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Influence of parking on location and mode choice

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Context

SVI project 2008/001 – «Einfluss des Parkierungsangebotes auf das Verkehrsverhalten und den Energieverbrauch»

Project team:

- IVT: C. Weis, K.W. Axhausen
- TransOptima: M. Vrtic
- Büro Widmer: P. Widmer
- Intervista: C. Wüthrich, M. Zaugg

Tasks:

- Identify the parking attributes that influence travel behaviour
- Model the influences in the context of:
    - Choice of parking
    - Destination choice
    - Mode choice
    - Choice of workplace

Survey methodology

Stated Choice survey in 4 parts:

(1) Choice of parking
- Parking 1
- Parking 2
- Abort search

(2) Destination choice:
- Location 1
- Location 2
- Abort search

(3) Mode choice:
- Available modes (walk / bicycle / car / public transport)

(4) Choice of workplace:
- Current
- New

Procedure

- Recruitment of respondents (over several weeks):
  - Existing online panel run by Intervista
  - Incentive worth 3.- CHF

- Questions on:
  - Sociodemographics
  - Frequently visited locations (workplace / shopping / leisure)
  - Mode choice for trips to those locations
  - Parking search strategies in cities

- Construction of alternatives for trips to reported locations:
  - Walk / bike: based on distance
  - Car: MATSim routing
  - Public transport: Query on SBB web site (HAFAS)

- Construction of SP experiments based on reported trips and alternatives

Generation of SP questionnaires

- Efficient experimental designs in *Ngene*

1st experiment	2nd experiment	Distance	Mode alternatives	Nr.
SP 1	SP 3	short	walk / car / p.t.	1
SP 1	SP 3	short	bike / car / p.t.	2
SP 1	SP 3	long	car / p.t.	3
SP 1	SP 4	-	-	4
SP 2	SP 3	short	walk / car / p.t.	5
SP 2	SP 3	short	bike / car / p.t.	6
SP 2	SP 3	long	car / p.t.	7
SP 2	SP 4	-	-	8
SP 1	SP 2	-	-	9

Experimental design: SP 1

Attribute	Values
Activity type	Shopping, leisure
Activity duration	15, 45, 120 (shop) / 45, 120, 180 (leisure) minutes
Fixed parking cost	0.-, 2.-, 5.- Swiss Francs
Variable parking cost	0.-, 2.-, 5.- Swiss Francs per hour
Total parking cost	Calculated from the previous three
Type of parking	On-street, open parking lot, parking garage
Car travel time	3, 7, 12 minutes
Parking search time	0, 5, 15 minutes
Access time	5, 8, 12 minutes
Total travel time	Sum of the previous three

SP 1

	Parkplatz 1		Parkplatz 2		Abbruch
Typ	Auf der Strasse		Im Parkhaus		-
Kosten	6.0	CHF	4.5	CHF	-
Gesamtzeit bis zum Ziel	25	min	31	min	-
davon Fahrtzeit	12	min	8	min	-
davon Suchzeit	5	min	15	min	-
davon Abgangszeit	8	min	8	min	-

← Wahl →

Experimental design: SP 2

Attribute	Values
Activity type	Shopping, leisure
Activity duration	15, 45, 120 (shop) / 45,120, 180 (leisure) minutes
Fixed parking cost	1.50, 3.-, 5.- Swiss Francs
Variable parking cost	0.-, 1.-, 3.- Swiss Francs per hour
Total parking cost	Calculated from the previous two
Type of parking	On-street, open lot, parking garage
Type of location	In a city center, in the outskirts
Price level of location	low, medium, high
Cost-performance-ratio	Adequate, good, very good
Car travel time	5, 15, 30 minutes
Parking search time	0, 3, 9 minutes
Access time	2, 4, 10 minutes
Total travel time	Sum of the previous three

SP 2

	Standort 1		Standort 2		Abbruch
Typ des Parkplatzes	Auf der Strasse		Im Parkhaus		-
Kosten	6.0	CHF	4.5	CHF	-
Gesamtzeit bis zum Ziel	25	min	31	min	-
davon Fahrtzeit	12	min	8	min	-
davon Suchzeit	5	min	15	min	-
davon Abgangszeit	8	min	8	min	-
Typ des Standorts	Innenstadt		Stadtrand		-
Preisniveau	Hoch		Mittel		-
Preis- / Leistungsverhältnis	Gut		Sehr gut		-

← Wahl →

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Experimental deign: SP 3

Alternatives	Attribute	Values
Walk / bike	Travel time	From reported trip, not varied
Car	Fuel cost	-15%, $\pm$0%, +25%
	Fixed parking cost	0.-, 1.50, 4.- Swiss Francs
	Variable parking cost	0.-, 1.-, 2.50 Swiss Francs per hour
	Total parking cost	Calculated from the previous two
	In-vehicle travel time	-10%, +10%, +30%
	Parking search time	0, 3, 9 minutes
	Access time	2, 4, 10 minutes
	Total travel time	Sum of the previous three
Transit	Ticket cost	-25%, -10%, +10% of current
	In-vehicle travel time	-15%, -5%, +5% of current
	Access time	2, 4, 10 minutes
	Total travel time	Sum of the previous two
	Number of transfers	-1, $\pm$0, +1
	Headway	-2, -1, $\pm$0 levels

SP 3

Velo				Auto				Öffentlicher Verkehr		
Fahrtzeit	12	min		Fahrtzeit	10	min		Fahrtzeit	15	min
				Kosten Treibstoff	2.0	CHF		Fährt alle	20	min
				Kosten Parkplatz	20.0	CHF		Kosten	9.0	CHF
								Umsteigen	1	Mal

	←	Wahl	→	
☐		☐		☐

SP 4

	Bisher		Neu	
Dauer des PW-Anfahrtsweges	40	min	32	min
Dauer des ÖV-Anfahrtsweges	50	min	60	min
Eine ÖV-Verbindung alle	20	min	30	min
Parkplatz verfügbar	ja		ja, fester Platz	
Parkplatzkosten	80	CHF / Monat	120	CHF / Monat
Durchschnittliche Suchzeit	5	min	0	min
Bruttoeinkommen	6'000	CHF / Monat	7'200	CHF / Monat
Verantwortung über	15 Mitarbeiter / 3 Mio. CHF		5 Mitarbeiter / 1 Mio. CHF	
Firmenwagen verfügbar	nein		nein	
GA durch Arbeitgeber gestellt	ja		nein	
Wechsel des Bereiches	nein		nein	
Wechsel der Firma	nein		ja	

☐ ← Wahl → ☐

Falls Sie sich für den neuen Arbeitsplatz entscheiden würden:

Mit welchem Verkehrsmittel würden Sie dann wahrscheinlich zur Arbeit fahren?

☐ mit dem Auto   ☐ mit dem öffentlichen Verkehr

Recruitment and response

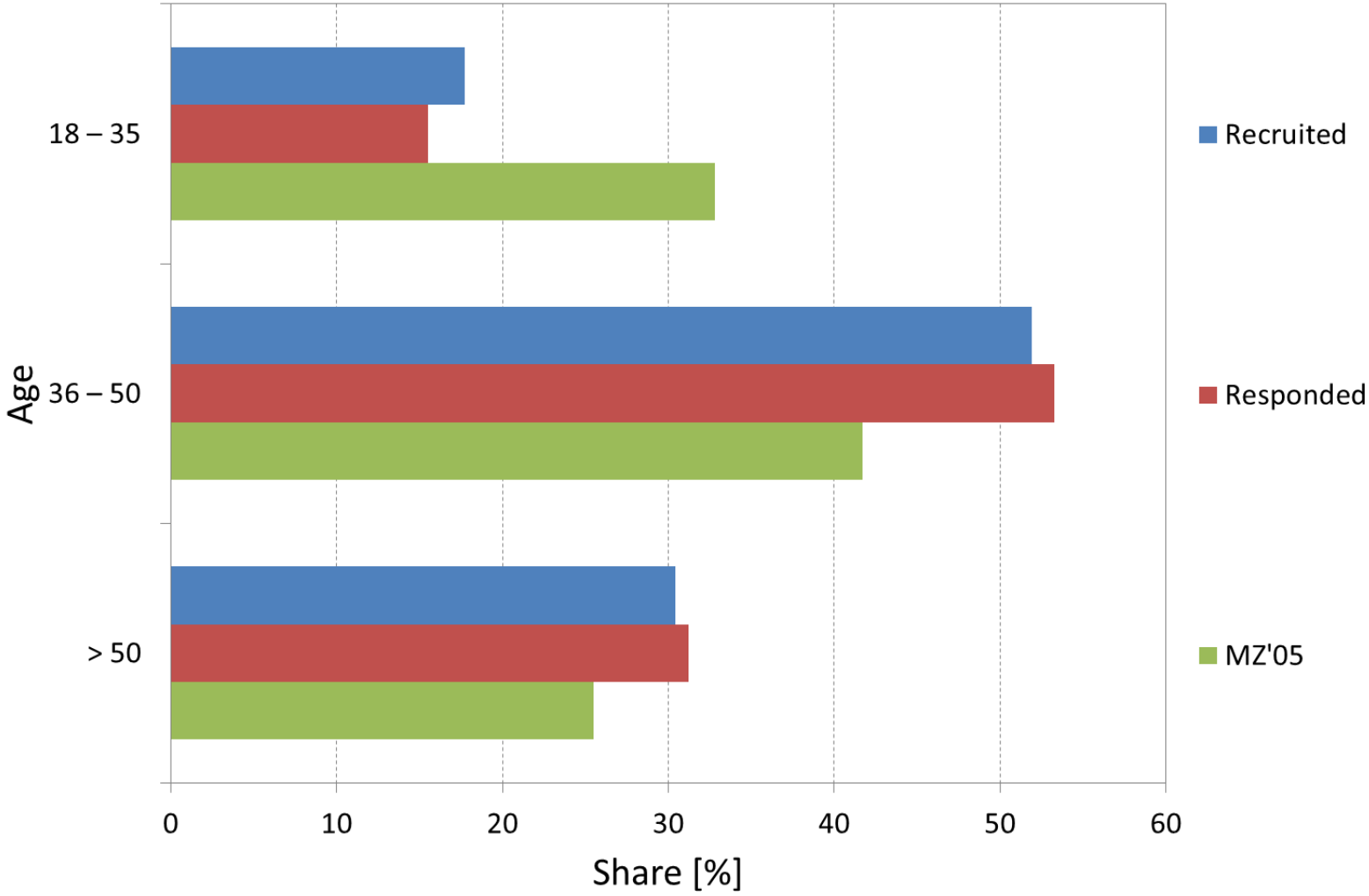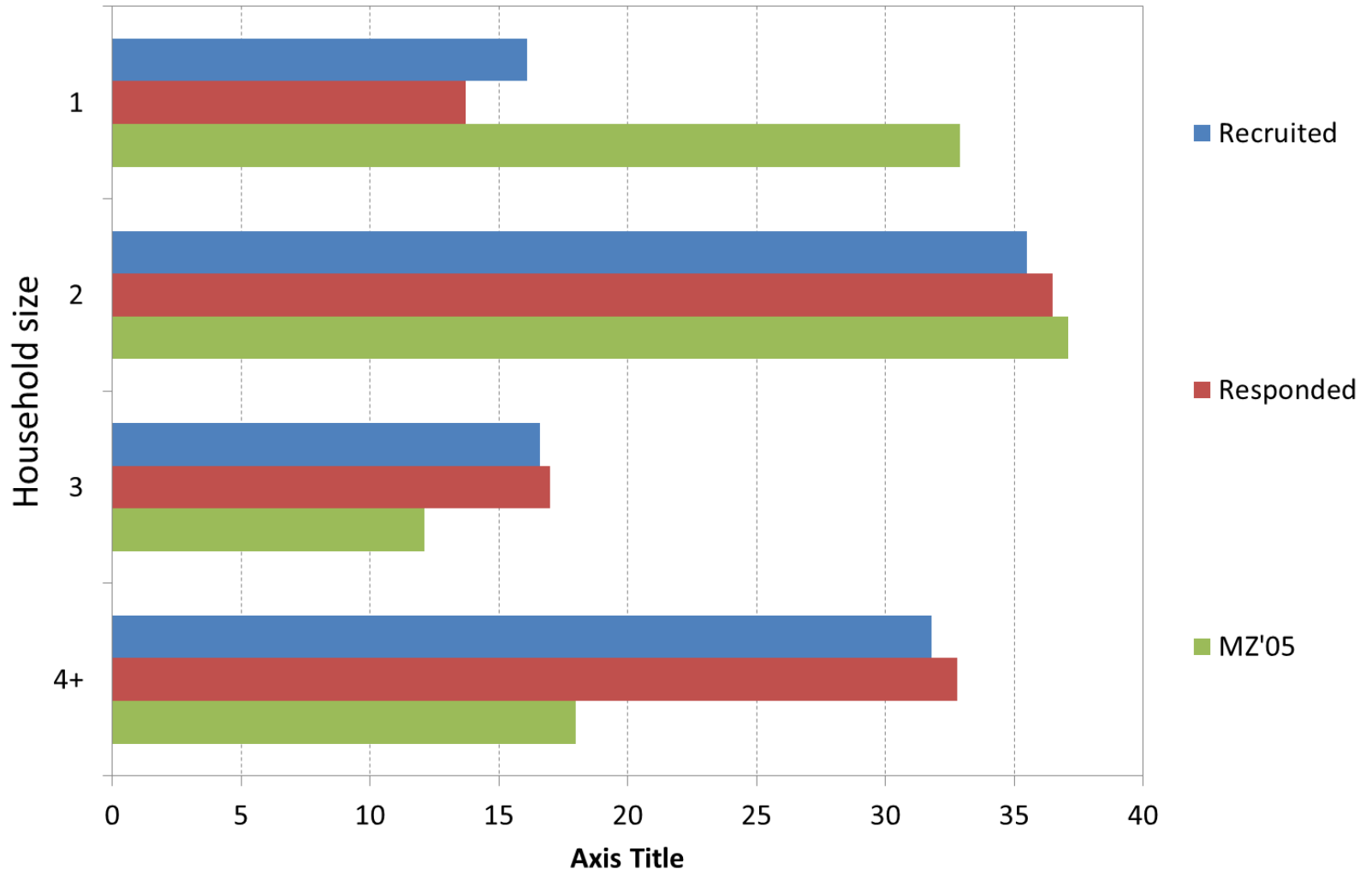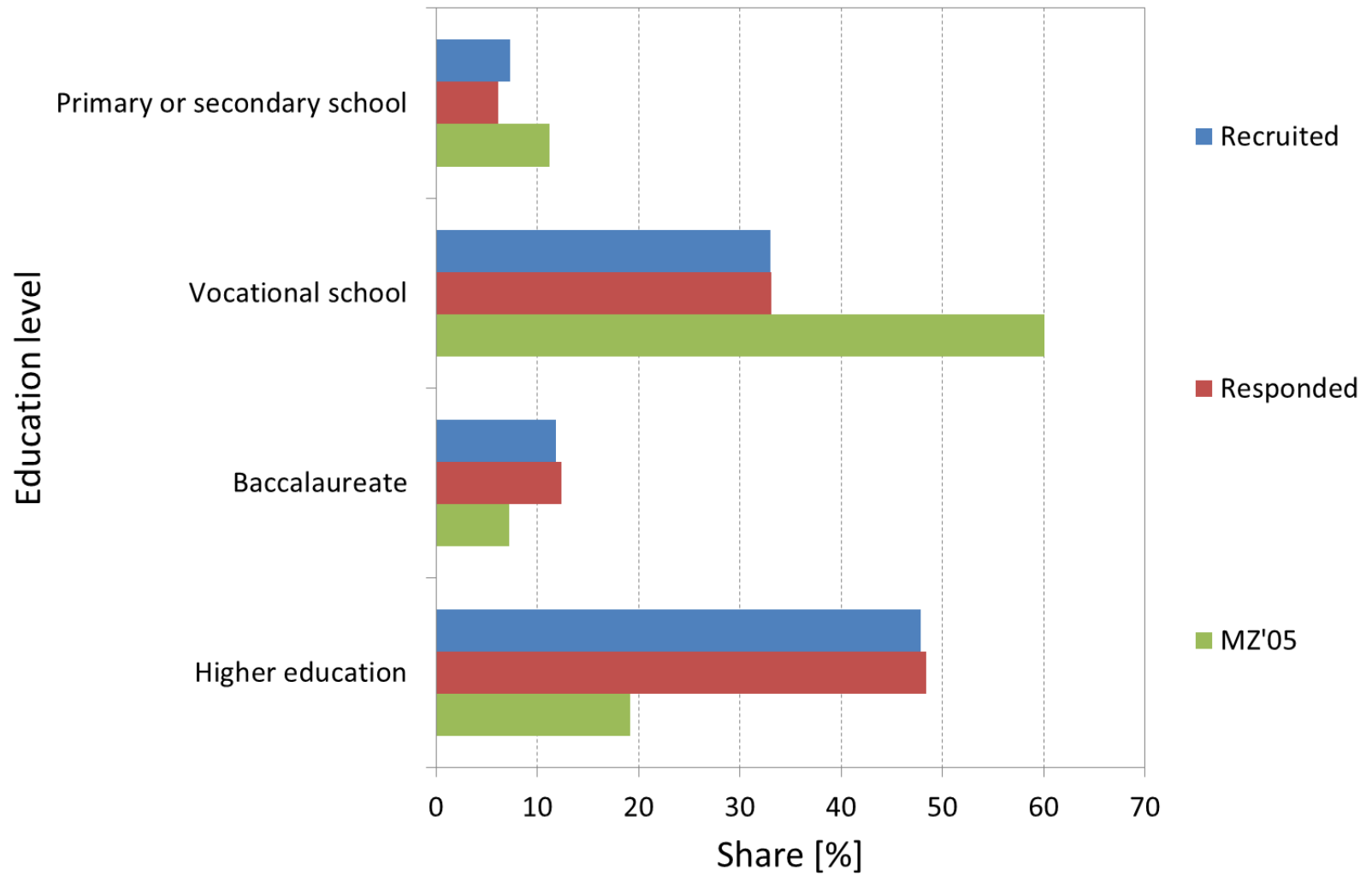|	
Recruited participants	1'248
Invalid addresses	6
Questionnaires sent	1'242
Questionnaires returned	1'040
Response rate	83.9 %

Response speed
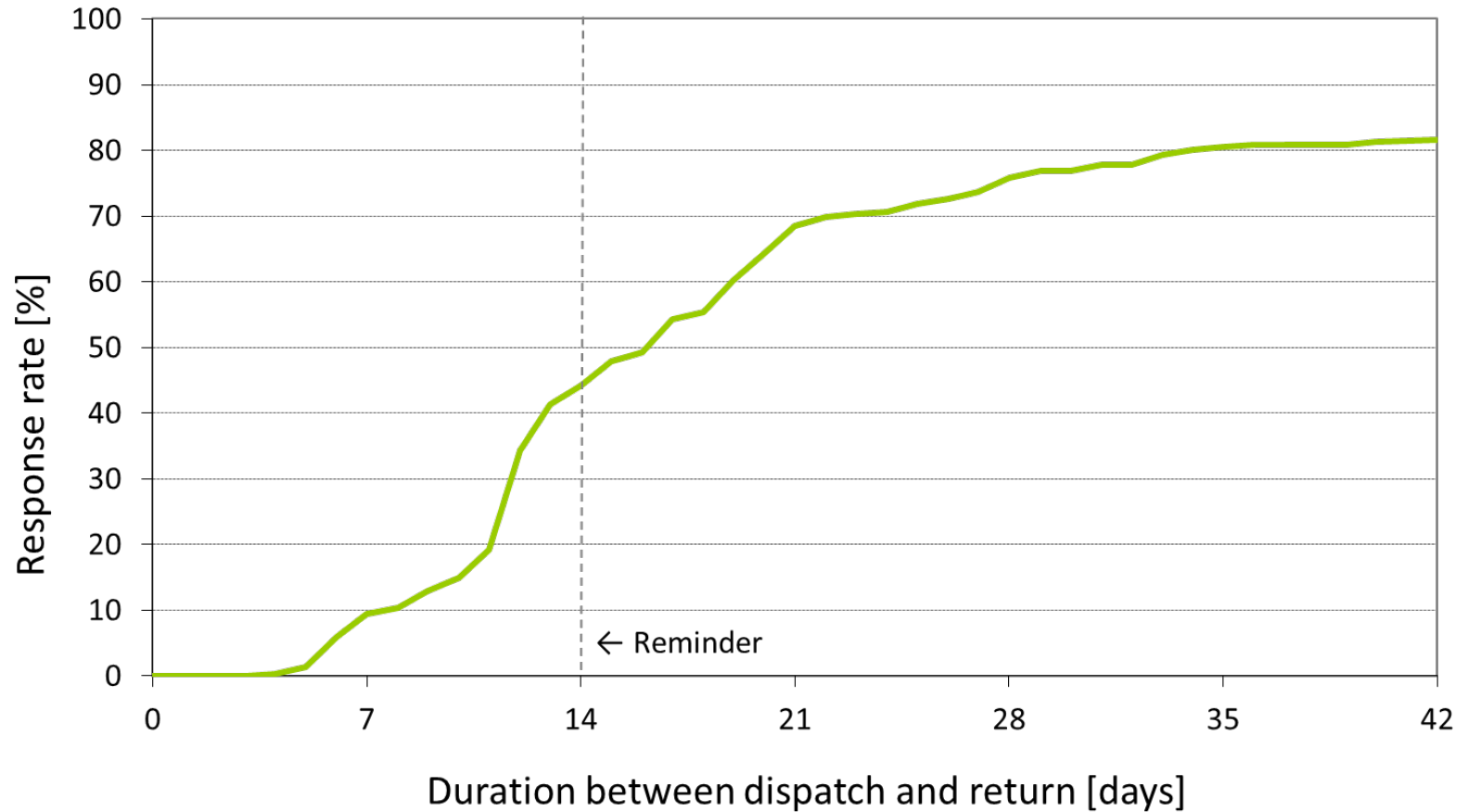
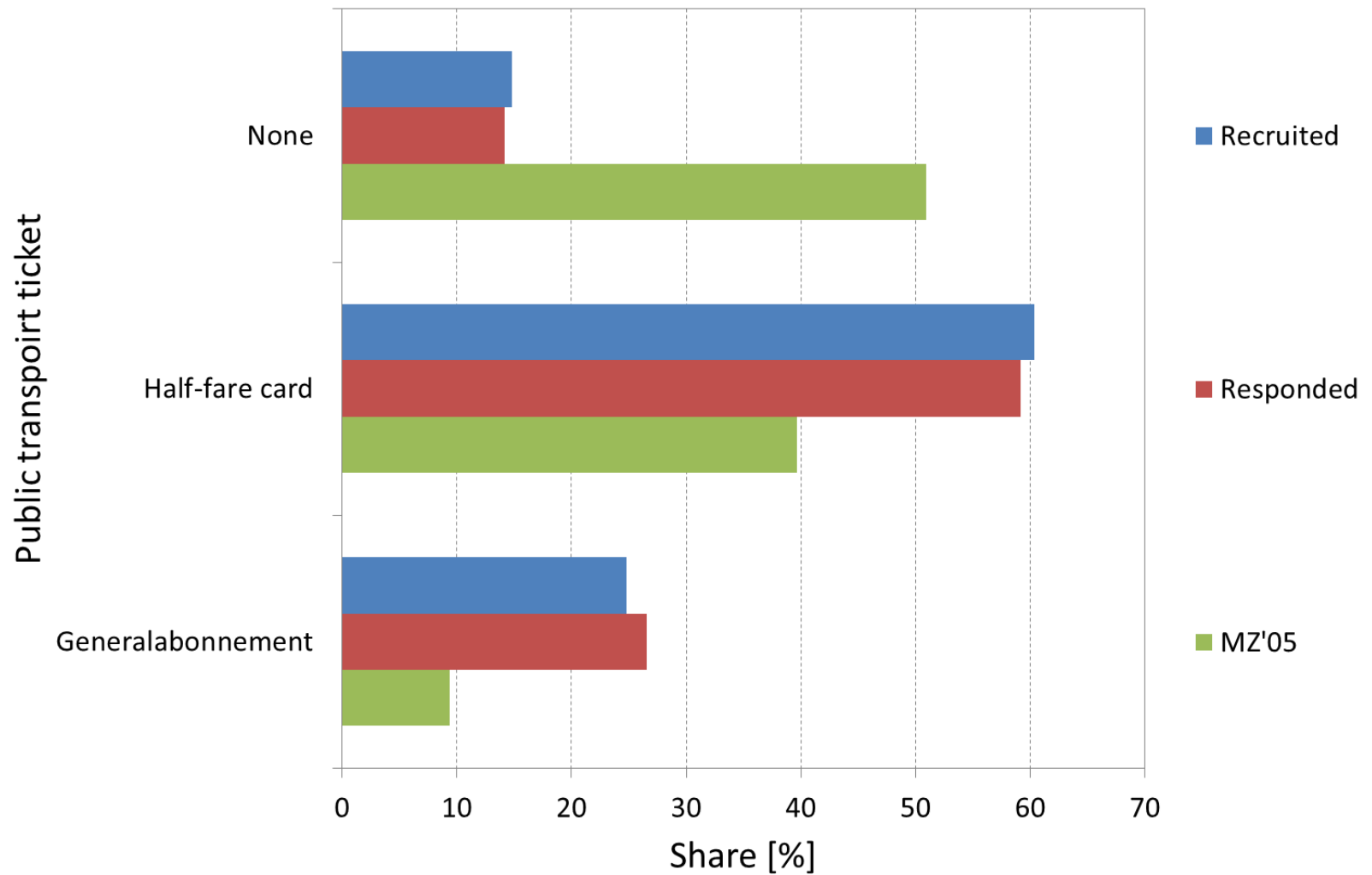# Response rate comparison
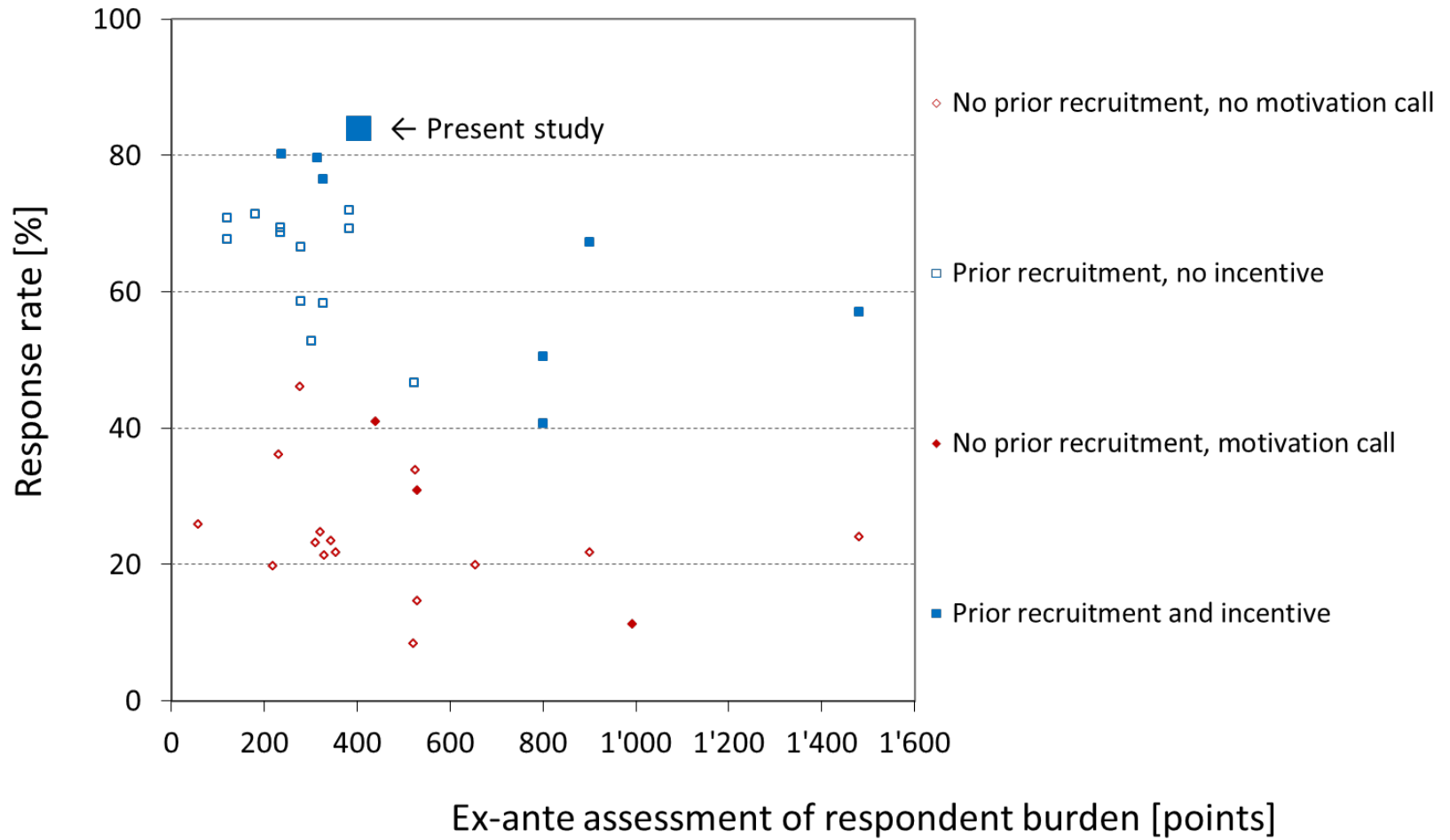
Age distribution

Household size distribution

Education level distribution

Public transport ticket ownership distribution

Modelling framework: short-term decisions

Multinomial Logit (MNL) vs. Mixed Logit model for SP 1-3:

- MNL with non-linear interaction terms: $f(y,x) = \beta_x \cdot \left(\dfrac{y}{\overline{\overline{y}}}\right)^{\lambda_{y,x}} \cdot x$
  - VTTS – trip distance
  - VTTS – income
  - WTP for parking search time reductions – duration of stay
  - WTP for parking search time reductions – income

- *Mixed Logit* model: interactions are replaced by random taste heterogeneity (randomly distributied parameters) for:
  - VTTS
  - WTP for parking search time reductions

- Both models include sociodemographics: age, gender, mobility tools, etc.

Model results: main findings

- Parking choice:
    - Parking garage preferred to open, on-street rated worst

- Location choice
    - City center preferred to outskirts / shopping center

- Mode choice:
    - Expected effects of travel time, access time, cost, headway, etc.
    - Significant effects of mobility tool availibility (car, transit passes)
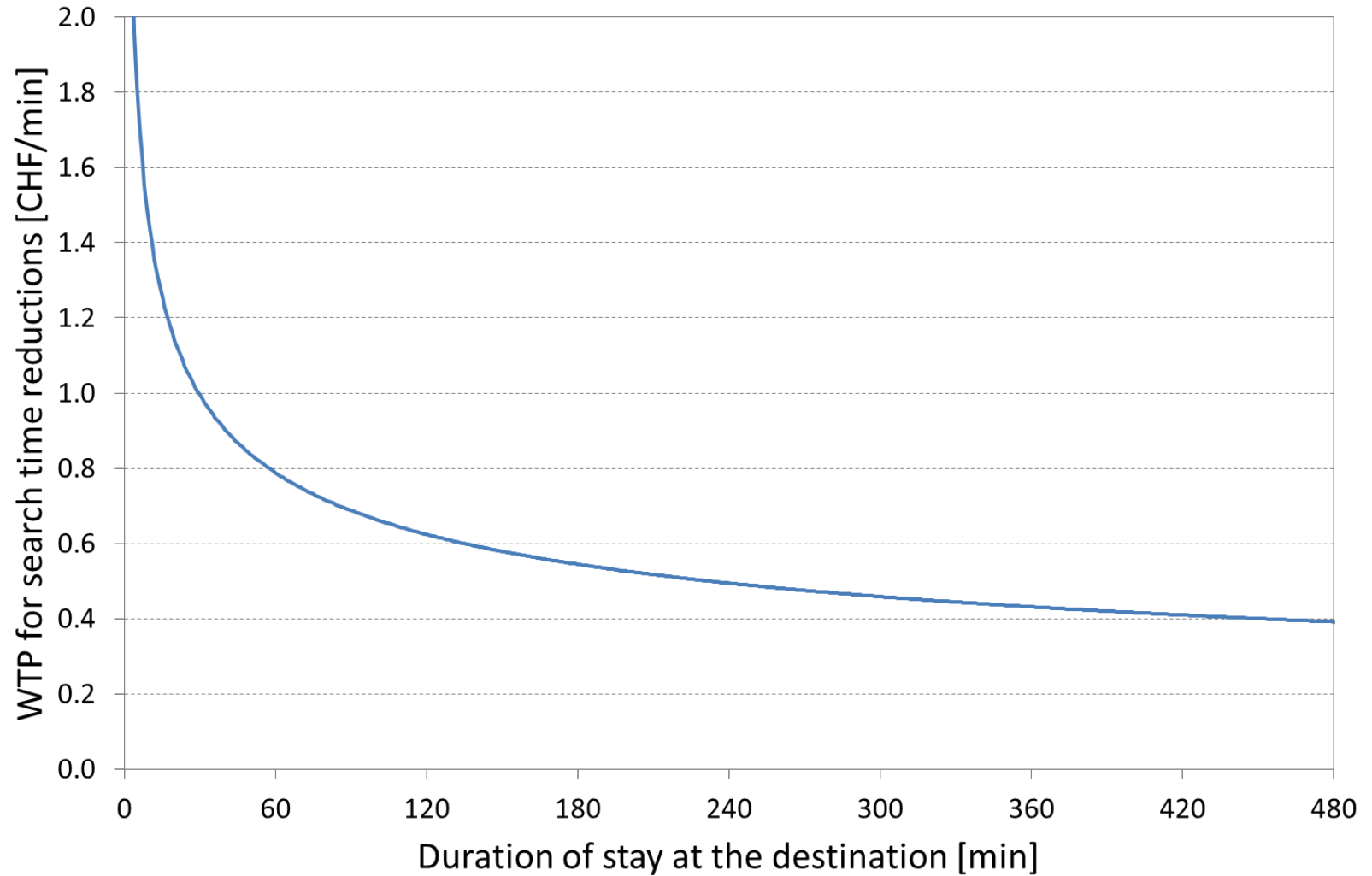   - Car preferred for shopping trips

Model diagnostics

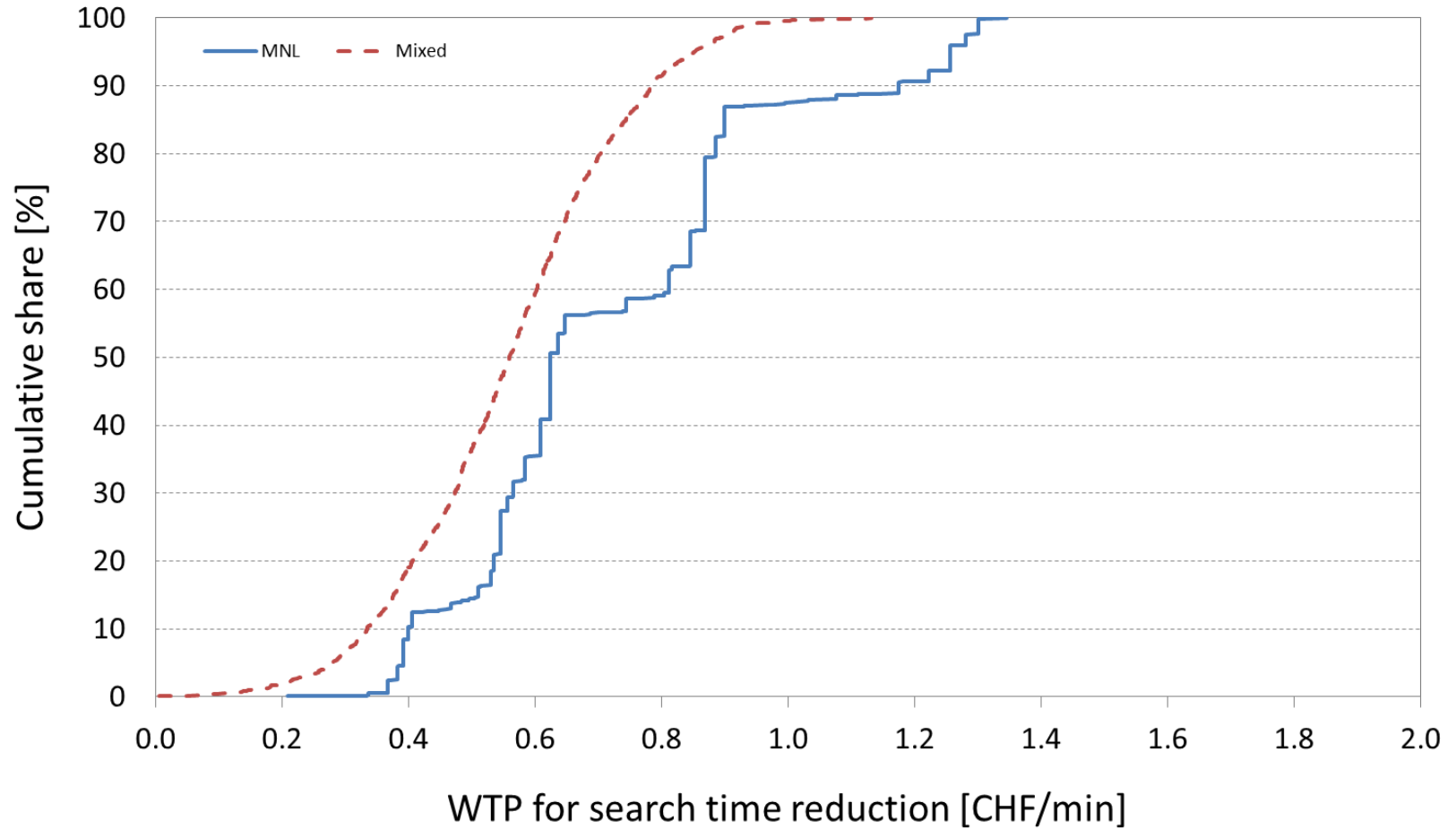|	MNL	Mixed Logit
Null Log-Likelihood	-18'575	-18'575
Final Log-Likelihood	-10'837	-9'246
Adjusted ρ^2	0.414	0.500
Number of observations	14'499	14'499
Run time for estimation (on nomwin)	44 minutes	17 days

Model results MNL: Value of travel time savings (VTTS)
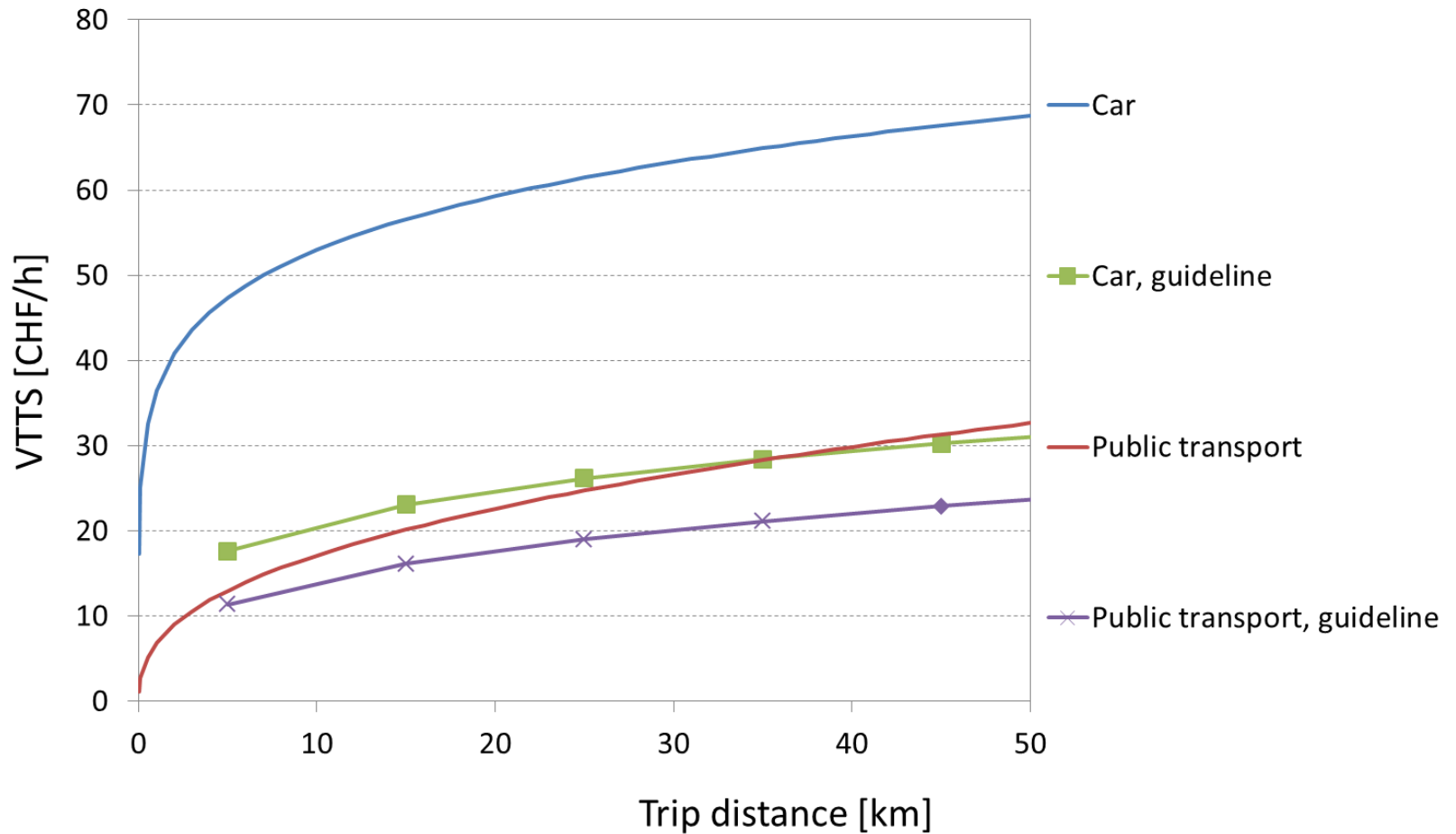
Model results MNL: Willingness-to-pay (WTP)

Model results MNL vs. Mixed: WTP distribution

Conclusions and outlook

- Here, non-linear MNL is better suited than Mixed Logit:
  - Deterministic (and behaviourally consistent) explanation for taste heterogeneity
  - Application in forecasting models: no simulation needed
  - Model fit is very good
  - Computation time (44 minutes vs. 17 days!)

- Up next:
  - Computation of population-level WTP and elasticities (weighting)
  - Models for long-term decisions (SP 4)

Model results: Demand elasticities (for sample)

	MNL	Mixed Logit
Car travel time	-0.85	-1.25
Parking search time	-0.20	-0.40
Fuel cost	-0.12	-0.76
Parking cost	-0.64	-1.34
Transit travel time	-0.78	-0.87
Ticket cost	-0.24	-0.44
Headway	-0.31	-0.50