How autonomous vehicles will affect the Swiss transport system: What we already know and what we can’t know yet

NSL Colloquium: Transport planning: Where do we go now?

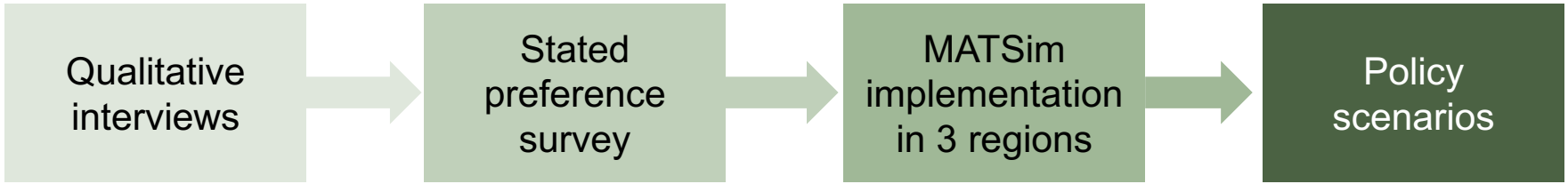
Alex Erath, 7th December 2023, ETH Zurich

Fachhochschule Nordwestschweiz
Hochschule für Architektur, Bau und Geomatik

A NEW SET OF MODES

	Autonomous ridehailing (aRH)	Autonomous ridepooling (aRP)
	 Source: Daimler	 Source: Rinspeed
Service type	Door-to-door	Between pick-up points As feeder to public transport
Cost	Competitive to car	Competitive to public transport
Travel time elements	Response time Travel time	Response time Travel time Access / Egress time
Travel time uncertainty	Due to traffic	Due to traffic and other passengers

OUR STUDY AS PART OF THE RESEARCH PROJECT



Drivers and barriers of ridepooling and usage of autonomous vehicles

Behavioural parameters for travel demand modell

Simulating interaction of demand and supply

Testing approaches to increase (space and energy) efficiency of mobility system

Preliminary results!

Sponsor: Swiss Federal Roads Office FEDRO
Project ID: MB4 20 01A 01

LITERATURE

Krueger *et al*. (2016)

- 3 alternatives: chosen mode, aRH, aRP
- “Prezi” slide show to explain aRH and aRP
- Classification of respondents according to their modality
- Travel time and cost: aRP >> aRH
- Waiting time: aRP and aRH >> public transport
- High a priori preference for aRH compared to aRP

Bansal and Daziano (2018)

- 3 alternatives: reported mode, aRH, aRP
- Information on (a)RH and (a)RP based on text and illustration
- Waiting and access time perceived 3x as much as in vehicle time

Becker *et al*. (2019) and Hörl *et al*. (2021)

- 6 alternatives, including aRP, aRH and aRH+PT
- 5159 choices from 453 respondents (Zurich area)
- Perception of travel time:
  aRH-Feeder >> aRP / aRH > car > public transport
- Some key parameters only weakly significant

LITERATURE

Choice experiment

- Pivot design based on reported trip
- 3 alternatives: chosen mode, aRH, aRP
- Information on (a)RH and (a)RP based on text and illustration

Results

Krueger et al. 2016

- Travel time and cost: aRP >> aRH
- Waiting time: aRP and aRH >> public transport
- High a priori preference for aRH compared to aRP

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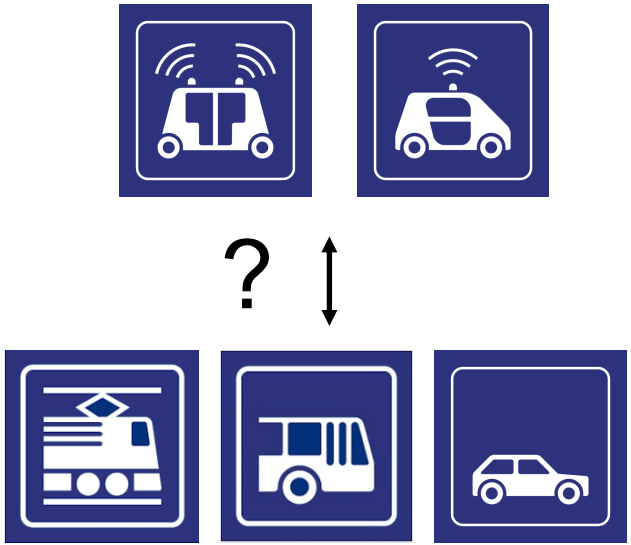
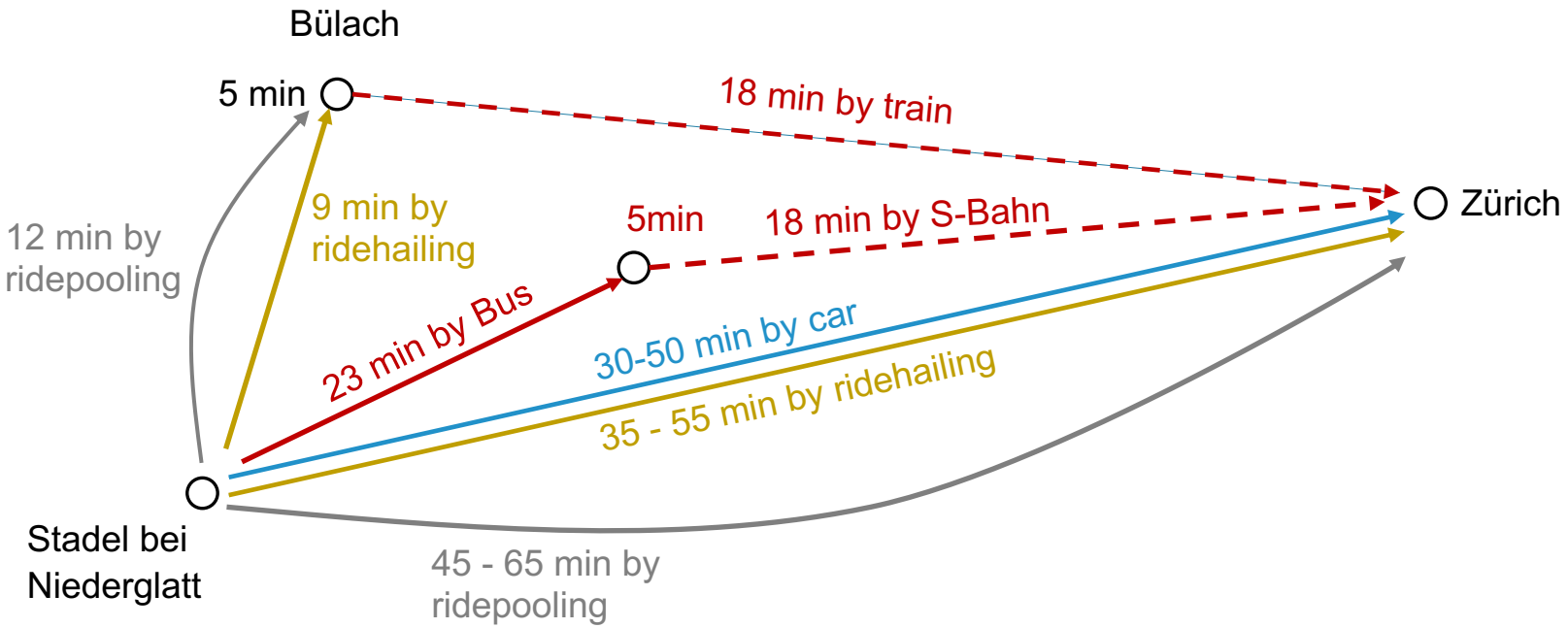
RESEARCH QUESTIONS

- How do behavioural parameters for ridehailing (aRH) and ridepooling (aRP) **compare to parameters of existing modes**?
- Which **additional parameters** for aRH and aRP **can we reliably quantify** with a nationwide stated preference survey?
- How do the new modes **impact car ownership**?
- Is there a **market for ridepooling travel cards**?



STADEL BEI NIEDERGLATT

OUR CASE STUDY: A 25KM TRIP TO THE CITY ON A THURSDAY EVENING



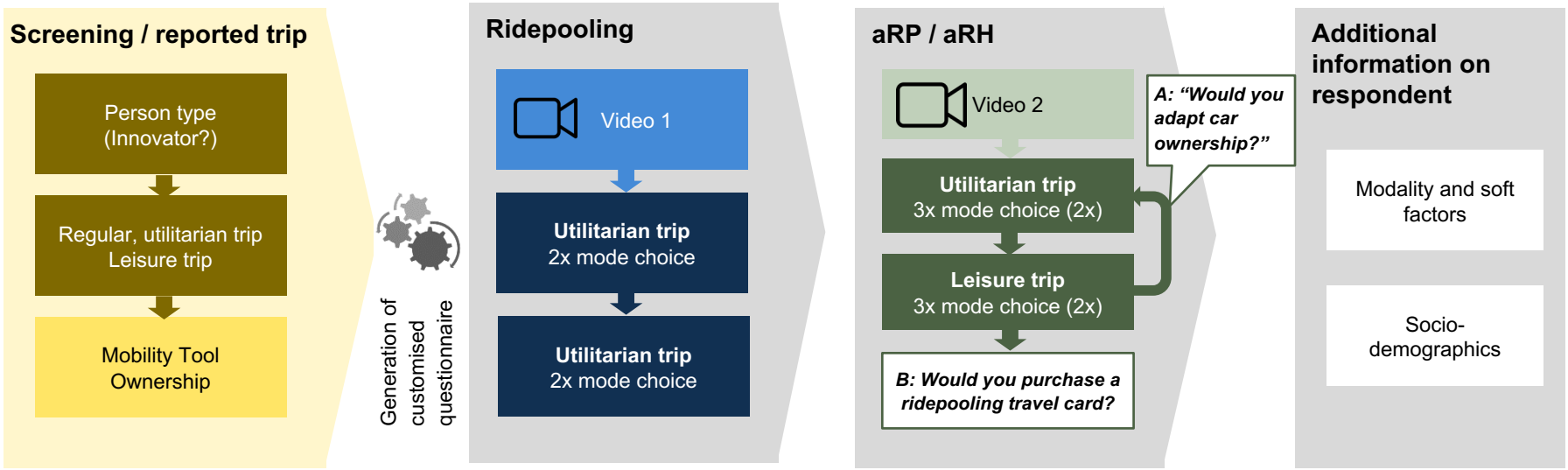
OUR CASE STUDY AS A CHOICE EXPERIMENT






	Car	Public transport	aRH (direct)	aRH + PT (intermodal)	aRP (direct)	aRP + PT (intermodal)
	30-50 min	53 min	32 min	35- 55 min	35 min	45-65 min
	CHF 15	CHF 5	CHF 12	CHF 20	CHF 9	CHF 12
	-	1 transfer	1 transfer	-	1 transfer	-
	…	…	…	…	…	…
Your choice:	○	○	○	○	○	○

SURVEY


Screening / reported trip
Person type (Innovator?)
Regular, utilitarian trip Leisure trip
Mobility Tool Ownership
Generation of customised questionnaire
Ridepooling
Video 1
Utilitarian trip 2x mode choice
Utilitarian trip 2x mode choice
aRP / aRH
Video 2
Utilitarian trip 3x mode choice (2x)
Leisure trip 3x mode choice (2x)
B: Would you purchase a ridepooling travel card?
A: "Would you adapt car ownership?"
Additional information on respondent
Modality and soft factors
Socio-demographics
Questionnaire 1
Questionnaire 2

EXPLANATORY VIDEOS

Objectives:

- Ensure consistent information among all respondents
- Address concerns raised in exploratory interviews
- Easy to understand and watch

Addressed topics in video 2:

- AV technology
- Traffic safety
- **Vehicle types and new services**
- **Fare and travel cards**
- **Personal safety**

Video in German / French

ADAPTIVE PIVOT POINT EXPERIMENT DESIGN

Goal

- Simple, realistic and efficient choice sets
- Can be implemented in a web-based questionnaire

Approach

- Choice set with 3 labelled alternatives
- Pivot random design based on reported trips
- Prices ranges for aRH and aRP based on Bösch et al. (2018)
- Attribute levels adaptive to trip length and spatial type of origin and destination
- Selection of alternatives based on attractiveness of aRP as direct mode vs. feeder mode

Choice set 1

Public transport	aRH (direct)	aRP (direct)
53 min	32 min	35 min
CHF 5	CHF 12	CHF 9
1 transfer	1 transfer	1 transfer
○	○	○

73%

<90%: random assignment of experiment

>90%: always experiment with more attractive mode

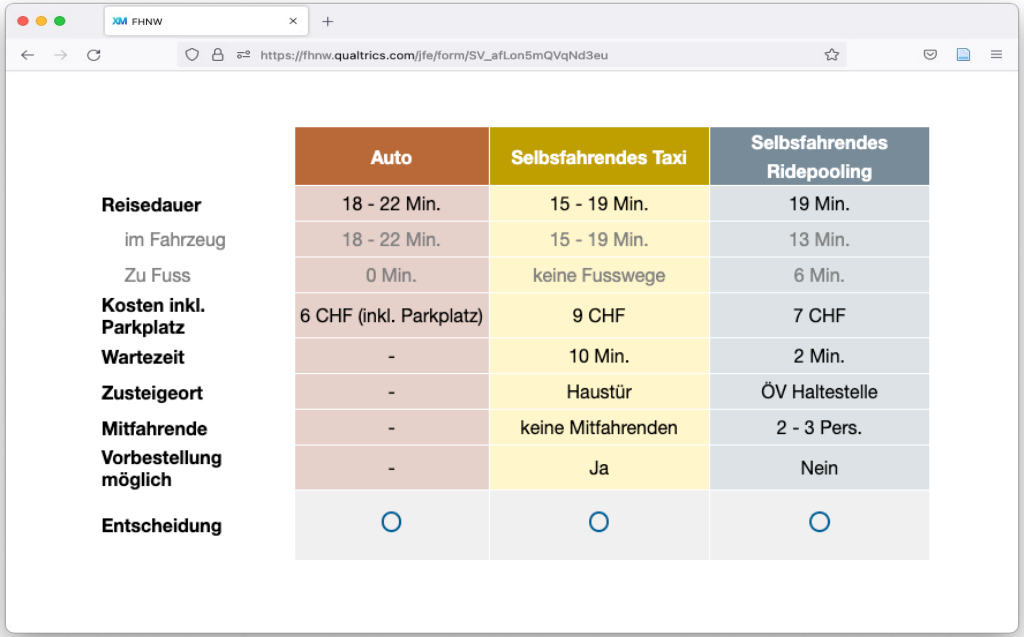
28%

Choice set 2

Public transport	aRH + PT (intermodal)	aRP + PT (intermodal)
53 min	35- 55 min	60-70 min
CHF 5	CHF 20	CHF 12
1 transfer	-	-
○	○	○

IMPLEMENTATION

Desktop Browser



	Auto	Selbsfahrendes Taxi	Selbsfahrendes Ridepooling
Reisedauer	18 - 22 Min.	15 - 19 Min.	19 Min.
im Fahrzeug	18 - 22 Min.	15 - 19 Min.	13 Min.
Zu Fuss	0 Min.	keine Fusswege	6 Min.
Kosten inkl. Parkplatz	6 CHF (inkl. Parkplatz)	9 CHF	7 CHF
Wartezeit	-	10 Min.	2 Min.
Zusteigeort	-	Haustür	ÖV Haltestelle
Mitfahrende	-	keine Mitfahrenden	2 - 3 Pers.
Vorbestellung möglich	-	Ja	Nein
Entscheidung	○	○	○

Mobile Browser

SAMPLING AND SAMPLE

intervista Webpanel

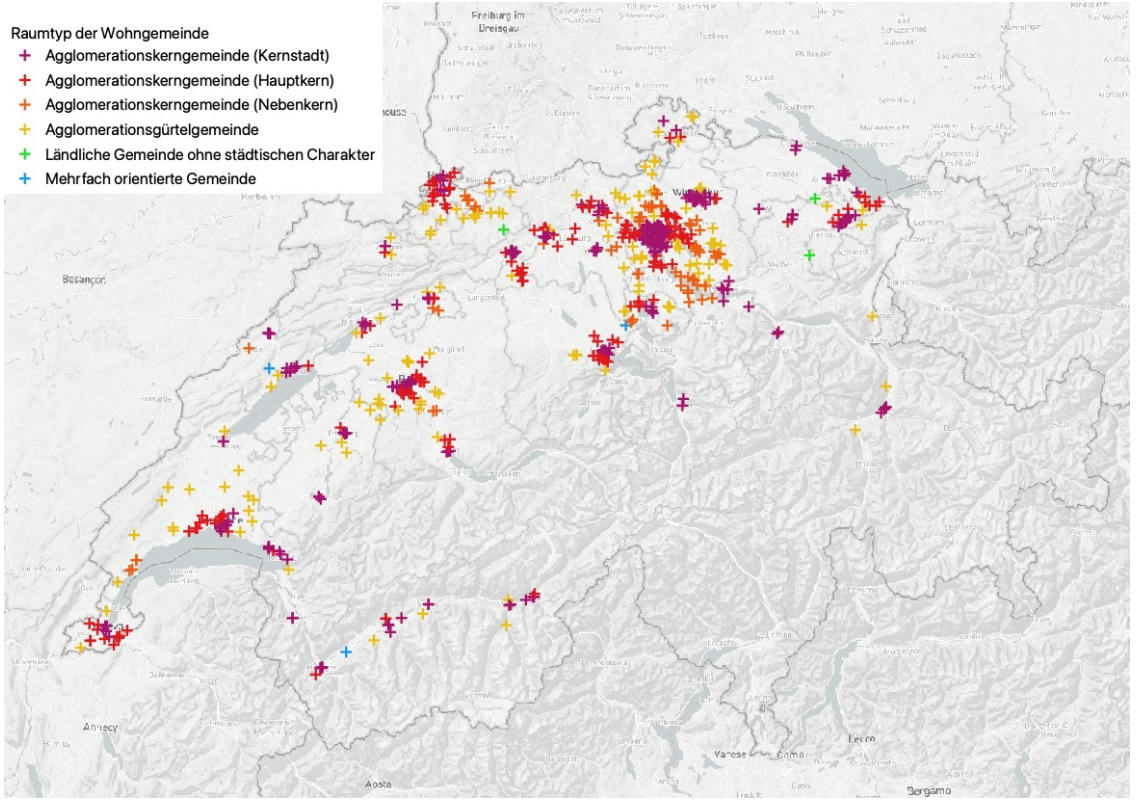
- 110k residents
- Stratified sample for spatial type of residence, innovation diffusion and various quotas

Deviation from national shares smaller than 5%

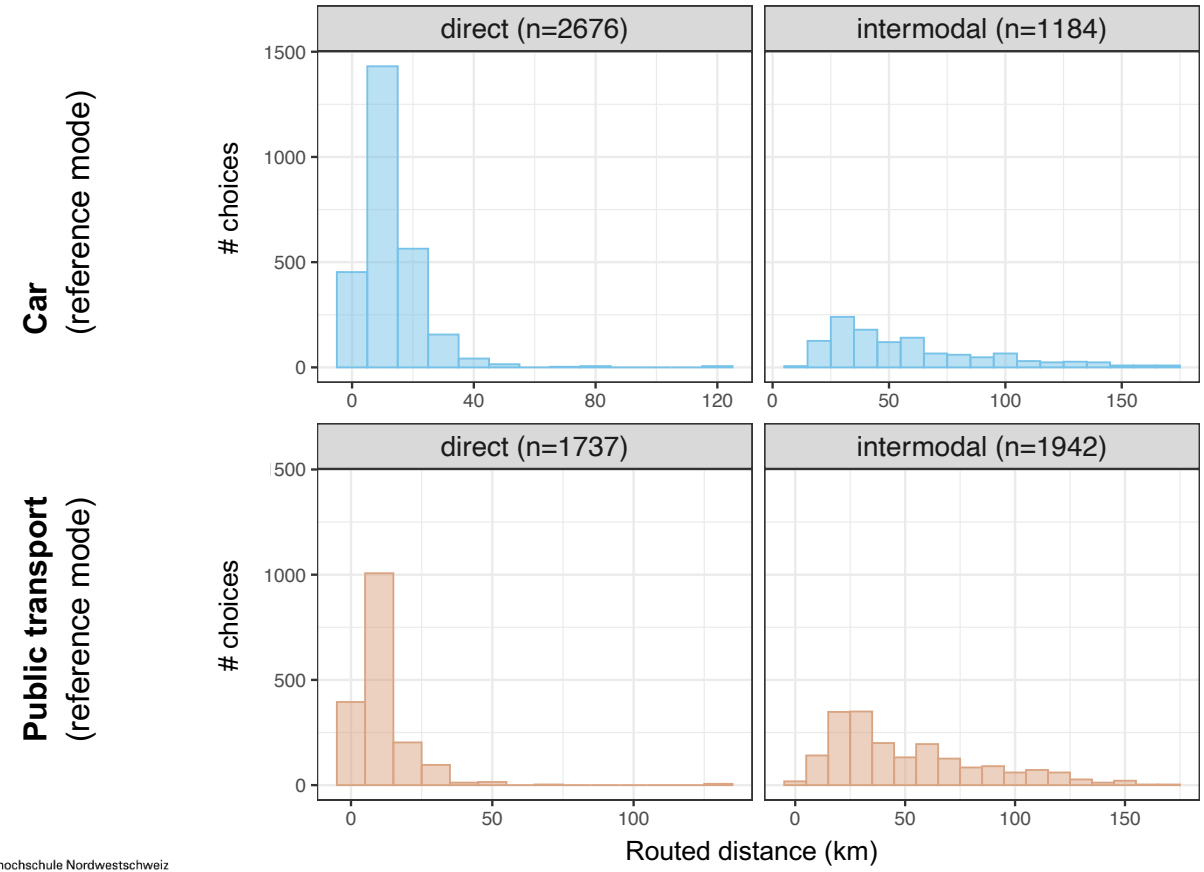
- Age groups
- Car availability
- Language (German and French)
- Spatial type of residence municipality

Slightly overrepresented groups

- GA and regional travel card (34% vs 20%) due to restrictions WRT trip distance
- 20% higher income than for reference population

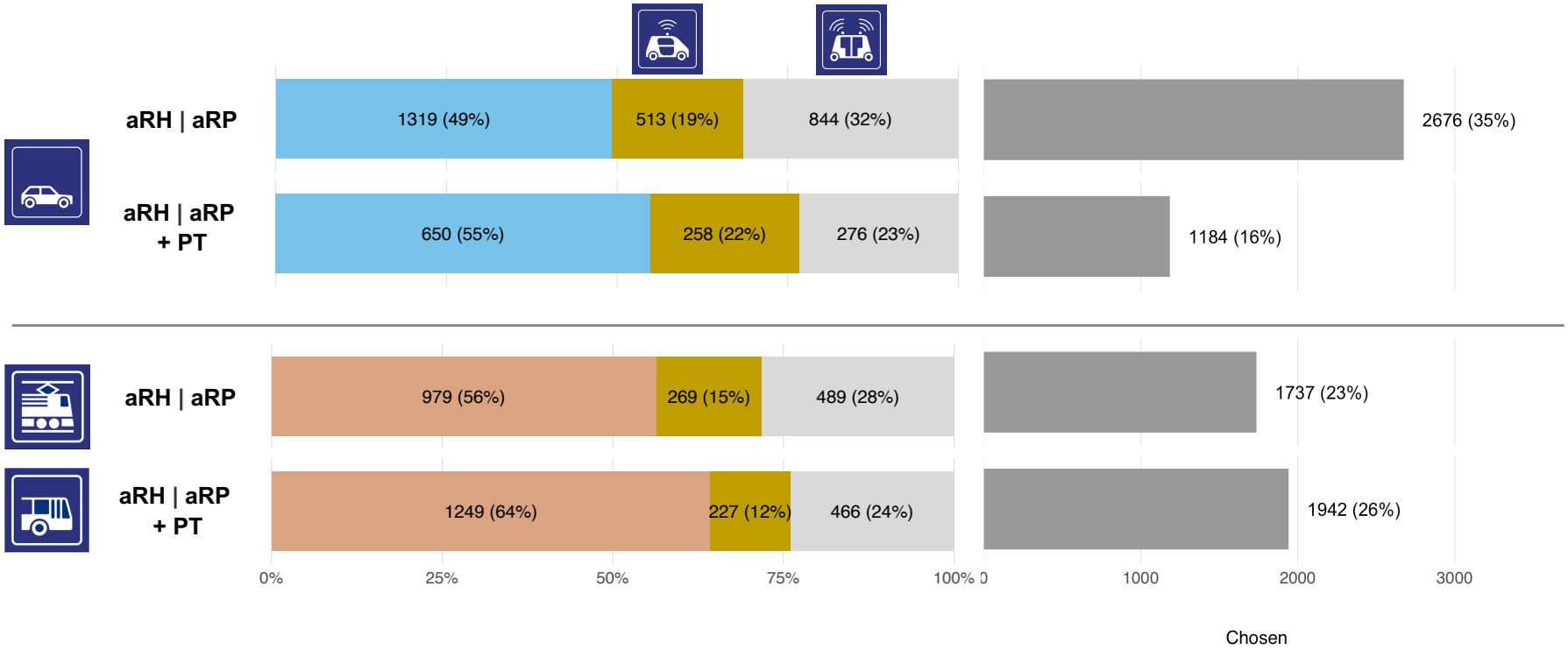


DISTANCE DISTRIBUTION OF REFERENCE TRIP BY EXPERIMENT TYPE

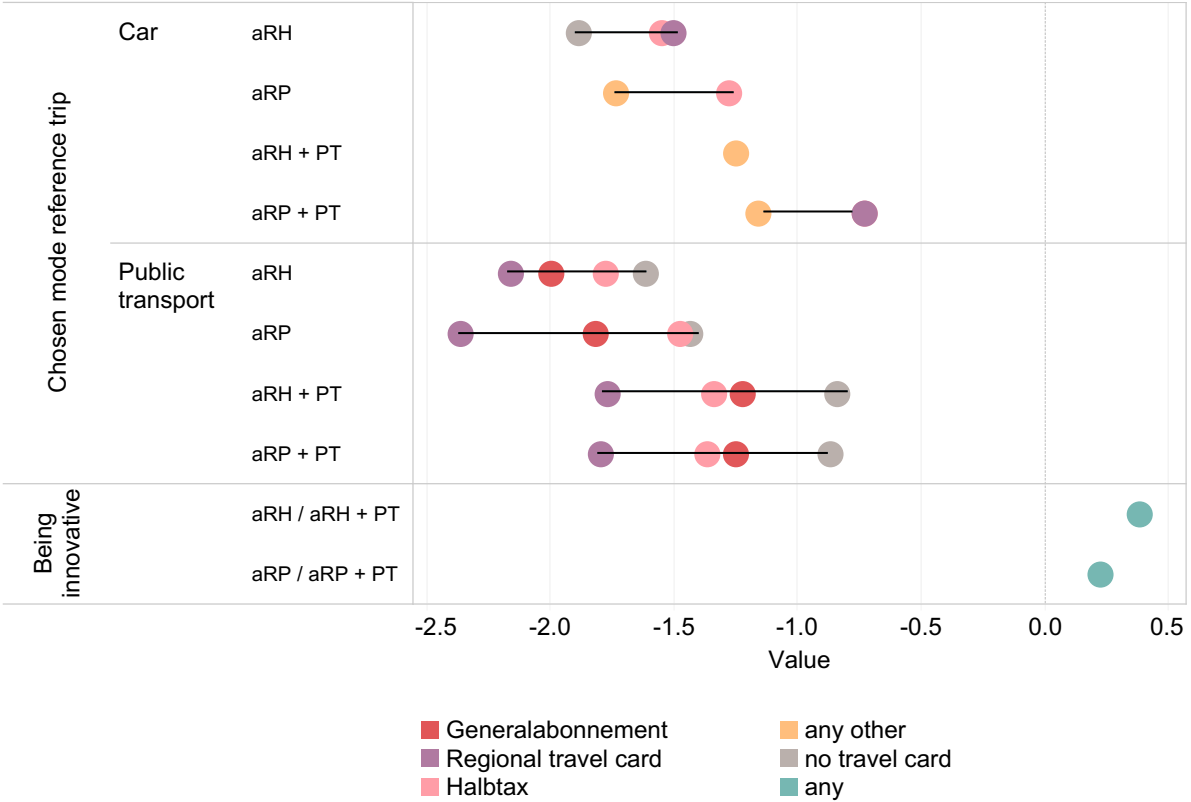


Total choices
n=7539

MARKET SHARES



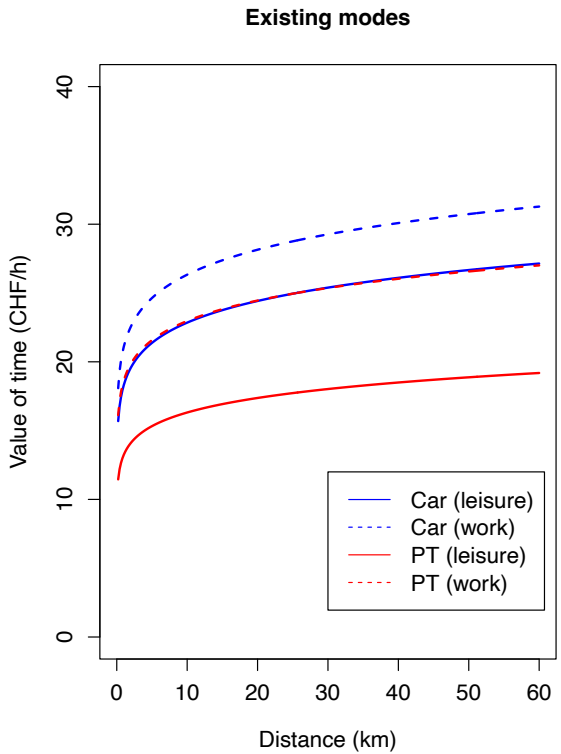
CONSTANTS

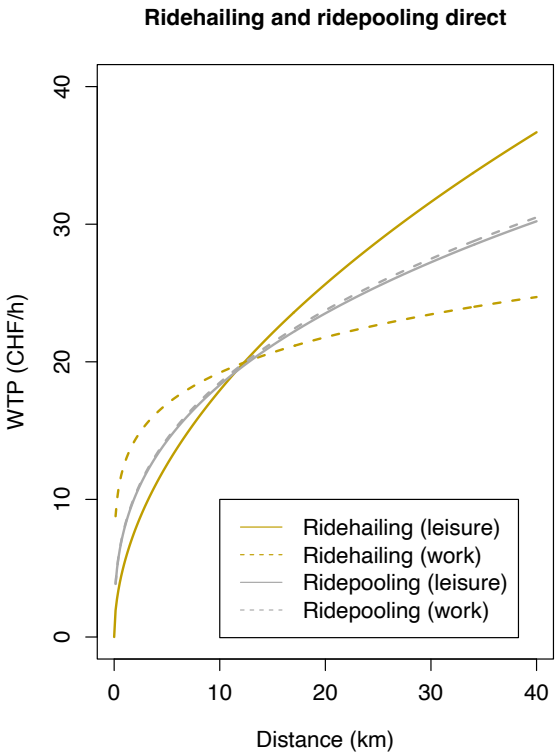


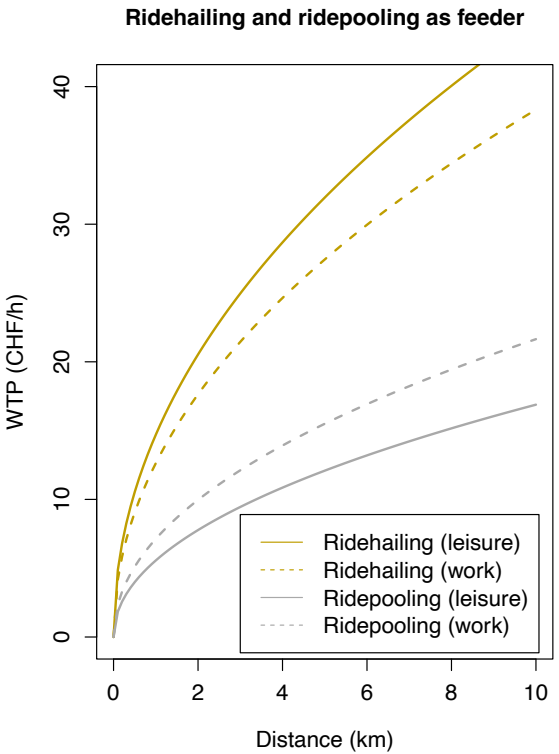
Insights:

- Respondents are rather hesitant to choose the new modes
- Car trips are more likely to be replaced by aRH or aRP
- No a priori preference for aRH
- Lower hesitance to choose aRH or aRP as part of an intermodal trip
- Car users with travel cards are more likely to use aRH or aRP
- PT users with travel cards are less likely to use aRH or aRP
- “Innovative” persons are more likely to use aRH or aRP

VALUES OF TIME



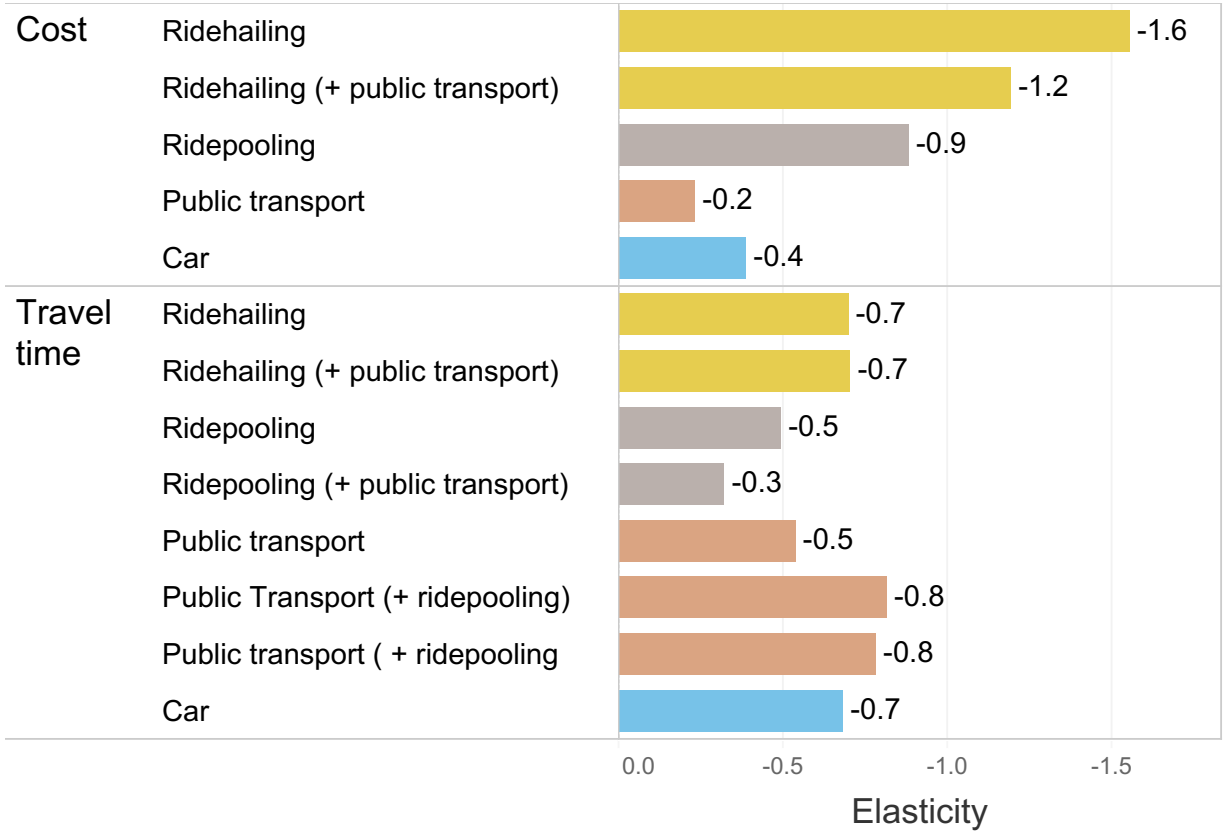




PARAMETER RATIOS

	Car	PT	aRH	aRH +PT	aRP	aRP + PT
Access vs. in-vehicle time	170%	200%	-	-	160%	
5 min transfer as in- vehicle time	-	9.6 min	-	10.9 min	-	14.1 min
Response time vs. in-vehicle time	-	-	30%		61%	
Bookable	-	-	3.3 CHF		1.3 CHF	
Travel time at high occupancy	-	+20%	-	-	insign.	insign.
Uncertainty: +/- 1 Min vs. in vehicle time	21%	-	insign.	insign.	44%	insign.
Headway vs. in vehicle time	-	26%	-	20%	-	26%

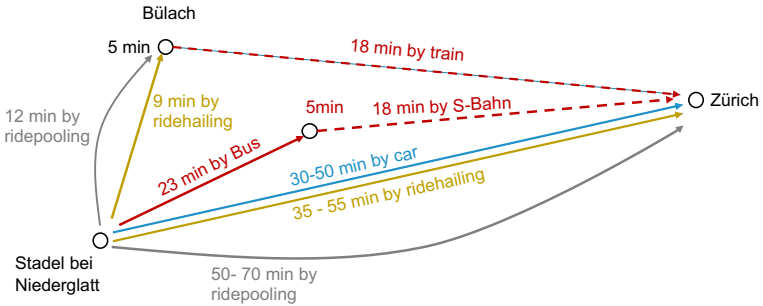
ELASTICITIES OF DEMAND WITH REGARDS TO…



OUR CASE STUDY: 25KM TRIP TO THE CITY

Andrea

- Lives in Stadel bei Niederglatt
- Still owns a (old) car
- Has half fare card including aRP trips up to 10km



	Today	Today's view of the future	A less hesitant future
Car	74%	50%	28%
Public transport	26%	17%	10%
aRH	-	9%	21%
aRH + PT	-	4%	10%
aRP	-	5%	11%
aRP + PT	-	14%	20%
Veh-km on road	18.6	17.5	17.8
Pkm in public transport	7.1	8.7	9.0

DISCUSSION

Credible results

- Confirms insights from existing aRH/aRP-studies
- Adds new insights with regards to travel behaviour with aRH and aRH as direct and feeder mode

(Non-)confirmation of earlier findings

- Confirmation of earlier study by Becker / Hörl *et al.*
    - Hesitance to use aRP as compared to aRH identified by Krueger et al. cannot be confirmed: Switzerland as a “multimodal” nation?

New modes fill a gap

- For people who are neither public transport addicts nor petrol heads
- For areas with low public transport service quality

Limitations

- Influence of the number of additional passengers on willingness to pool could not be quantified.
- No nested structures tested (yet)
- No consideration of trips in groups (highly relevant for pricing of aRH and aRP)
- Competition with cycling not examined.

CONCLUSION AND OUTLOOK

Insights

- aRH and aRP can supplement existing modes and can lead to a more sustainable transport system
- Mobility pricing seems very effective to shift people from aRH to aRP
- aRP has limited potential as feeder service due to high transfer penalty

Contribution:

- New type of an adaptive pivot design choice experiment
- Wide set of credible and stat. sign. estimated behavioural parameters for aRH and aRP.

Outlook

- Implementation of choice model parameters in MATSim models
- Simulating where, when, and where the demand potential can be served with aRH and aRP supply.

Open (research) questions

- By how much will the hesitance towards the new modes will decrease as they become better known?
- How should we shape the Swiss transport system to leverage on shared autonomous vehicles and which role should aRP have?

THANK YOU!



Understanding people's hopes and concerns



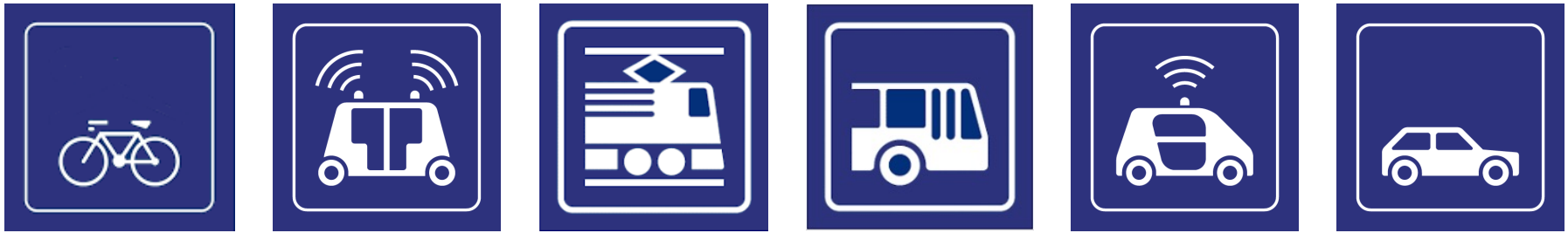

Sketching, planning, designing, implementing, conducting and analysing stated preference survey




Contributing MATSim features, setting-up & calibrating simulations and running policy scenarios

Initiating, supporting, advising, questioning, guiding, checking, trusting.

QUESTIONS AND CONTACT



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https://www.fhnw.ch/verkehr-und-mobilitaet

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LITERATURE

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