Bevorzugter Zitierstil

Axhausen, K.W. (2011) Development paths for agent-based models of activity scheduling, ITLS Seminar, University of Sydney, May 2011.

Development paths for agent-based models of activity scheduling

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May 2011

FUTURE CITIES
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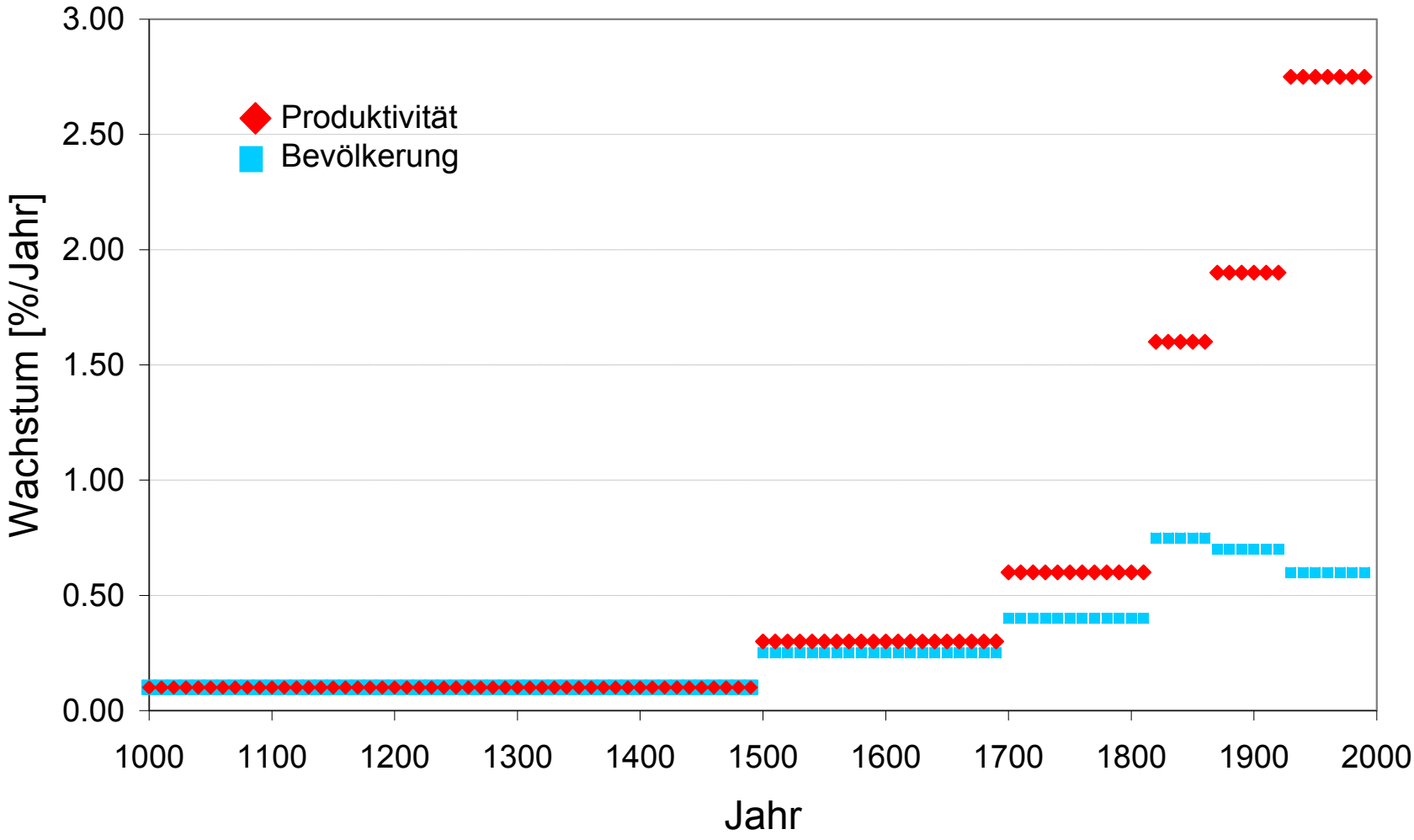
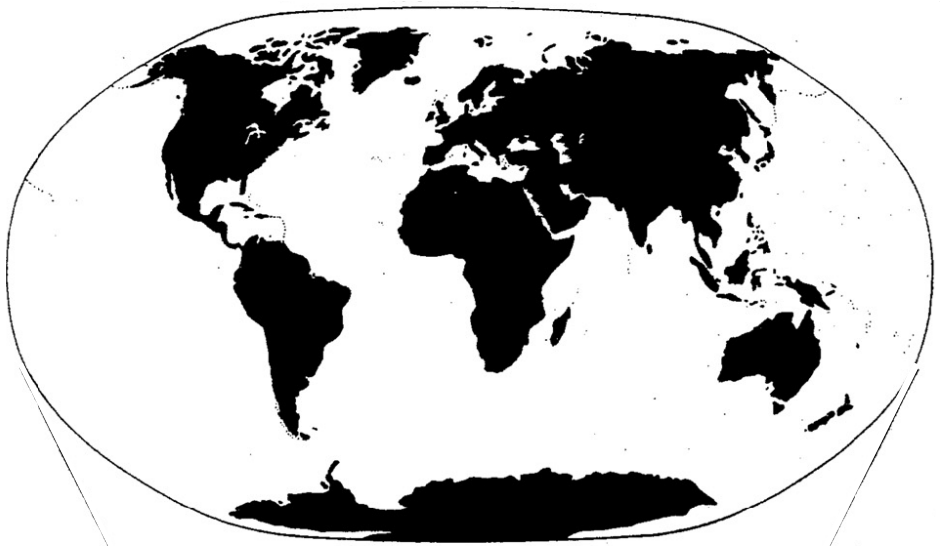
What are the big issues ?

Productivity and population growth in Western Europe



Singapore, 2011 (2000), Figure 1

A shrinking world



Coach and sailing boat until 1840

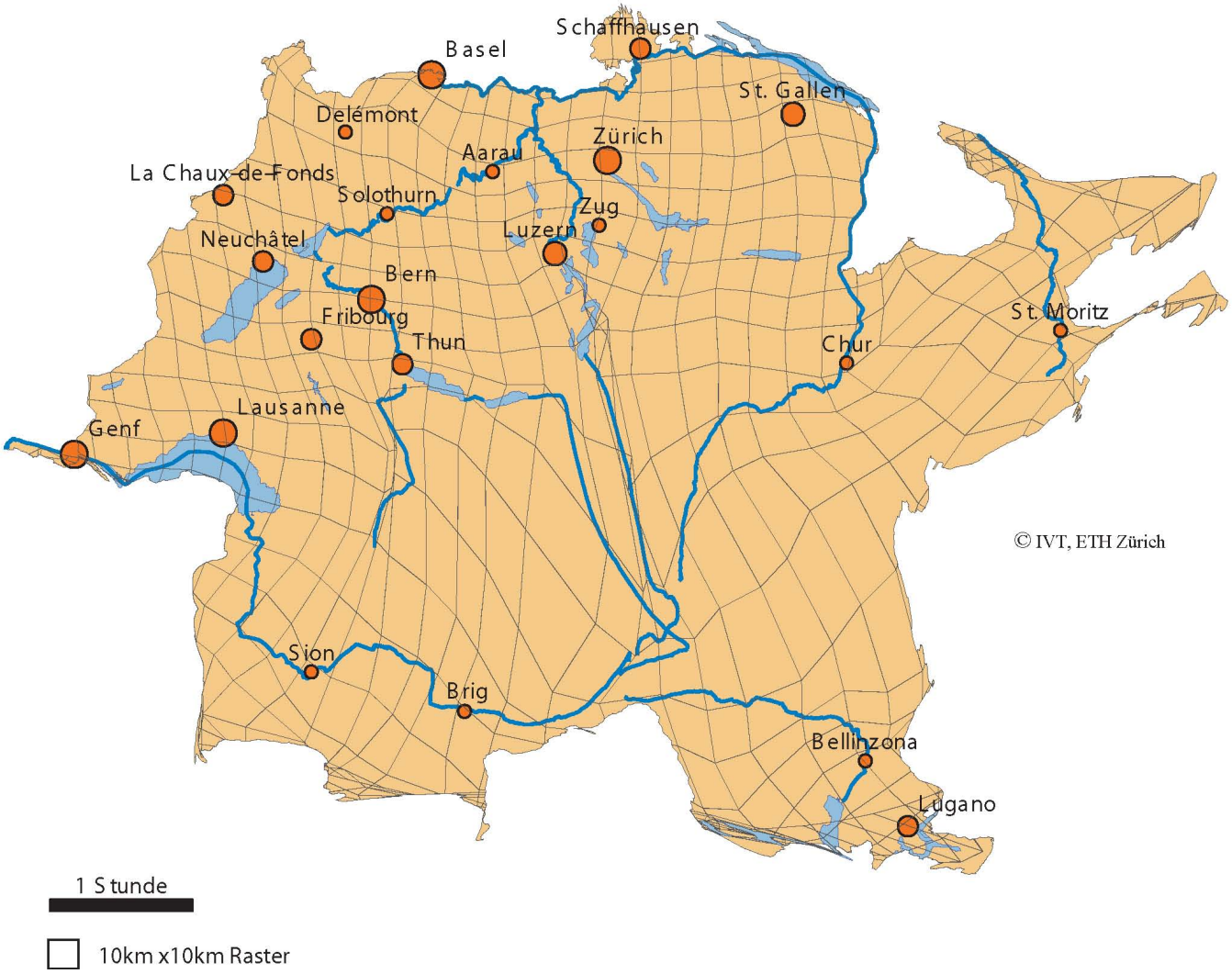
Steam ship and locomotive, 1840 - 1930

Propeller aircraft, 1930-1950

Jets, from 1950

Dicken, 1998

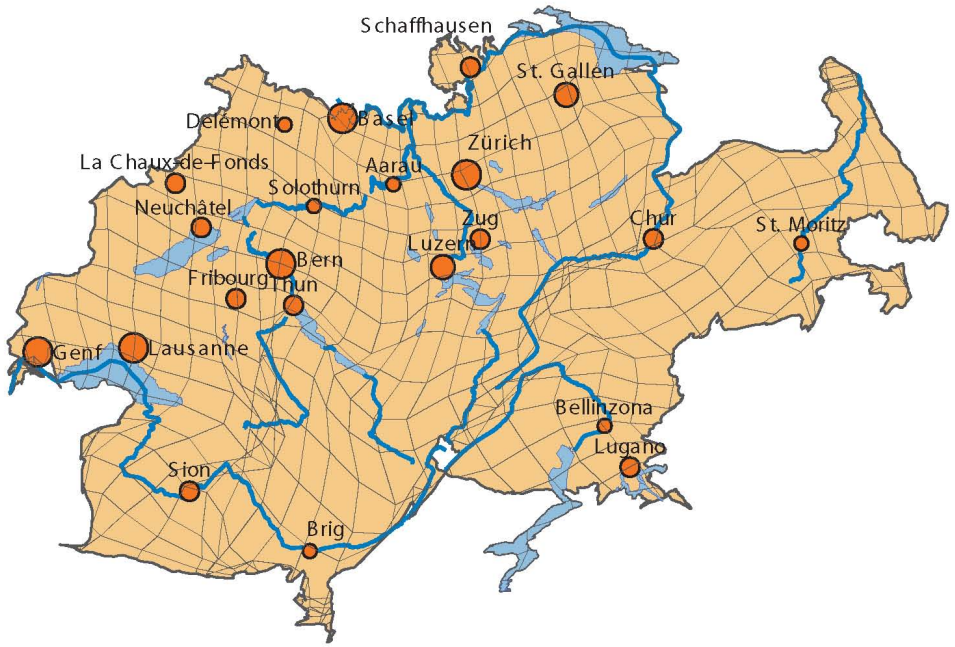
Shrinking “road” – Switzerland (1950)



Scherer, 2004

Stunde 1

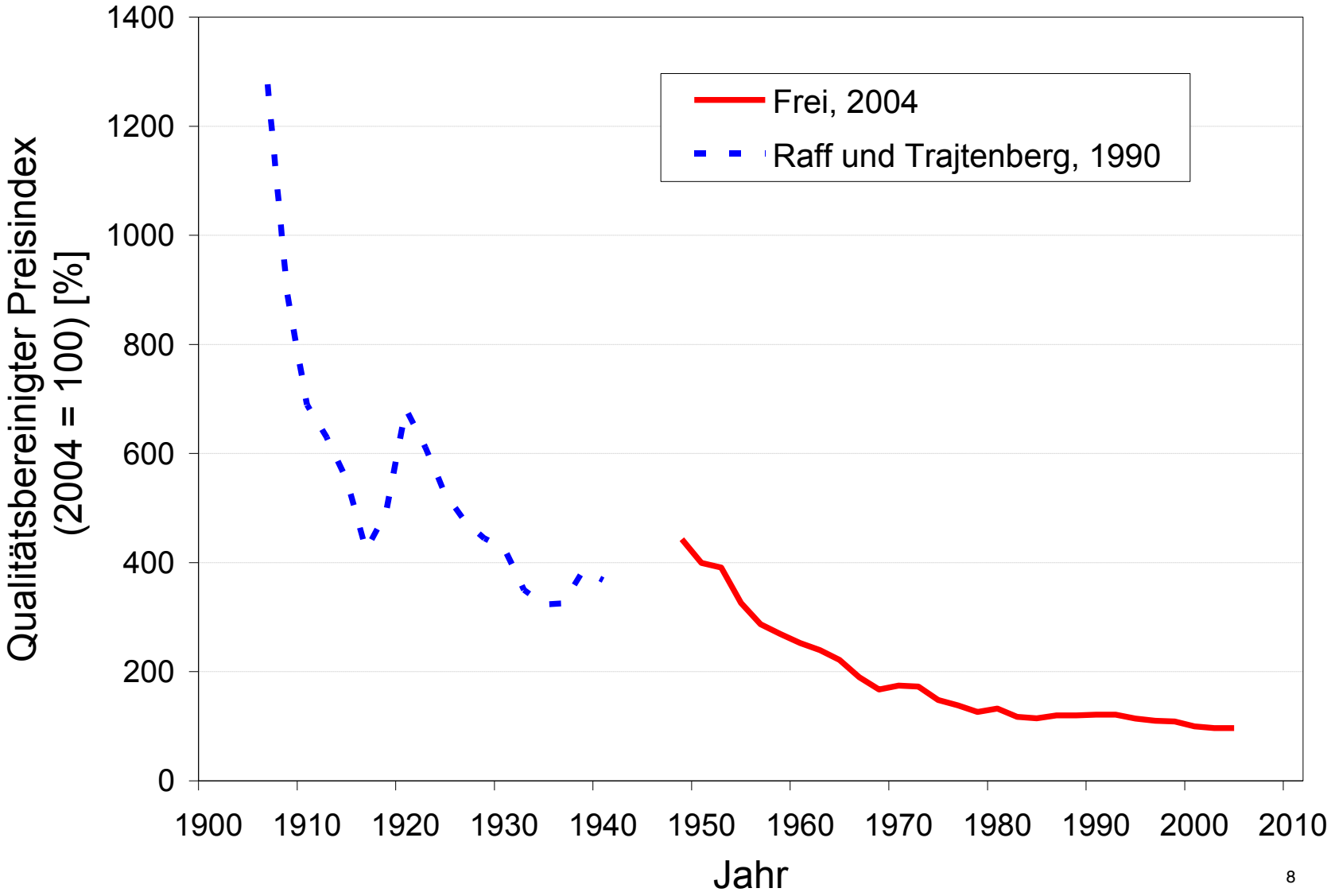
Shrinking “road” Switzerland (2000)



Scherer, 2004

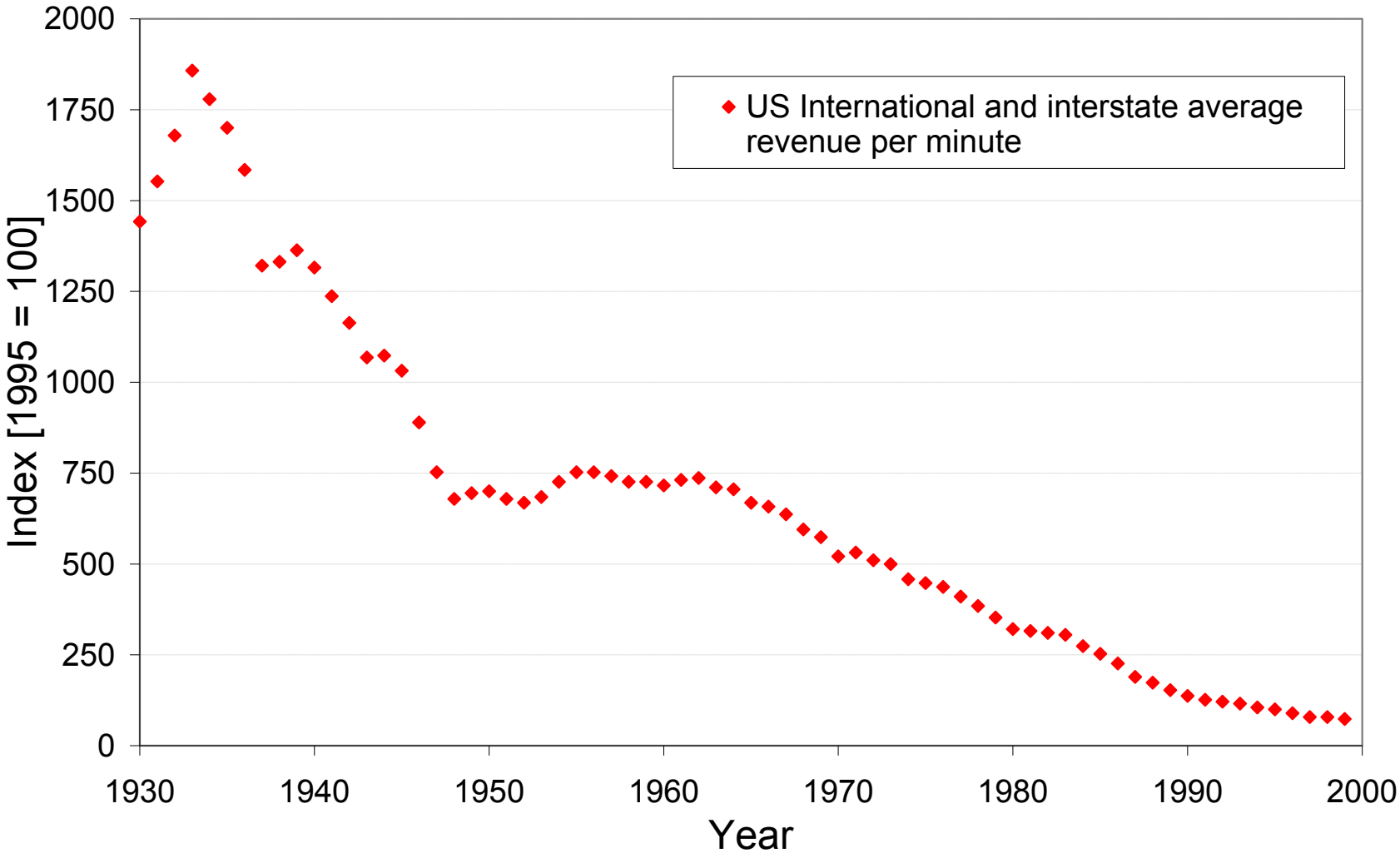
Stunde 1

Quality-adjusted price of a new car in Switzerland



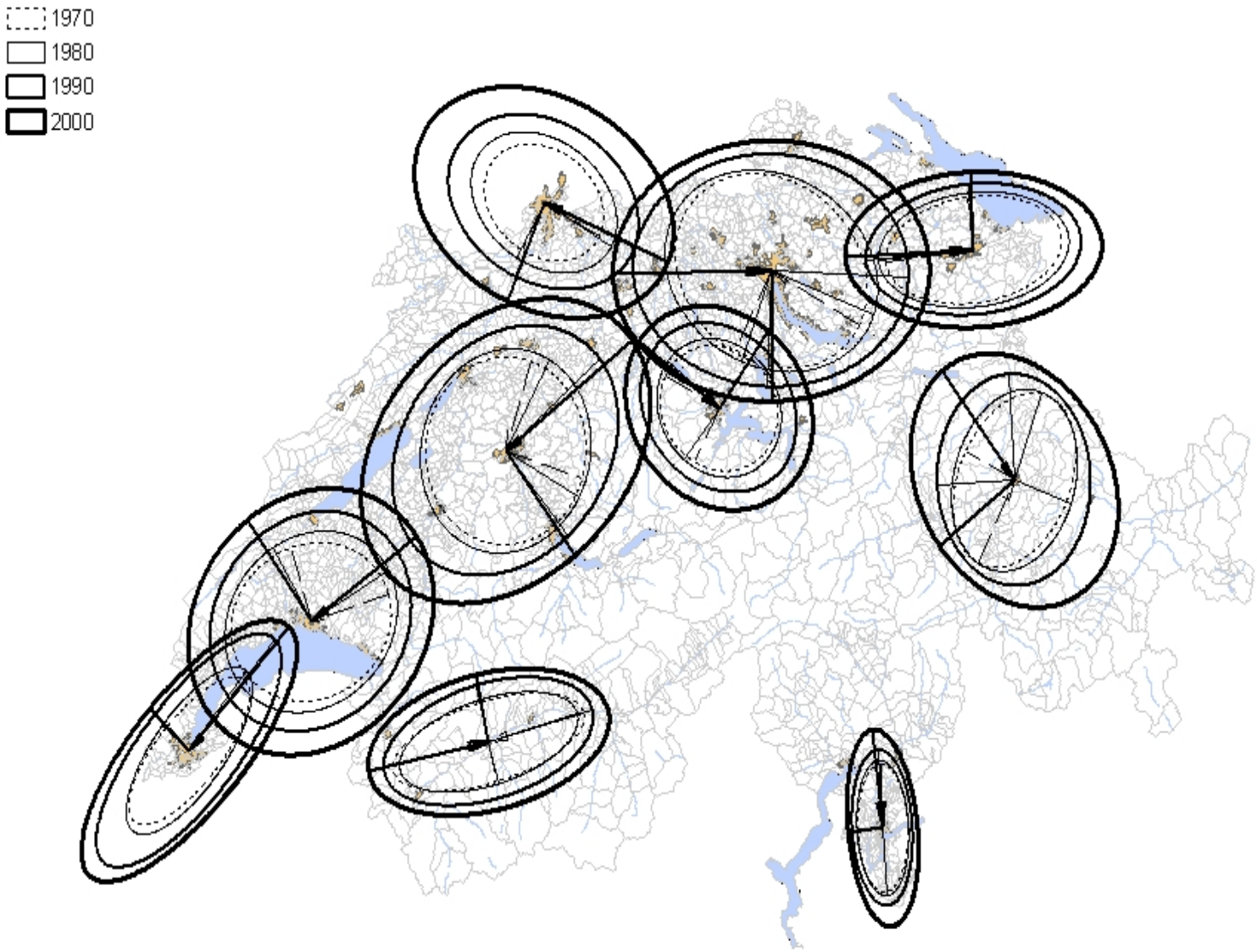
Frei, 2005

Price of telecommunication



Adapted from FCC (2001)

Swiss commuter catchment areas since 1970



Adapted from Botte, 2003

Retail productivity 2003 in selected European countries

Country	€/Employee	€/m²	m²/Head	€/Head
Austria	134.612	5.261	1,9	2.767
Germany	132.052	4.198	1,4	3.038
Italy	139.131	4.224	1,4	3.128
Belgium	199.585	5.384	1,4	3.835
Denmark	152.703	5.671	1,4	4.029
Netherlands	111.656	4.845	1,1	4.412
France	203.985	5.772	0,9	6.411
UK	115.926	6.089	0,7	8.696

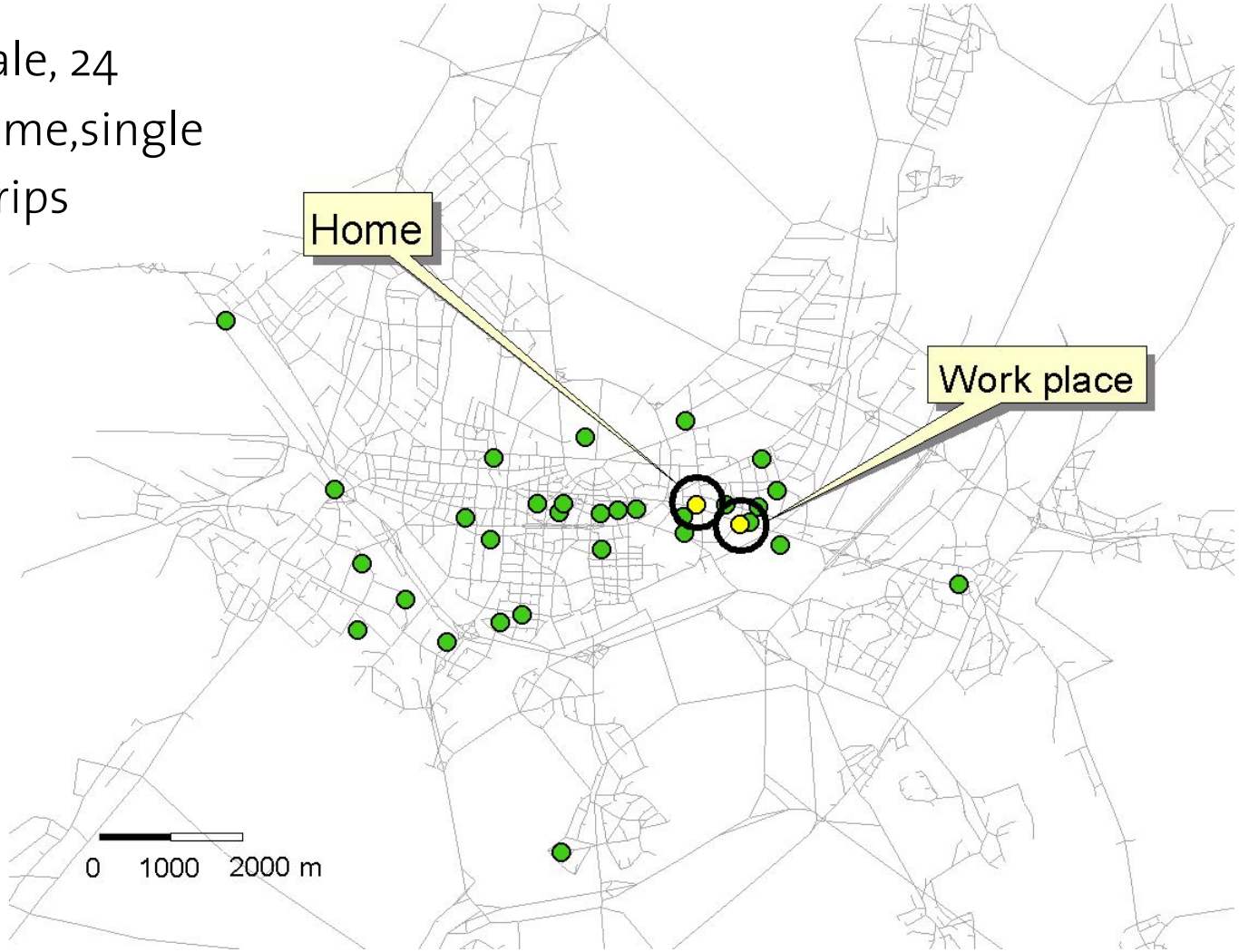
Source: empirica, EHI Handel aktuell 2006/2007

An example activity space

Female, 24

Fulltime,single

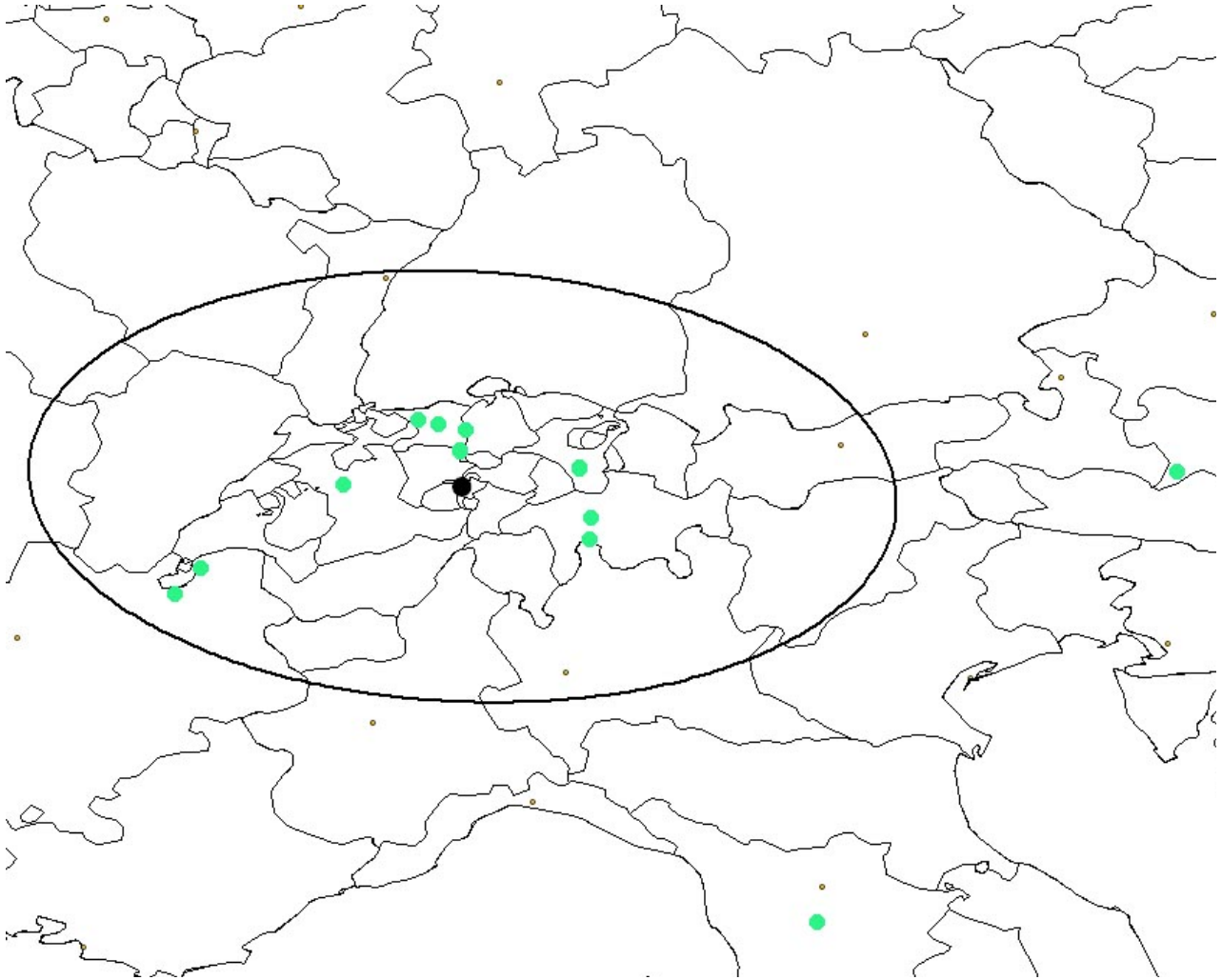
216 trips



Trip purpose distributions (ca. 2005)

Share of kilometers traveled [%]	Switzer-land	Germany	UK	USA
Leisure	44.8	38.3	33.7	32.2
Work/School	35.0	29.7	32.0	31.3
Shopping/Privat business	11.2	21.7	19.7	27.6
Escort	4.9	4.5	7.6	8.5
Others	1.8	4.8	7.1	0.5
Total	100.0	100.0	100.0	100.0

Example social network geography



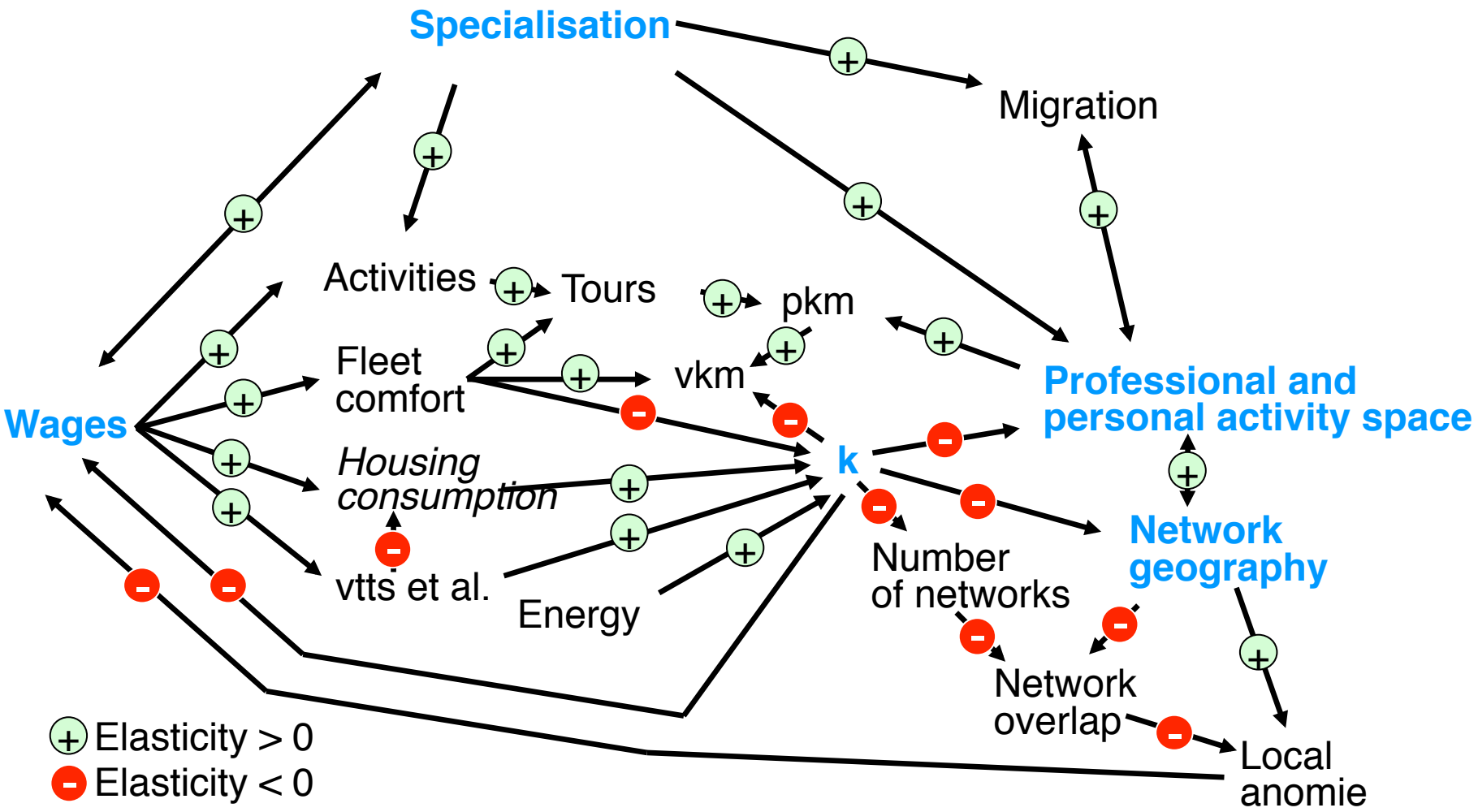
Female, 28,

4 residential moves

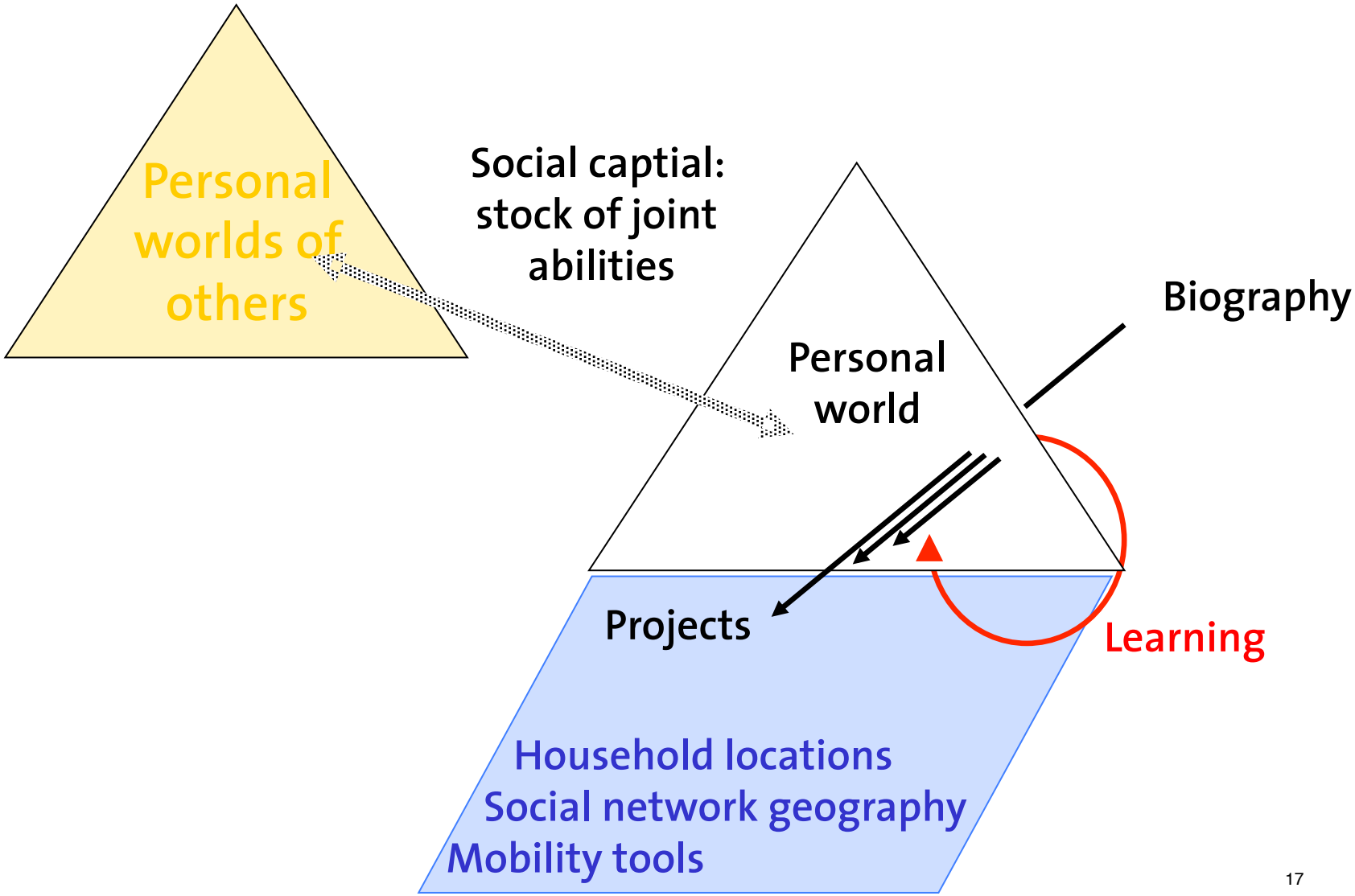
Ohnmacht, 2004

Theoretical approaches

Dynamics of personal space use and speed

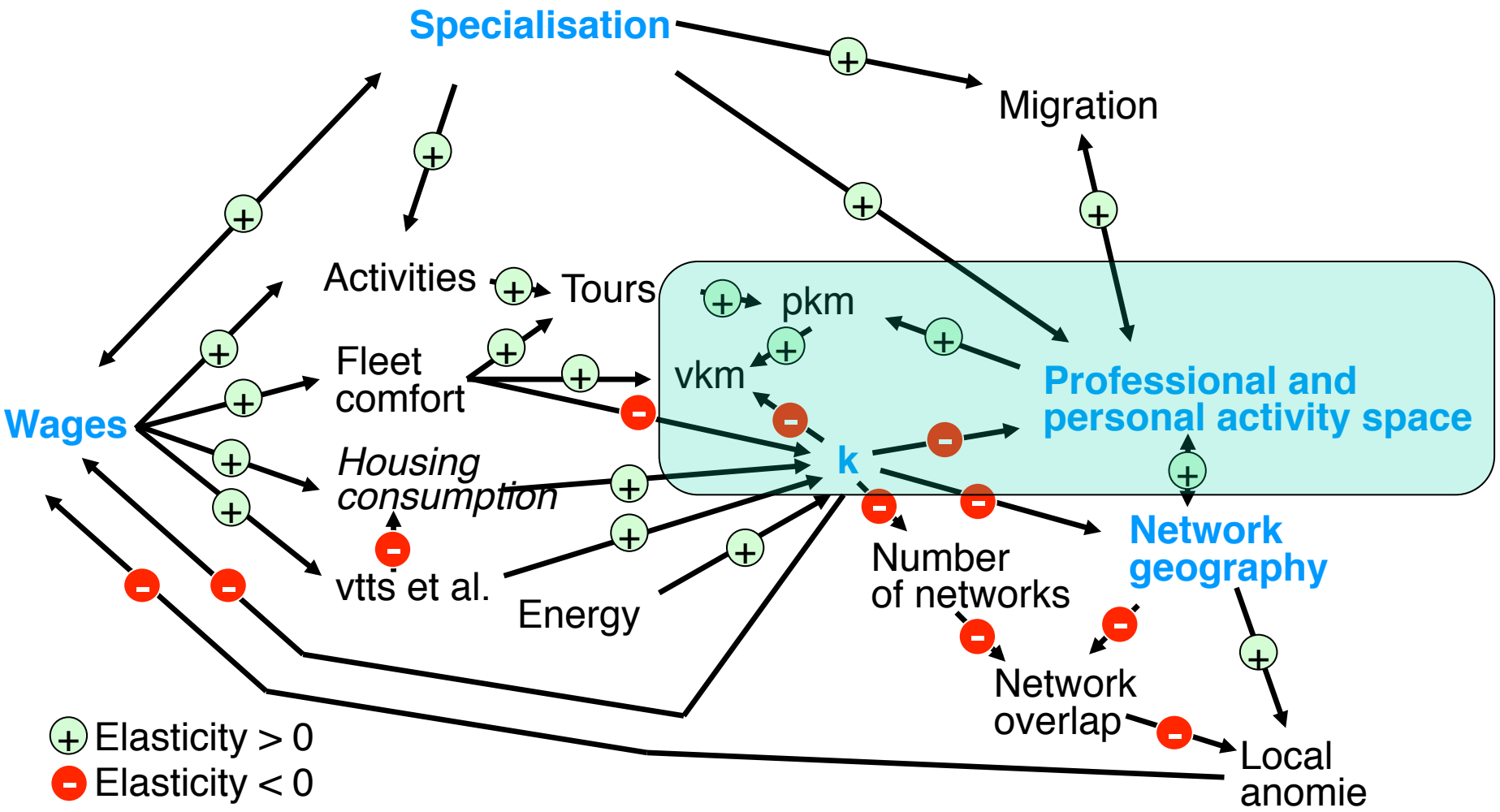


(Moving) actors in social/physical networks



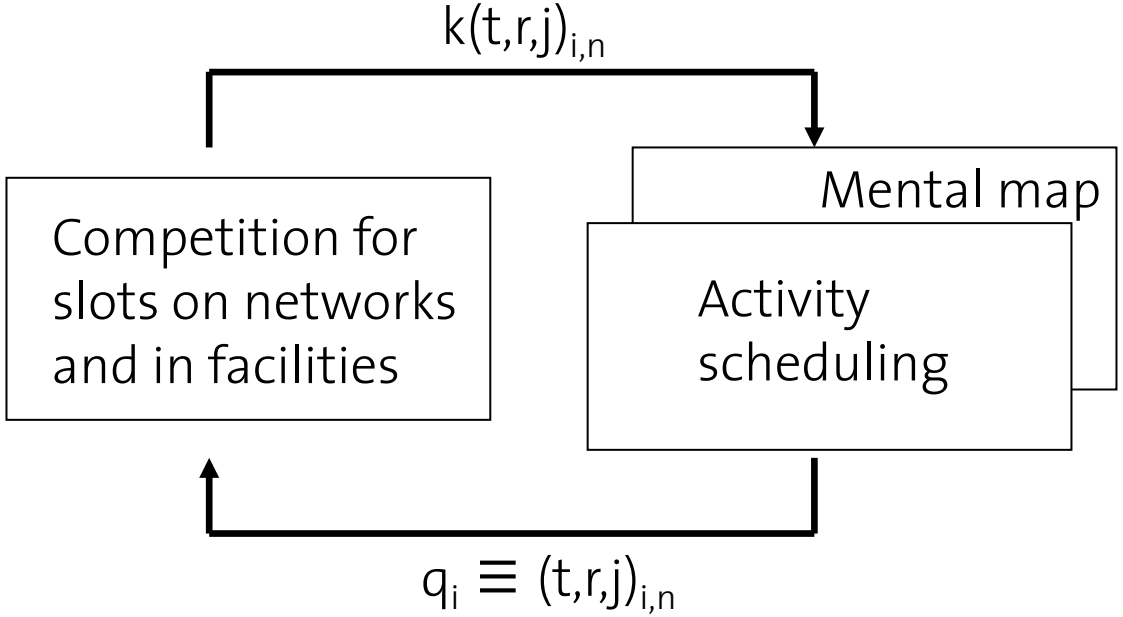
What are we currently looking at ?

A microscopic explanation ?

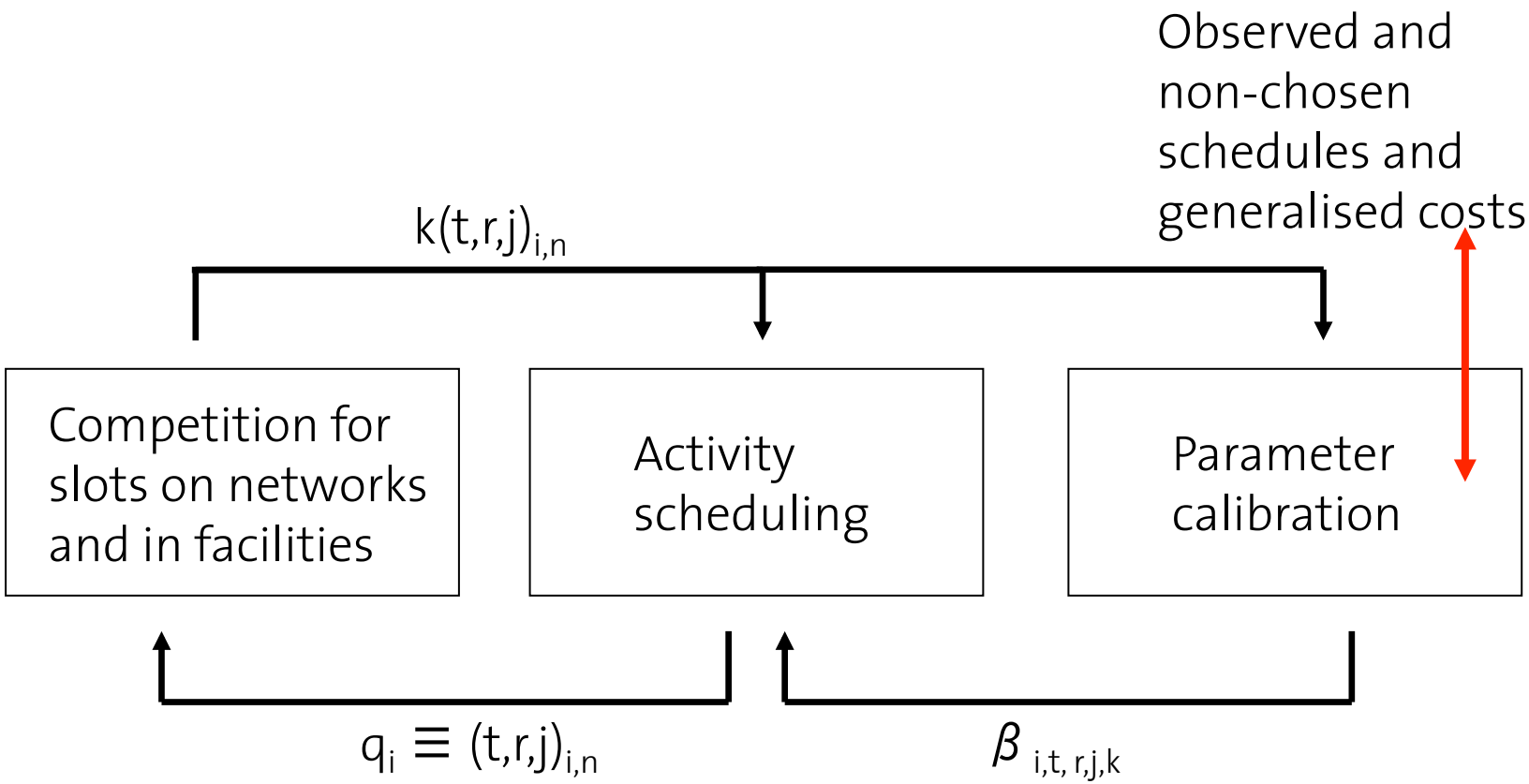


What do we do ?

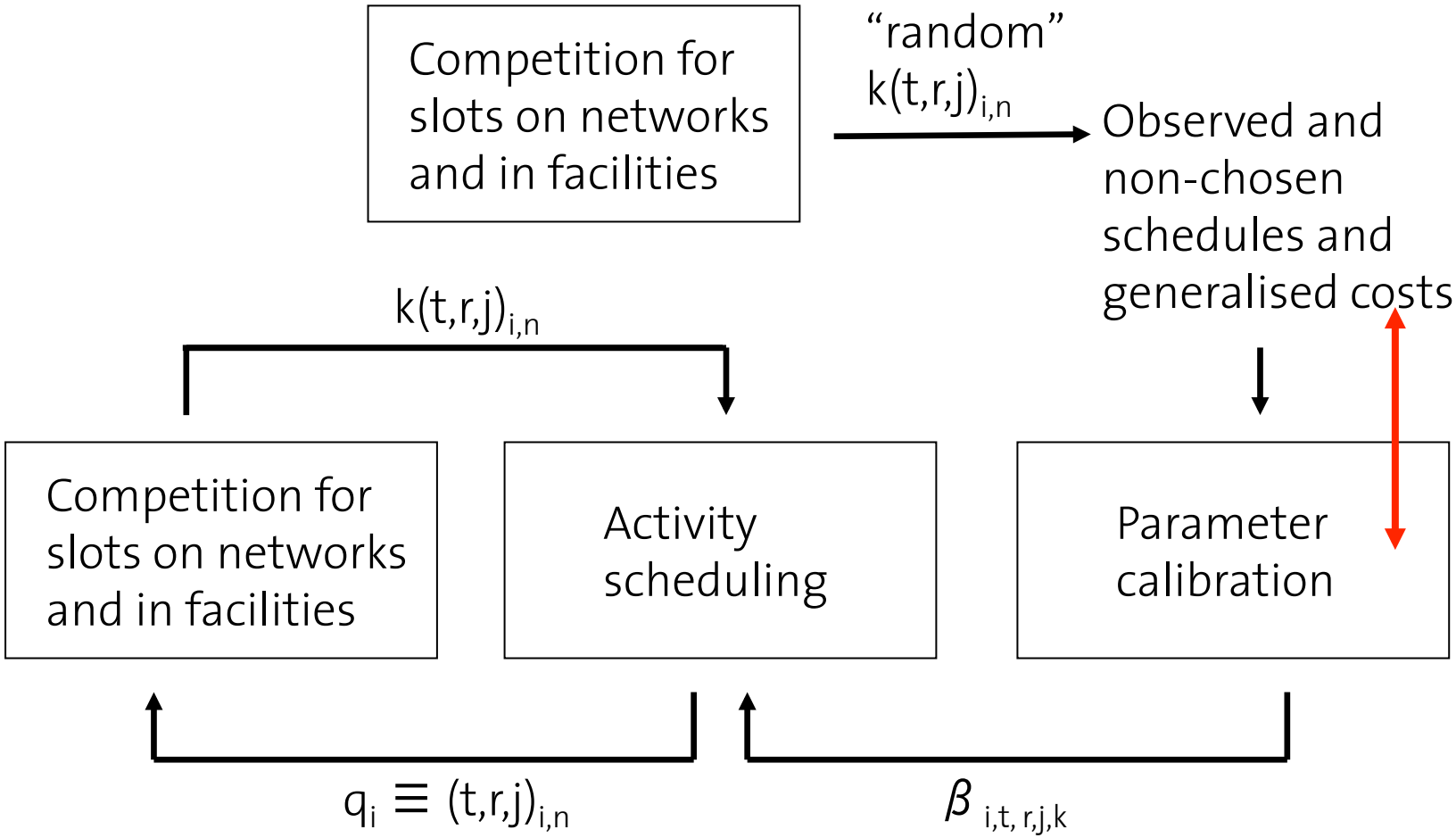
Learning approach of the generic one-day transport model



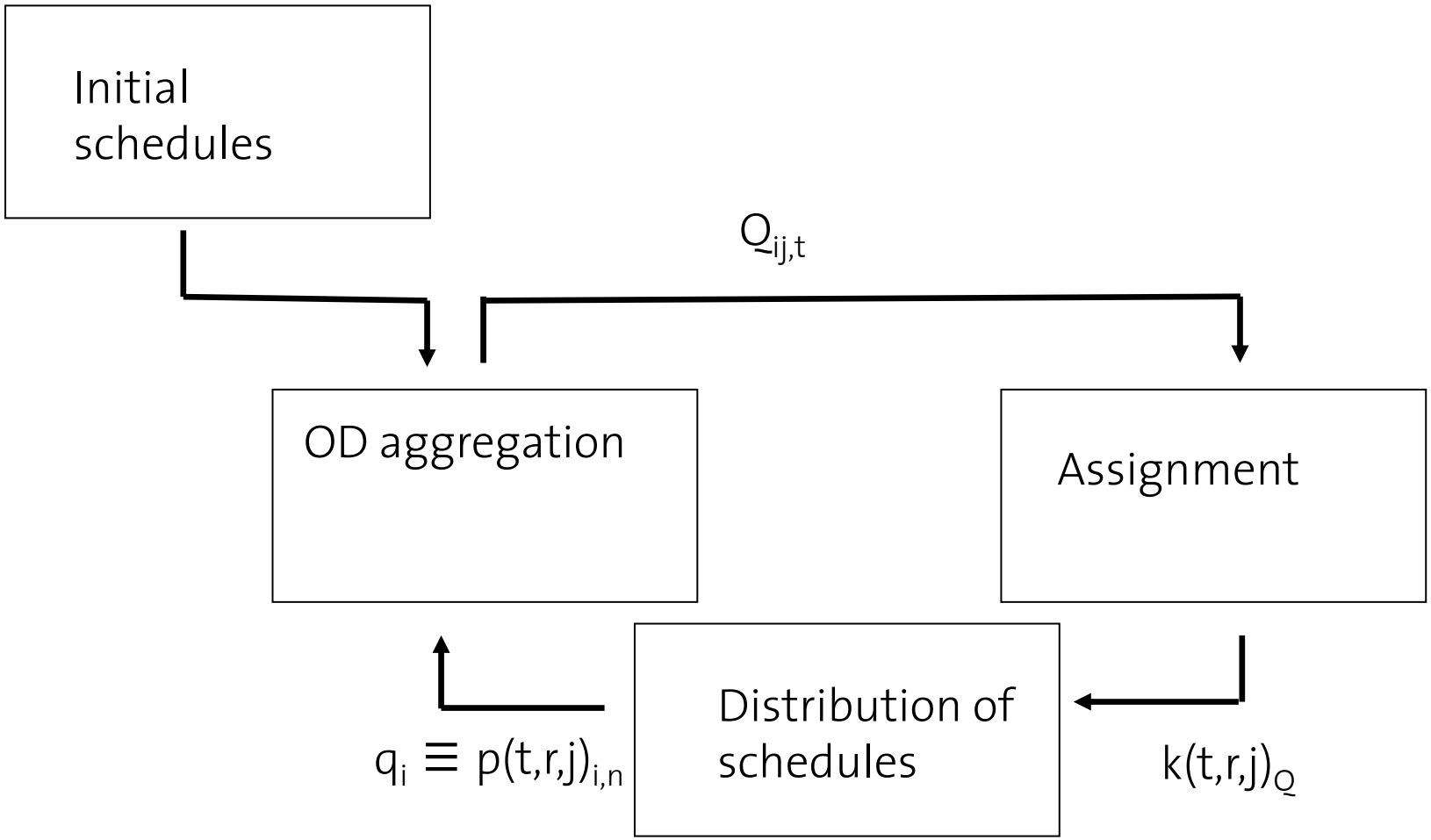
Which equilibrium ? With parameters ?



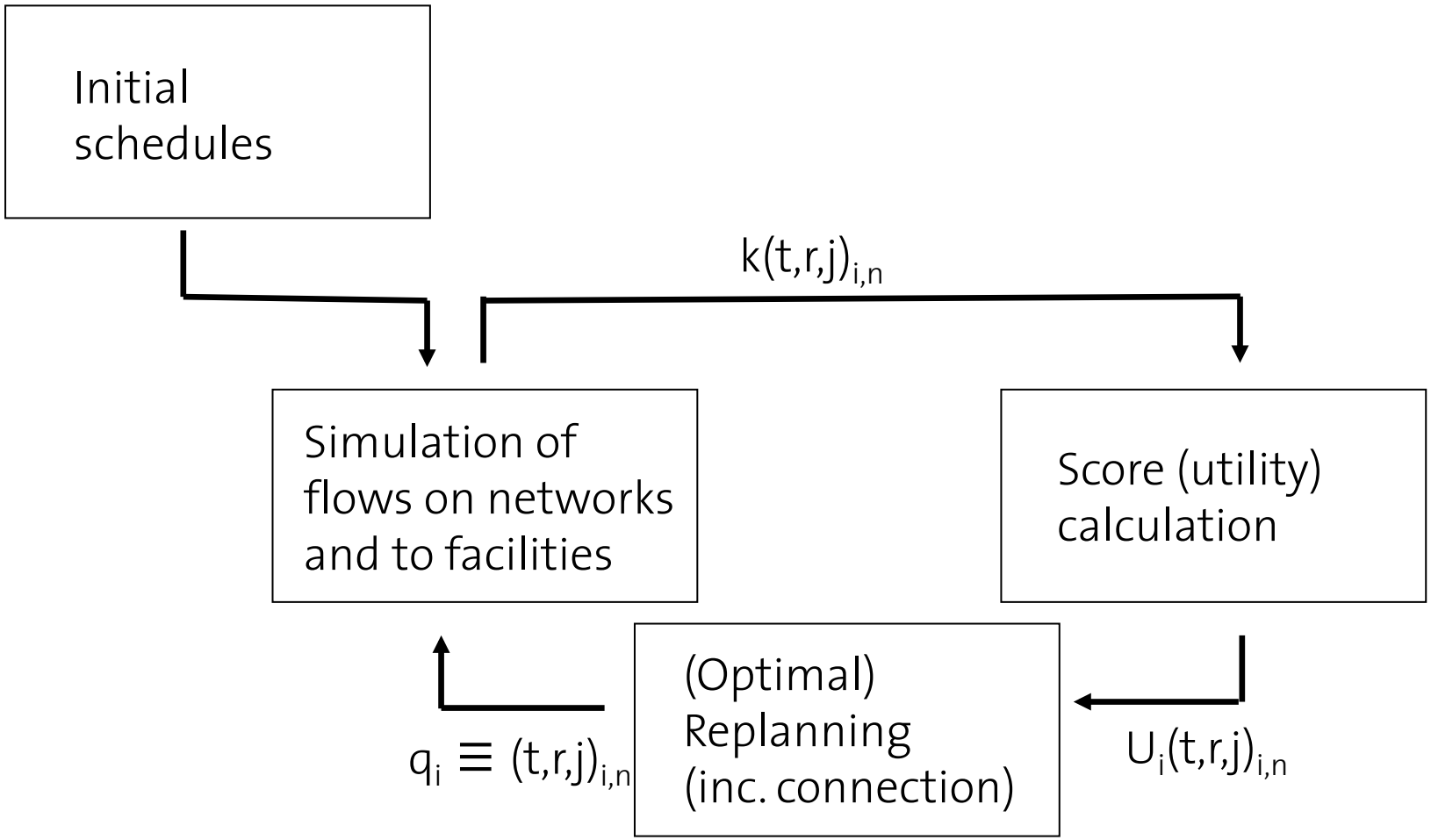
But what we do



Equilibrium search in ABM & assignment combinations



Equilibrium search in MATSim



Development paths

- Choice modelling driven:
    - Construction of choice sets
    - Complex nested choice models
- Equilibrium-driven:
    - Optimal schedules
    - Description of traveller heterogenity
- Naturalistic non-equilibrium
    - Unforeseen interactions and possibilities
    - Incremental dynamic choices at different strategy levels

MATSIM: equilibrium driven agent-based simulation

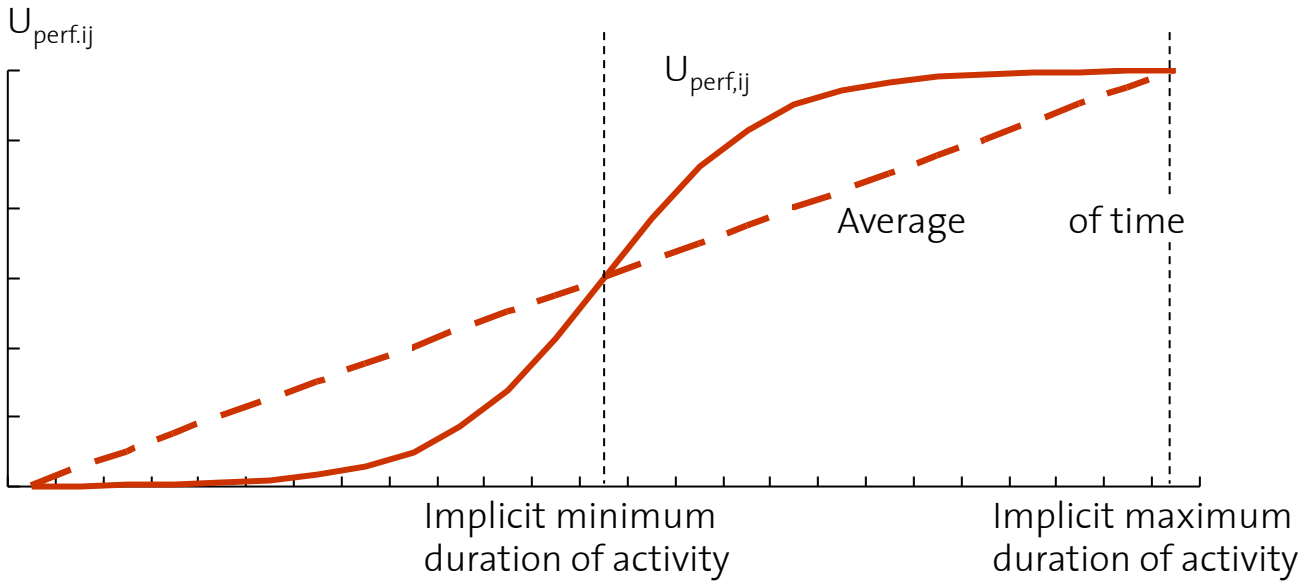
Activity scheduling with Vickrey-style utility function

Number and type of activities
Sequence of activities

- Start and duration of activity
- Composition of the group undertaking the activity
- Expenditure division
- Location of the activity
    - Movement between sequential locations
        - Location of access and egress from the mean of transport
            - Parking type
        - Vehicle/means of transport
        - Route/service
        - Group travelling together
        - Expenditure division

Joh's 2004 utility function for activities

$$U_{perf,ij}(t_{perf,ij}) = U_{ij}^{min} + \frac{U_{ij}^{max} - U_{ij}^{min}}{(1 + \gamma_{ij} \cdot exp\left[\beta_{ij}(\alpha_{ij} - t_{perf,ij})\right])^{1/\gamma_{ij}}}$$



Activity schedule with Joh-style utility function

Number and type of activities
Sequence of activities

- Start and duration of activity
- Composition of the group undertaking the activity
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- Location of the activity
    - Movement between sequential locations
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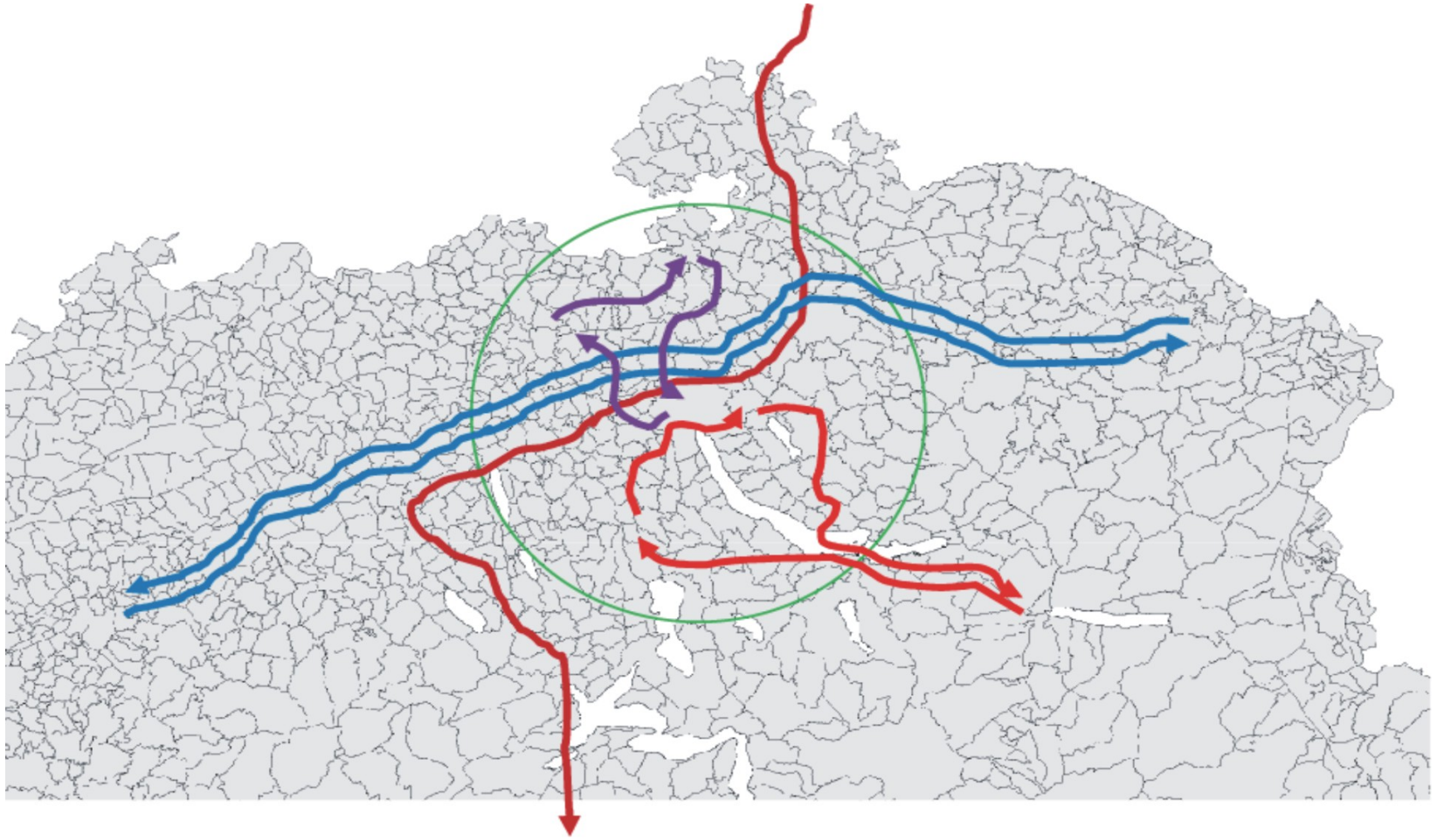
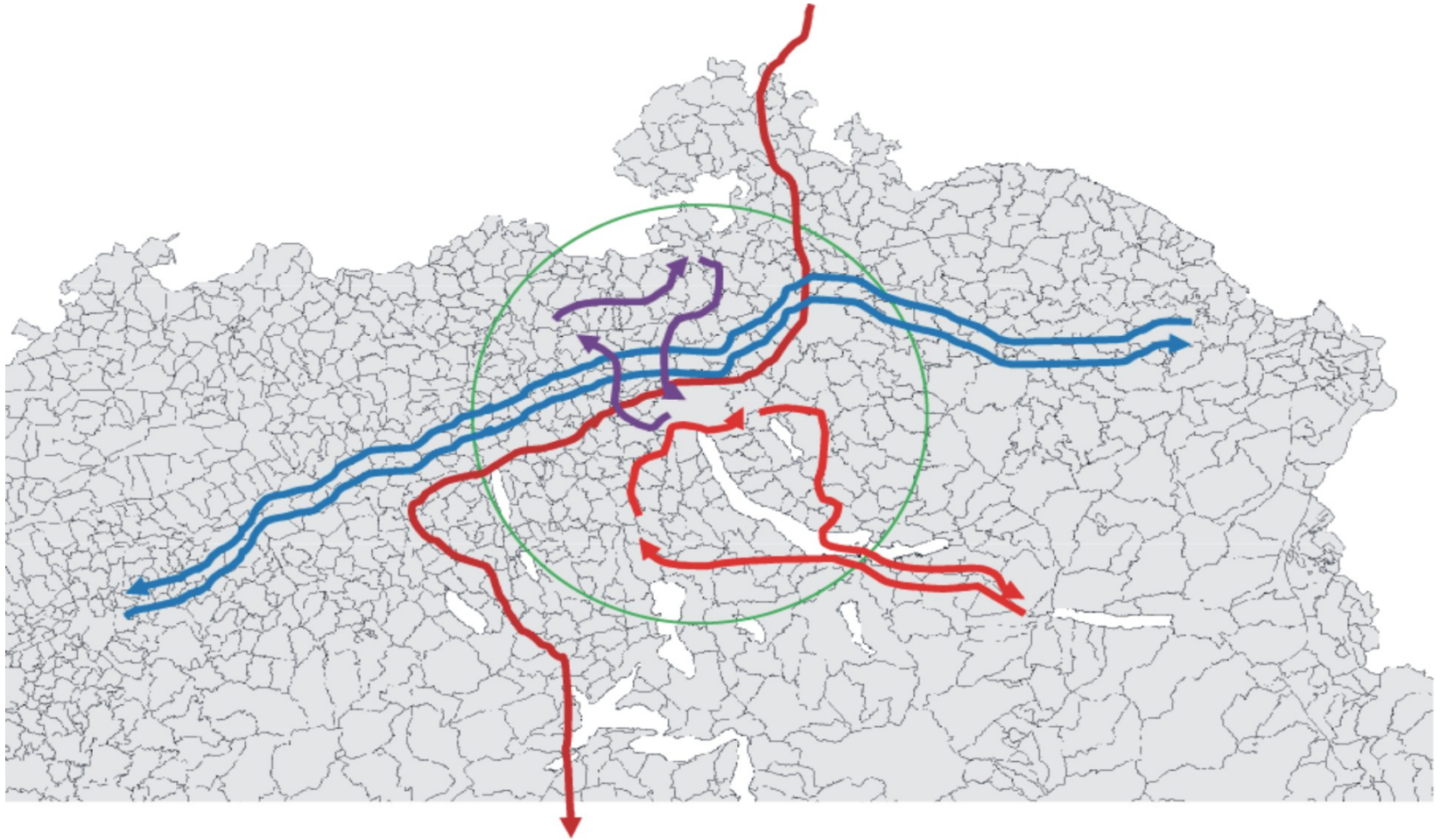
        - Route/service
        - Group travelling together
        - Expenditure division

Example: MATSim – Zürich scenario



Case study area: 10% sample with NPVM network



Case study, but

170’000 agents travelling in and through 30 km radius

NPVM – planning network

1’300’000 home locations, 300’000 facilities

No freight traffic

No border crossing traffic

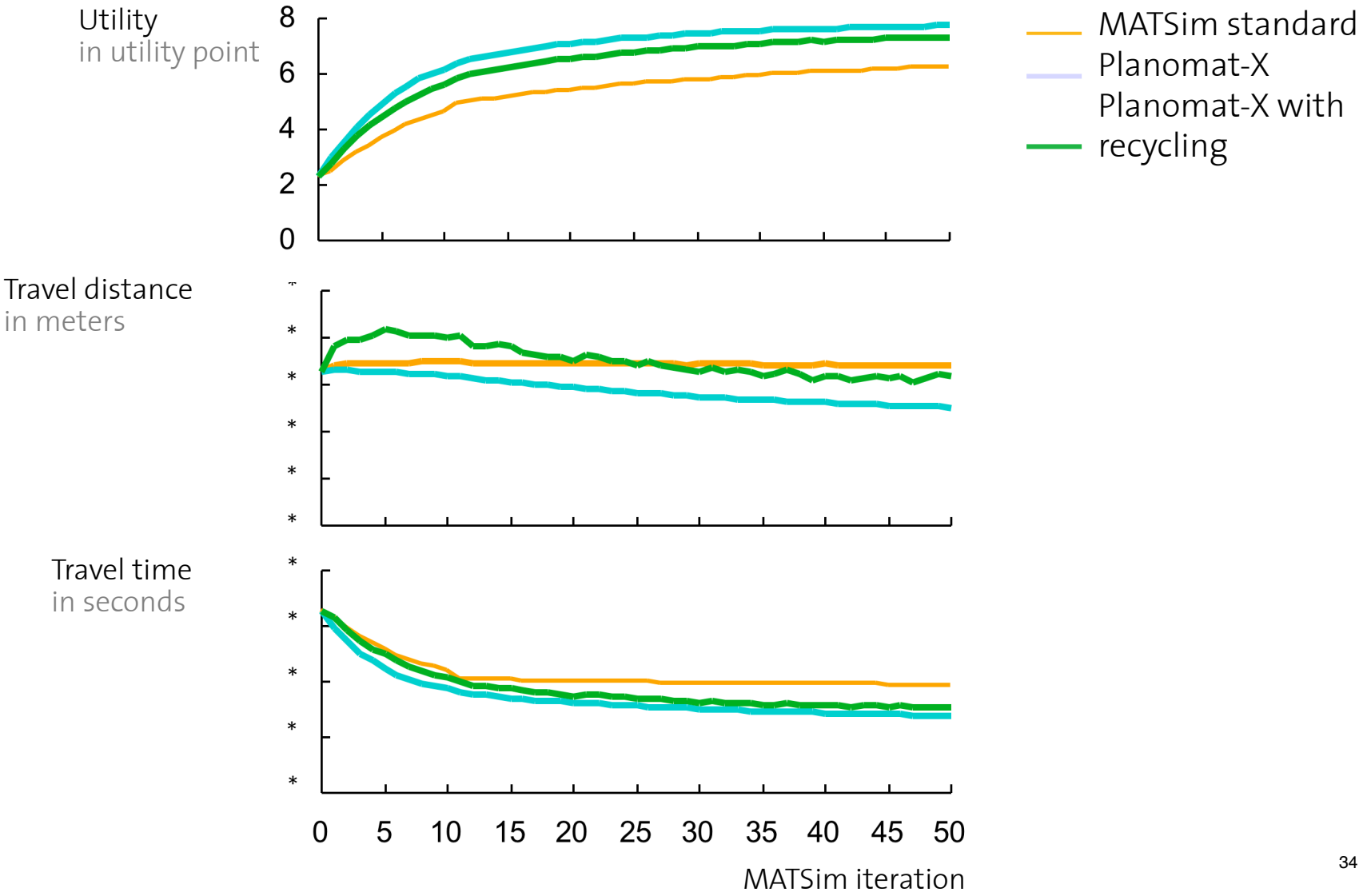
Rule of thumb - public transport travel times

Rule of thumb – marginal cost estimates (accounting for mobility tool ownership)

Undifferentiated closing times for leisure facilities

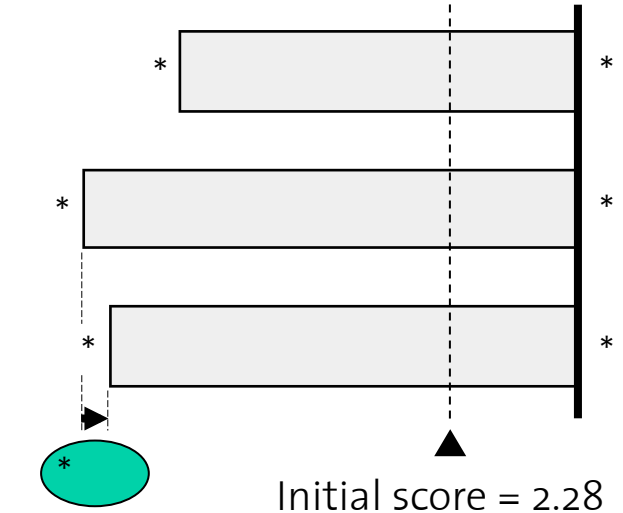
Leisure only out-of-home

Planomat-X with schedule recycling

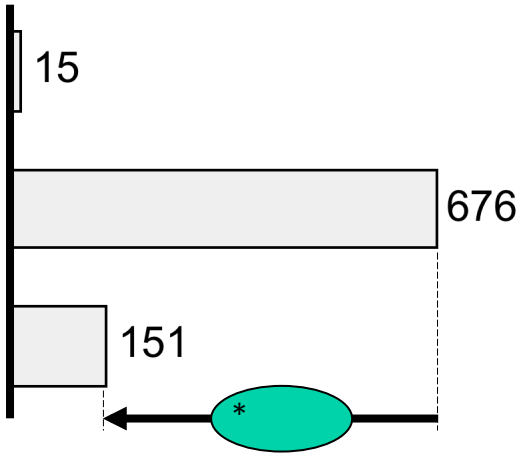


Planomat-X with schedule recycling

Final average utility score of executed schedules (in utility points)



Replanning runtime* per agent (in msec)



Choice set for estimation

- 19 randomly selected sequences
- Personalised with Planomat-X (locations, mode, timings)

- “dissim” based Joh’s multi-dimensional similarity measure (sequence, mode, location)

Estimates and corrections

Parameter		Estimated parameters Value	t-test	Manually calibrated parameters Value
home	α	5.32	9.72	**12.00**
	β	0.249		**0.429**
	γ	1.00		1.00
	V min	0.00		0.00
	V max	9.58	14.49	**5.41**
innerHome	α	0.249	8.5	**1.90**
	β	15.2		**17.80**
	γ	1.00		1.00
	V min	0.00		0.00
	V max	1.92	26.38	**1.10**
work	α	3.86	26.24	**4.50**
	β	0.491		**0.568**
	γ	1.00		1.00
	V min	0.00		0.00
	V max	4.97	19.09	**5.00**
education	α	1.49	11.54	**6.00**
	β	2.29		**2.50**
	γ	1.00		1.00
	V min	0.00		0.00
	V max	5.09	18.83	**4.00**
leisure	α	0.0488	6.91	**2.00**
	β	100.0		**5.00**
	γ	1.00		1.00
	V min	0.00		0.00
	V max	1.92	30.88	**1.90**
shopping	α	0.0453	5.22	**0.70**
	β	100.0		**5.00**
	γ	1.00		1.00
	V min	0.00		0.00
	V max	1.94	25.49	**0.35**

Estimates and corrections

Parameter		Estimated parameters Value	t-test	Manually calibrated parameters Value
car	β travelTime	-3.77	-15.33	**-3.10**
	β travelCost	0.0374	6.83	0.0374
	λ income	0.185	2.67	0.185
pt	constant	-0.578	-16.17	**-0.35**
	β travelTime	0.563	8.77	0.563
	β travelCost	-0.117	-9.7	-0.117
	λ income	-0.27	-3.88	-0.27
bike	constant	0.145	3.21	**-0.07**
	β travelTime	-1.07	-10.49	-1.07
walk	constant	0.854	19.34	**0.40**
	β travelTime	-1.48	-18.83	**-1.90**
β female_act		-0.0577	-2.35	-0.0577
β female_travel		0.0797	4.13	0.0797
β age_education		-0.0146	-16.08	-0.0146
β age_work		-0.00664	-11.49	-0.00664
β license_car		-0.537	-15.11	**-0.25**
β dissim		-139.0	-3.63	-139.0
λ dissim		-0.949	-8.47	-0.949
β repeat		-	-	**-0.50**

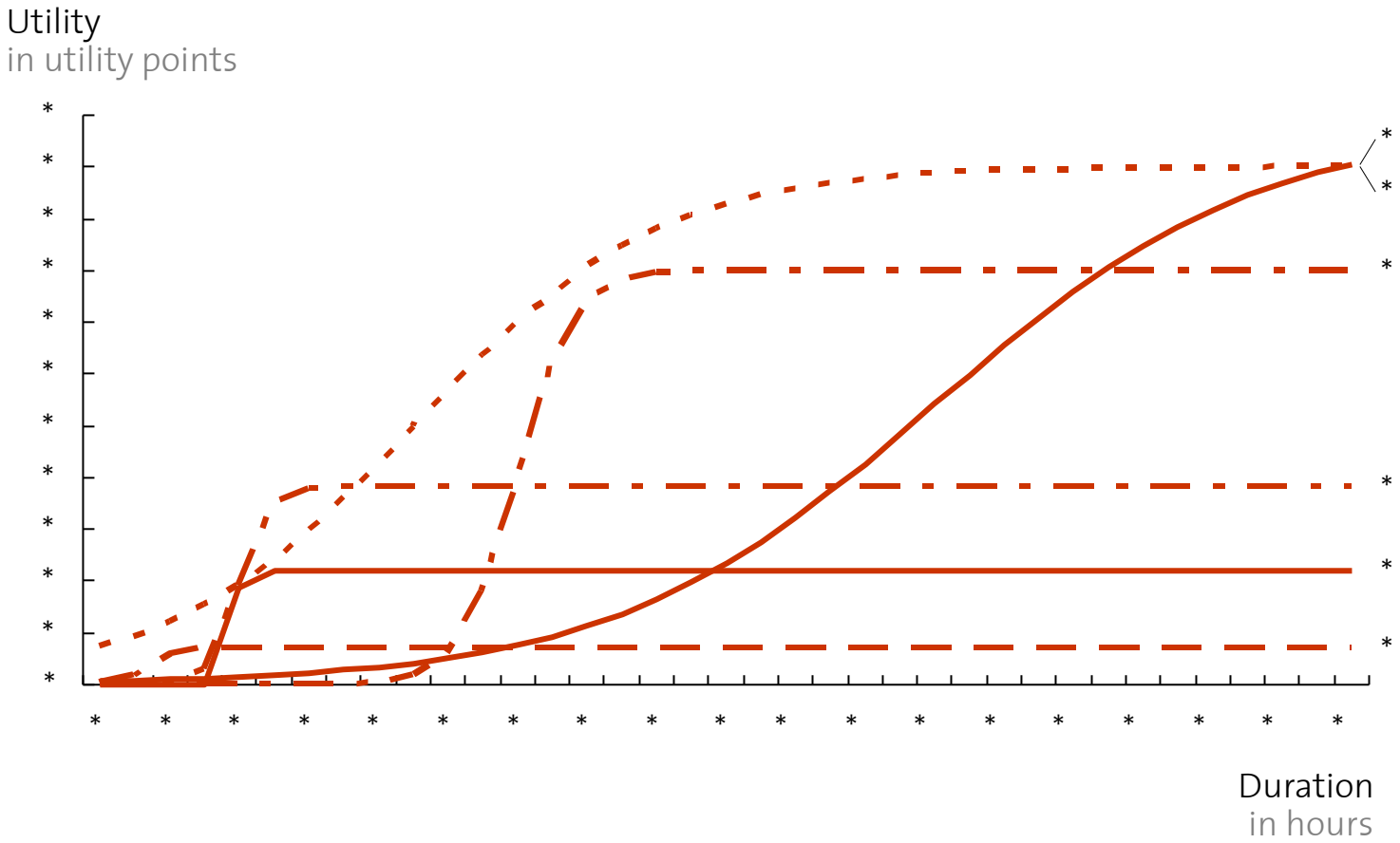
Disconnect from true choice situation

- (Implicit) full-factorial choice set across all dimensions
- (Unweighted) random selection from exhaustive choice set

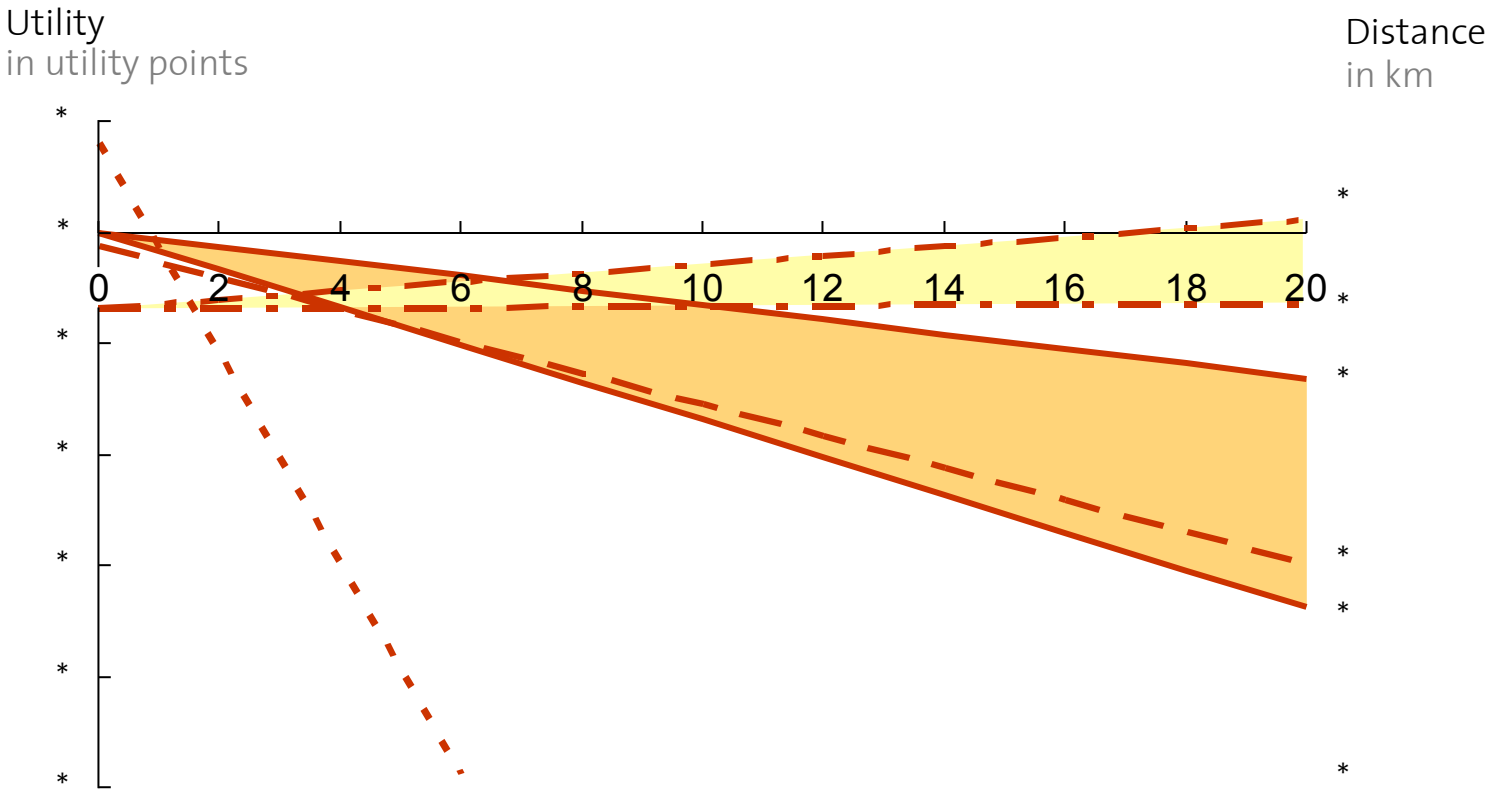
- No on-the-spot change during the day
- No history of the choice situation
- No social content variables
- No quality of location variable(s)
- Poor description of the choice situation (weather, luggage, social pressure etc.)

- No iteration between generalised cost estimation and parameter estimation

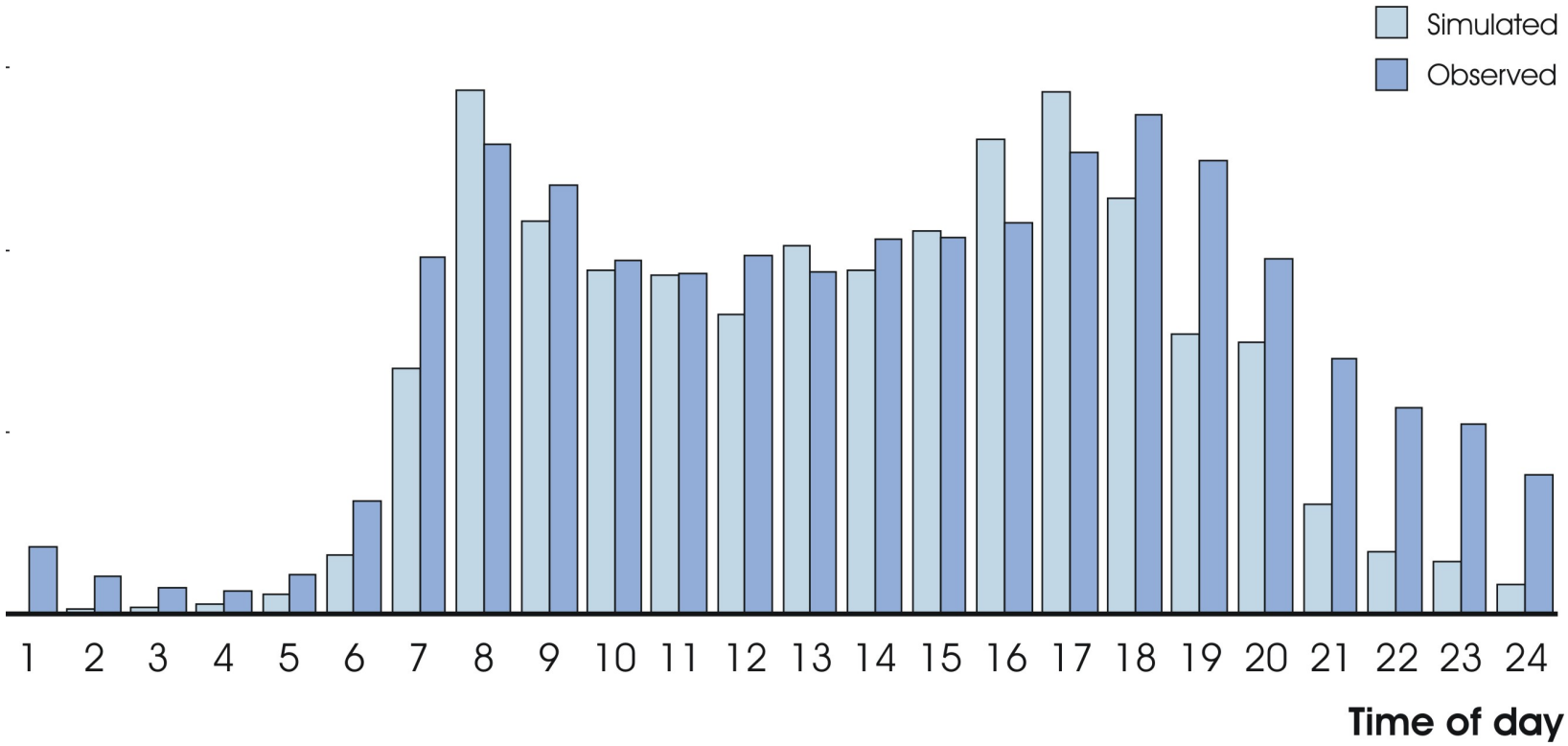
Utility profiles for activities



Modal utilities by distance



110 counting stations in the study area



Thinking about the development paths – 2. round

Basics: Traffic DUE and SUE

- Search or add a shortest path to the set of paths considered
- Allocate flows among the set of paths considered
- Check if chosen convergence criterion is met

Basics: Traffic DUE and SUE

- Search or add a shortest path given the current generalised cost estimate to the set of paths considered
- Allocate flows among the the set of paths considered
- Check if chosen convergence criterion is met

Basics: ABM scheduling SUE

- Enumerate all possible schedules
- Allocate flows randomly among the set of schedules
- Execute the schedules without within-day replanning
- Check if chosen convergence criterion is met

Basics: ABM scheduling SUE

- Construct all schedules considered relevant
- Allocate flows randomly among the set of schedules
- Execute the schedules without within-day replanning
- Check if chosen convergence criterion is met

Activity scheduling with some best response modules

- **Number and type of activities**
- **Sequence of activities**
  - **Start and duration of activity**
  - Composition of the group undertaking the activity
  - Expenditure division
  - **Location of the activity**
    - Movement between sequential locations
      - **Location of access and egress from the mean of transport**
        - Parking type and location
      - **Vehicle/means of transport**
      - **Route/service**
      - Group travelling together
      - Expenditure division

Source of variance in MATSim today

- Home location
- Work location

- (Socio-Demographics)

- Congestion feedback through the facilities and network

- MNL – models, if variance among the plans is still available

Source of variation in MATSim tomorrow

- Home location
- Work location

- Congestion feedback from facilities and network

- **Quality of location**
- **Social network membership**

- **Agent-specific taste parameters (via socio-demographics)**
- **(Agent-specific choice sets)**

Scheduling SUE with MATSim (tomorrow)

- For all agents:
  - Find dissatisfied agent
  - Construct a best schedule given the current generalised cost estimate and agent specific tastes to add to the set of schedules already considered.
  - Rescore existing schedules
  - Select best schedule
- Execute schedule with congestion feedback
- Check if convergence criterion is met

Challenges

Diversified MATSims for S, M, L

Within-day rescheduling	Time horizon	
	One-day	Open-ended multiple days
Yes	MATSim& (Short-term control; evacuation and events)	[CIRST] (Learning; longer-time horizon demand shifts, impacts of events)
No	MATSim (SUE; project evaluation)	MATSim+ (Learning; Supply-side and demographic adaptations)

Parameters

- Find/define the minimum set needed
- Get an idea of the distributions and their correlations

- Finding general attitudional scales for:
  - Variety seeking
  - Risk seeking- and aversion
  - Impatience (short term) and myopia (personal discount rates) (mid- and long-term)
  - Modal preference as a product of comfort, status, independence seeking
  - Location preference as a product of value for money, quality needed, goods and budgets

Algorithms

- Speed up search for convergence
  - With-in day replanning as a short-cut
- Maintenance of variance in MATSim

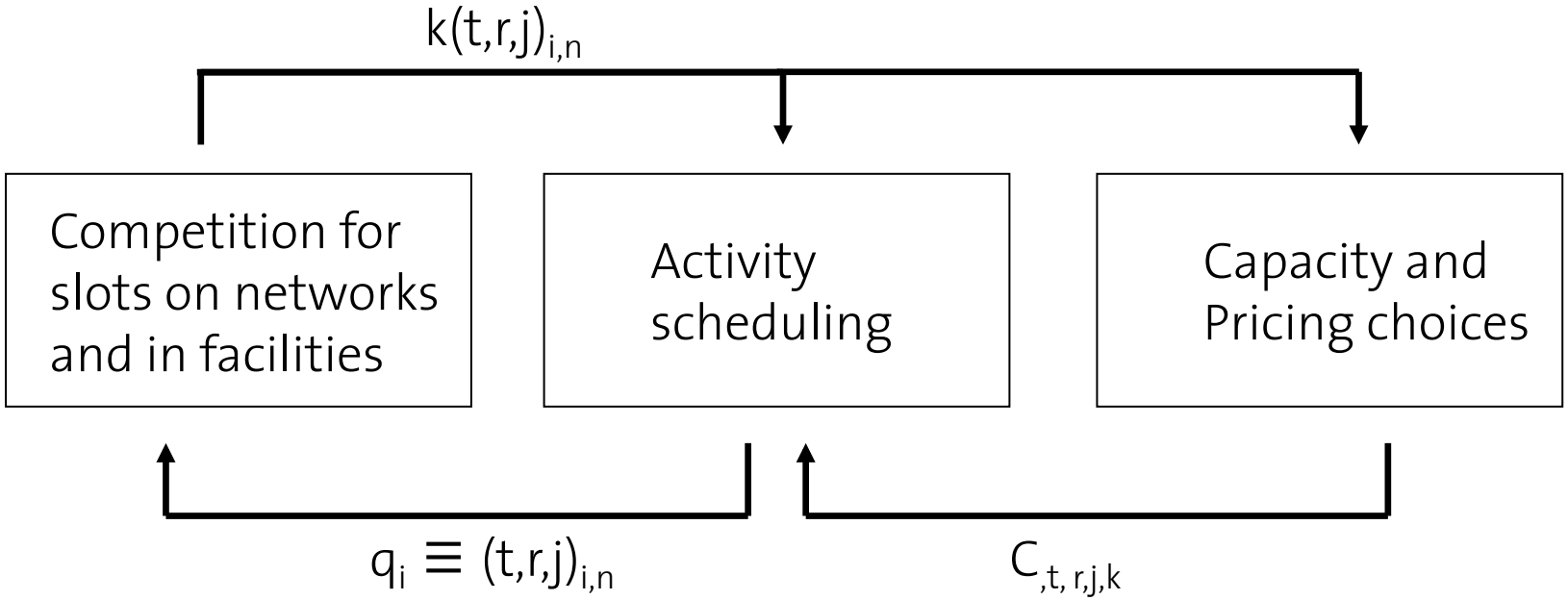
- Demonstrate (unique) convergence of both approaches
  - Explicit models of choice set construction
  - Choice models with general similarity structures (space, schedule, social space)

- Integration of social networks and of their dynamics

Agents

- Demographics development
  - Migration
  - Residential moving
  - Change in tastes with aging and social change
- Developers
  - Mass optimisation
- Stores and service providers
  - Location choice
  - Capacity choice
- Environmental services

Equilibrium including suppliers



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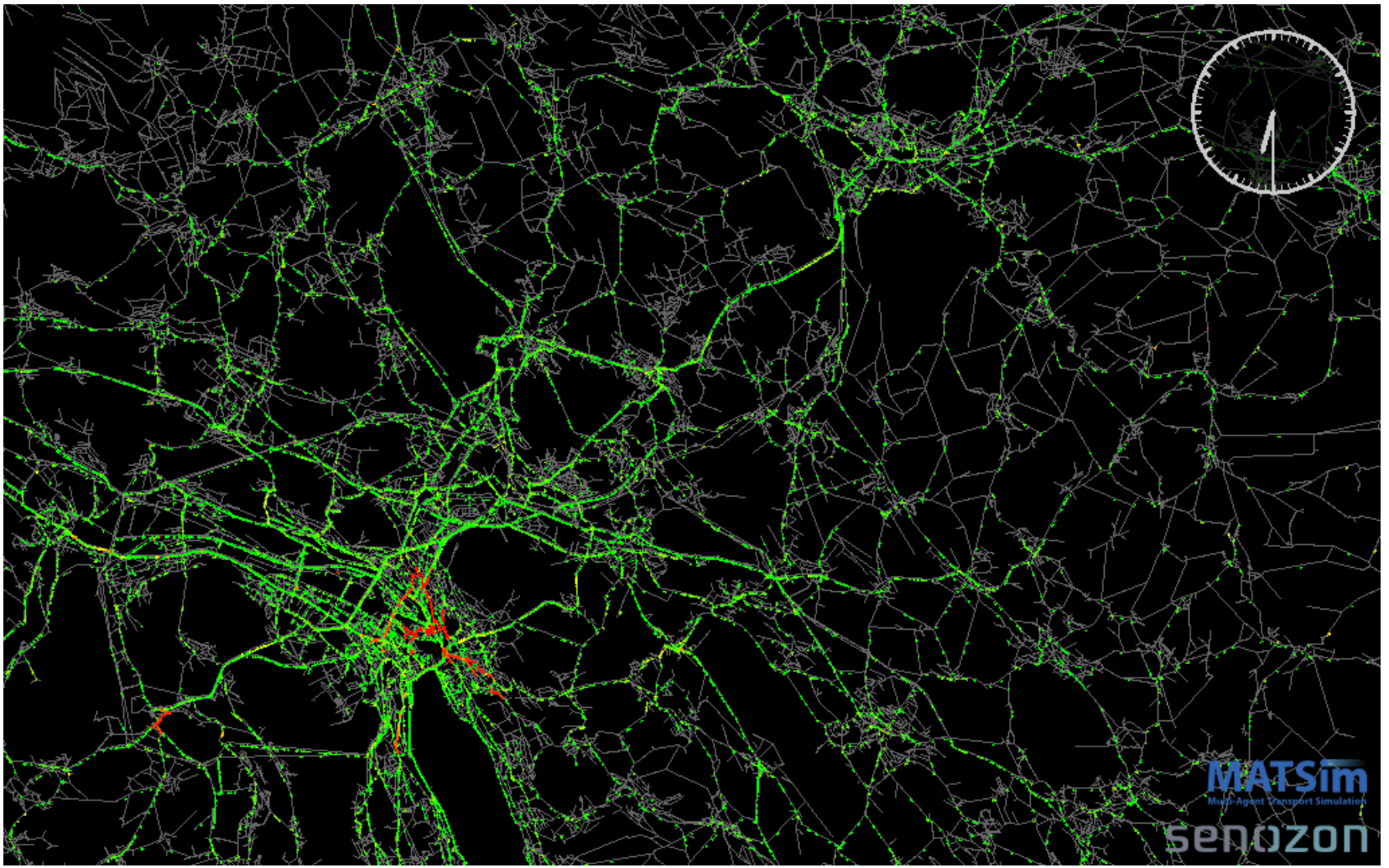
Questions ?



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