Estimation of value of time for autonomous driving using revealed and stated preferences method

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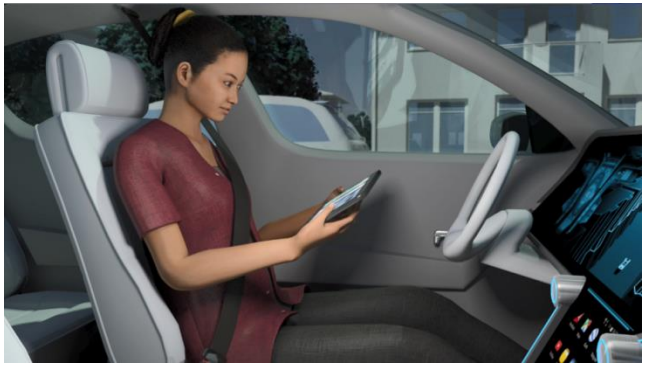
DLR

Introduction

- Continuing trend toward fully autonomous vehicles



the driver can undertake other activities => **perception of travel time** might change

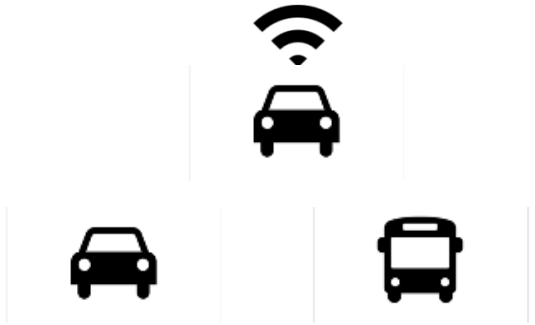
new mobility options – vehicle on demand => **mode choices** might change

Focus of the study:
How autonomous driving may affect value of time and mode choices?

The concept of Value of time (VoT)

- subjective VoT = willingness to pay for saving travel time

many studies addressing **current** mode choice preferences



some first studies that address used preferences **by autonomous driving**

=> but: examining changes is only possible when addressing both (when having a base line)

Methodology
Overview

- Online survey, 500 respondents (representative sample for Germany by age and gender)

- Combination of **revealed and stated preference methods**

- **Two stated choice experiments**
  - current mode choice related user preferences
  - "future" mode choice related user preferences

- Additional questions on socio economics and individual mobility

- First analysis: multinomial logit

Methodology
Revealed preference

Which of the following modes of transport do you usually use for your commuting trip?

○	○	X	○
			
Walk	**Bicycle**	**Car**	**PT**

How long does it usually take to get to work?

Trip duration

30 **Minutes**

Trip length

20 **Kilometers**

back next

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DLR

Methodology
Stated choice preference

Choice sets: attributes and attributes´ levels

	Option 1	*Option 2*	*Option 3*	*Option 4*
Mode of transportation	By foot	Private car	Bike	Public transportation
Trip duration	-30% / -10% / +20%	-30% / -10% / +20%	-30% / -10% / +20%	-30% / -10% / +20%
Access/ egress time		2 min / 5 min	2 min/ 5 min/ 10min	2 min/ 5 min /10 min
Waiting time				2 min/ 5 min /10 min
Cost		-30% / -10% / +20%		-30% / -10% / +20%
	Total trip time:	**Total trip time:**	**Total trip time:**	**Total trip time:**
	Speed: 4.9 km/h	Speed: 26-68 km/h distance dependent Cost: 0.20 Euro/km	Speed: 15 km/h	Speed: 18 - 51 km/h distance dependent Cost: 1.5 – 12 Euro distance dependent

Methodology
First stated choice experiment

Imagine that all of the following modes of transportation are available for your **commuting trip**. The trip duration and the trip cost using one of them are as presented below.

Please mark below which of the following modes of transportation would you choose in this situation.

(Task 1 of 8)

	Option 1	*Option 2*	*Option 3*	*Option 4*
Mode of transportation	Walk	Private car	Bike	Public transportation
Trip duration	3 h 40 min	0 h 36 min	1 h 12 min	0 h 39 min
Access/ egress time		5 min	5 min	5 min
Waiting time				5 min
Cost		3.6 Euro		3.15 Euro
	Total trip time: 3 h 40 min	**Total trip time:** 0 h 39 min	**Total trip time:** 1 h 17 min	**Total trip time:** 0 h 49 min
	○	○	○	○

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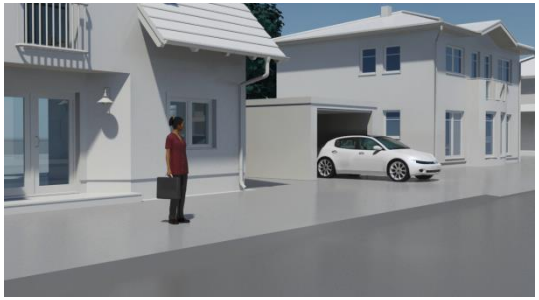
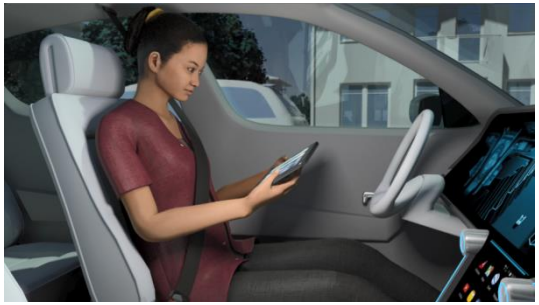
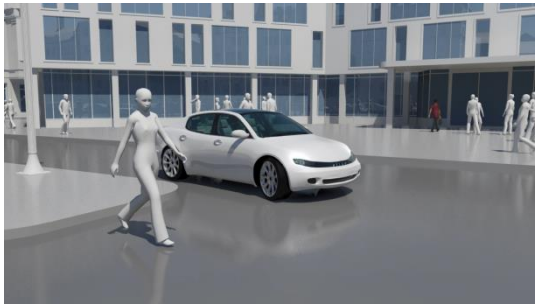
Introduction of the autonomous driving

Privately owned autonomous vehicle







Driverless taxi

Methodology
Second stated choice experiment

(Task 1 of 8)

	Option 1	*Option 2*	*Option 3*	*Option 4*	*Option 5*
Mode of transportation	Bicycle	AV	Driverless taxi	By foot	PT
Trip duration	1 h 12 min	0 h 36 min	0 h 36 min	3 h 40 min	0 h 39 min
Access/ egress time	5 min				2 min
Waiting time		5 min	2 min		5 min
Other passengers			no, alone		
Cost		3.6 Euro	6 Euro		3.15 Euro
	Total trip time:	**Total trip time:**	**Total trip time:**	**Total trip time:**	**Total trip time:**
	1 h 17 min	0 h 39 min	0 h 38 min	3 h 40 min	0 h 46 min

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First results – MNL estimations

	Model 1: Current available alternatives	**Model 2: future available alternatives**	
Parameters	Estimated value	Estimated value	
ASCwalk	3.02	2.39	
ASCbicycle	0.74	*0.29*	
ASCpt	*0.22*	*- 0.01*	
ASCdriverless_taxi	-	- 0.82	
ß time_walk	- 0.10	- 0.09	**Perception of in-vehicle time**
ß time bicycle	- 0.07	- 0.07	
ß time pt	- 0.01	- 0.01	
ß time private car / AV	- 0.02	- 0.01	
ß time driverless taxi	-	- 0.02	
ß waiting time	- 0. 05	- 0.05	
ß access/egress time	- 0 .06	- 0.03	
ß cost - low income	- 0.48	- 0.58	**Perception of cost**
ß cost – middle income	- 0.30	- 0.38	
ß cost – high income	- 0.28	- 0.28	
ß shared ride	-	*0.09*	

First results – MNL estimations

	Model 1: Current available alternatives	**Model 2: future available alternatives**	
Parameters	Estimated value	Estimated value	
ß shopping, bicycle	- 0.87	- 0.66	**Differences between trip purposes**
ß shopping, pt	- 0. 83	- 0.67	
ß leisure, by foot	0. 64	0.78	
ß license, by foot	- 2.11	-1.4	
ß license, bicycle	- 0.70	*0.26*	
ß license, pt	- 2.45	-1.52	
ß license, driverless taxi	-	*-0.09*	
ß pt pass, by foot	1.48	0.76	
ß pt pass, bicycle	1.42	0.65	
ß pt pass, pt	2.31	1.27	
ß pt pass, driverless taxi	-	*0.01*	

First results – Value of Time

$$VoT = \frac{\beta_{time,i}}{\beta_{cost,i}} * 60$$

- not the final VoT values -

	Low income		Middle income		High income	
	Model 1	Model2	Model 1	Model 2	Model 1	Model 2
Public transport	1.72	1.01	2.72	1.55	2.86	2.12
Private car / private AV	2.84	1.29	4.49	1.99	4.72	2.73
Driverless taxi		1.96		3.02		4.14

=> Values can be integrated in an existing microscopic travel demand model (aim: to scale-up and quantify the impact of autonomous driving for certain region)

Conclusion and Outlook

Main (first) results:

- Value of time reduction when driving autonomously vs. driving manually
- Riding autonomously is perceived similar as using public transportation
- Privately owned AV is more attractive than driverless taxi
- Using a baseline is a viable method to approach changes in VoT

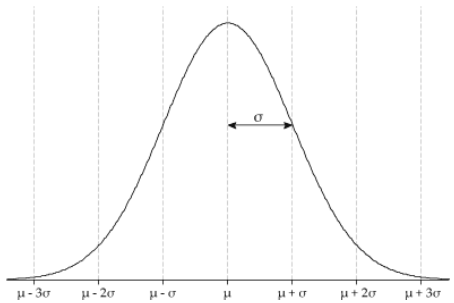
Next steps:

- applying more advanced methods incl. Mixed Logit Model

in order to:

  - consider heterogeneity (distribution of coefficient values)
  - consider panel effect (8 situations per person)

- Decreasing time and cost utility can be examine
- VoT for different trips purposes
- Implementation in microscopic models to examine impact



Thank you for your attention!