Preferred citation style

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Direct Demand models: A relevant alternative In the age Of Big Data?

KW Axhausen

IVT
ETH
Zürich

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Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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Issue at hand

Activity scheduling dimensions envisaged

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

Land use dimensions envisaged

Parcel use by type
Land value by parcel

- Intensity of use
- Value added by the use
  - Wages paid to the workers
  - Rents paid to the landlords
- Environmental services rendered
- Aesthetic externalities

  - Space for movement between locations
  - Space for parking at the locations
  - Service level of public transport, taxi & sharing fleets

    - Home-work linkage
    - Home-education linkage

Are we willing ?

To agree to the (comprehensive) tracking required of:

- Public transport use (smart cards, face recognition via CCTV)
- Car use (ERP, automatic video analysis, blue tooth)
- Walking (face recognition via CCTV, phone identification)
- Movement (GSM records, GPS traces)

To wait for the models:

- (To be programmed)
- To be estimated
- To be implemented
- To be calibrated
- To be run and the results analysed
- To be run including a full/adequate risk analysis

What do we need ?

What does service planning and pricing need ?

- Basic:
  - $\Delta volume_{ijmg}$
  - $\Delta travel\ time_{ijmg}$
  - $\Delta price_{ijmg}$
- Group g by
  - Income
  - (Distance)
  - Purpose
  - Age
  - Gender
  - Ethnicity

What does CBA need ?

- Basic:
  - $\Delta volume_{im}$
  - $\Delta speed_{im}$
- Advanced:
  - $\Delta volume_{ijm}$
  - $\Delta travel\ time_{ijm}$

Minimum requirements

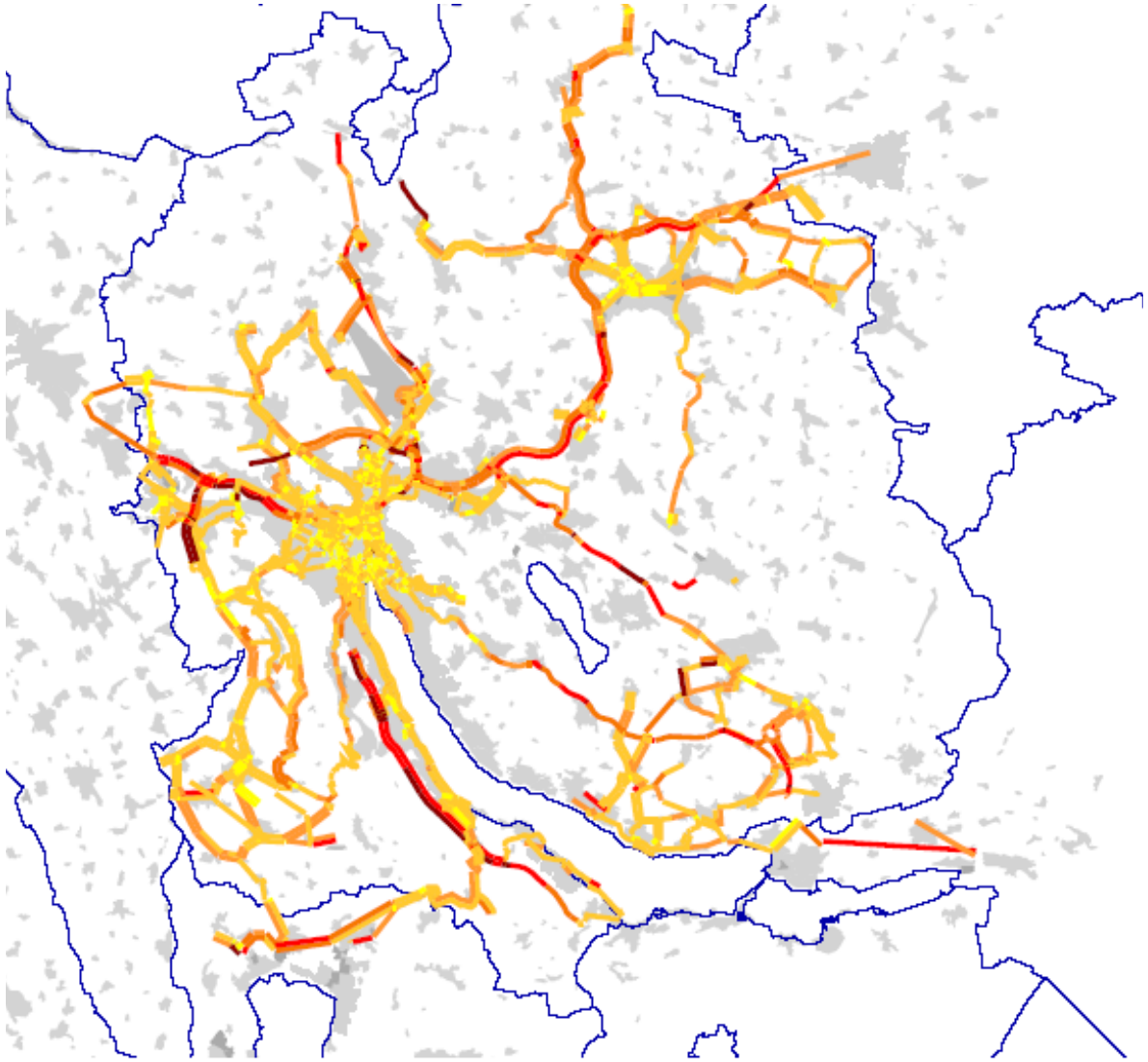
q, v sensitive to density

- Intensity of land use by
  - Car-owning population (by type)
  - Employment (by type)
- Network densities by
  - Node
  - Link capacity
  - Parking spaces
  - Seat capacity
- Prices (densities) of
  - Parking
  - Link

Some initial examples

Hackney and Bernard on speeds in Kt. Zürich

Average weekday peak hour speeds (Kanton Zürich)



Km/h
0-19
20-39
40-59
60-79
80-99
100-119
>120

Hackney and Bernard, 2005

Alternative approach and its model formulation

	$\rho W_a Y$	$\lambda W_e \varepsilon$	$u \sim N(o, \sigma)$
OLS			✔
Spatial error model (SEM)		✔	✔
Spatial autoregressive model (SAR)	✔		✔
General spatial model (SAC)	✔	✔	✔

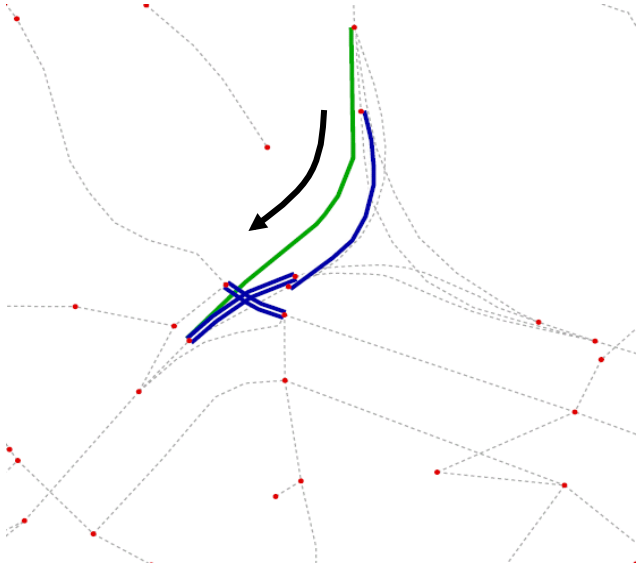
Spatial weighting matrix (2) – Spatial/network neighbour

Spatial neighbour:

- n closest links from centre of link

5 spatial neighbours

(Euclidian distance)

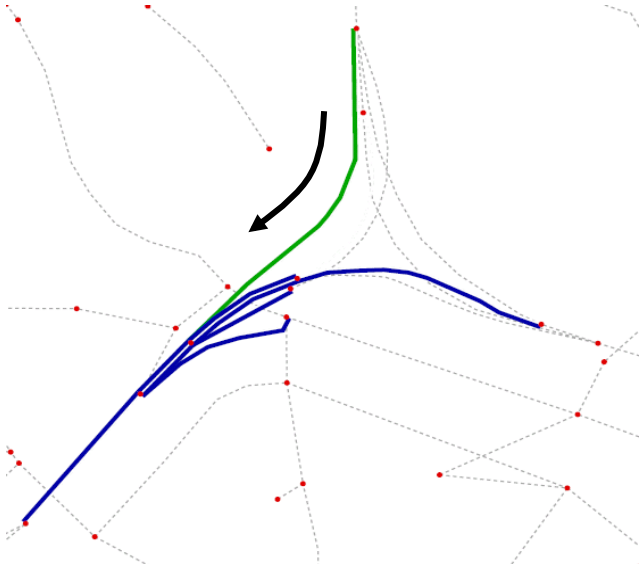


Network neighbour:

- reachable links passing n (max.) intersections

2 intersections → ~5 neighbours

(network distance)

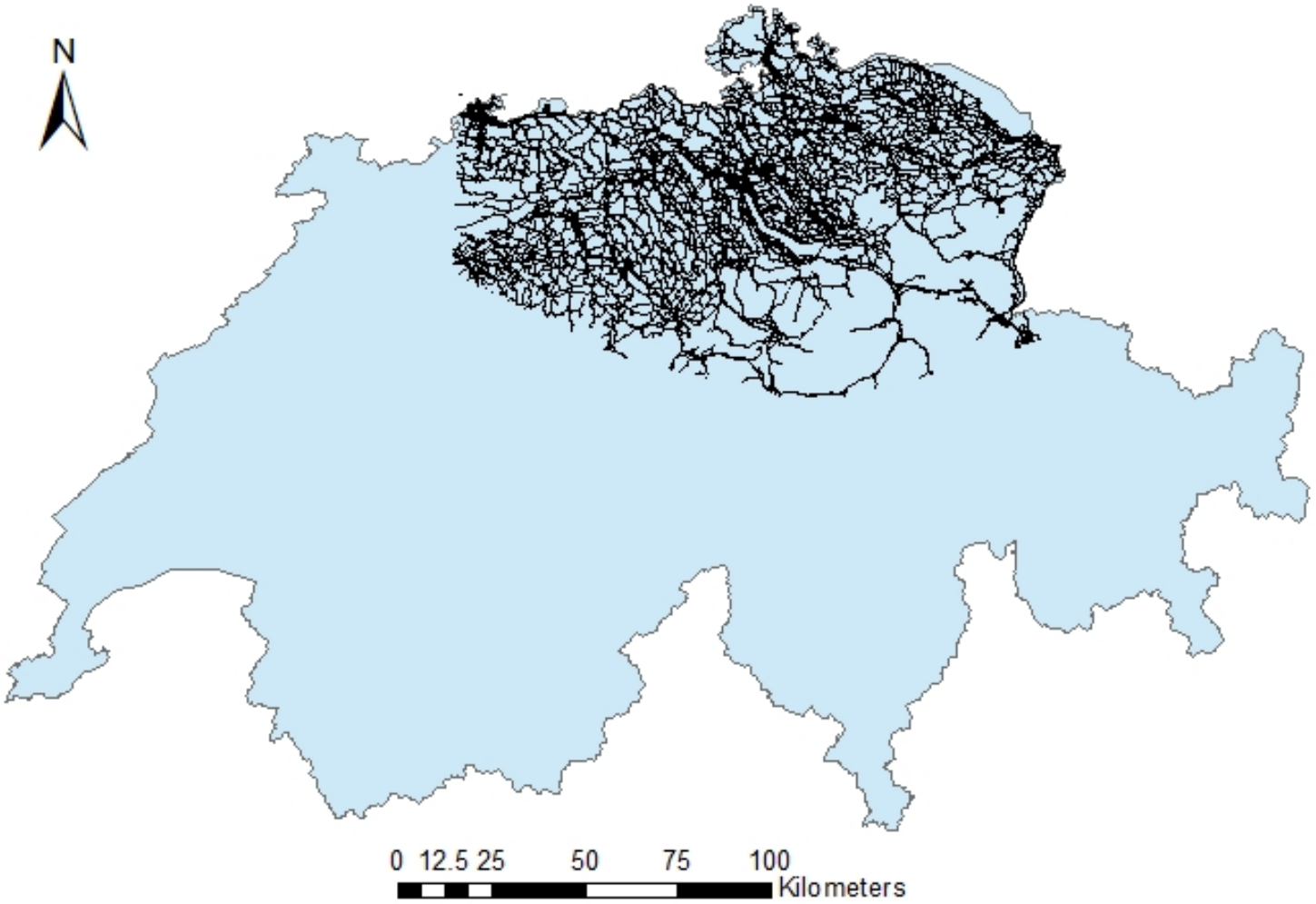


Best spatial weighting

Model	Best W-matrix	$\overline{R}^2$
Weighted least squares (WLS)	*not needed*	0.5347
Spatial error model (SEM)	W_a: *not needed* W_e: 3 network neighbours	0.5749
Spatial autoregressive model (SAR)	W_a: 4 network neighbours W_e: *not needed*	0.5518
General spatial model (SAC)	W_a: 4 network neighbours W_e: 3 network neighbours	0.5827

Sarlas on Swiss speeds

Case study

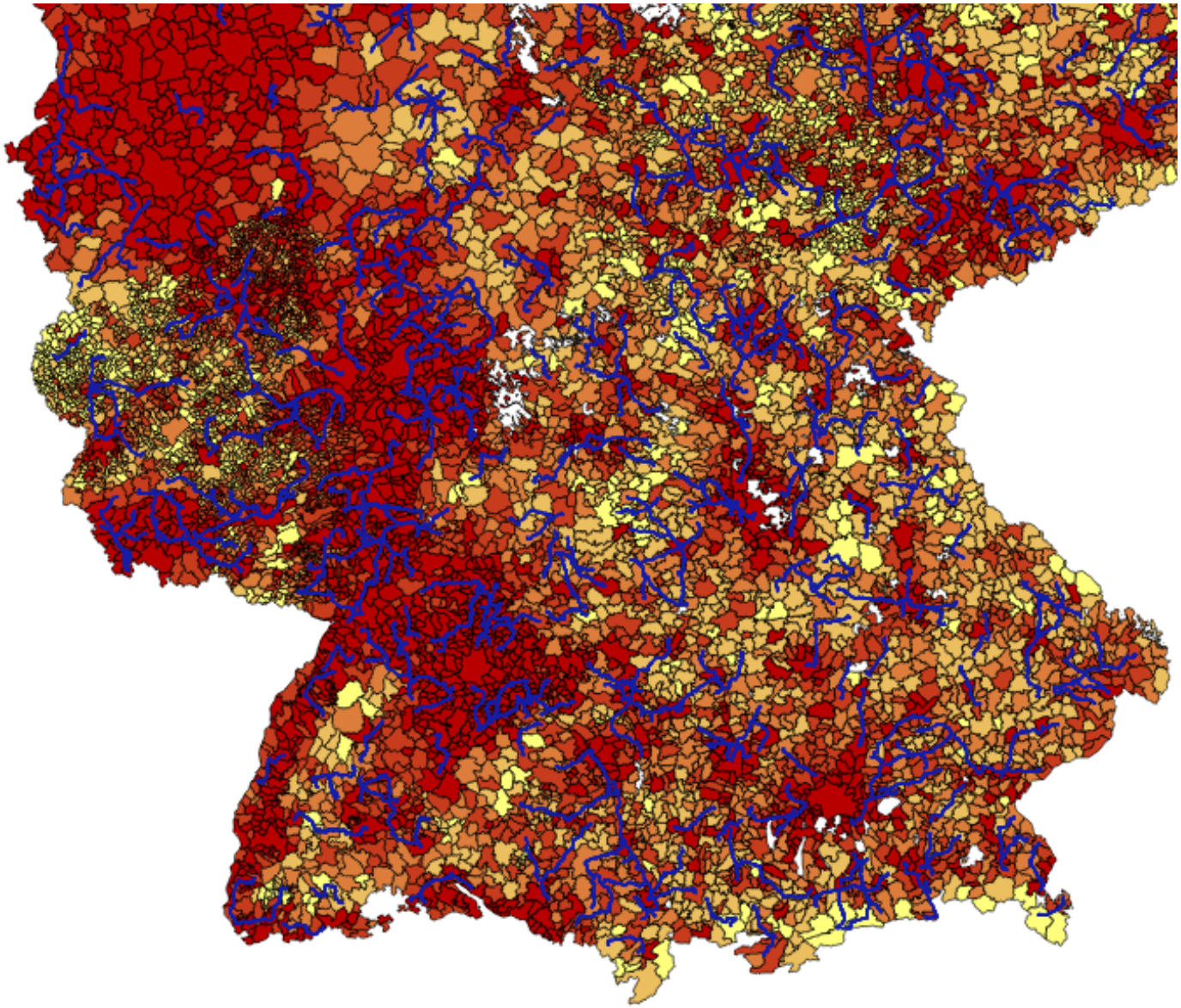


Estimation and comparison of models of average v

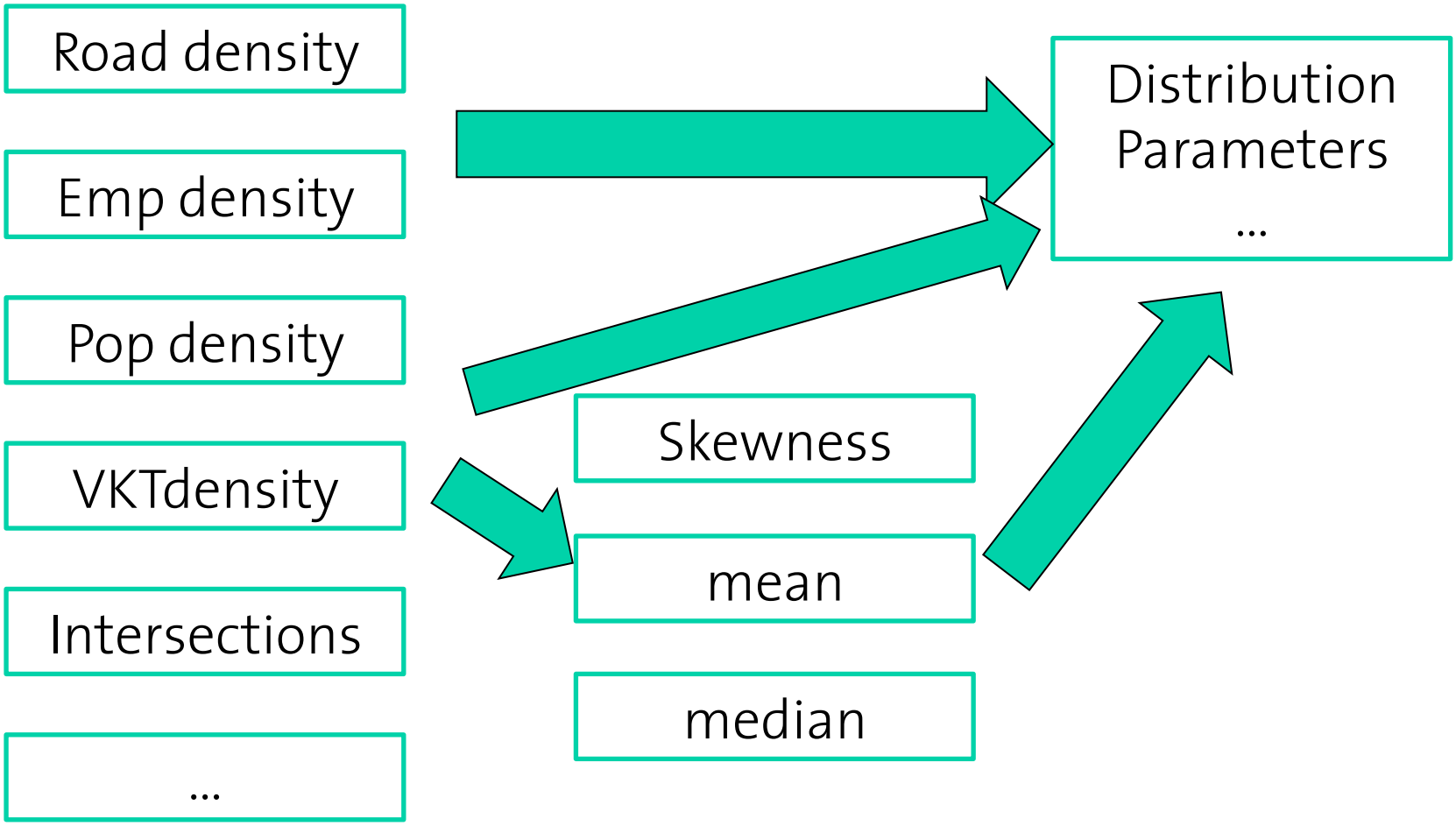
	SAR error	SAR lag	SAC
Explanatory variables	coeff.	coeff.	coeff.
Speed-limit	0.254	0.272	0.26
Highways: Constant	96.456	38.421	83.897
Trunk roads: Constant	56.704	26.84	51.514
Collector roads: Constant	54.042	30.047	51.287
Distributor roads: Constant	38.941	24.363	38.95
Urban roads: Constant	30.332	20.189	30.428
Curveness	-3.592	-4.248	-3.597
Distributor: PuT stops density,r=0.5km	-0.083	-0.186	-0.143
Urban: PuT stops density, r=0.2km	-0.095	-0.073	-0.094
Highways: ln(popul, r=5km)	-7.978	-2.073	-5.962
Trunk roads: ln(popul,r=2km)	-3.602	-1.497	-3.15
Collector roads: ln(employm,r=2km,kernel)	-3.429	-2.04	-3.452
Distributor roads: ln(employm,r=1km,kernel)	-1.081	-0.881	-1.244
Urban roads: ln(employm,r=0.5km,kernel)	-0.501	-0.404	-0.554
Urban roads: Ramps' dens, r=1km	0.346*	-0.054	-0.049
Distributor roads: Road density, r=500 m	-0.271	-0.133	-0.256
Urban roads: Road density, r=100 m	-0.112	-0.093	-0.115
(length dummies)			

Lu on travel time reliability in Germany

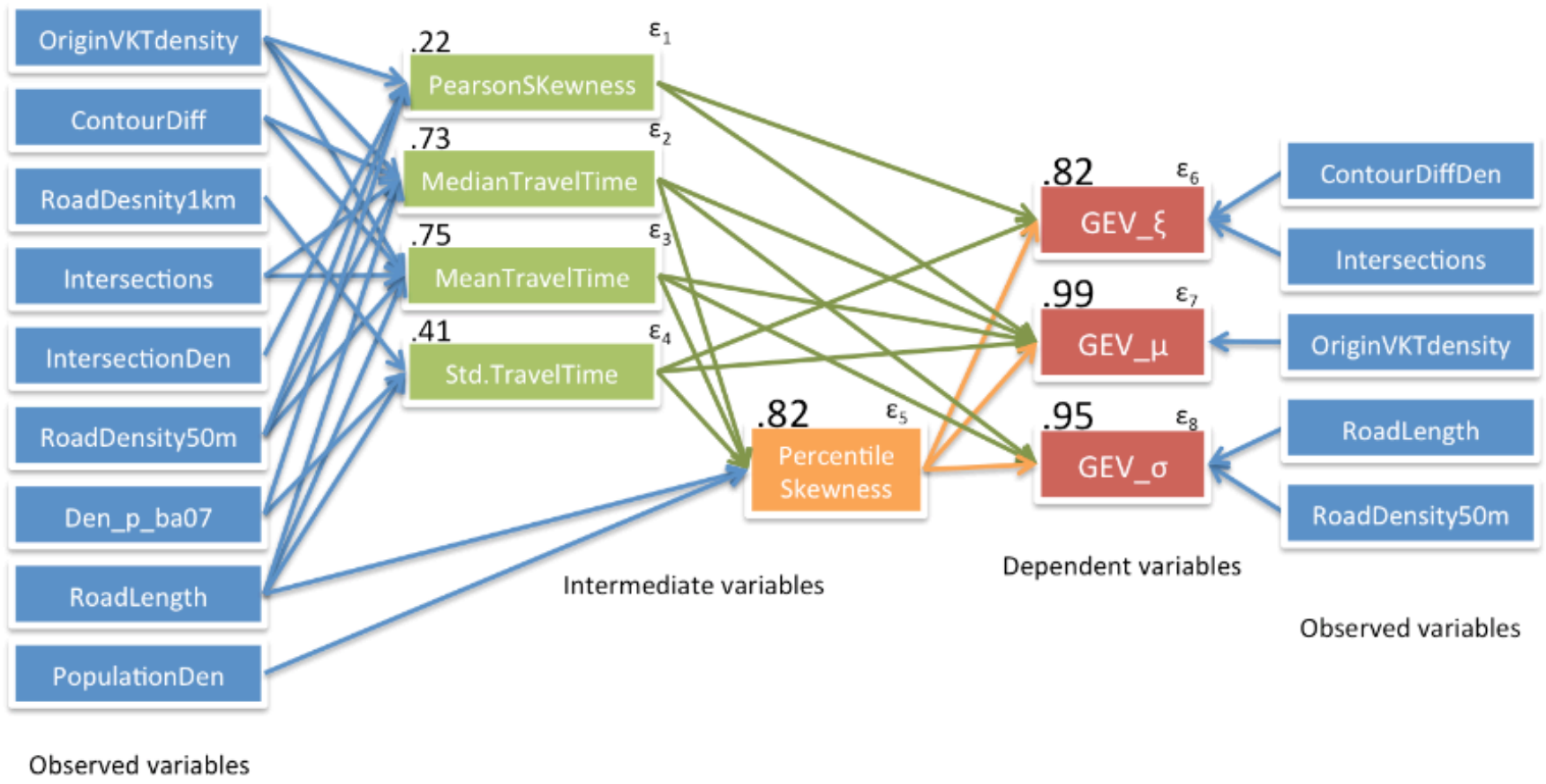
Map of some of the 635 elected routes (635)



Path analysis of the 3 parameter GE



Path analysis – path chart



What is next ?

What is next ?

- Compare
  - Differences by model against counts, measurements
  - Differences between models
- Which (policy) changes can be captured
  - Fully
  - Partially
  - How to translate change into model variable change
- How often is the CBA recommendation different ?

Questions ?

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Literature and references

Hackney, J., F. Marchal and K.W. Axhausen (2004) Monitoring a road system's level of service: The Canton Zurich floating car study 2003, paper presented at the *84th Annual Meeting of the Transportation Research Board*, Washington, D.C., January 2005.

Hackney, J.K., M. Bernard, S. Bindra and K.W. Axhausen (2007) Predicting road system speeds using spatial structure variables and network characteristics, *Journal of Geographical Systems*, **9** (4) 397-417.

Lu, M. (2014) RP and SP Data-Based Travel Time Reliability Analysis, Ph.D. Thesis, ETH Zurich, Zurich.

Sarlas, G. and K.W. Axhausen (2014) Localized speed prediction with the use of spatial simultaneous autoregressive models, *Arbeitsberichte Raum- und Verkehrsplanung*, **1017**, IVT, ETH Zurich, Zurich.