. Median distance of the quartile [km]

- **Face-to-face (Female)**
- **Phone (Female)**
- **Email (Female)**
- **SMS (Female)**
- **Face-to-face (Male)**
- **Phone (Male)**
- **Email (Male)**
- **SMS (Male)**
Distribution of the social geographies

95% Confidence ellipse of the social network geography

Japan: 378; U.S.A: 9'629 \([10^3 \text{ km}^2]\)
Future trends: Hypotheses
Hypotheses

- Message costs
- Migration
- Professional activity space
- Personal activity space
- Number of networks
- Network geography
- Left skew of intensity distribution
- Network overlap
- Local anomie

Elasticity > 0
Elasticity < 0
Expected impacts: Improved welfare

The social networks should be more homogeneous and therefore more productive for their members.

But, the selectivity excludes the „less attractive“ persons who are disadvantaged through a reduced ability to travel or a reduced ability to participate in activities.

But, the dependence on commercial or state-provided services for “care” increases.
Next steps
Changing our understanding of travel

- Budget constraints
- Capability constraints

- Generalised costs of the schedule
  - Generalised cost of travel
  - Generalised cost of activity participation
    - Risk and comfort-adjusted weighted sums of time, expenditure and social content
Research issues

- Measurement of the activity spaces (geographies, markets)
- Estimate of historical activity spaces ...

- Taste differences in network form and geography
- Social/cultural preferences for network form and geography

- Stability of the geographies under pressure
- Elasticities to policy (or environmental) change
- Time until trend change
Policy questions

- Is „happiness“ still growing?
- How large are the social externalities?
- How stable is the overall system under pressure?
The hypotheses summarized

Wages

Specialisation

Fleet comfort

Activities

Energy costs

Tours

Housing consumption

vkm

k

Energy costs

vtt et al.

Elasticity > 0

Elasticity < 0

Migration

Professional and personal activity space

Network geography

Number of networks

Network overlap

Local anomie
See

www.ivt.ethz.ch
Appendix: Dynamics of social networks
Social networks: Hypotheses

[1] The size of the social network geography is inversely proportional to the generalised costs of travel and communication.

[2] The number of contacts individuals maintain is inversely proportional to the generalised costs of travel and communication.

[3] The probability of being linked to a member of one’s network through multiple networks increases with the spatial density of one’s contacts.

[4] The distribution of effort on non-household members will become more left skewed as the spatial social network tightness decreases.

[5] The knowledge about the contacts of contacts in a social network is proportional to the generalised costs of travel and communication.
Social networks: Hypotheses (2)

[6] The activity space of an individual is proportional to its social network geography

[7a] The size of the local activity space of an individual stabilises after an initial exploration.

[7b] The size of the total activity space will grow in line with the growth of social network geographies.

[8] The reliance on commercial or publicly funded personal services increases proportionally with the geography of social networks.

[9] The welfare of the individuals should increase inversely proportional to the generalised costs of travel.
Appendix: Preliminary results (Cost/ifmo – survey)
Poisson regression of the number of social contacts

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>St. dev</th>
<th>Beta</th>
<th>Standardised beta</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td>3.753</td>
<td>-</td>
<td>0.000</td>
</tr>
<tr>
<td>Age [years]</td>
<td>45.68</td>
<td>19.08</td>
<td>-0.051</td>
<td>-0.124</td>
<td>0.000</td>
</tr>
<tr>
<td>Age²/1000 [years²/1000]</td>
<td>2.44</td>
<td>0.09</td>
<td>0.401</td>
<td>0.102</td>
<td>0.000</td>
</tr>
<tr>
<td>Data_horizon [y/n]</td>
<td>0.19</td>
<td>0.39</td>
<td>-0.289</td>
<td>-0.015</td>
<td>0.000</td>
</tr>
<tr>
<td>Data_COST 355 [y/n]</td>
<td>0.57</td>
<td>0.50</td>
<td>-0.256</td>
<td>-0.016</td>
<td>0.000</td>
</tr>
<tr>
<td>Number of relocations [n]</td>
<td>5.82</td>
<td>2.74</td>
<td>0.037</td>
<td>0.013</td>
<td>0.000</td>
</tr>
<tr>
<td>University degree [y/n]</td>
<td>0.28</td>
<td>0.45</td>
<td>0.116</td>
<td>0.007</td>
<td>0.045</td>
</tr>
<tr>
<td>N</td>
<td>128</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td></td>
<td></td>
<td>0.16</td>
<td></td>
<td></td>
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</table>
# Probit results of contact modes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Market shares of contact modes</th>
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</thead>
<tbody>
<tr>
<td>Category</td>
<td>Face-to-face</td>
</tr>
<tr>
<td>Age</td>
<td>-.004</td>
</tr>
<tr>
<td>Sex: Male</td>
<td>-.127</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Compulsory school</td>
<td>-.251</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>-.171</td>
</tr>
<tr>
<td>Baccalaureat</td>
<td></td>
</tr>
<tr>
<td>Professional tertiary</td>
<td>-.384</td>
</tr>
<tr>
<td>University degree</td>
<td>-.628</td>
</tr>
<tr>
<td>Type of contact</td>
<td></td>
</tr>
<tr>
<td>Others and friends</td>
<td>.197</td>
</tr>
<tr>
<td>Family and partner</td>
<td>-</td>
</tr>
<tr>
<td>Work mates</td>
<td>.600</td>
</tr>
<tr>
<td>Ln (distance)</td>
<td>-.108</td>
</tr>
<tr>
<td>Income</td>
<td>.028</td>
</tr>
<tr>
<td>Income * Male</td>
<td>.048</td>
</tr>
<tr>
<td>Adjusted R²/Chi²</td>
<td>10046</td>
</tr>
<tr>
<td>N</td>
<td>381</td>
</tr>
</tbody>
</table>
# Tobit results of social geography size

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>St. dev</th>
<th>Beta</th>
<th>Standardised beta</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data_ifmo [y/n]</td>
<td>0.26</td>
<td>0.43</td>
<td>2.309</td>
<td>0.184</td>
<td>0.048</td>
</tr>
<tr>
<td>Male [y/n]</td>
<td>0.57</td>
<td>0.50</td>
<td>2.293</td>
<td>0.212</td>
<td>0.021</td>
</tr>
<tr>
<td>Age [years]</td>
<td>44.72</td>
<td>18.92</td>
<td>-0.078</td>
<td>-0.277</td>
<td>0.002</td>
</tr>
<tr>
<td>University degree [y/n]</td>
<td>0.28</td>
<td>0.45</td>
<td>2.286</td>
<td>0.192</td>
<td>0.047</td>
</tr>
<tr>
<td>Car ownership [y/n]</td>
<td>0.52</td>
<td>0.50</td>
<td>3.842</td>
<td>0.358</td>
<td>0.000</td>
</tr>
<tr>
<td>Annual or monthly public transport ticket [y/n]</td>
<td>0.90</td>
<td>0.32</td>
<td>6.585</td>
<td>0.398</td>
<td>0.000</td>
</tr>
<tr>
<td>Number of relocations [n]</td>
<td>5.87</td>
<td>2.74</td>
<td>0.634</td>
<td>0.325</td>
<td>0.000</td>
</tr>
<tr>
<td>N</td>
<td>117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>