Preferred citation style

Schüssler, N. and K.W. Axhausen (2009) Accounting for Route Overlap in Urban and Suburban Route Choice Decisions Derived from GPS Observations, *12th International Conference on Travel Behaviour Research*, Jaipur, December 2009.

Accounting for Route Overlap in Urban and Suburban Route Choice Decisions Derived from GPS Observations

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December 2009

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Motivation

The increasing use of GPS studies to observe drivers' route choice behaviour leads to two major challenges for researchers

- the large number of available alternatives
- the similarity between alternatives

Neither the decision-maker nor the analyst is able to evaluate the full set of alternatives, the universal choice set.

The similarities issue is amplified due to the large number of alternatives and the density of the road network

=> Interdependencies between choice set and similarity treatment should be investigated for high-resolution data

Choice set generation

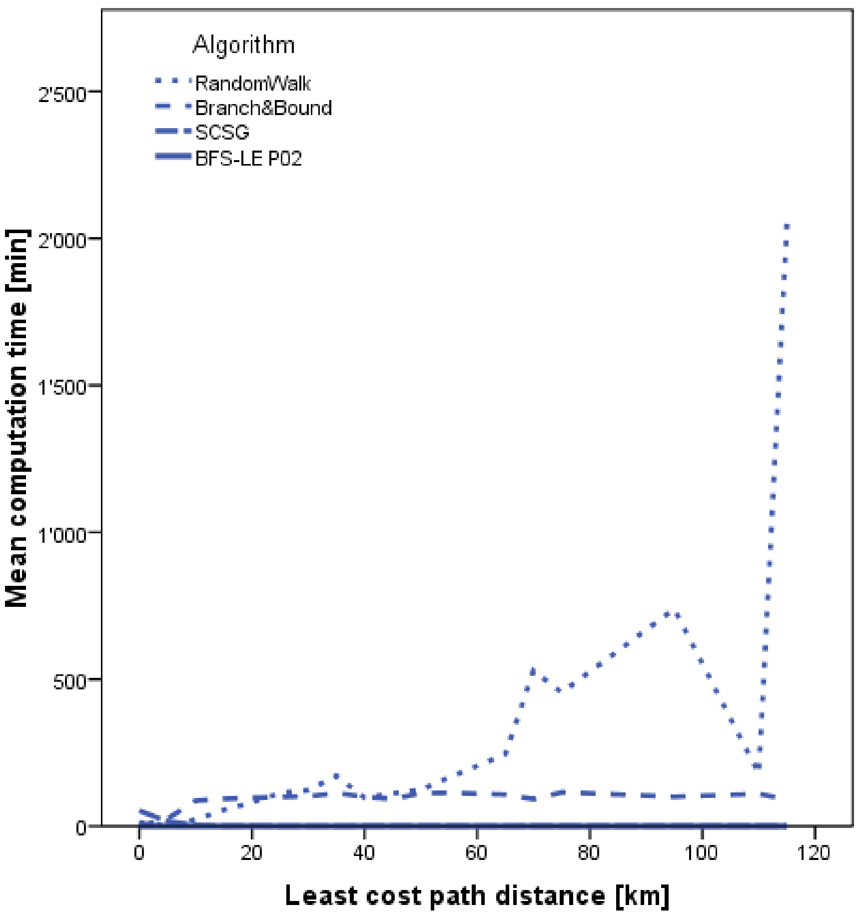
Generation of 20, 60 and 100 alternatives for 1500 car trips

Swiss Navteq network
(408,636 nodes and 882,120 unidirectional links)

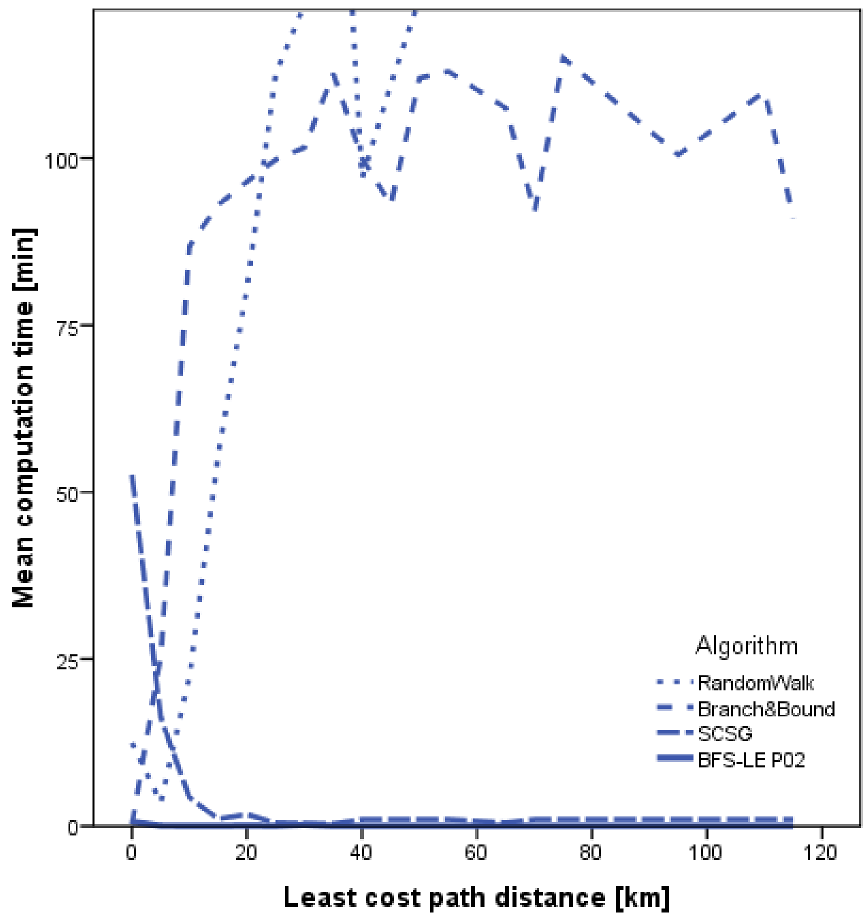
Choice set generation procedures tested:

- Random Walk (Frejinger, 2007)
- Branch & Bound (Prato and Bekhor, 2006)
- Stochastic Choice Set Generation (SCSG)
- Breadth First Search on Link Elimination (BFS-LE)

Computational Performance



Complete scale



Zoomed

Choice set size reduction

Bovy (2009) recommends:

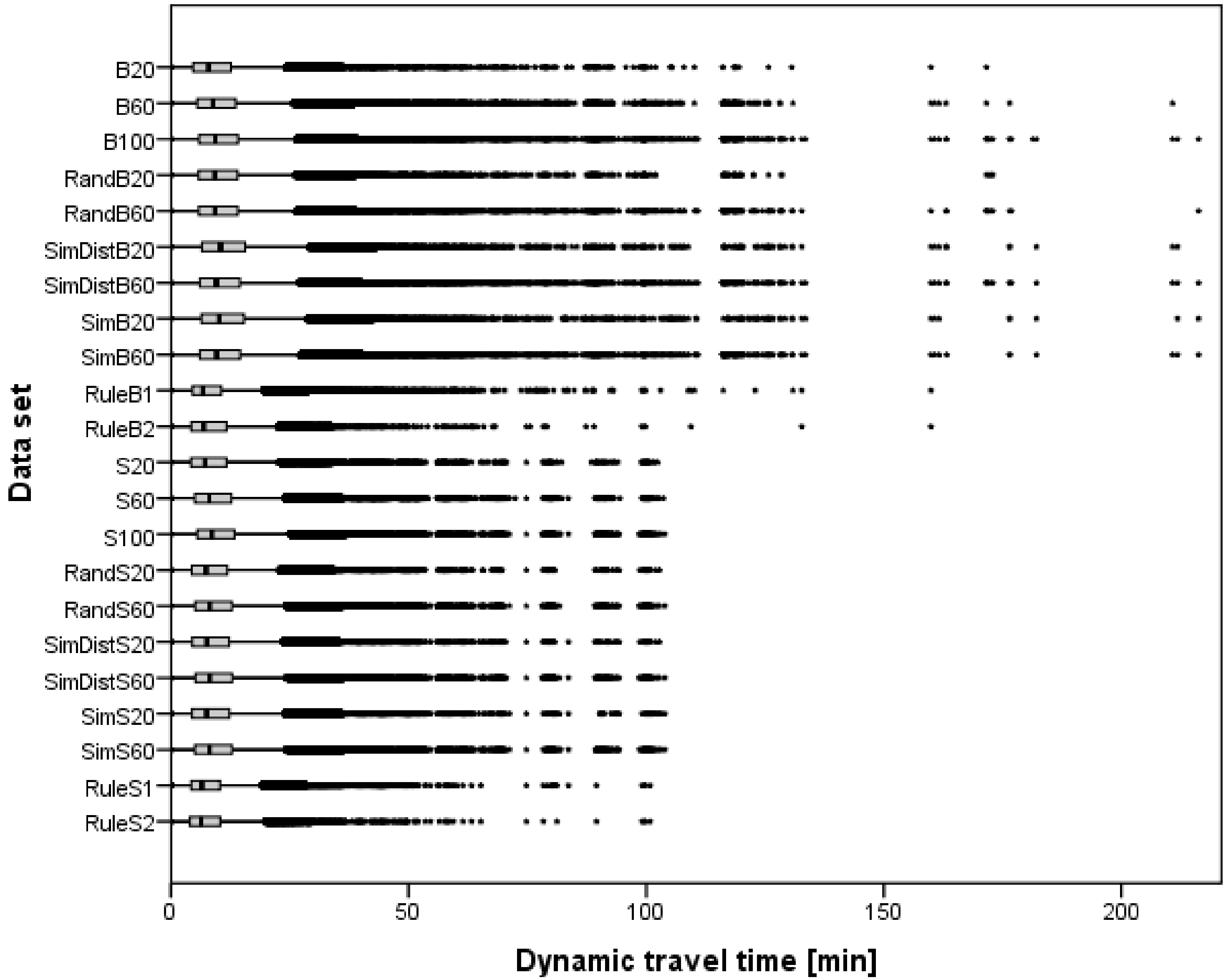
- establish a master set as exhaustive as possible
- Reduce master set to the individual choice set taking into account attractiveness, plausibility and overlap

Reduction of choice sets with 100 alternatives to choice sets with 20 and 60 alternatives

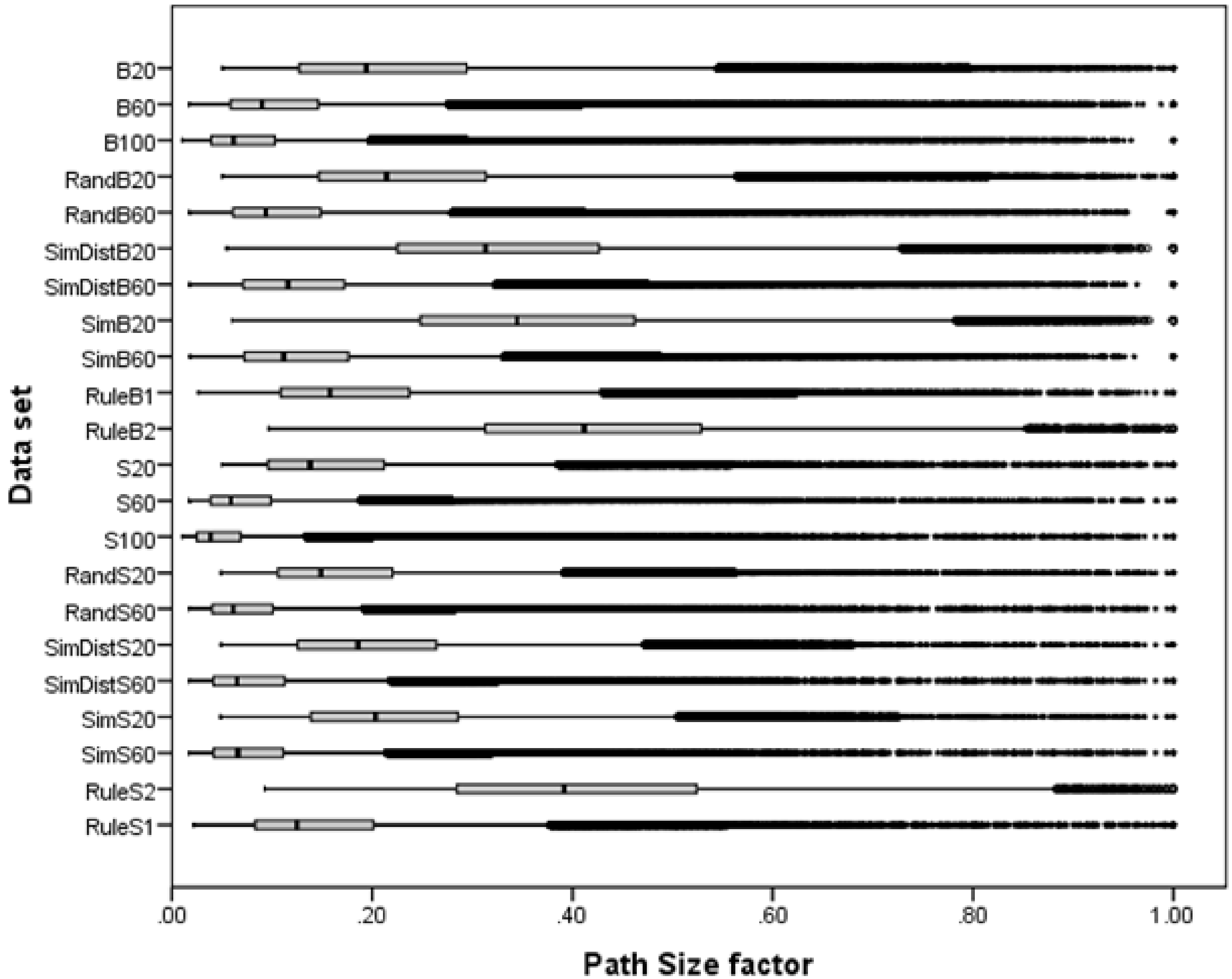
Choice set size reduction procedures tested:

- Random
- Similarity-based
- Similarity distribution-based
- Rule-based

Travel time distributions for the different choice sets



Path size distributions for the different choice sets



Model estimations

Estimating models for all choice sets

Testing the influence of

- Travel time, road types, Sampling Correction (Bovy *et al.*, 2009)

Treatment of route overlap

- Path Size (Ben-Akiva and Bierlaire, 1999)
- Path Size Correction (Bovy *et al.*, 2008)
- Commonality Factor (Cascetta *et al.*, 1996)
- Road type specific Path Size factor (based on Hoogendoorn-Lanser and Bovy (2007))

The road type specific Path Size

Formulation 1:

$$RTPS1_{irn} = \frac{1}{L_{ir}} \sum_{a \in \Gamma_{ir}} \frac{l_a}{N_{na}}$$

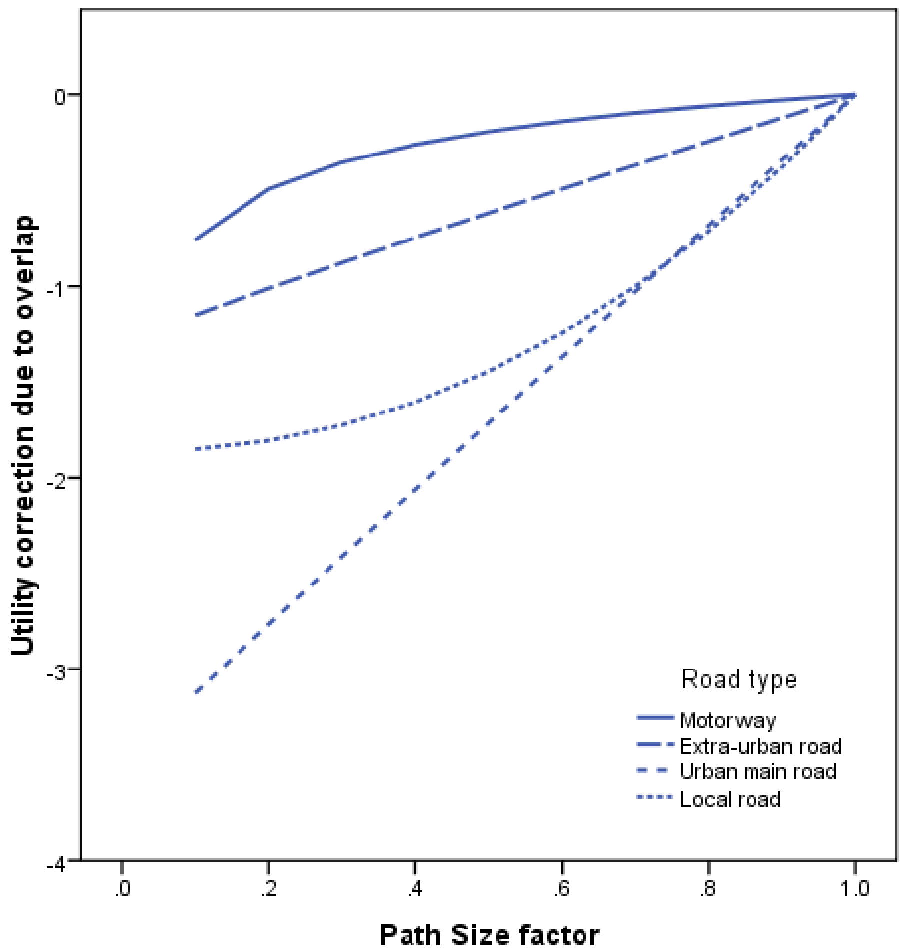
Formulation 2:

$$RTPS2_{irn} = \frac{1}{L_i} \sum_{a \in \Gamma_{ir}} \frac{l_a}{N_{na}}$$

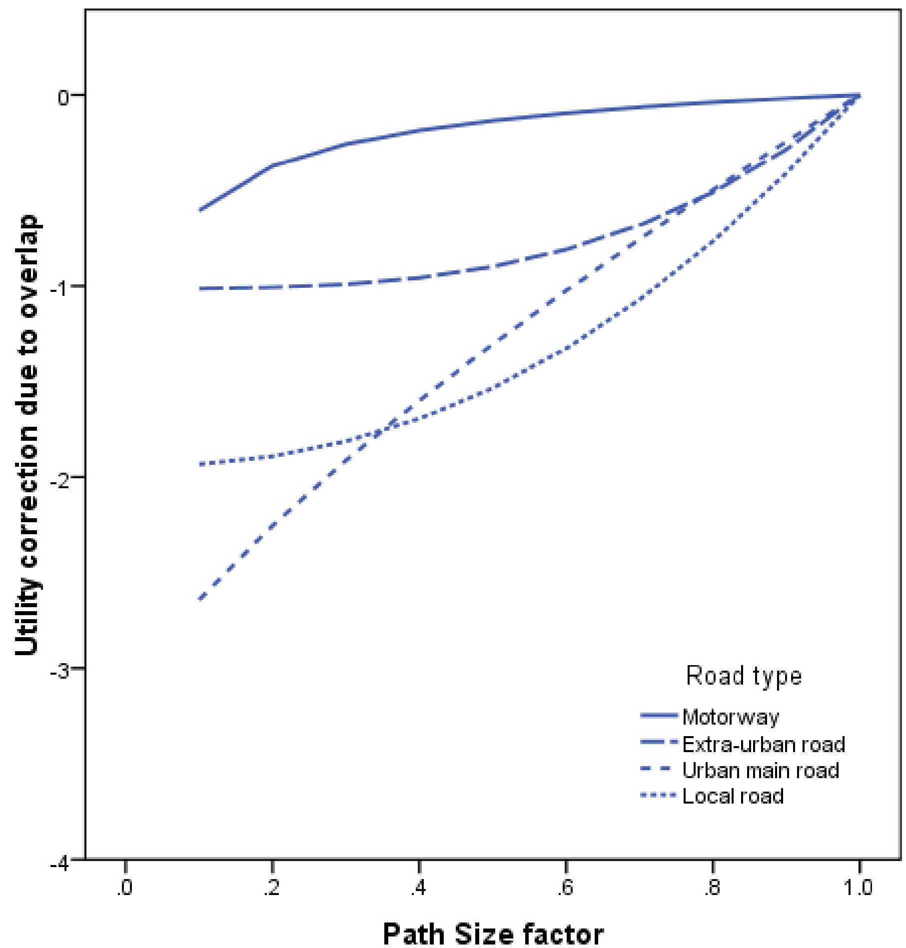
Adj. ρ^2 for the transformations of the adjustment terms

	B100			S100		
Adjustment term	None	LN	BC	None	LN	BC
None	0.21	--	--	0.12	--	--
PSC	0.22	--	--	0.13	--	--
PS1	0.23	0.22	0.24	0.14	0.13	0.14
PS2	0.24	0.22	0.24	0.14	0.13	0.14
CF1	0.23	0.24	0.24	0.13	0.13	0.13
PSRT1	0.26	0.24	0.26	0.16	0.14	0.17
PSRT3	0.25	0.23	0.25	0.16	0.14	0.16

Utility correction for route overlap per degree of overlap

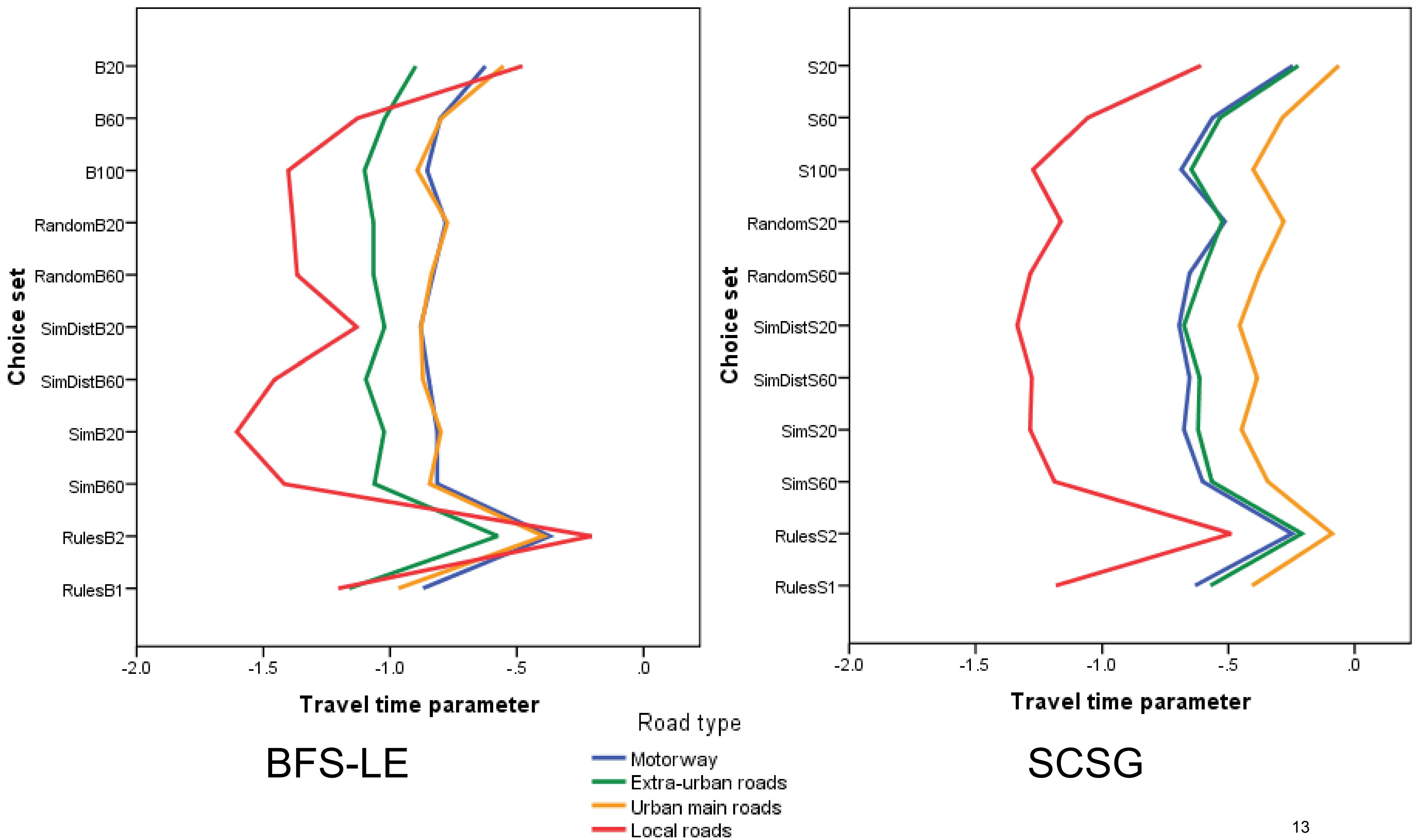


B100 – BoxCox(PSRT1)

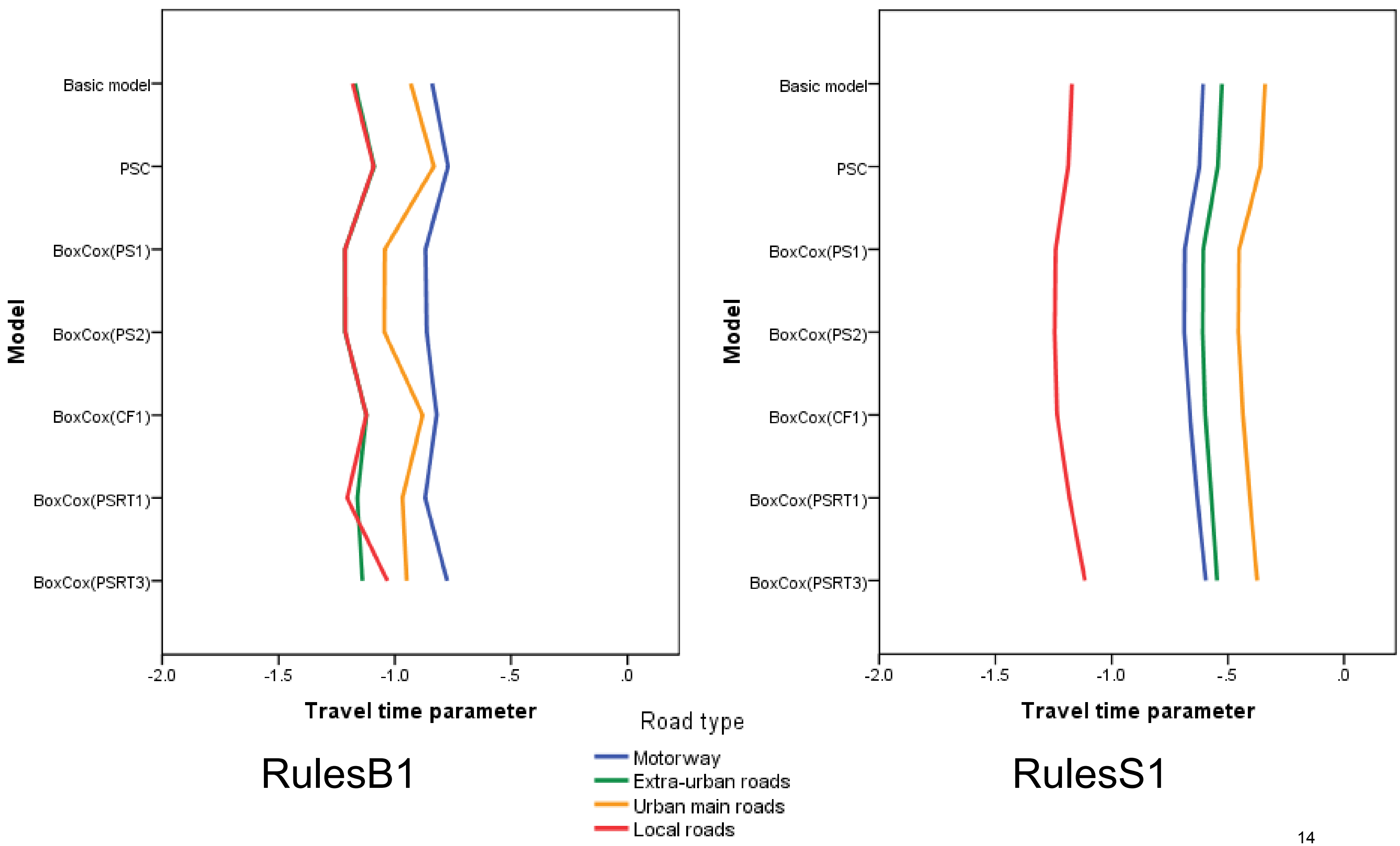


S100 – BoxCox(PSRT1)

Influence of choice sets on travel time parameters



Influence of adjustment terms on the travel time parameters



Conclusions

Most suitable choice set:

- First generate large route set, then reduce to a behaviourally realistic choice set
- Best reduction procedure: Rule-based
- Systematic parameter testing required for rule-based reduction

Best way to account for similarities:

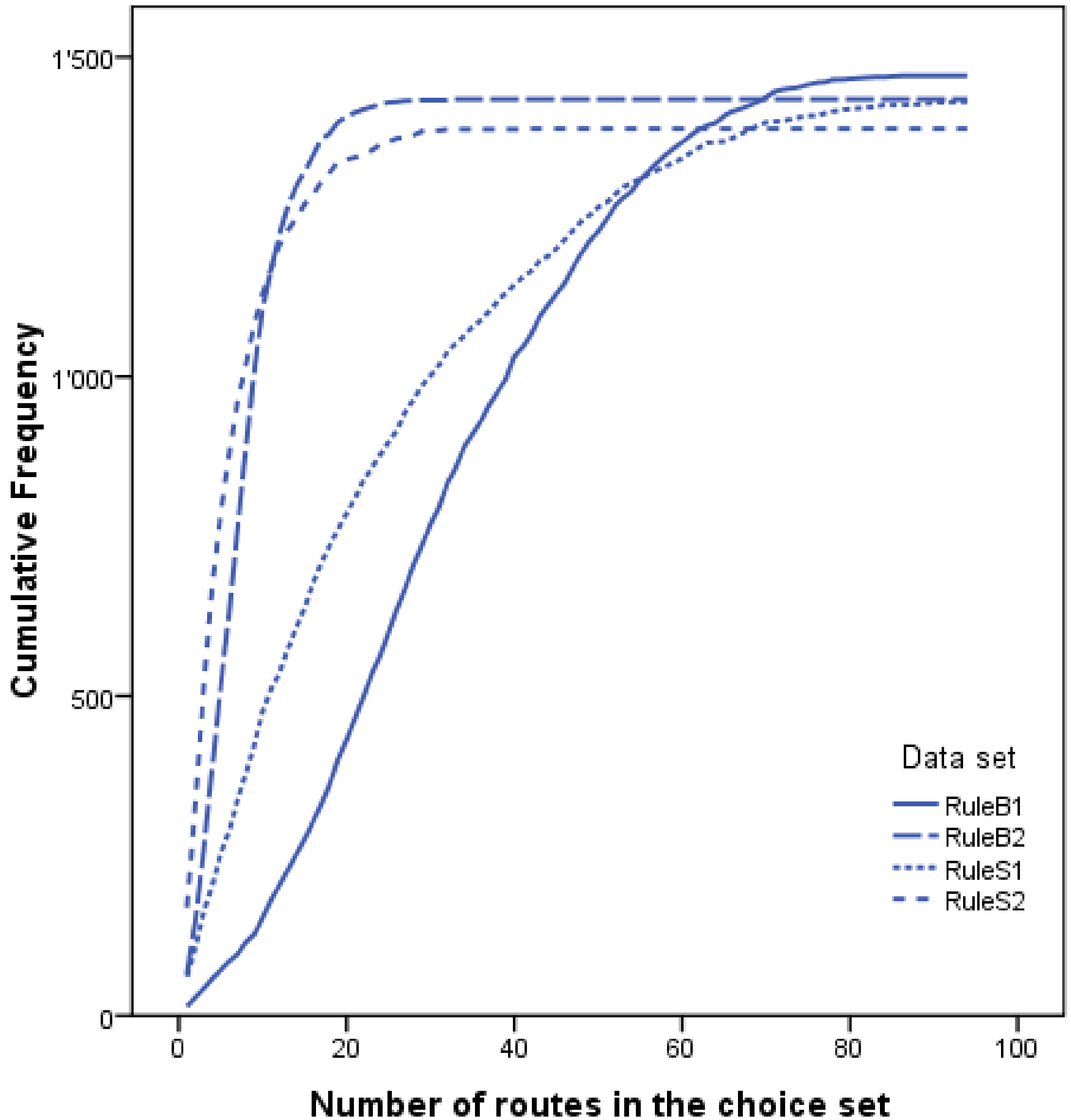
- Road type specific Path Size
- BoxCox transformation

Appendix

Choice sets used in the model estimation

Algorithm	Choice set size	Reduction procedure	Identification code
BFS-LE	20, 60, 100	--	B20, B60, B100
	20, 60	Random	RandB20, RandB60
	20, 60	Similarity distribution-based	SimB20, SimB60
	20, 60	Similarity-based	SimDistB20, SimDistB60
	34, 87	Rule-based	RuleB1, RuleB2
SCSG	20, 60, 100	--	S20, S60, S100
	20, 60	Random	RandS20, RandS60
	20, 60	Similarity distribution-based	SimS20, SimS60
	20, 60	Similarity-based	SimDistS20, SimDistS60
	43, 95	Rule-based	RuleS1, RuleS2

Number of routes in rule-based reduced choice sets



Commonality Factor and Path Size

Commonality Factor

$$CF_{in} = -\beta_0 \ln \sum_{j \in C_n} \left(\frac{L_{ij}}{\sqrt{L_i \cdot L_j}} \right)^{\gamma}$$

Path Size

$$PS_{in} = \sum_{a \in \Gamma_i} \frac{l_a}{L_i} \frac{1}{\sum_{k \in C_n} \delta_{ak} \frac{L^*_{C_n}}{L_k}}$$

Sampling Correction (SC) and Path Size Correction (PSC)

Sampling Correction

$$SC_{in} = ln\left(\frac{f_{in}}{Q_{in}}\right)$$

where

$$Q_{in} = \frac{PS_{in}\ exp\left(-c_{in} / b\right)}{\sum_{j \in C_n} PS_{jn}\ exp\left(-c_{jn} / b\right)}$$

Path Size Correction

$$PSC_{in} = -\sum_{a \in \Gamma_i} \left(\frac{l_a}{L_i}\right) ln \sum_{j \in C_n} \delta_{aj}$$