Impact of bicycle highways on mode choice: A scenario analysis

Co-evolution of network investment and modal demand

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Impact of bicycle highways on mode choice: A scenario analysis

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Bicycle highways

Dedicated cycling paths for fast and direct long-distance commutes.

Main characteristics:
• Sufficient width for safe overtaking.
• Minimal interaction with motorised traffic.

Figure 1: Bicycle highway corridors proposed in the Munich region

Source: Planungsverband Aüßerer Wirtschaftsraum München (2015) and OpenStreetMap contributors (2017), reproduced with permission.
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Objective

To quantify the impact of bicycle highways on mode shares using a mode-choice model in a case study of Munich.

Method

- Commute mode-choice model
- Scenario analysis

Data used

- Commute trips from Mobilität in Deutschland 2008 (Bundesministerium für Verkehr und digitale Infrastruktur, 2009)
- Zone system, synthetic population and MATSim network developed for Munich (Moeckel and Nagel, 2016)
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Model: Explanatory variables

Personal attributes:
- Age
- Sex
- Possession of driver’s licence

Household attributes:
- Household income
- Household size
- Number of autos
- Number of employed persons
- Distance to closest transit stop

Travel-related attributes:
- Travel time

Figure 2: Variable correlations
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Model: Logit structures

- Multinomial logit: alternatives are mutually independent
- Nested logit: alternatives can be correlated within nests

![Figure 3: Modelled logit structures](image)

<table>
<thead>
<tr>
<th></th>
<th>Auto (%)</th>
<th>Bicycle (%)</th>
<th>Transit (%)</th>
<th>Walk (%)</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multinomial logit</strong></td>
<td>71.05</td>
<td>10.89</td>
<td>11.66</td>
<td>6.40</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Nested logit 1</strong></td>
<td>71.13</td>
<td>12.38</td>
<td>11.50</td>
<td>4.66</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Nested logit 2</strong></td>
<td>71.15</td>
<td>10.86</td>
<td>11.53</td>
<td>6.47</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Observed</strong></td>
<td>71.09</td>
<td>10.89</td>
<td>11.55</td>
<td>6.47</td>
<td>—</td>
</tr>
</tbody>
</table>

*Table 1: Commute shares — predicted vs. observed*
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Scenario Analysis

Personal, household and commute attributes
- Zone system (Molloy and Moeckel, 2017)
- Synthetic population (Moreno and Moeckel, 2018)
- Travel times from MATSim network

Bicycle highway corridor
- 17 km pilot route (ADFC München e.V. (2014)

Study areas
- Zones within 2 km radius of the bicycle highway
- Zones within 1 km radius of the bicycle highway
- Zones containing the bicycle highway

Figure 4: Scenario study areas
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Scenario Analysis

Scenarios

- **Base case**: No bicycle highway
- **Scenario 100**: Bicycle highway + existing cycling speeds
- **Scenarios 120, 140, 160, 180, 200**: Bicycle highway + 20, 40, 60, 80 and 100% increase in cycling speeds on the bicycle highway

Conclusions

- Modest mode shift
- Conservative estimates
- Data limitations, hypothetical scenarios

Figure 5: Commute shares predicted across scenarios
References


- Planungsverband Außerer Wirtschaftsraum München (2015), Radschnellverbindungen in München und Umland. Munich, Germany.
Co-evolution of network structure and modal demand

*Advisor:* Prof. David Levinson, University of Sydney
Co-evolution of network structure and modal demand

Objective and research questions

To understand the nature of the causal relationship between network investments and travel demand.

- Does change in modal demand drive network investments or do network investments drive mode shares?
- How does modal demand co-develop across modes in response to network investments in one mode?

Method: Granger causality tests

Case studies: Australian, German, and American cities

Data requirement

- Historical mode shares and network modifications
- Socioeconomic and land-use data
Thank you!
### Impact of bicycle highways on mode choice: A scenario analysis

#### Model: Coefficients

<table>
<thead>
<tr>
<th></th>
<th>Auto (t-value)</th>
<th>Bicycle (t-value)</th>
<th>Transit (t-value)</th>
<th>Walk (t-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>0</td>
<td>1.78 (13.68)</td>
<td>0.57 (13.16)</td>
<td>3.87 (18.34)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>0</td>
<td>-</td>
<td>-0.0039 (-5.62)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>0</td>
<td>0.17 (2.64)</td>
<td>-0.086 (-5.49)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Driver's licence</strong></td>
<td>0</td>
<td>-0.88 (-7.48)</td>
<td>-0.46 (-14.39)</td>
<td>-1.16 (-6.45)</td>
</tr>
<tr>
<td><strong>Household autos</strong></td>
<td>0</td>
<td>-0.73 (-15.19)</td>
<td>-0.36 (-22.66)</td>
<td>-0.56 (-8.42)</td>
</tr>
<tr>
<td><strong>Distance to transit</strong></td>
<td>0</td>
<td>-</td>
<td>-0.13 (-5.32)</td>
<td>-0.30 (-2.34)</td>
</tr>
<tr>
<td><strong>Travel time</strong></td>
<td>-0.0070 (-11.30)</td>
<td>-0.073 (-26.76)</td>
<td>-0.00092 (-3.60)</td>
<td>-0.15 (-20.87)</td>
</tr>
</tbody>
</table>

Note: "-" indicates statistically insignificant estimates. Corresponding variables were eliminated and the model was re-estimated.

*Table 2: Model estimates (Nested logit 2)*
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Scenario Analysis

Figure 6: Average bicycle speeds across scenarios