Preferred citation style for this presentation

Zöllig Renner, C.

Simulating the evolution of urban systems for sustainability assessment

Simulating the evolution of urban systems for sustainability assessment

C. Zöllig Renner

Overview

Introduction
Model
Case study results
Experiences and challenges
Urban systems' evolution

1950

1980

2010
Consequence of decisions

Source: Zöllig at al. (2011)
Overview

Introduction

Model

Case study results

Experiences and challenges
Simulation area and time period

Simulation start: 2000
Evaluation period: 2000-2010
Simulation period: 2010-2030
Structure of the model system

- Plan types (development constraints)
- Environment data (e.g. topography)

Agents / entities
- UrbanSim model
- MATSim model
- Modgen model

Demography
- Income and car ownership update

Household
- Departure time choice
- Mode choice
- Route choice

Real estate price

Building location choice

Building transition

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Geographies

Network

Parcel

Parcels

Accessibility

Resident

Job

Workplace choice

Employment transition

Employment relocation

Employment location choice

Household relocation

Living unit

Living units

Building

Building location choice

Accessibility

Network

Parcel

Parcel

UrbanSim model

MATSim model

Modgen model
Interaction of sub-models

Demogr.

New households/split & merge of hh

Distribution of households

MATSim

Accessibility/Traveltime (10%)
Mode Choice (10%)

Distribution of Jobs

REPM

Price

HLCM

Location

BLCM

Price

ELCM

Location

Location
### Real estate price model

<table>
<thead>
<tr>
<th></th>
<th>UrbanSim</th>
<th>Comparis 2005 (Löchl 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect</td>
<td>Sign.</td>
</tr>
<tr>
<td>Constant</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Car accessibility</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>PT accessibility</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Built in 1921 to 1930</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Built in 1981 to 1990</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Built after 1991</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Built before 1921</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Distance to station</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td>Proximity to highway (&lt; 100 m)</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td>Is a single family house</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Jobs in hotels and gastronomy</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>View of lake (ha)</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Population density (ln)</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td>Size in m² (ln)</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Slope of terrain</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Sunshine index (evening)</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Foreigners within 300 m</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Adj. Likelihood ratio index:</td>
<td>0.78173</td>
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## Household location choice model

<table>
<thead>
<tr>
<th>Effect</th>
<th>Sign.</th>
<th>Variable</th>
<th>Effect</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building age</td>
<td>+ **</td>
<td>Proximity to main road and railway (noise)</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td>Building is new build (dummy)</td>
<td>+ **</td>
<td>Distance to Zurich CBD</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Share of rent to income</td>
<td>- **</td>
<td>Distance to motorway on-ramp (car owners)</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td>Rooms per person</td>
<td>- **</td>
<td>Distance to station (car non-owners)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Space per room (m²)</td>
<td>+ **</td>
<td>Denisty of retail jobs</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td>Distance to previous location (beta *dist ^eta)</td>
<td>- **</td>
<td>Distance to school</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>Distance to workplace (beta *dist ^eta)</td>
<td>- **</td>
<td>Density of service jobs</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td>Car accessibility</td>
<td>- **</td>
<td>Share of households in same age</td>
<td>+</td>
<td>**</td>
</tr>
<tr>
<td>PT accessibility</td>
<td>+ **</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adj. likelihood ratio index | 0.522 | Schirmer, van Eggermond and Axhausen (2013)
Number of observations | 1065 |
Overview

Introduction
Model
Case study results
Experiences and challenges
Valuation – Persons

Difference of simulation to validation 2000:
Persons per km$^2$ of municipality

Difference of simulation to validation 2008:
Persons per km$^2$ of municipality
Valuation – Jobs

Difference of simulation to validation 2001:
Jobs per km² of municipality

Difference of simulation to validation 2008:
Jobs per km² of municipality
Scenario: Definition policies

Roadpricing (cordon toll)

Legend
Priced links Zurich
Zurich

Densification

Legend
Densified
Lakes
Settlements
Canton Zurich
Scenario: Evaluation over time

Scale of observation
- cordon crossing traffic (CC)
- within-cordon residents (Zrh)

Travel time for residents of densification zones

Scenario legend:
- Baseline
- Road pricing
- Densification
- Road pricing and densification

Graphs showing share of cars, travel time, and travel distance for CC and Zrh over the years 2005 to 2025.
Scenario: Cross-sectional evaluation

Percentage deviation from baseline, 2030

<table>
<thead>
<tr>
<th>Variable</th>
<th>Road pricing</th>
<th>Densification</th>
<th>Road pricing &amp; Densification</th>
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<tbody>
<tr>
<td><strong>Travel indicators</strong></td>
<td></td>
<td></td>
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<tr>
<td>Travel time in study area</td>
<td>5.1</td>
<td>0.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Travel time in cordon crossing traffic</td>
<td>5.3</td>
<td>0.3</td>
<td>4.6</td>
</tr>
<tr>
<td>Travel time of inhabitants of densification zones</td>
<td>10.2</td>
<td>24</td>
<td>30.2</td>
</tr>
<tr>
<td>Distance travelled by car in study area</td>
<td>-1</td>
<td>-0.7</td>
<td>-1.9</td>
</tr>
<tr>
<td>Distance travelled by car in cordon crossing traffic</td>
<td>-3.2</td>
<td>0</td>
<td>-3.5</td>
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<tr>
<td>Distance travelled by car by residents of Zurich</td>
<td>-1.9</td>
<td>3.1</td>
<td>-1.4</td>
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<tr>
<td>Travel time by car in study area</td>
<td>-1.3</td>
<td>-1</td>
<td>-1.9</td>
</tr>
<tr>
<td>Travel time by car in cordon crossing traffic</td>
<td>-3.5</td>
<td>-0.2</td>
<td>-3.6</td>
</tr>
<tr>
<td>Travel time by car by residents of Zurich</td>
<td>6.9</td>
<td>2.8</td>
<td>-0.6</td>
</tr>
<tr>
<td>Car share in study area</td>
<td>-4</td>
<td>-0.6</td>
<td>-4.1</td>
</tr>
<tr>
<td>Car share in cordon crossing traffic</td>
<td>-4.5</td>
<td>-0.2</td>
<td>-4.5</td>
</tr>
<tr>
<td>Car share of residents of Zurich</td>
<td>-2.4</td>
<td>-0.2</td>
<td>-2.7</td>
</tr>
<tr>
<td><strong>Land use indicators</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of households in Zurich</td>
<td>-0.7</td>
<td>1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Number of jobs in Zurich</td>
<td>4.9</td>
<td>-0.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Number of living units in Zurich</td>
<td>-0.6</td>
<td>0.9</td>
<td>-0.1</td>
</tr>
<tr>
<td>Number of households in densification zones</td>
<td>-0.6</td>
<td>18.3</td>
<td>16.8</td>
</tr>
<tr>
<td>Number of jobs in densification zones</td>
<td>1.1</td>
<td>0.8</td>
<td>2.3</td>
</tr>
</tbody>
</table>
Experiences

Integrated consideration of land use and transport changes problem perception
Dynamic and detailed modelling allows flexible assessment (scale, aspect)
Extensible to other aspects of sustainability
Packages of measures can be assessed → Coordination

Data preparation is work intensive
Important data is not available
Considerable computation time (2.5 days)
Expertise required

→ Potential to help governing regional sustainability transition.
How can such a system be put to practice?
The management model of regional capital stocks

Capital stocks
(comprehensive, location specific)

Stakeholder / Actors

Public sector, administration
Companies, associations
Social organisations, NGO’s
Inhabitants, employees, consumers
Scientists, planers, consultants

Adapted from Renner (2012)
Simulation as crystallisation point on round table about regional capital stocks with stakeholders

Adapted from Renner (2012)
Supporting the regional management cycle

1: Find relations in regional data, derive preferences for characteristics
2: Describe current state
3: Stimulate visions, strategies and innovative solutions by contrasting expectations to scenarios
4: Integrate monitoring and controlling to achieve lean processes and continuity

Adapted from Renner (2012)
Conclusion

Integrated land use transport simulation offers a distinct approach to governance and can be a helpful tool in various stages of regional management processes aiming for sustainability transition in regions.