

Preferred citation style

Axhausen, K.W. (2016) Accessibility, mobility tools (and some LUTI models), presentation at the Symposium on Integrated Land Use/Transport Modeling, TU München, November 2016.

Accessibility, mobility tools (and some LUTI models)

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November 2016



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Swiss Federal Institute of Technology Zurich

Acknowledgments

A Loder for the mobility tool ownership work

G Sarlas and R Fuhrer for the work on Swiss wages/productivity

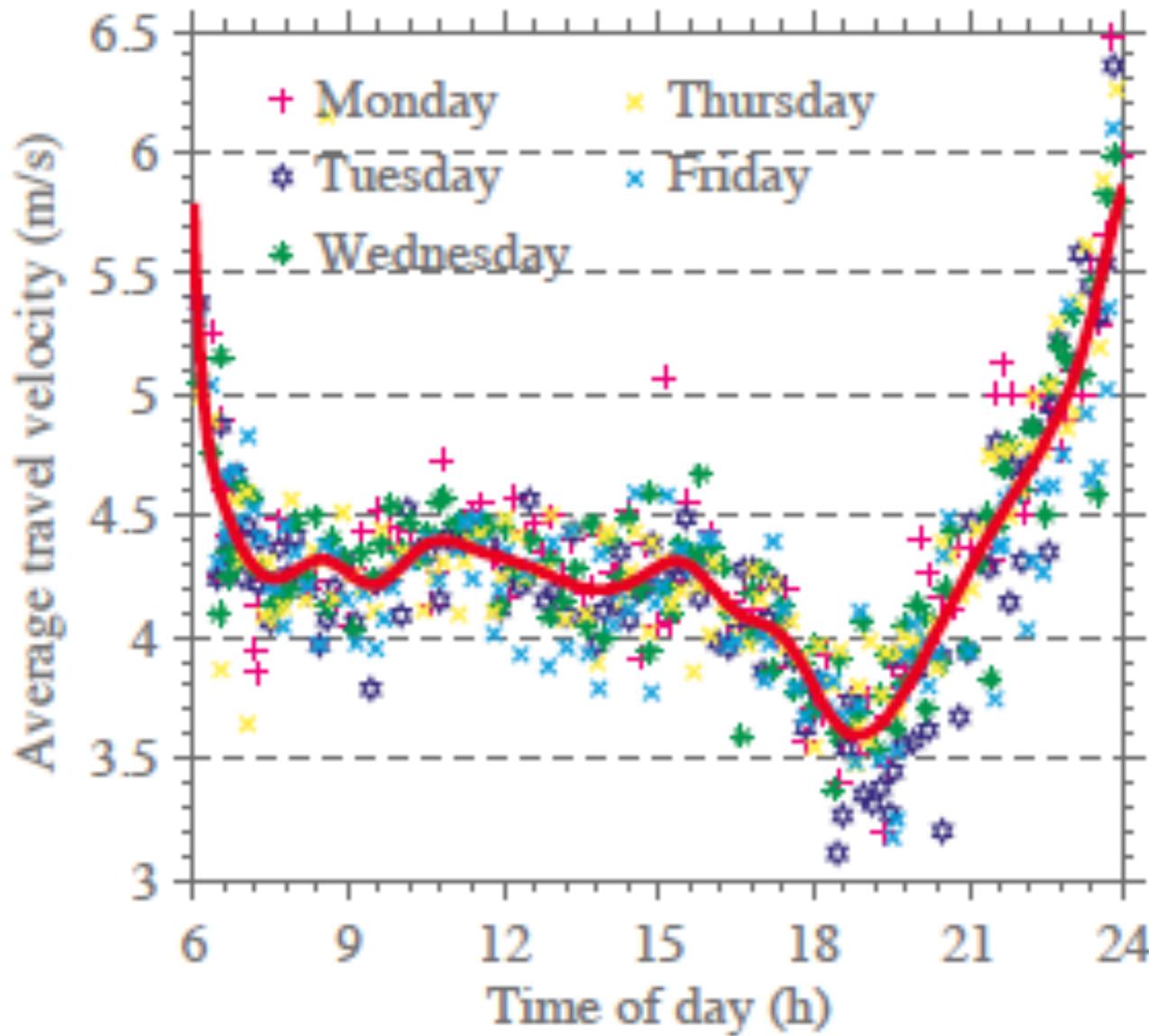
L Sun for the big data analysis

FCL M8 for the SG MATSim model

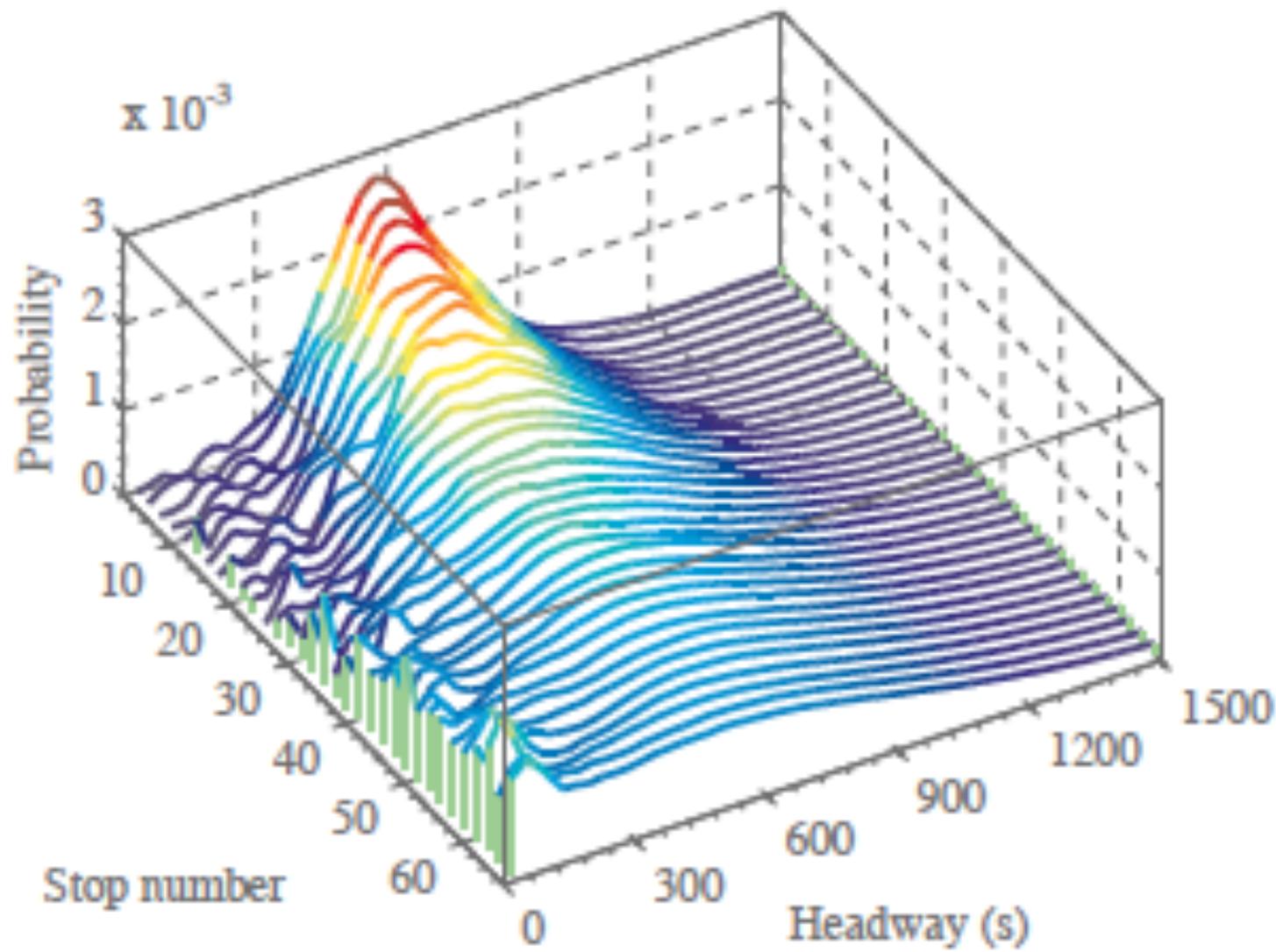
B Bodenmann for FALc

Current problems in Singapore

Bus speeds in Singapore by time of day (2012)



Headways along a bus line in Singapore (2012)

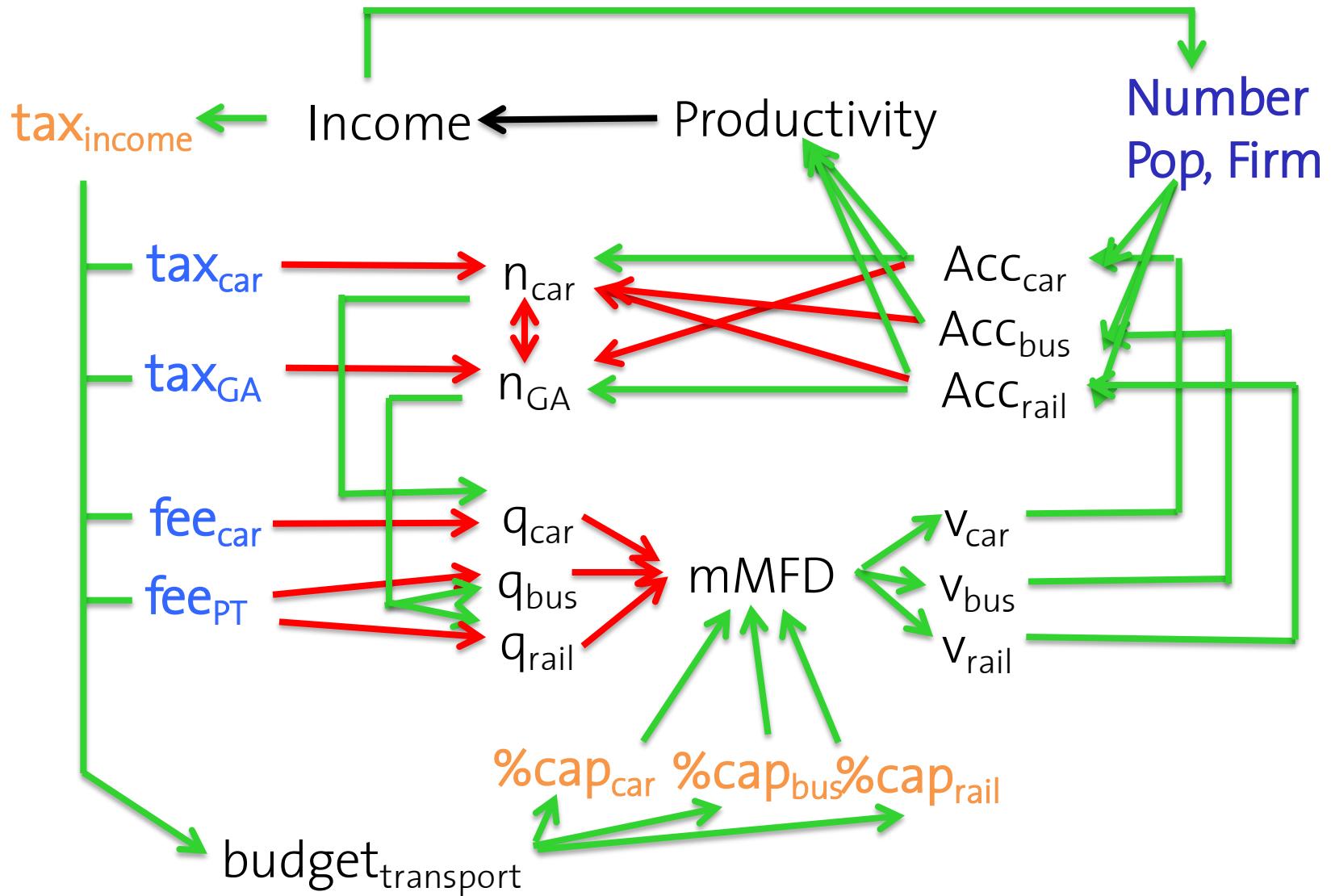


What type of model would be enough ?

A model of Singapore's travel demand and traffic

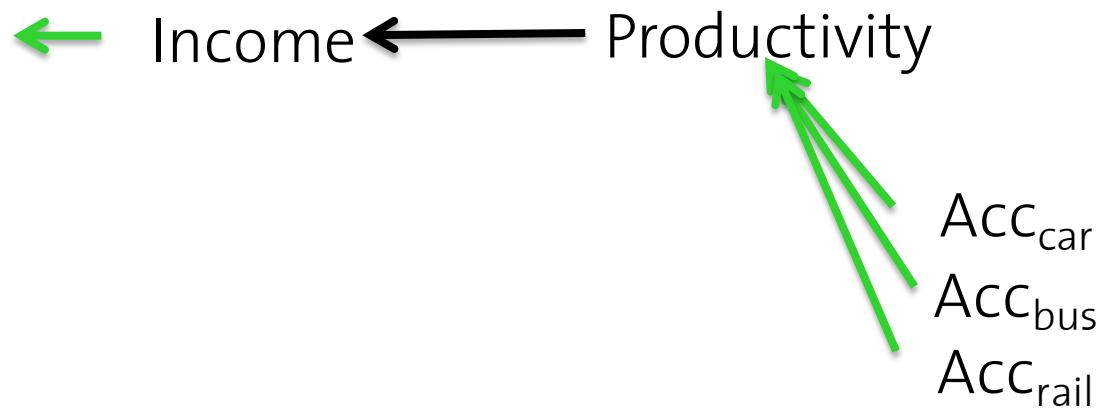


Would this be enough ?

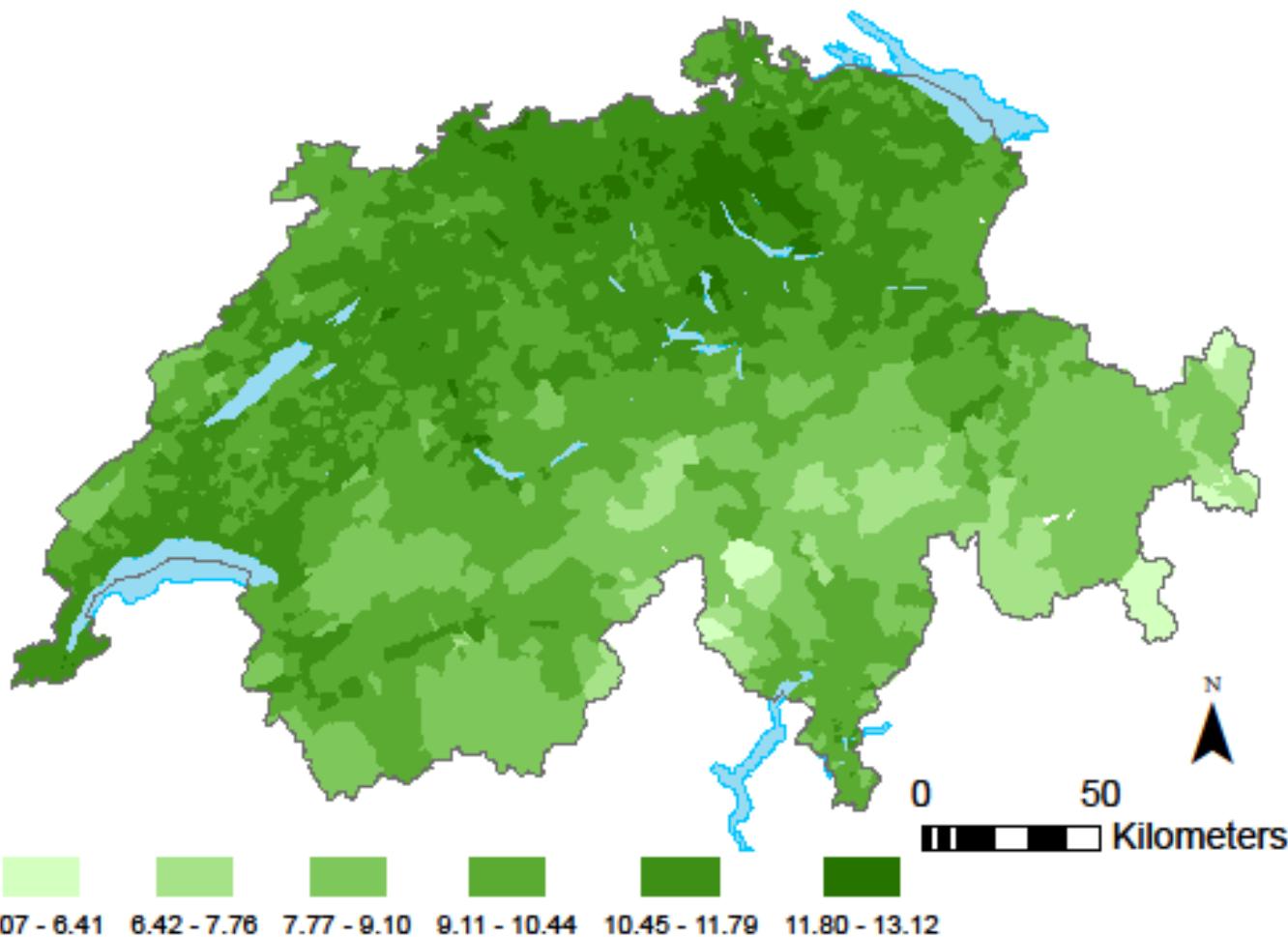


What do we know ?

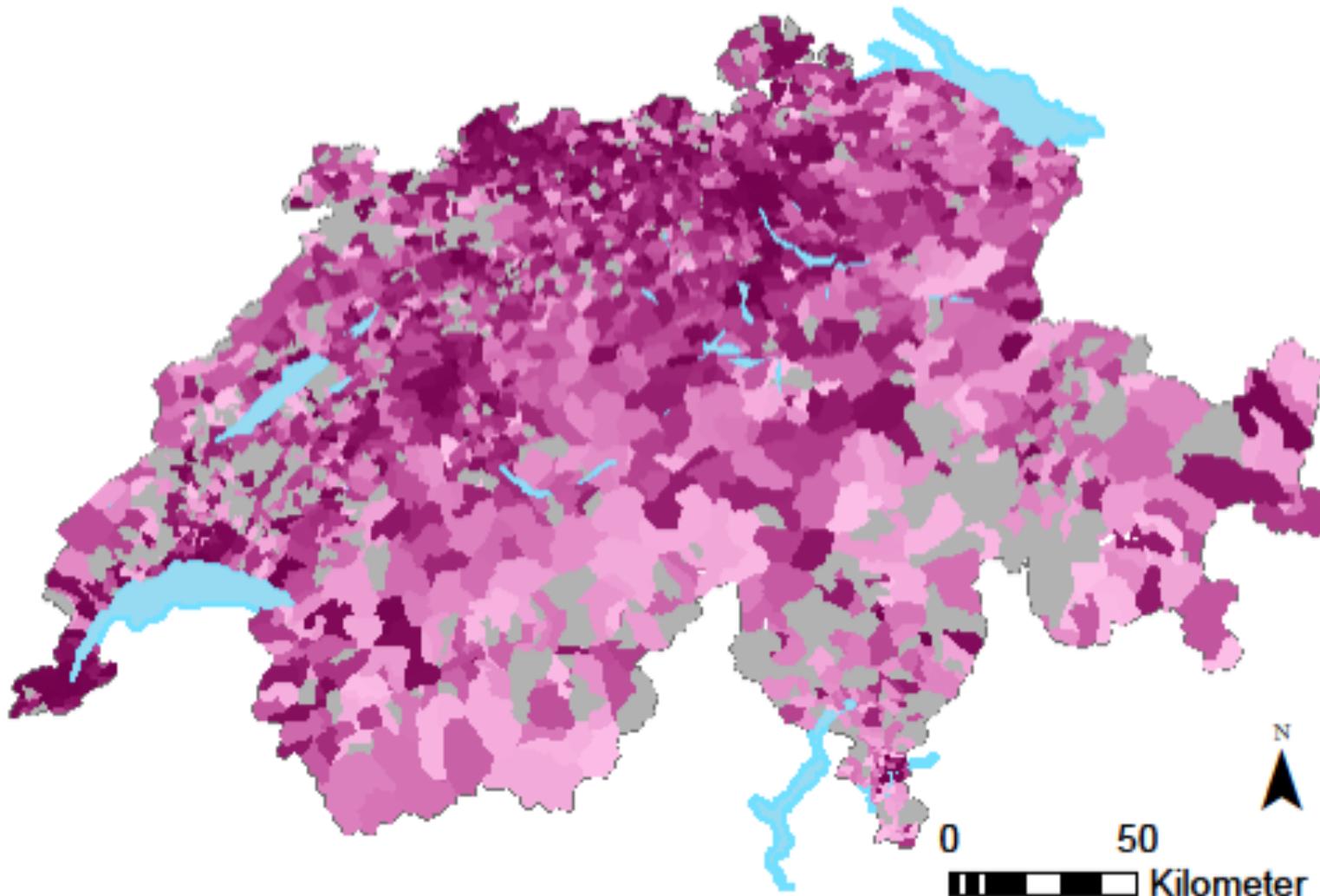
Access and productivity: Switzerland



Population accessibility by public transport: 2010



Income levels: 2010



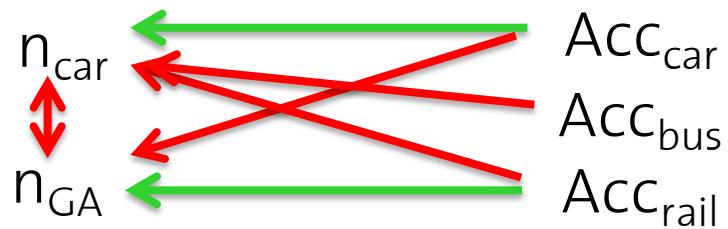
Grey: less than 20 observations

TUM2010
Pink to purple: Low to high wages

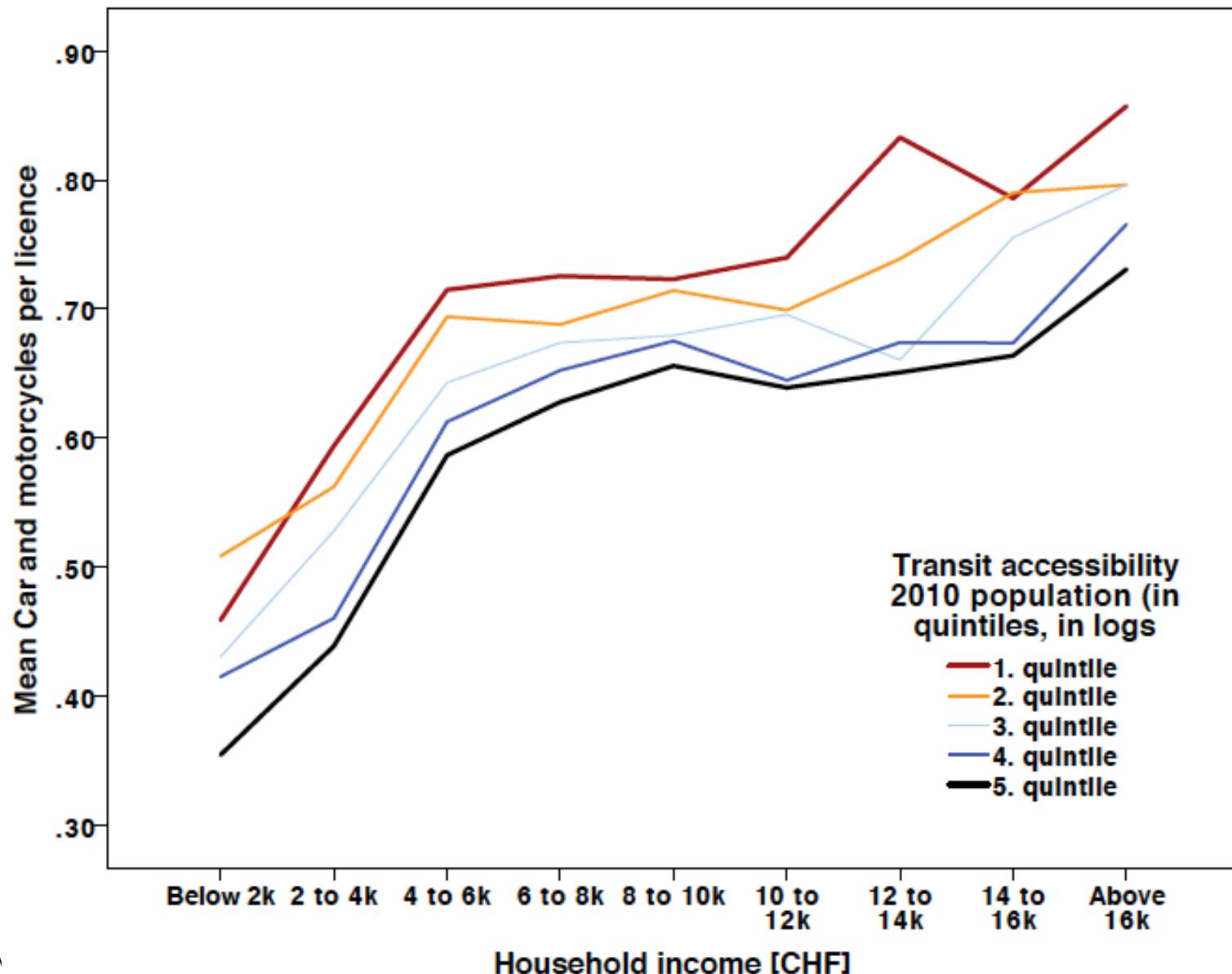
Spatial error model – (some variables not shown)

	2000	2005	2010			
Y: Ln mean salary	Estimate	Sig.	Estimate	Sig.	Estimate	Sig.
Intercept	6.43 ***		7.07 ***		6.89 ***	
Ln car accessibility	0.01 **		0.02 ***		0.01 **	
Ln public transport accessibility	0.01 **		0.01 ***		0.01 *	
Ln number of local employed	0.02 ***		0.01 ***		0.01 ***	
From outside Switzerland	-0.11 ***		-0.09 ***		-0.09 ***	
Average duration in-post	0.00 *		0.01 ***		0.01 ***	
Ln average age	0.36 ***		0.24 ***		0.32 ***	
Men	0.17 ***		0.07 ***		0.13 ***	
lambda parameter	0.33 ***		0.41 ***		0.40 ***	
Nagelkerke pseudo-R-squared	0.693		0.665		0.623	
# observations	1448		2298		2229	

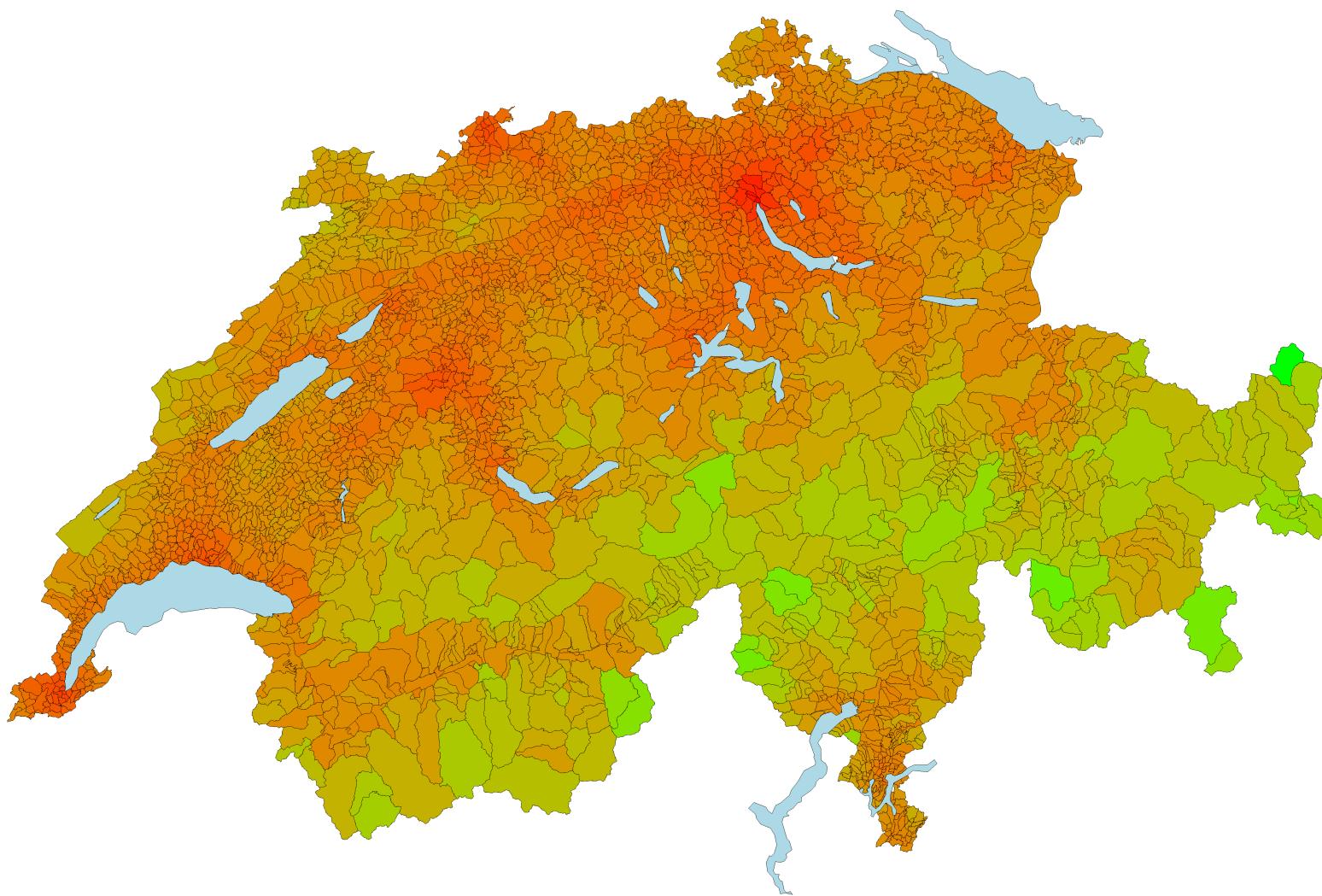
Accessibility and mobility tools: Swiss case



Accessibility and car ownership in Switzerland

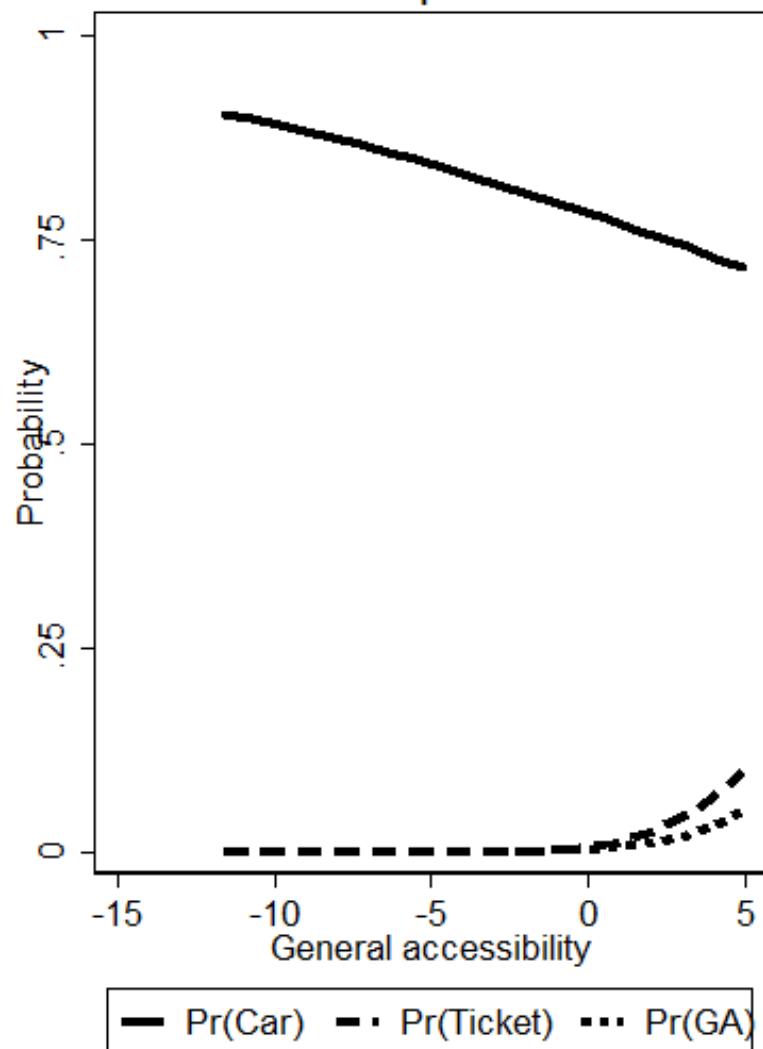


Switzerland: general accessibility

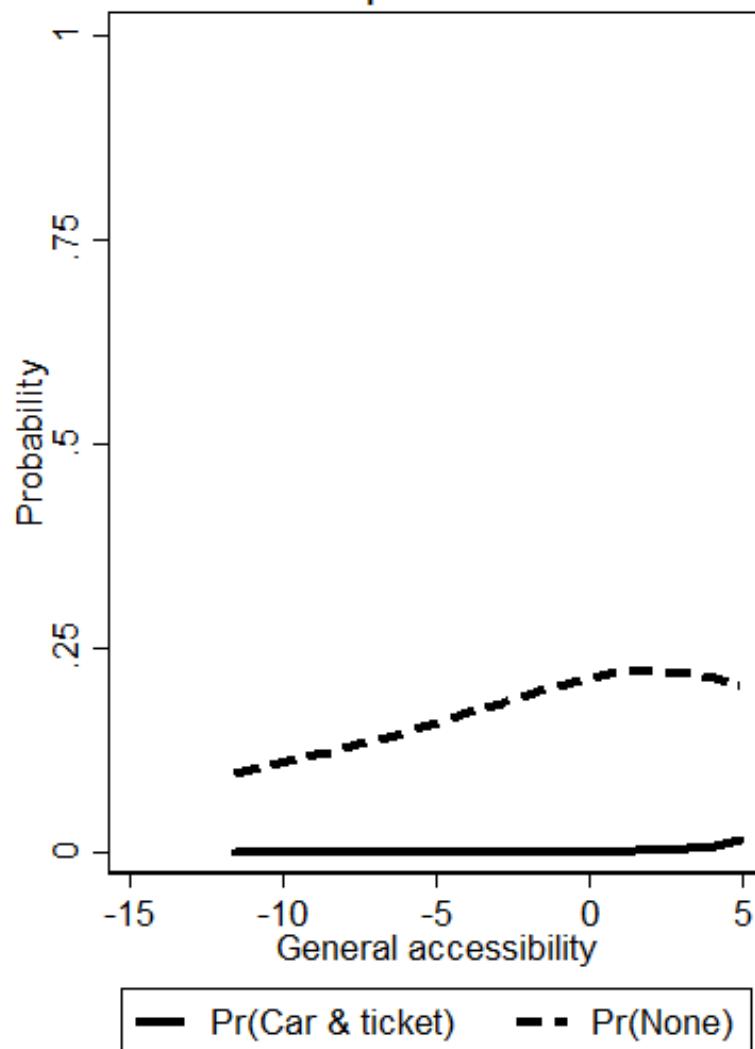


Switzerland: Probabilities by general accessibility

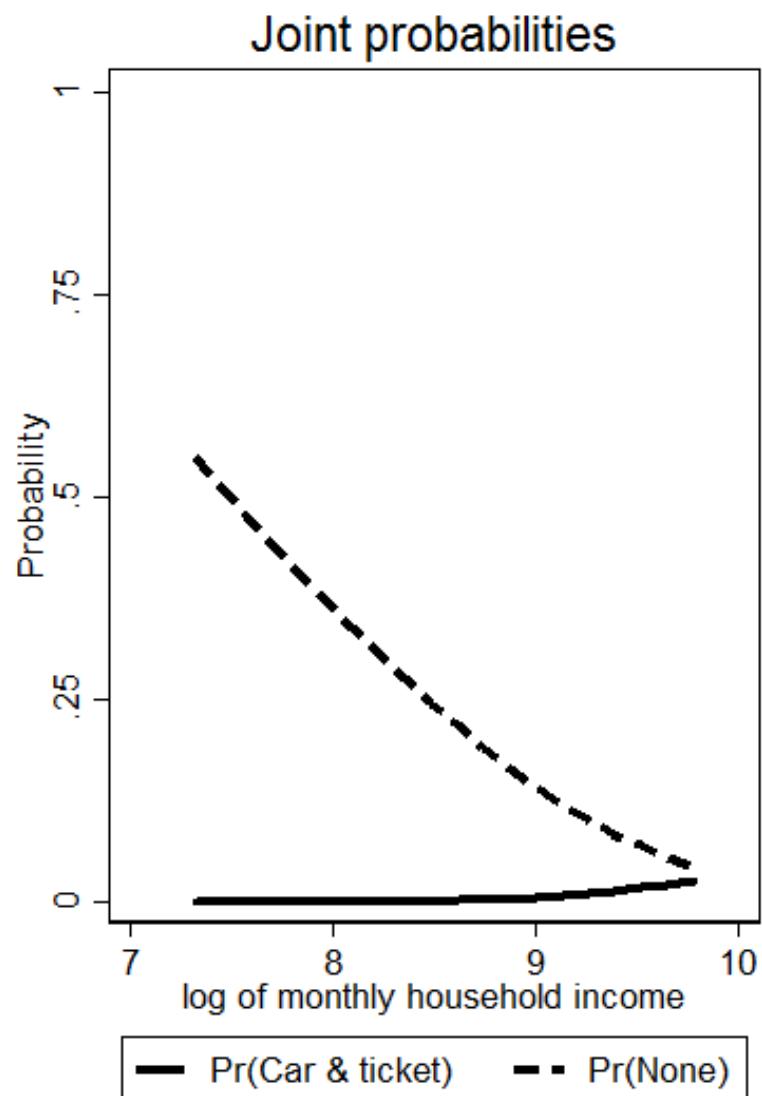
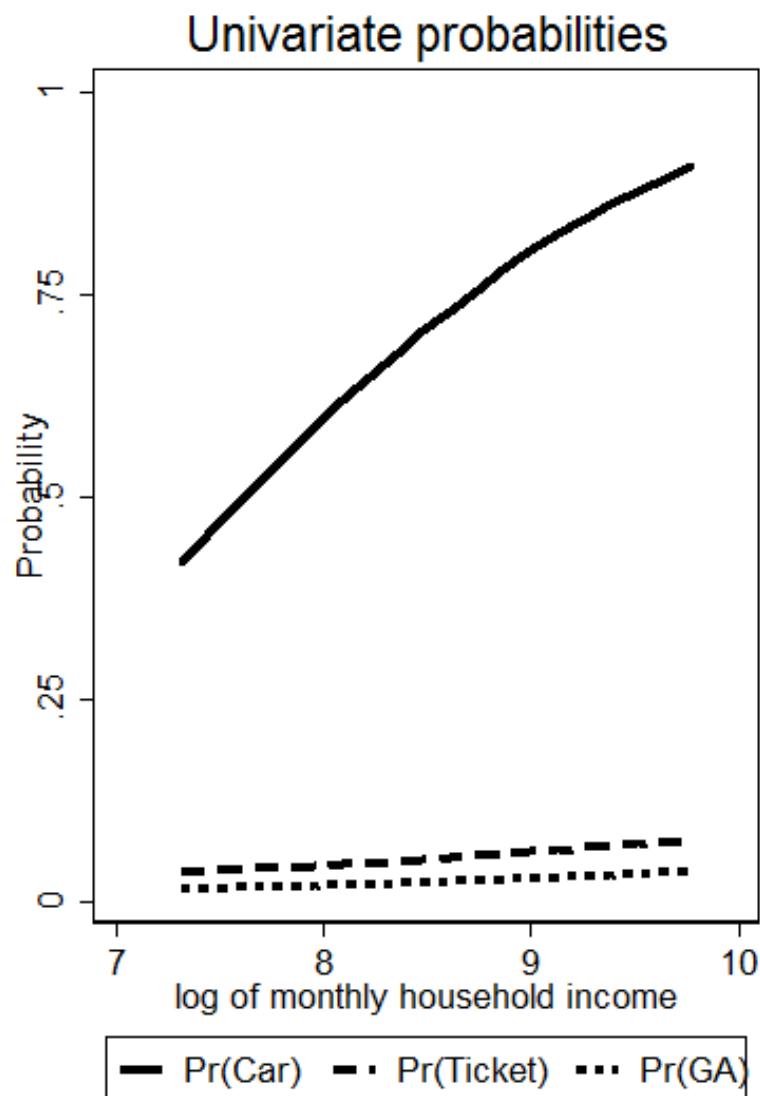
Univariate probabilities



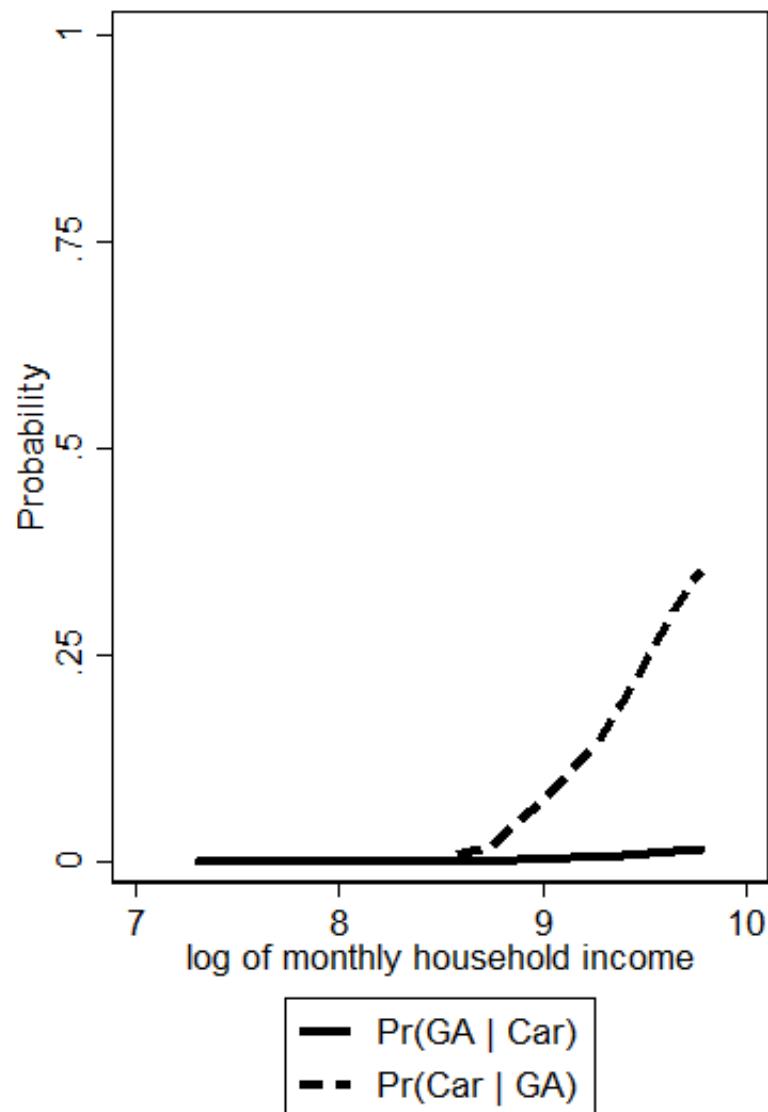
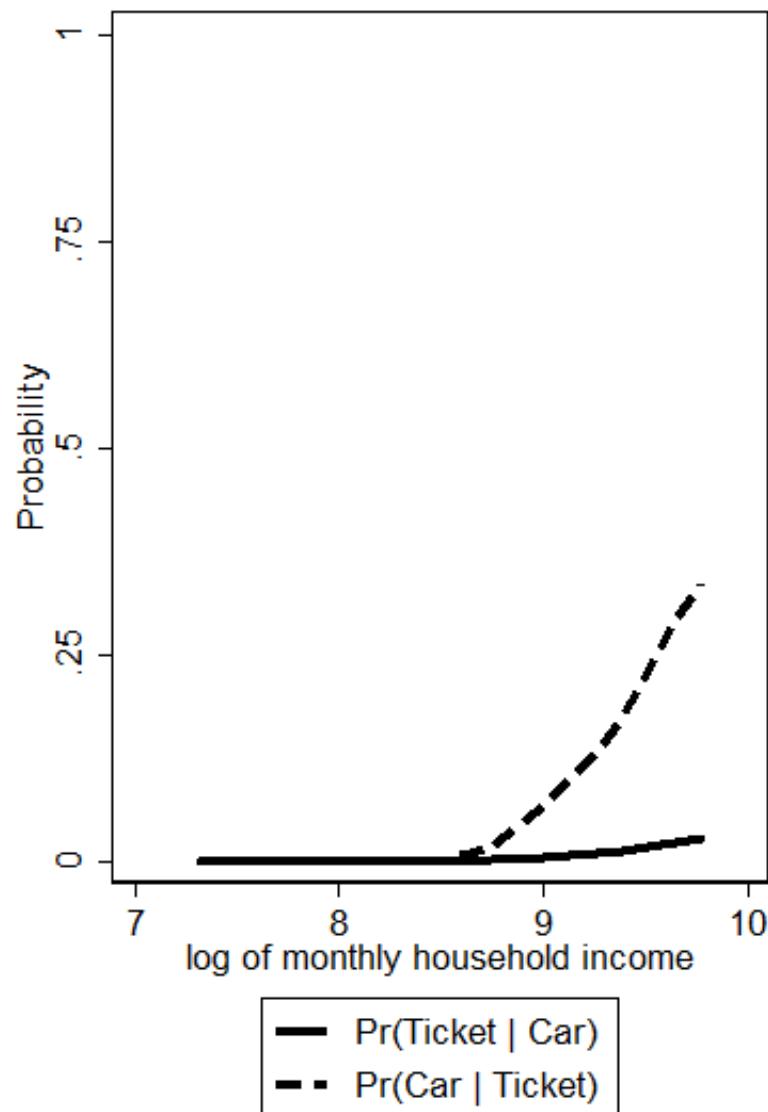
Joint probabilities



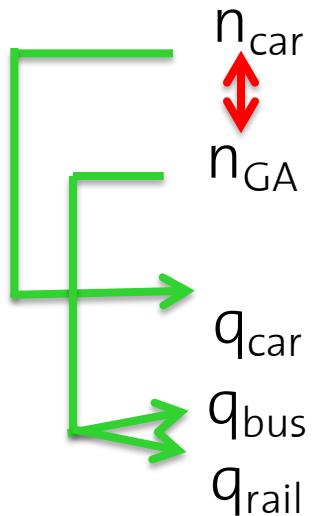
Switzerland: Probabilities by log of income



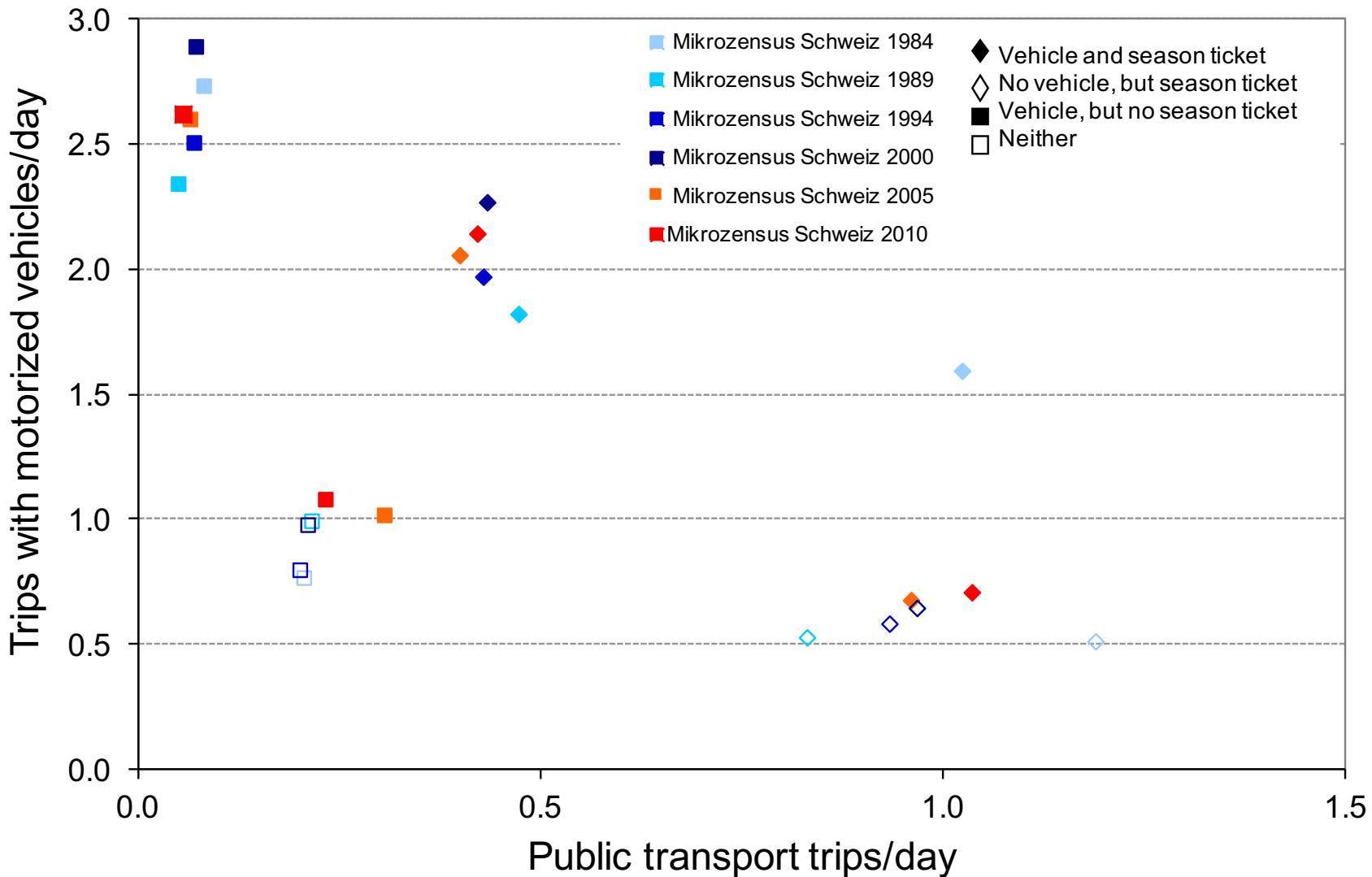
Switzerland: Conditional probabilities by log of income



Mobility tools and use: Swiss case



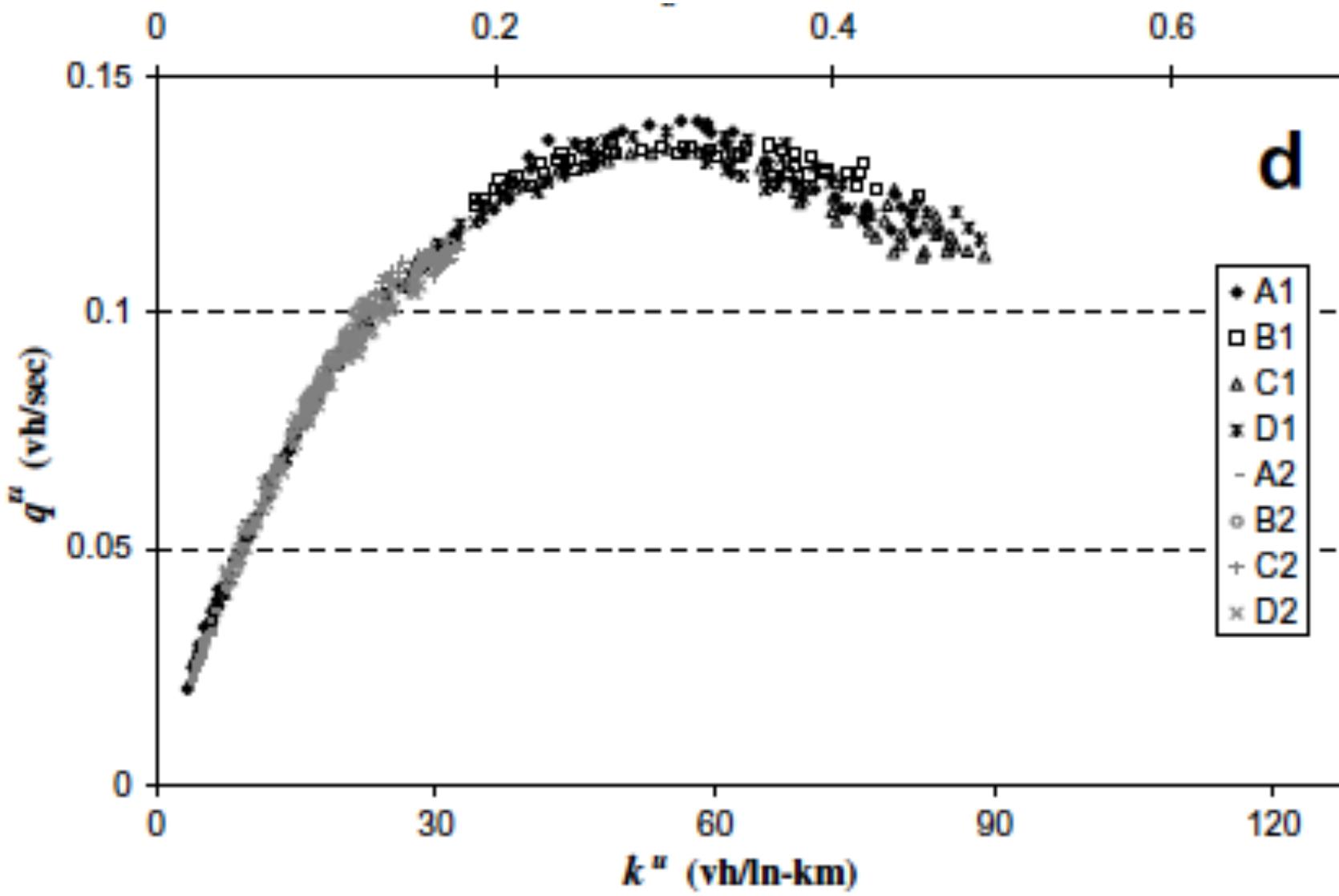
Travel, car and season-ticket ownership (CH, 1984-2010)



Fleet size and speeds

q_{car}  MFD  v_{car}

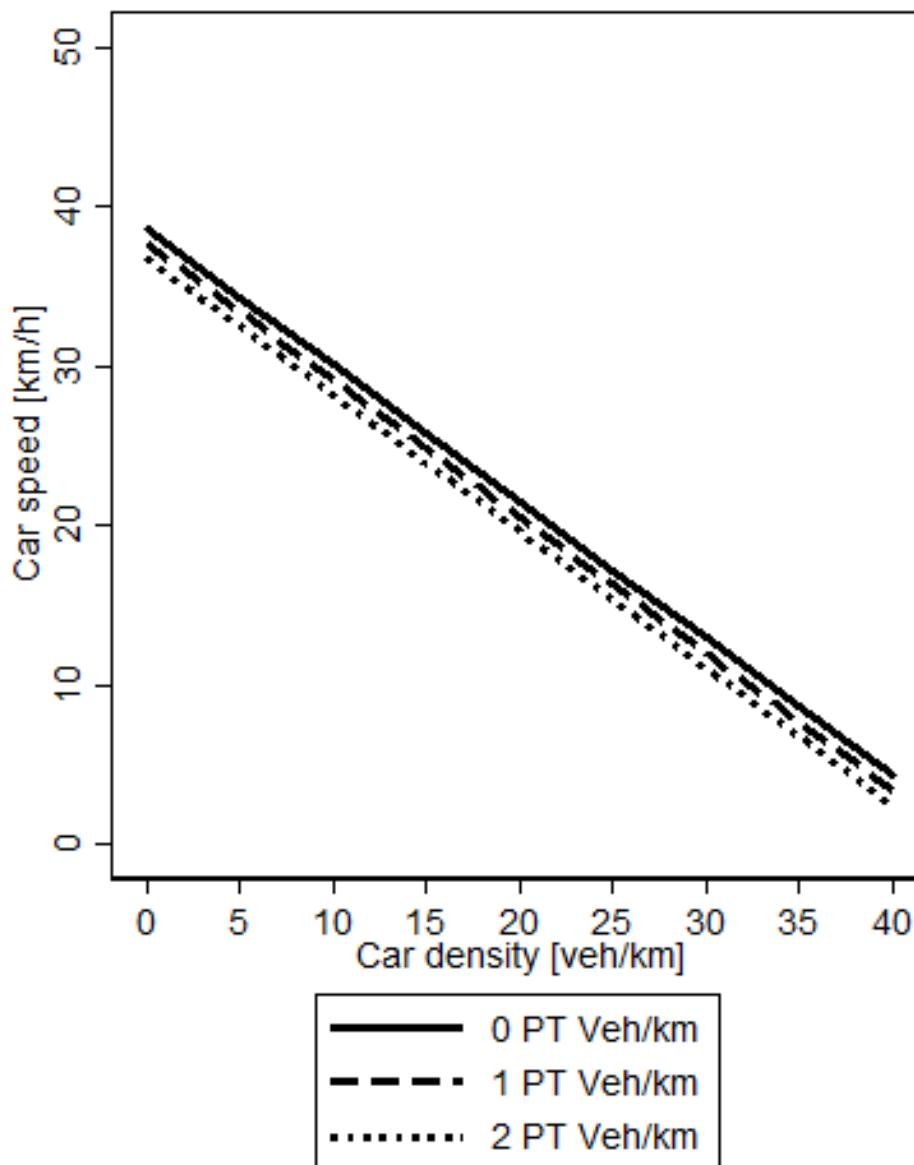
Macroscopic fundamental diagram MFD (Yokohama)



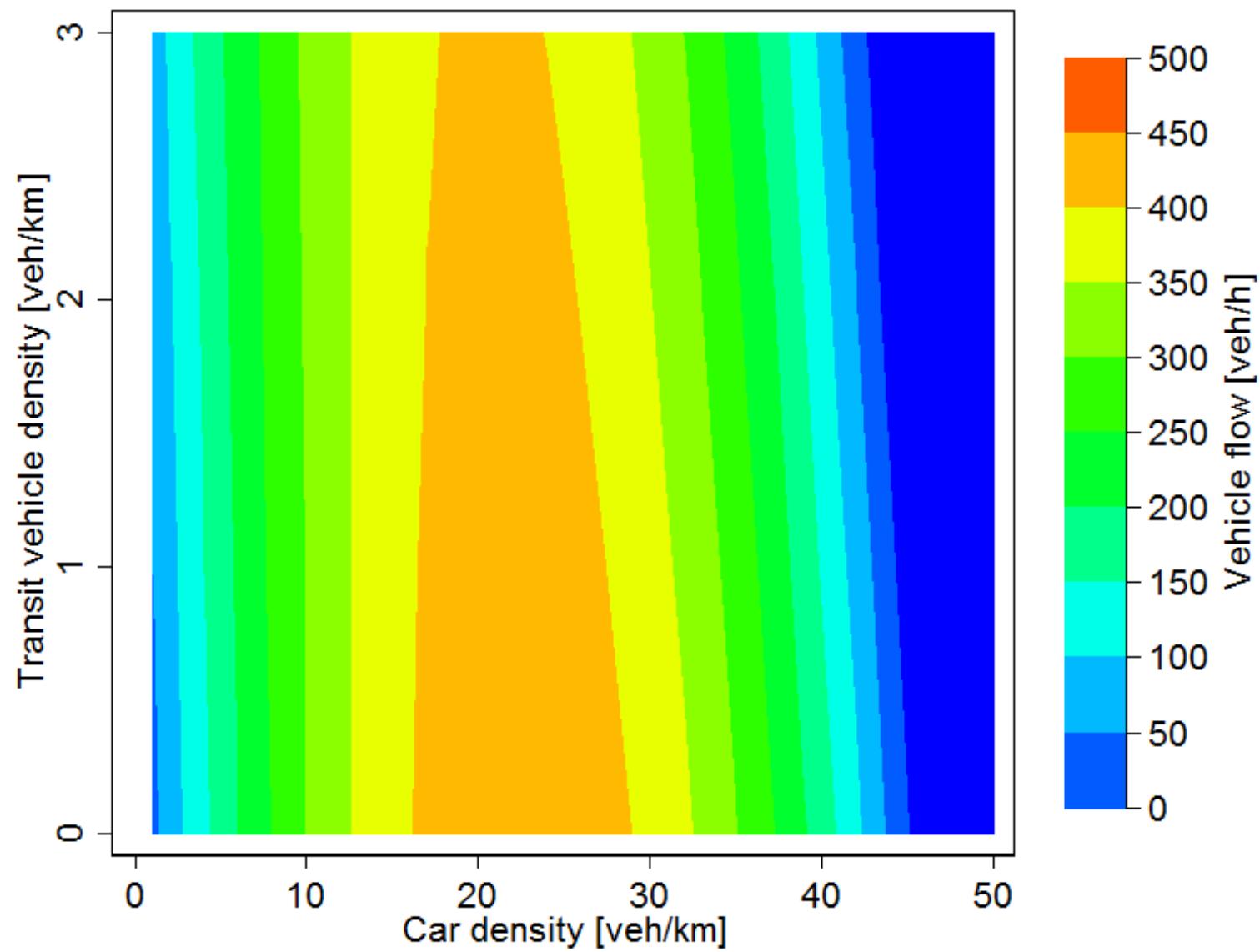
Fleet size and speeds



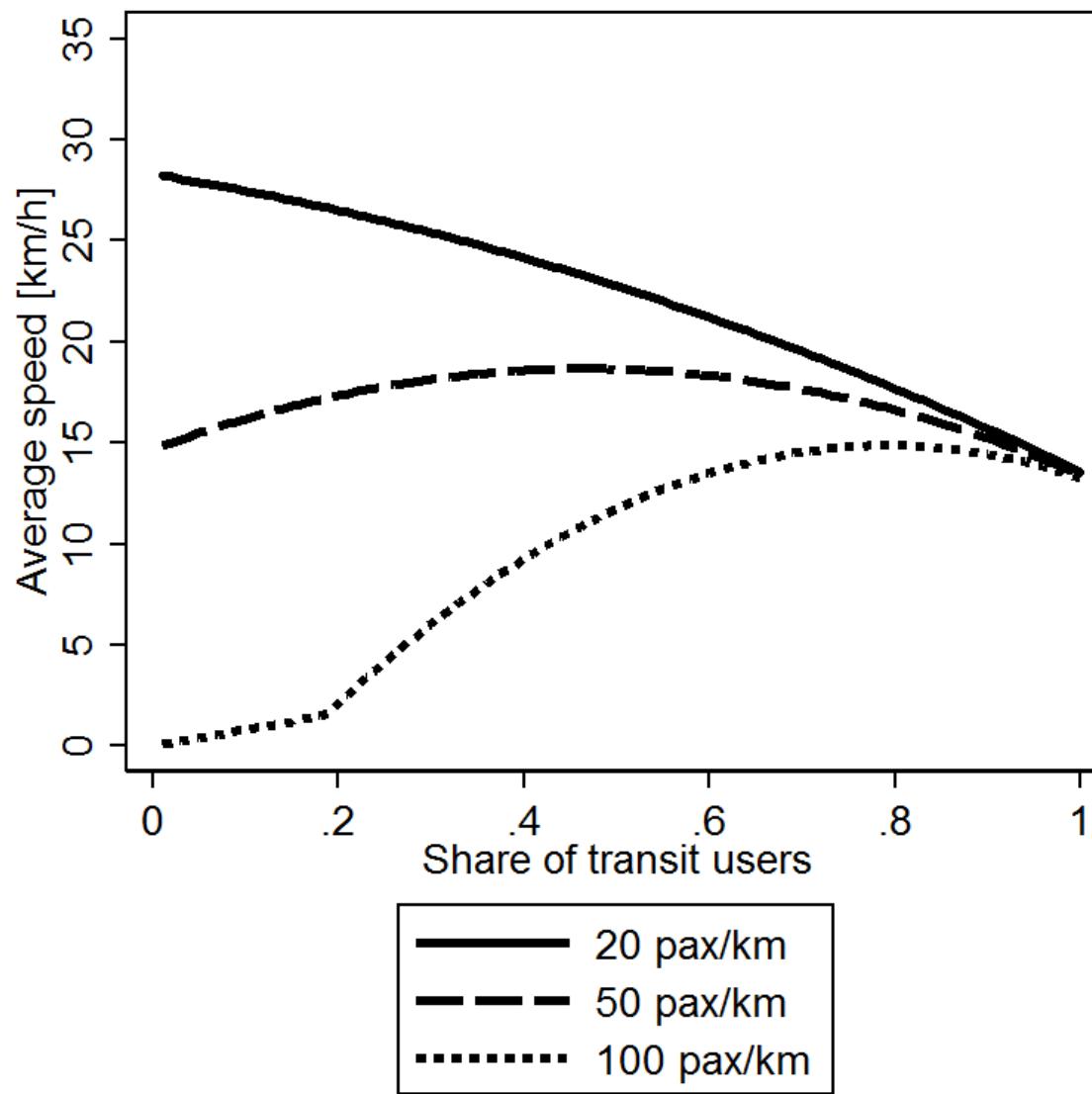
3d MFD (Zürich, FCD & loops) City centre



3d MFD (Zürich, FCD & loops) city centre



3d MFD (Zürich, FCD & loops) city centre - max speed



Our LUTI experience

Our LUTI experience

- Two large projects:
 - ZUK – Zukunft urbaner Kulturlandschaften (ETH-funded)
 - SustainCity (7th Framework funded)
- Implementation of a **parcel-fine** *UrbanSim* (with MATSim)
 - Set up of a (semi-)automatic data pipeline
- Estimation of the necessary models, e.g.
 - Hedonics (including urban morphology)
 - Land-use change models
 - Residential choice (including vicinity of core social network and work place location)
 - Labour market interaction still missing (wages as a function of competition)

Our LUTI experience

- My conclusions:
 - Too wide an intellectual span for one chair without a second permanent colleague/staff member
 - Need for a short-cut transport model
 - Too fine a resolution for many questions
- Focus on choice models directly related to movement (long and short term)
- Focus on direct demand models

Our LUTI experience translated



Our LUTI experience translated

- Much lower resolution:
 - Municipalities @ 2500 inhabitants on average
 - Land use from existing and projected numbers/plans
- Focus on population synthesis and updating
- Transport interfaces to
 - aggregate national model
 - Native spatial regression model of speeds & shortest paths
- Future issues:
 - Improved modelling of land prices/rents
 - Improved modelling of wages/incomes

FALc: St. Gall Projects

Neubauprojekte Raum St. Gallen

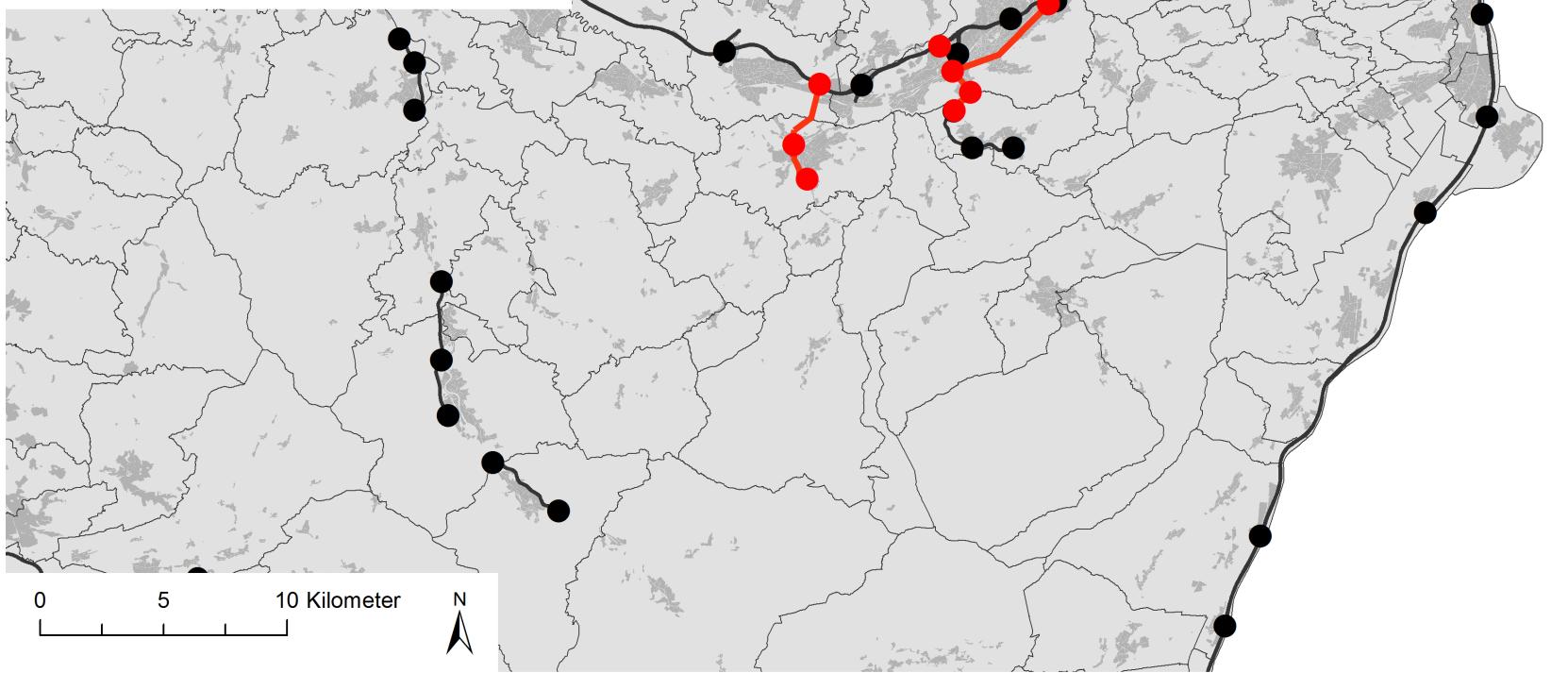
Siedlungsgebiet
Gemeinden GG25

Autobahnen und Autostrassen

— Autobahnen und Autostrassen
— Neubauprojekte Raum St. Gallen

Autobahnanschlüsse

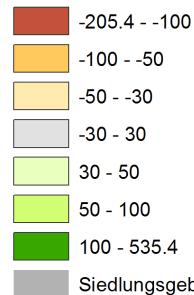
- 0
- 1



FALC: St. Gall simulated impact residents (10 years later)

Neubauprojekte Raum St. Gallen

Einfluss auf die Einwohner [Personen]

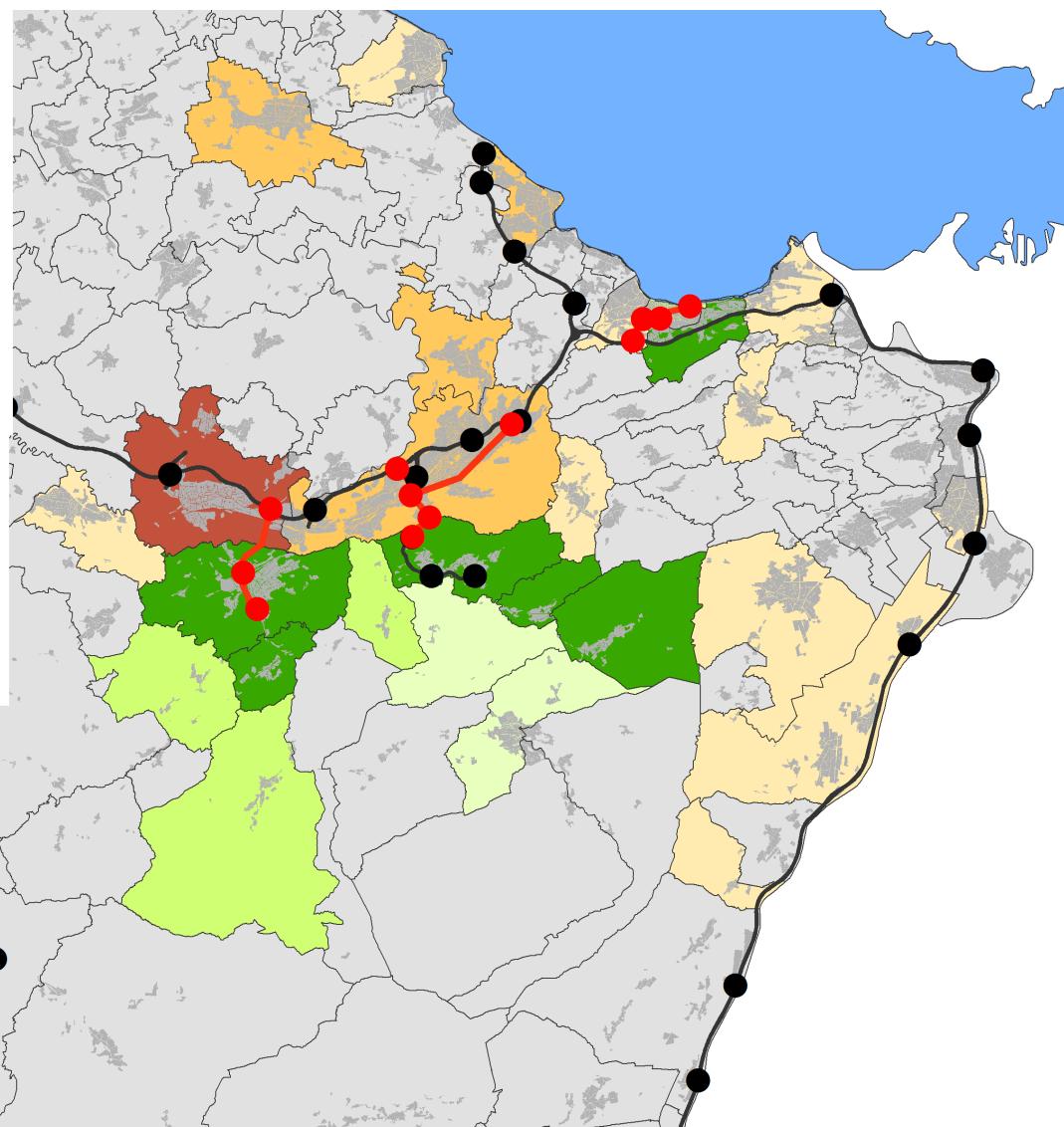
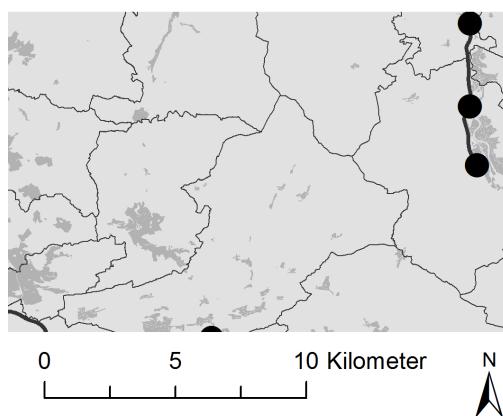


Autobahnen und Autostrassen

- Autobahnen und Autostrassen
- Neubauprojekte Raum St. Gallen

Autobahnanschlüsse

- 0
- 1



What next ?

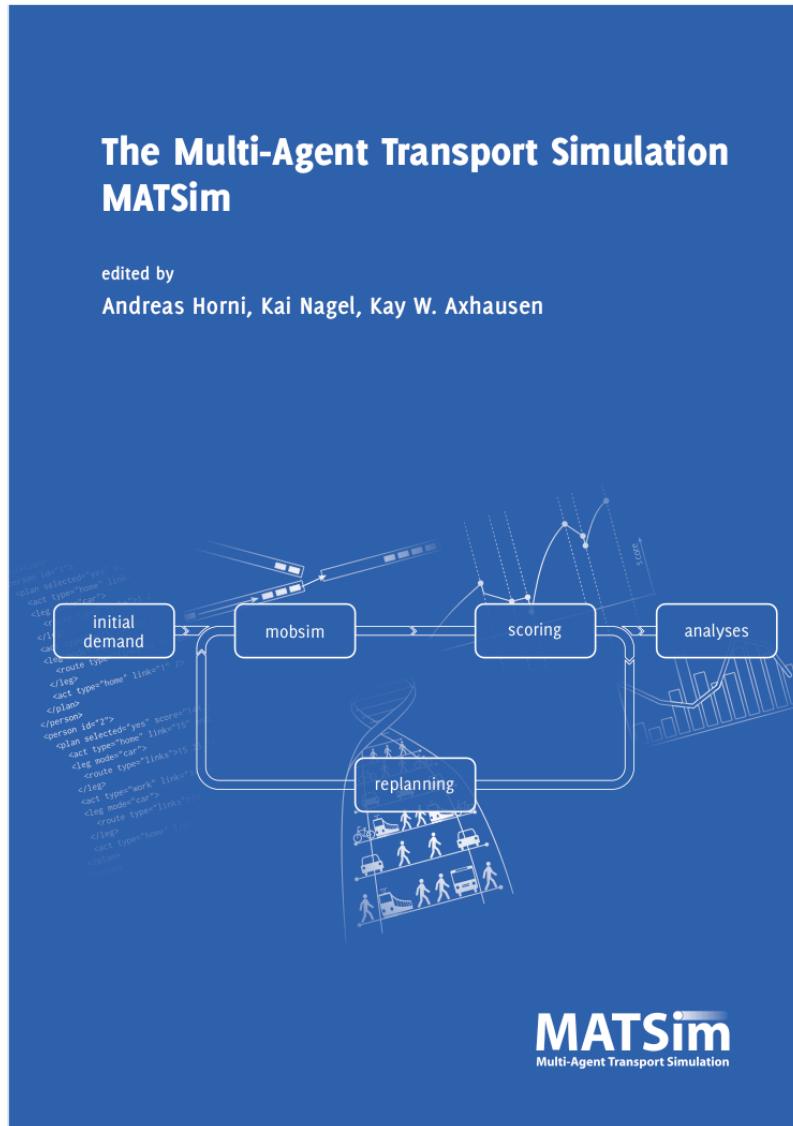
What next ?

- Close knowledge gaps for Switzerland
 - Budget allocation process
 - Budget capacity link
- Replicate results beyond Switzerland
- Add estimates of externalities
- Formulate a closed form optimisation model
- - For desired speed (accessibility) level
 - For welfare maximisation

What next ?

- For MATSim
 - Modelling expenditures and quality/price/social worth trade-offs
 - Modelling bargaining in social networks
 - ‘Predicting’ social network structures
- Better integration with land use and labour market models

Questions ? See also www.ivt.ethz.ch and



Literature

- Aschauer, D. (1989) Is public expenditure productive?, *Journal of Monetary Economics*, **23** (2) 177-200.
- Cappellari, L., and S. P. Jenkins (2006) Calculation of multivariate normal probabilities by simulation with applications to maximum simulated likelihood estimation, *Stata Journal*, **6** (2) 156–189.
- Geroliminis, N., and C.F. Daganzo (2008) Existence of urban-scale macroscopic fundamental diagrams: Some experimental findings, *Transportation Research Part B*, **42** (9) 759-770.
- Graham, D.J. (2007) Agglomeration, Productivity and Transport Investment, *Journal of Transport Economics and Policy*, **41** (8) 317–43.
- Jenkins, S. P., L. Cappellari, P. Lynn, A. Jäckle, and E. Sala (2006) Patterns of consent: Evidence from a general household survey, *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, **169** (4) 701–722.

Appendix

Model formulation 1/2

Choice environment

Case	Choice	Probability
1	None	$P_1 = \Phi_2(-x_1\beta_1; -x_2\beta_2; \mathbf{P}_2)$
2	Car & no ticket	$P_2 = \Phi_2(-x_1\beta_1; x_2\beta_2; \mathbf{P}_2)$
3	Car & local ticket	$P_3 = \Phi_3(x_1\beta_1; x_2\beta_2 - x_3\beta_3; \mathbf{P}_3)$
4	Car & GA	$P_4 = \Phi_3(x_1\beta_1; x_2\beta_2; x_3\beta_3; \mathbf{P}_3)$
5	No car & local ticket	$P_4 = \Phi_3(x_1\beta_1; -x_2\beta_2; -x_3\beta_3; \mathbf{P}_3)$
6	No car & GA	$P_5 = \Phi_3(x_1\beta_1; -x_2\beta_2; x_3\beta_3; \mathbf{P}_3)$

Likelihood function

$$\mathcal{L}(\boldsymbol{\alpha}) = \delta \iiint_{\mathbf{x}_{low}}^{x_{up}} \phi_3(\beta_1 \hat{x}_1, \beta_2 \hat{x}_2, \beta_3 \hat{x}_3; \mathbf{P}_3) d\hat{\mathbf{x}} + (1 - \delta) \iint_{\mathbf{x}_{low}}^{x_{up}} \phi_2(\beta_1 \hat{x}_1, \beta_2 \hat{x}_2; \mathbf{P}_2) d\hat{\mathbf{x}}$$

Estimation method:

- Maximum simulated likelihood in Stata using Newton Raphson technique
- Using draws to compute the integral

Model formulation 2/2

- δ Sample selection dummy, equal to 1 if observation holds season ticket
- Φ_n N-dimensional cumulative distribution function of the normal distribution
- ϕ_n N-dimensional probability density function of the normal distribution
- β Parameters of the model
- Σ Symmetric correlation matrix with typical elements ρ_{ij} and $\rho_{ii} = 1$.
The same correlations appear in both Σ_2 and Σ_3 by using their Cholesky decomposition and estimating the Cholesky factors in the model
- α Parameter vector to be estimated that contains all β and Cholesky factors of Σ
- $x_{\text{up},\text{low}}$ Upper and lower limits of integration domain, determined by values of each observation

Switzerland: Ownership models (1/2)

	Season-ticket owner		Car available	
Age	-0.059	***	0.099	***
Age squared	0.052	***	-0.088	***
Male	-0.132	***	0.439	***
Working	0.066	***	0.258	***
University level education	0.146	***	-0.054	**
Log of monthly household income	0.075	***	0.391	***
Center of agglomeration	0.132	***	-0.22	***
Constant	0.052		-6.039	***

Switzerland: Ownership models (2/2)

	Season-ticket owner		Car available	
Local access to public transport: E	-0.474	***	0.505	***
Local access to public transport: D	-0.348	***	0.384	***
Local access to public transport: C	-0.253	***	0.286	***
Local access to public transport: B	-0.097	***	0.154	***
General accessibility	0.089	***	-0.028	***
Surplus public transport acc.	-0.005	***	-0.066	***
Surplus workplace accessibility	0.729	***	-0.527	***

Switzerland: GA given season ticket (2/2)

	General abonnement	
Secondary residence	0.302	***
Log of monthly household income	0.128	***
Self-reported distance [1000km]	0.005	***
Constant	-2.188	***

Error correlations		
	Car available	GA
Season ticket	-0.44	0.62
Car available		-0.24