The Same Mode Again?
Mode Choice Variability in Great Britain

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Which mode?
Importance of topic

- Potential for modal shift depends on people’s capability and willingness to use alternatives
- A better understanding of the extent to which people use different transport modes in their everyday travel is a starting point for assessing this potential
Outline of presentation

1. Literature review - outlining existing knowledge on mode choice variability
2. Data and analytical approach - obtaining appropriate data and choosing suitable indicators
3. Results - analysing extent of mode choice variability across population and factors that influence this
4. Conclusions
Travel behaviour research

• National Travel Survey does not report variability in mode use
  – Average person in Britain makes 64% of trips by car – are some people
    only using cars and others never using cars?

• Most research examines between person differences in travel
  behaviour (inter-personal variability)

• Only limited research on within person differences in travel
  behaviour (intra-personal variability)

• However, analysis of sample survey data shows two-thirds of
  total variance in travel behaviour is due to intra-personal
  variability
Intra-personal variability

- Day-to-day intra-personal variability of travel received some interest for 30 years

- Analysis using long period travel diaries (5 -6 weeks) (but for small samples)

- Different dimensions studied
  - Travel purpose
  - Time of day
  - Destination
  - Travel mode

- High degree of repetition found for travel combinations (e.g. mode-destination) (Huff and Hansen, 1986)

- But low similarity of travel sequences on consecutive days
Multimodality

- Research in Germany and US has used travel diary data to identify what proportion of population are multimodal and monomodal over a week’s travel

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Multimodality groups in Germany

Source: Nobis (2007)
Multimodality

- Research in Germany and US has used travel diary data to identify what proportion of population are multimodal and monomodal over a week’s travel
- Results are sensitive to data and definitions

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<td>Buehler and Hamre</td>
<td>US NHTS</td>
<td>69% multimodal</td>
<td>4 mode categories</td>
</tr>
<tr>
<td>(2014)</td>
<td>(1-day)</td>
<td></td>
<td>1-day diary + self-reported frequencies</td>
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Characteristics of multimodals

Common to Germany and US
- High income
- Low car ownership
- Live in larger urban area

Germany
- Women
- Young and old adults
- Not in full-time employment

United States
- Not old adults

Sources: Nobis (2007) for Germany and Buehler and Hamre (2014) for US
Modality styles

• Recent research has looked at modal tendencies rather than actual use
• Lavery et al (2011) investigated factors influencing number of perceived modes and found attitudes towards travel are important
Research opportunity

• Assess extent of intra-personal mode choice variability, not just whether individuals are multimodal or not

• Utilise advantages of GB National Travel Survey (NTS)
  – Large population representative sample
  – Seven day travel diaries
  – Mode recorded for each trip/trip stage
  – Detailed mode classification
  – Detailed personal characteristics

• Examine modal variability in British context
Data preparation

- Use of NTS 2010 data
- Diaries completed by 19,072 individuals from 8,097 households
- Our analysis restricted to adults (aged 16+) reporting at least one trip (N=14,607)
- NTS has separate data files for information on geographical areas, households, individuals, trips and stages
- Steps in preparing data:
  i. Obtain total number of stages by mode for each individual (using short walk weight and diary drop-off weight)
  ii. Append personal information to (i)
  iii. Calculate indicators of mode choice variability
Mode usage by individuals

N=14,607
Overall combinations

- Private transport only: 37.8%
- Public transport only: 4.5%
- Active transport only: 2%
- Private and public transport: 12.7%
- Private and active transport: 20%
- Active and public transport: 5.9%
- Private, public and active transport: 17.2%

Data

N=14,607
## Indicators of modal variability

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of modes used</td>
<td>1 - 8</td>
<td>Total number of modes used</td>
</tr>
<tr>
<td>Difference in proportion of stages between primary and secondary mode</td>
<td>0.0 – 1.0</td>
<td>Dependence on one mode</td>
</tr>
<tr>
<td>Herfindahl-Hirschman index normalised (for 8 mode categories)</td>
<td>0.0 – 1.0</td>
<td>Balance of usage across 8 mode categories</td>
</tr>
<tr>
<td>Herfindahl-Hirschman index normalised (for 3 mode categories – private, public and active travel)</td>
<td>0.0 – 1.0</td>
<td>Balance of usage across 3 more general mode categories</td>
</tr>
</tbody>
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The Herfindahl-Hirschman Index (HHI) is a measure of market concentration. It is calculated by the sum of the squared values of the share of each mode of the total number of stages. We normalized the calculated HHI in order to have a range from 0 to 1. The closer to 1 the more one mode dominates the travel of an individual.
## Example data

<table>
<thead>
<tr>
<th>Mode category</th>
<th>No. stages (weighted)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Case 1</td>
<td>Case 2</td>
<td></td>
</tr>
<tr>
<td>Car driver</td>
<td>0</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>Car passenger</td>
<td>7.3</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>7.1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Bicycle</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total stages</td>
<td>18.5</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Number of modes</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Difference primary-secondary</td>
<td>0.01</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>HHI 8 modes</td>
<td>0.26</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>HHI 3 modes</td>
<td>0.03</td>
<td>1.0</td>
<td></td>
</tr>
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Distributions of modal variability

Number of modes

N=14,607
Distributions of modal variability

Difference primary-secondary

N=14,607
Distributions of modal variability

HHI 8 modes

N=14,607
Distributions of modal variability

HHI 3 modes

N=14,607
Analytical approach

• Multiple regression used to identify factors that predict higher (or lower) modal variability
• Random selection of one adult per household
• Dependent variable – the four aforementioned indicators
  – Fractional probit model used for three proportion indicators
  – Poisson model used for count indicator
• Independent variables – theorised based on Hägerstrand (1970)
  – Capability constraints
    • Physical mobility constraints
  – Coupling constraints
    • Social role constraints
    • Work constraints
  – Authority constraints
    • Accessibility constraints
    • Economic constraints
    • Mobility resource constraints
HHI 8 modes – physical mobility and social role constraints

Results

Reduced variability

ref: 20-29

ref: household with child 0-15
HHI 8 modes – work constraints

Results

- Work part time
- Self-employed
- Work same place 2 days running
- Work at different places
- Work from home

Reduced variability
HHI 8 modes – accessibility constraints

<table>
<thead>
<tr>
<th>Category</th>
<th>Ref: London</th>
</tr>
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<tr>
<td>Met built-up areas</td>
<td></td>
</tr>
<tr>
<td>Other urban over 250K</td>
<td></td>
</tr>
<tr>
<td>Urban over 25K to 250K</td>
<td></td>
</tr>
<tr>
<td>Urban over 10K to 25K</td>
<td></td>
</tr>
<tr>
<td>Urban over 3K to 10K</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td></td>
</tr>
<tr>
<td>Terraced or semi</td>
<td></td>
</tr>
<tr>
<td>Flat or other</td>
<td></td>
</tr>
<tr>
<td>Bus access medium/poor</td>
<td></td>
</tr>
<tr>
<td>Rail access medium</td>
<td></td>
</tr>
<tr>
<td>Rail access poor</td>
<td></td>
</tr>
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</table>

Results

Reduced variability
HHI 8 modes – economic constraints

Results

[Bar chart showing reduced variability for different income and social grade categories]

- Household income £25-50k
- Household income £50k+
- Social grade B
- Social grade C
- Social grade D and E

ref: under £25k
ref: grade A
HHI 8 modes – mobility resource constraints

Results

- Reduced variability

Bar chart showing the variability of different mobility resource constraints:

- Not main driver of car
- Non driver
- Driver but no car
- Non driver and no car
- Own bicycle
- Bus pass
- No bus pass
- Other bus pass

Values range from 0.60 to 0.90.
Wider model testing

• Similar results for HHI 3 modes and difference primary-secondary

• HHI 3 modes: coefficients for female and income are lower, hence they are not so associated with balance between private, public and active transport, as across all modes

• Number of modes: coefficients of many variables are lower, hence the variables tend to have stronger influence on balance in modes used than number of modes used

• Sensitivity tests
  – Number of stages included as an independent variable and found to predict greater modal variability
Summary – most important predictors

Increased variability:
• High income
• Female
• Own bicycle
• Live in London
• Live in other large urban
• Work part-time
• Live in flat

Decreased variability:
• Household with children
• Low social grade
• Older adult
• Mobility difficulties
• Main car driver
• Season ticket/bus pass
Comparisons to Germany and US

• Like in Germany, females and those not in full-time employment have more modal variability (more household responsibilities and more diverse activities/destinations?)
• Like in US, older adults have less modal variability (unsupportive environment for using some modes?)
Future directions

• Our focus has been on extent to which individuals use different modes, rather than classifying into multimodal groups
• We acknowledge it is also useful to consider particular mode combinations used – a hybrid approach might be used in future (e.g. primary mode used + extent of modal variability)
• Only assessed role of objective factors and would be useful to examine role of subjective factors (attitudes)
• We looked at all travel and would be of interest to examine modal variability for specific types of travel (commuting)
• Modal variability over longer period of time is of interest, including how it is affected by time of year, life events and transport interventions
• In other research at UWE we have opportunity to do this (North Bristol Commuter Panel)
Conclusions

• Policy interest in encouraging a more balanced mix of transport (European Commission ‘Do the Right Mix’ campaign)
• Encouraging individuals to change their relative use of modes, rather than to substitute modes, is likely to be more palatable
• We identified various constraints and enablers of modal variability
• Our findings suggest that supporting bicycle transport and more flexible ownership/payment systems for cars/public transport can achieve more mixed transport use