

Automated vehicles – Game changer for urban mode choice?

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A large, curved portion of the Earth is visible in the bottom right corner, showing a blue horizon, white clouds, and green landmasses. The text "Knowledge for Tomorrow" is overlaid on this image in a white, sans-serif font.

Knowledge for Tomorrow

Studies expect strong impact of automation on urban transport – especially for **shared systems**

Up to **+12% VMT** resulting from additional trips with an AV made by people with mobility constraints¹

+4% bis +8% VMT resulting from willingness to longer trips and better capacity utilization³

Up to **+90% VMT** in a shared autonomous vehicle system without efficient public transport⁶

-67% Vehicles in an autonomous „on-demand“ system²

-90% Vehicles in a shared autonomous vehicle system⁴

-94% Parking space in an autonomous system with efficient public transport⁶

-80% Cost/ Mile with a shared autonomous vehicle fleet⁵



Sources: [1] Harper et al. 2015; [2] Spieser et al. 2014; [3] Gucwa 2014; [4] Fagnant & Kockelman 2014; [5] Burns et al. 2013; [6] ITF 2015;

Will people change their mode choice given new automated options? An SP-experiment on mode choice and time use...



Private fully automated vehicle (AV)



(Shared) automated vehicle (SAV)

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

Please mark which of the following transportation modes would you choose.

	Option 1	Option 2	Option 3	Option 4	Option 5
Mode of transport	Walk	Bicycle	Public transport	Private AV	Driverless taxi (SAV)
Trip duration	1 h 09 min	22 min	15 min	16 min	16 min
Access / egress time		2 min	5 min		
Waiting time			10 min	2 min	5 min
Ridesharing					no
Costs			2.25 €	1.05 €	2.16 €
Available time:	no	no	10 min	up to 11 min	11 min
Total trip time:	1 h 09 min	24 min	30 min	18 min	21 min
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

back

0% 100%

next

Mode choice preferences depend on the residential location – today and tomorrow



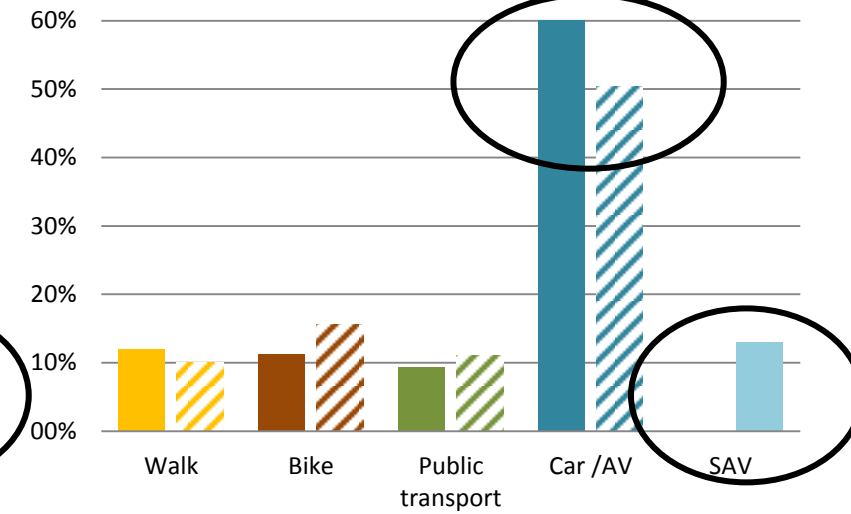
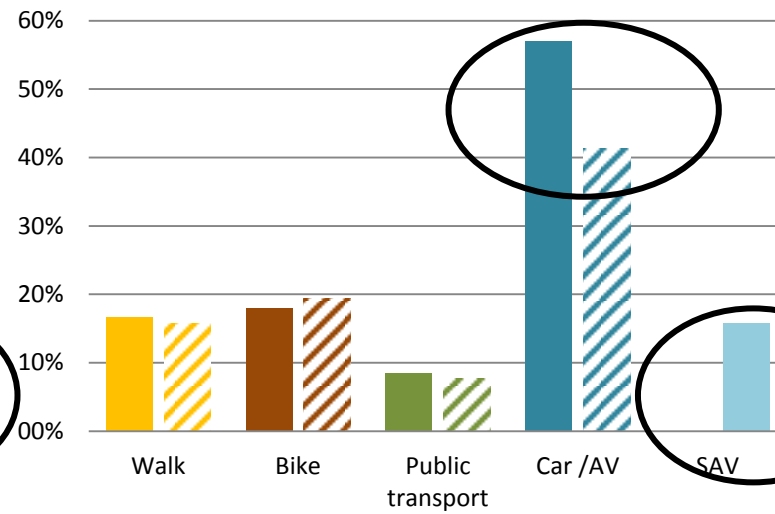
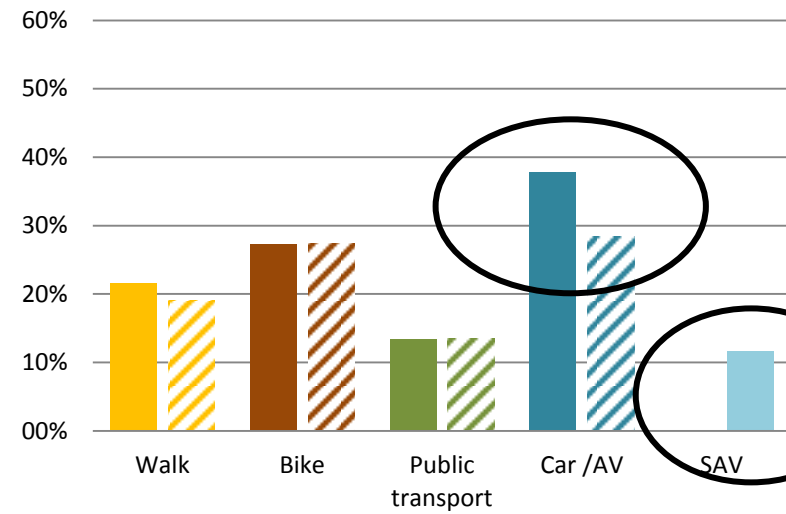
Urban / City (>100k)



Suburban / Town (>20k)



Rural / Village (<20k)



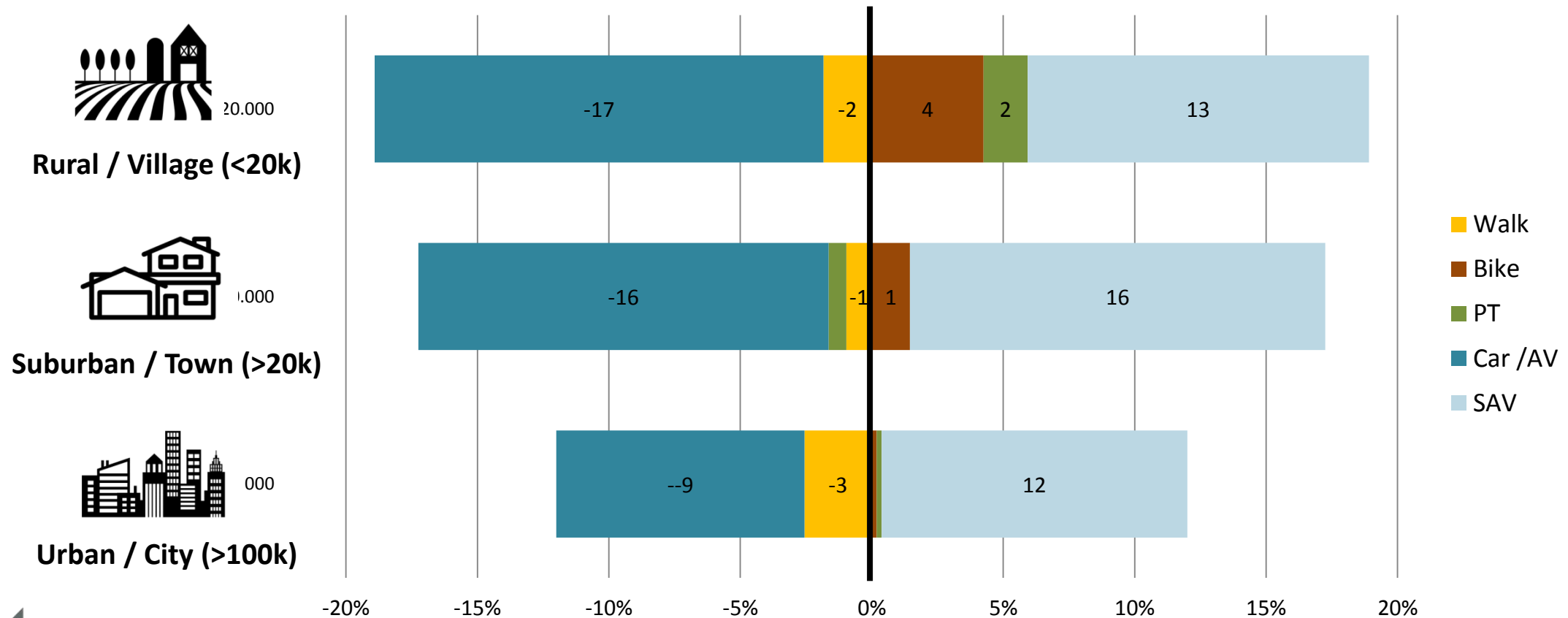
future situation



current situation



Users anticipate primarily trend towards shared car usage, but hardly at the expense of PT usage...



Do preferences also depend on other spatial characteristics, such as availability of a parking option?



Urban / City (>100k)



49%



51%



Suburban / Town (>20k)



23%



77%



Rural / Village (<20k)



14%



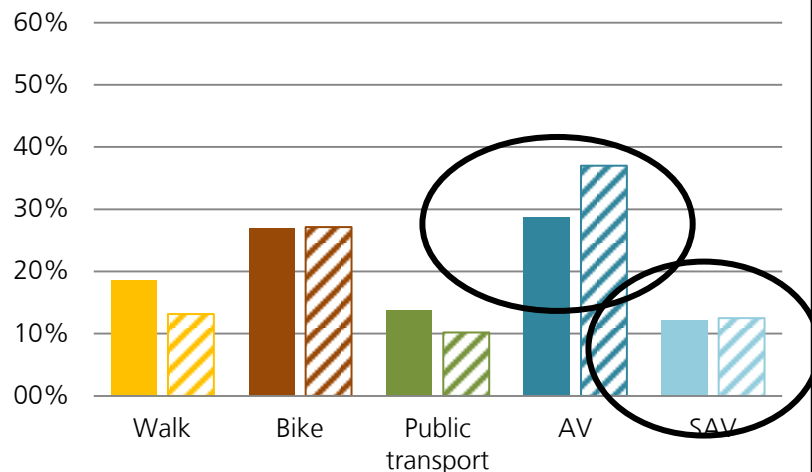
86%



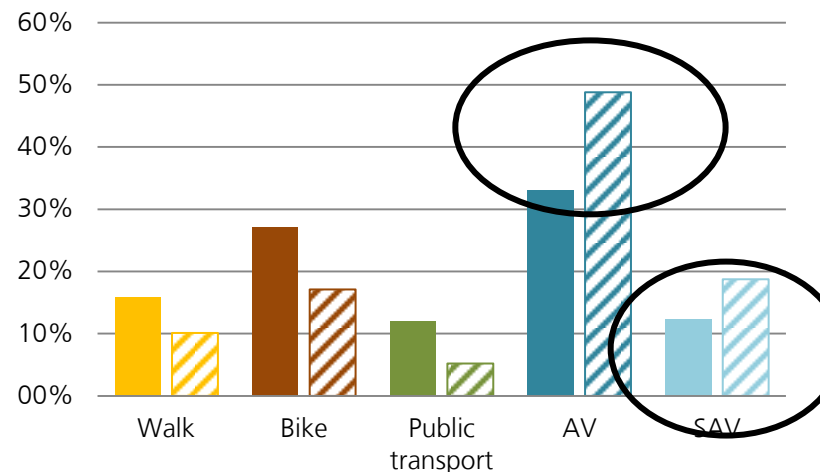
Available parking space at the residential location and at the destination location both play a role, even assuming a car picking you up at the place you are at ...



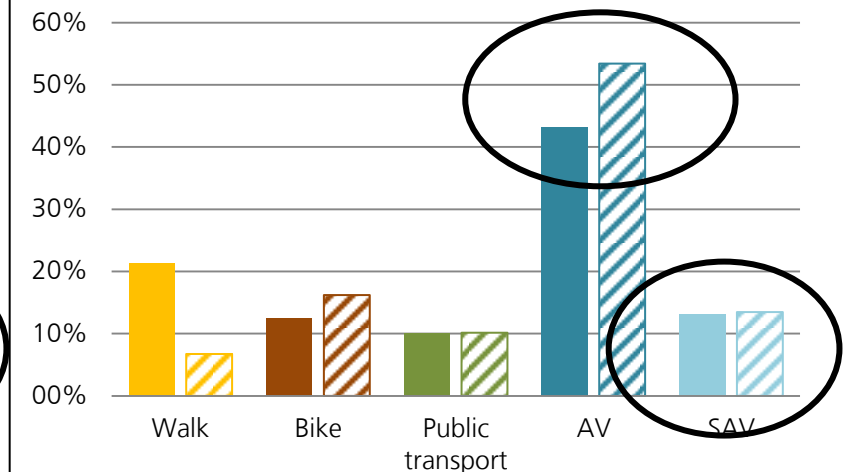
Urban / City (>100k)



Suburban / Town (>20k)



Rural / Village (<20k)



parking lot not available at residential location

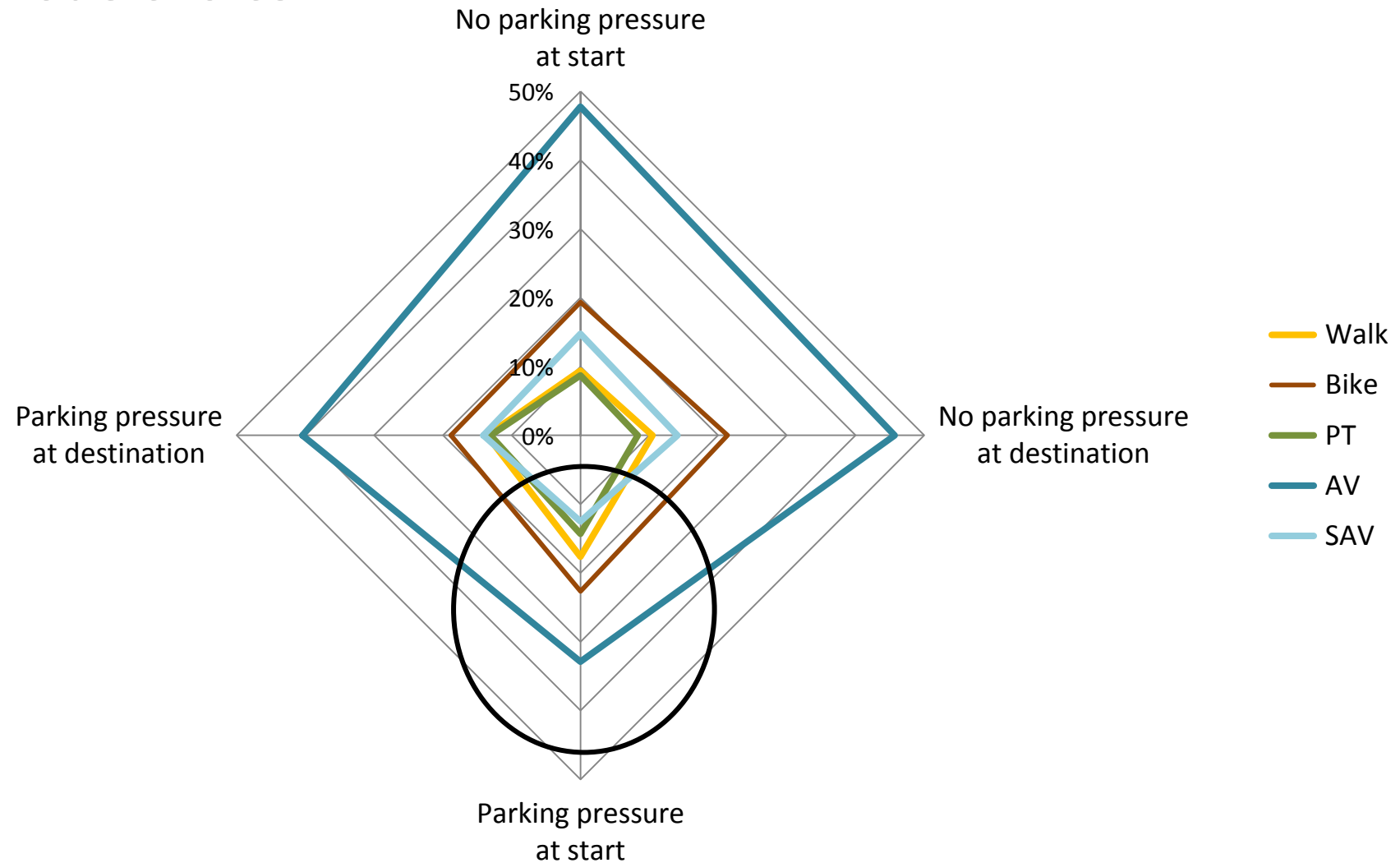


parking lot available at residential location

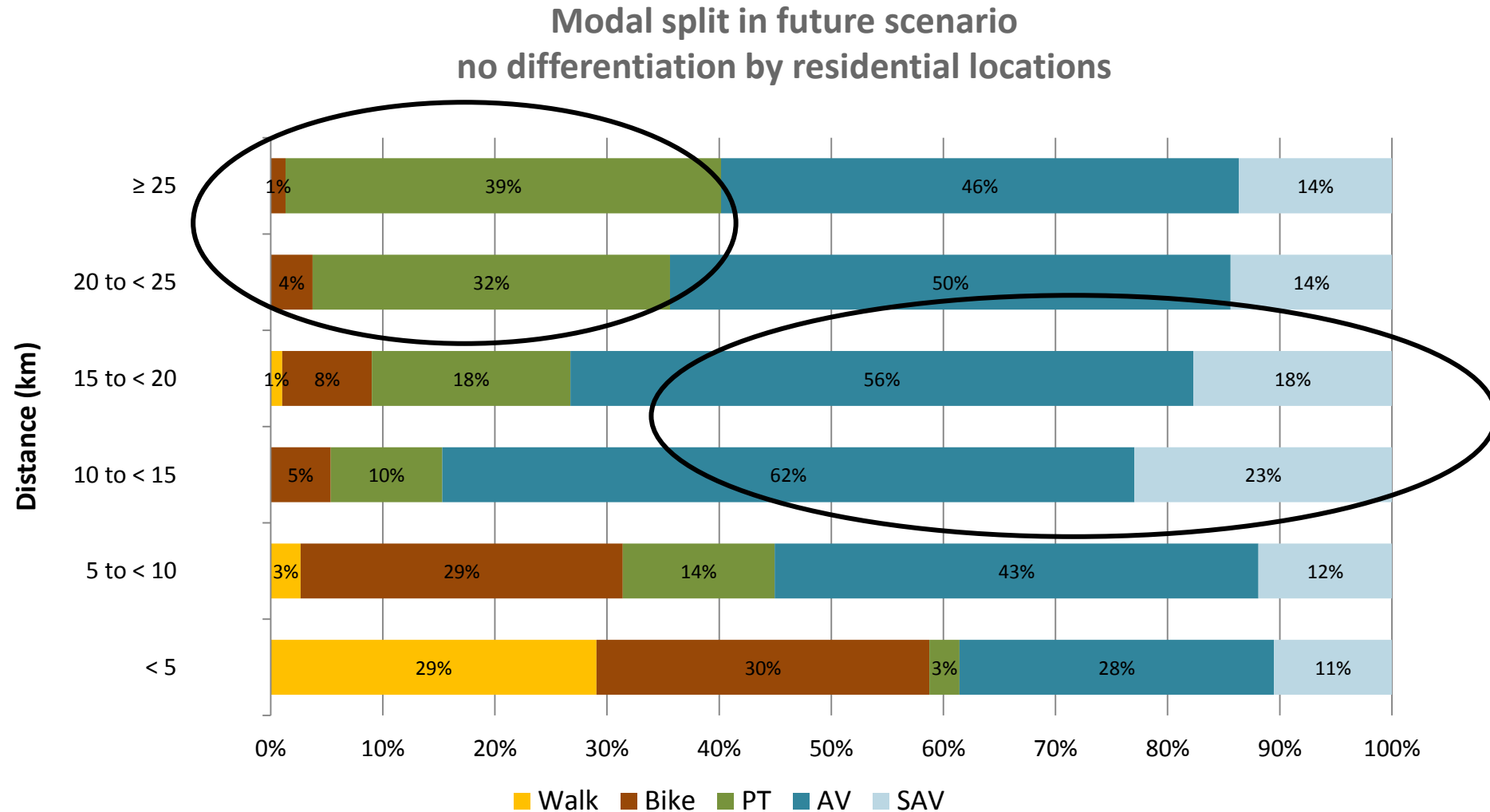
Filter: car-availability==true



...however, availability of parking at the residential location is more important for mode choice



While changes in mode choice are overall relatively small, usage shares of automated options depend on trip distances!



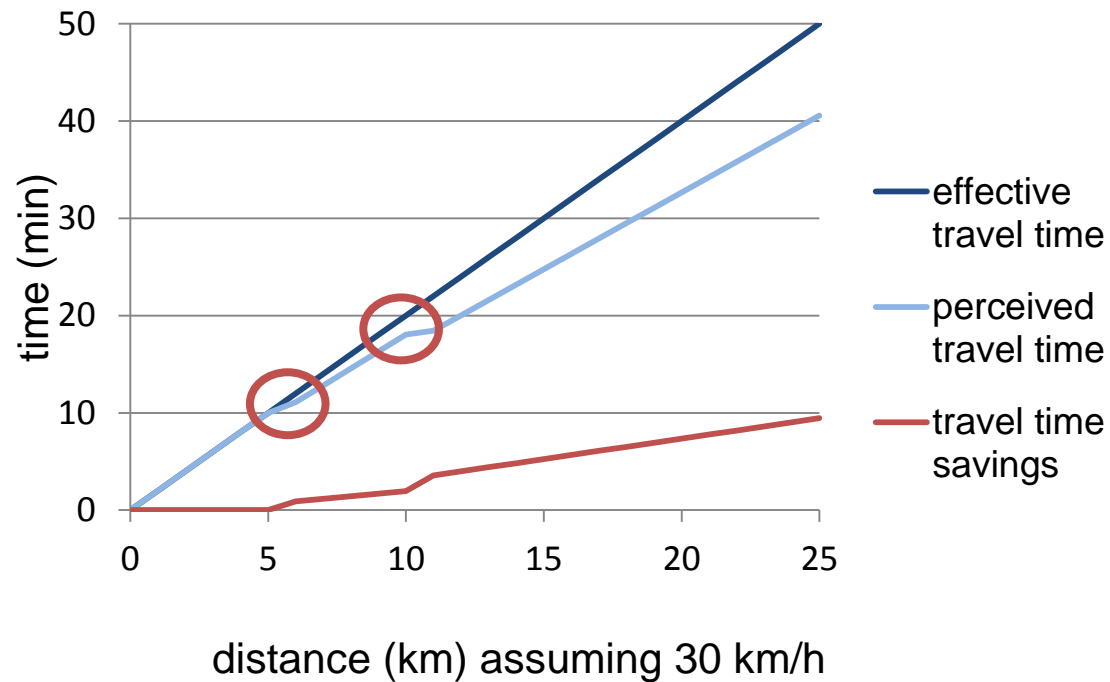
Private automation: time to relax while driving?

- SP-experiments of the survey were used to estimate different choice models
- Focus: changes in mode choice and travel time perception (value of time, VOT)
- Travel time perception in AV:
 - <10 km: 87% current travel time
 - > 10km: 79% current travel time
- Estimates used for scenario simulations
 - for the city of Brunswick
 - using the agent based transport demand model TAPAS
- Generally: Scenarios show only small implications for mode choice, perceived travel time & accessibility within the city of Brunswick

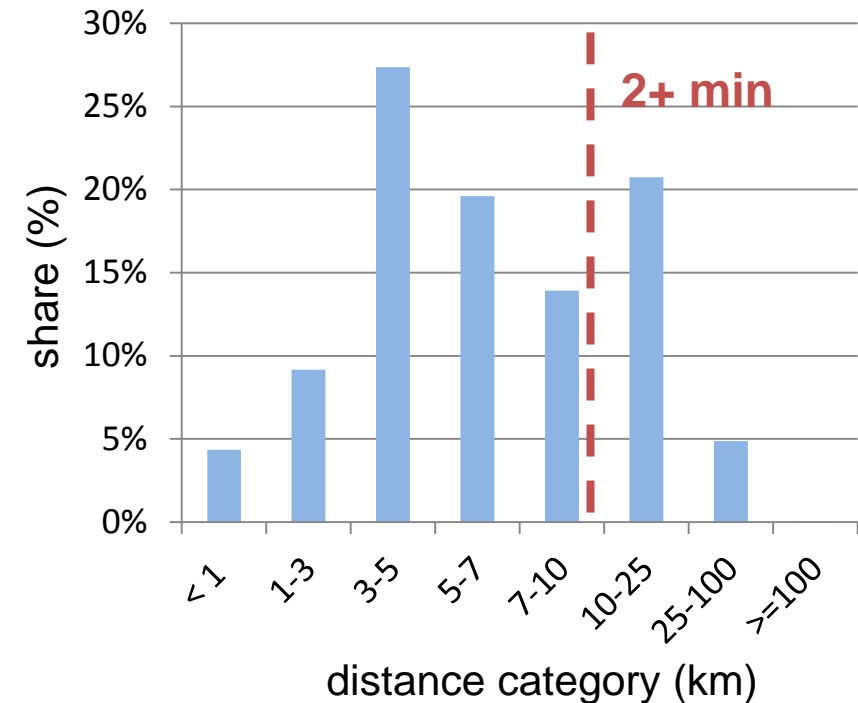


Time for relaxing? Let's have a look at trips within Brunswick for an example...

Real, perceived travel times and time savings in dependency to travelled distance



Trip distances within city of Brunswick conventional & automated vehicles*



Perceived travel time savings of 2+ min apply to only ¼ of the car trips – automated or not!

Respondents do not perceive AV and SAV as game changer for urban mode choice; Study results show preferences today and tomorrow strongly depend on residential location and parking situation



Urban / City (>100k)



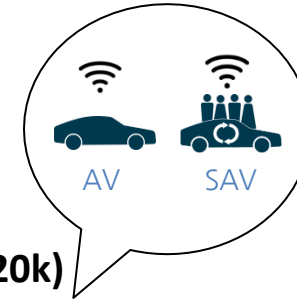
- Comparably small usage of AV as well as SAV
- SAV and AV preferred rather for shorter distances, PT for longer trips

Why?

- Short trip distances = higher use of active modes of transportation; parking issues; small time savings due to short trips



Suburban / Town (>20k)



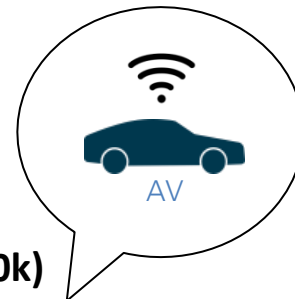
- AV and SAV preferred rather for longer distances
- Higher use of AV in suburban areas / towns but not in rural areas

Why?

- Longer trip distances; higher (private) car dependency; less parking issues and less experience with carsharing



Rural / Village (<20k)



Generally:

- Advantages of reduced access and egress times using AV and SAV not valued highly
- PT substitution by SAV not seen, usage in cities relatively low

But:

- Caution when anticipating behavioral change
- First/ last mile solutions were not considered (mitigating potential for decrease in PT attractiveness)



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Further readings:

Survey:

Steck et al. (2018): How Autonomous Driving May Affect the Value of Travel Time Savings for Commuting, TRR.
DOI:10.1177/0361198118757980

Scenario simulations:

Cyganski et al. (2018) Simulation of automated transport offers for the city of Brunswick. In: Procedia Computer Science, 130, pp. 872-879.
DOI: 10.1016/j.procs.2018.04.083



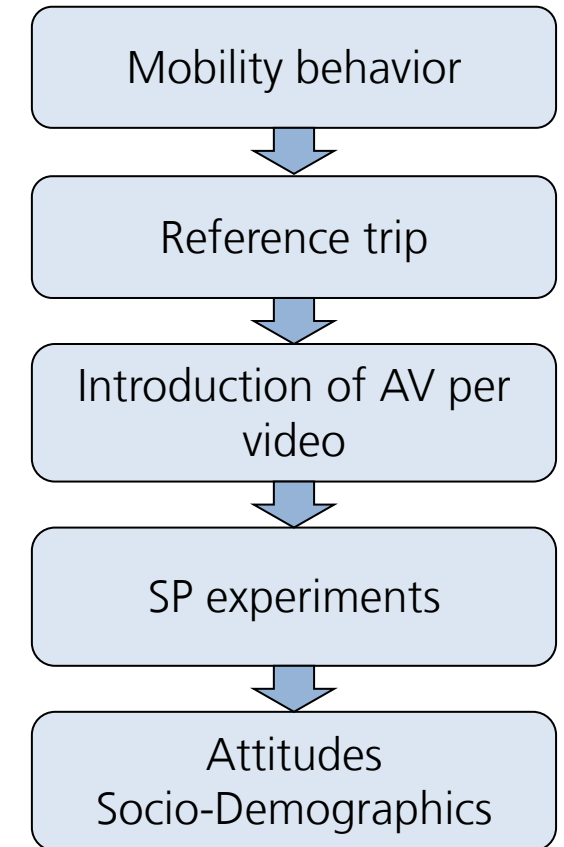
Backup for discussion



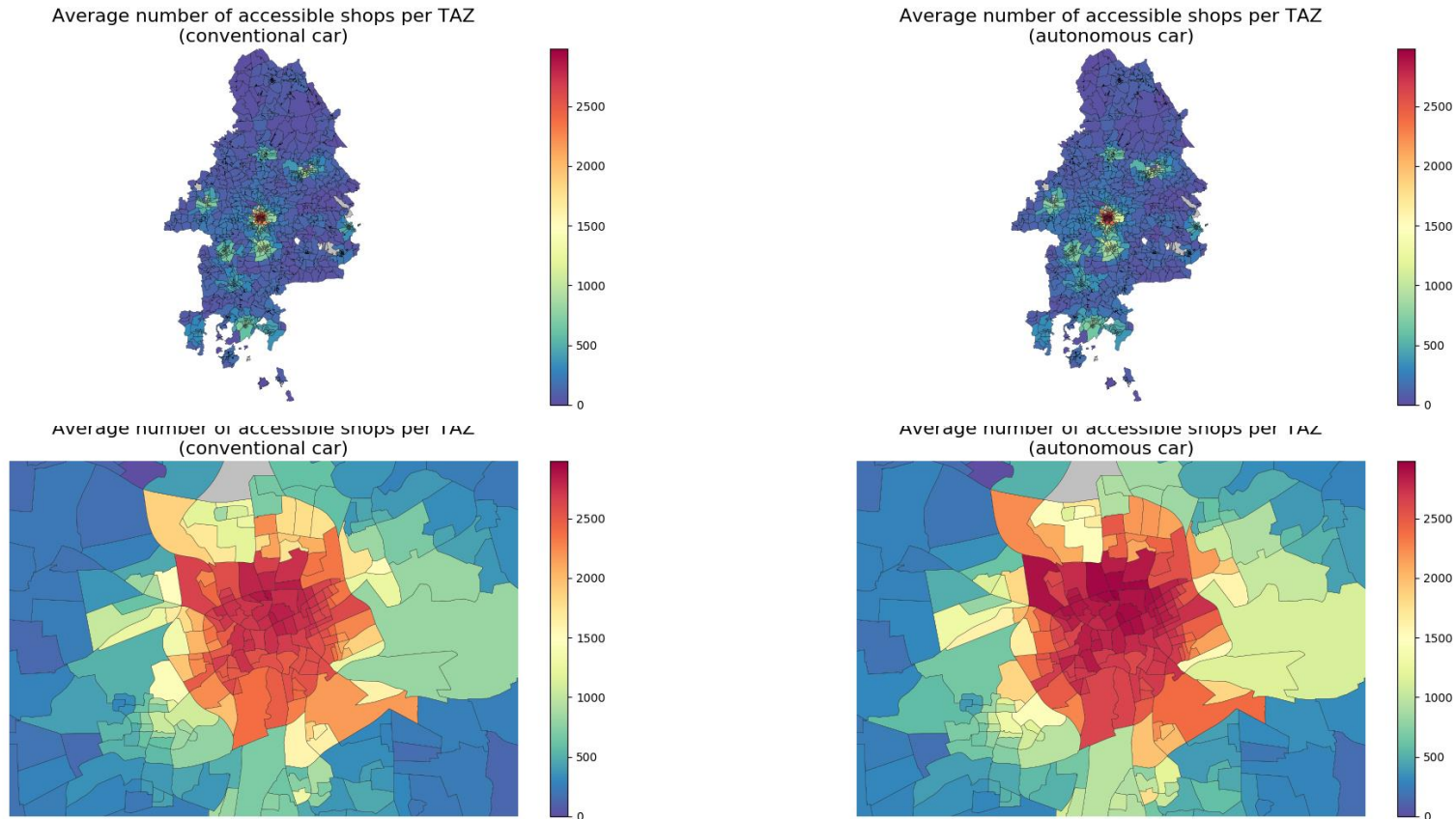
The survey on time use and mode choice in a nutshell

- Online survey, 485 respondents (representative sample for Germany by age (> 18) and gender)
- Combination of revealed and stated preference (SP) methods
- 2 SP experiments, based on a reference trip:
 - Current mode choice: foot, bike, pt, car
 - Future mode choice: automated instead conventional private car, (shared) VOD
- 8 choice situations per participant / time with different trip purposes: work / shopping / leisure / long distance
- Analysis: estimation of choice models with different complexity / goals; for simulation a MNL
- Results: mode choice parameters, value of travel by transport mode with differentiation by distance, income (, trip purpose)

Survey Design



Accessibility analysis of shopping locations: Number of shops within 10 minutes perceived travel time



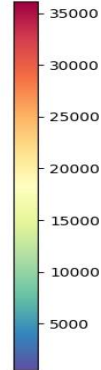
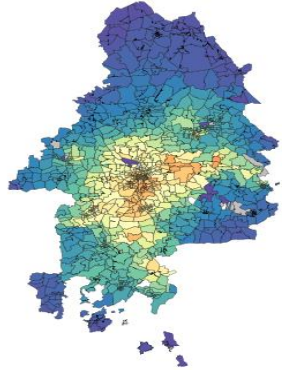
Only minor changes for short distance trips,...



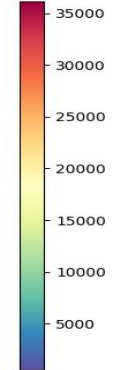
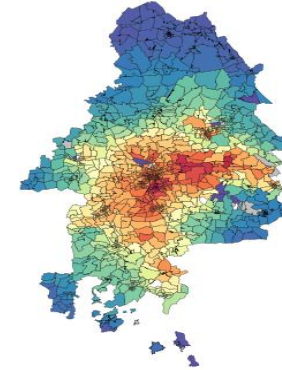
Accessibility analysis of working places:

Number of places within 10 minutes perceived travel time

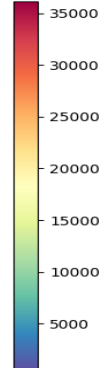
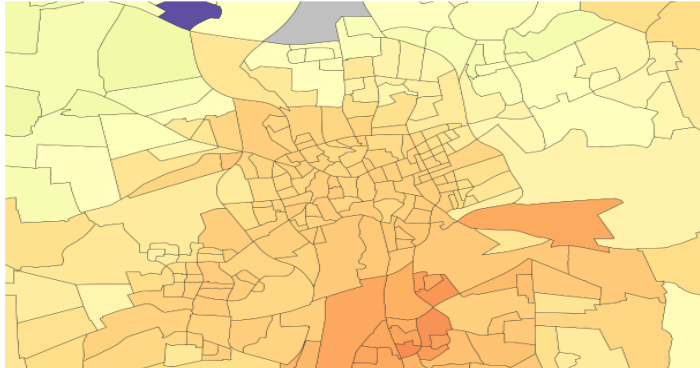
Average number of accessible work places per TAZ
(conventional car)



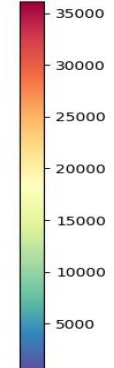
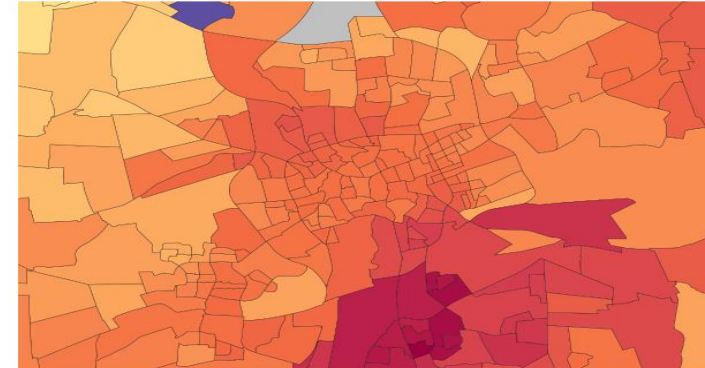
Average number of accessible work places per TAZ
(autonomous car)



Average number of accessible work places per TAZ
(conventional car)



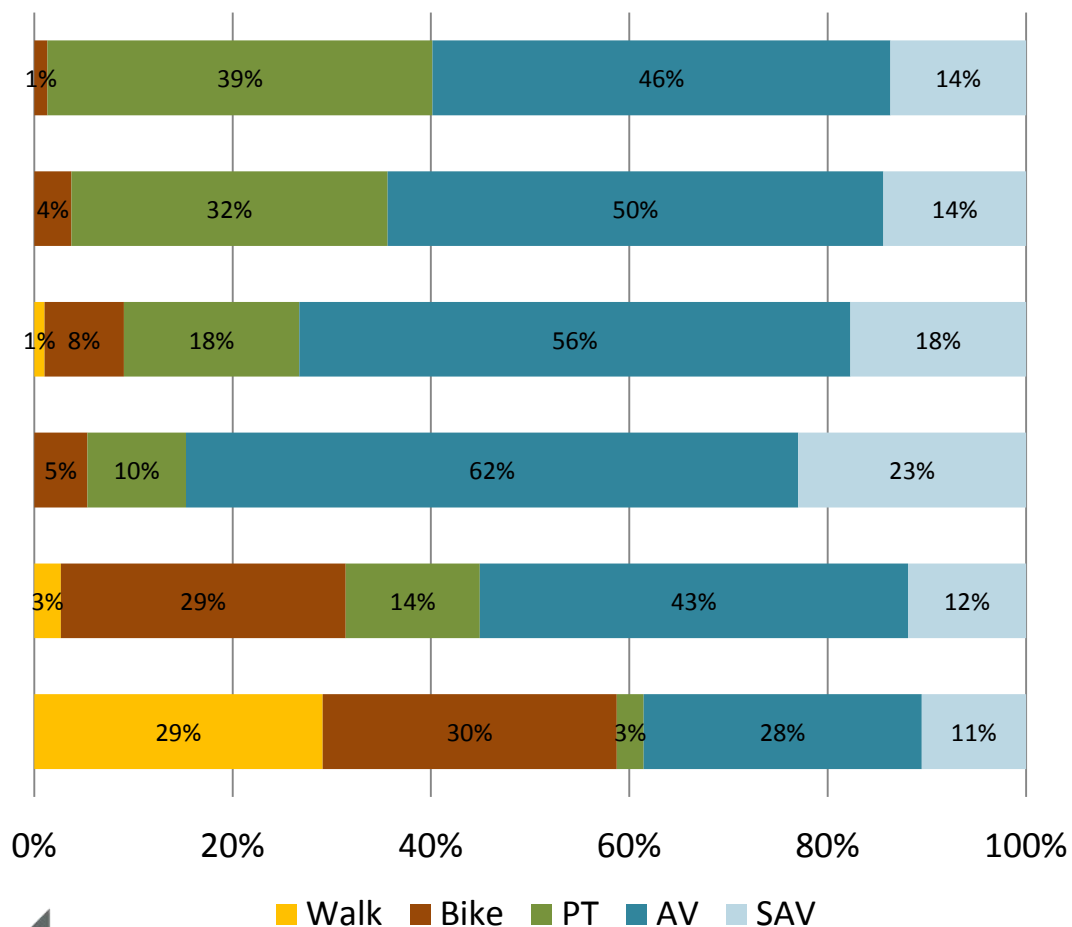
Average number of accessible work places per TAZ
(autonomous car)



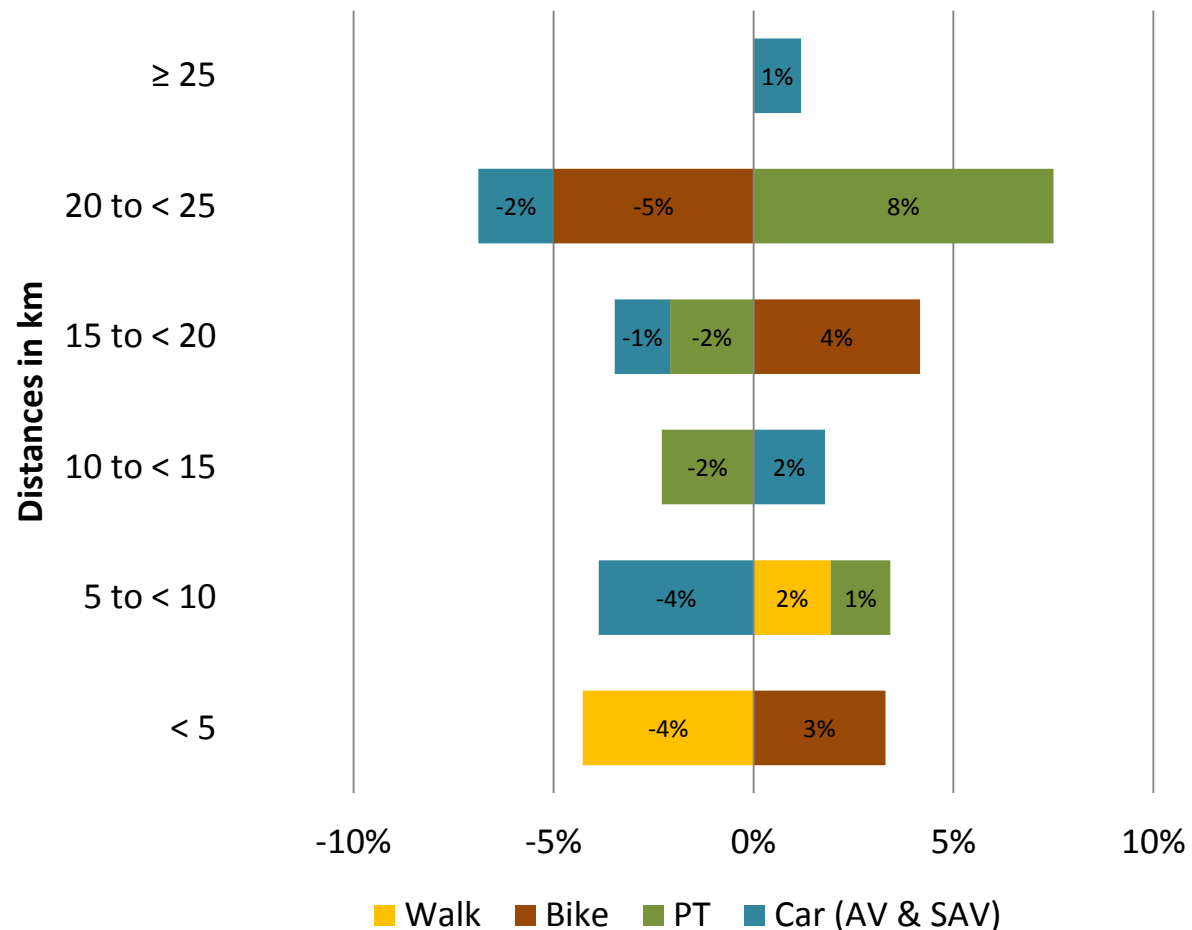
...but substantial increases when looking at wider ranges.

Changes in mode choice are relatively small and depend on trip distances!

Modal split in future scenario

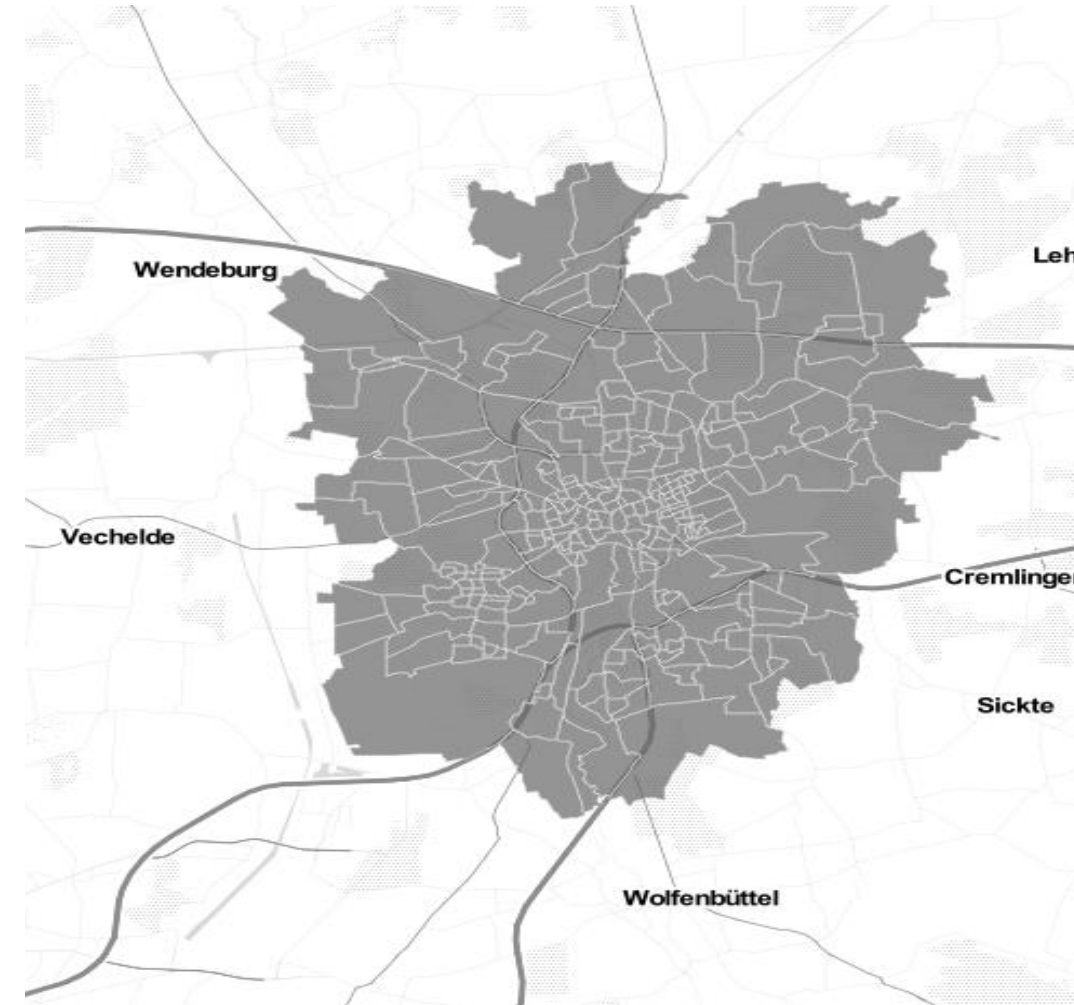


Changes in modal split compared to today's mode choice



Simulating the effect of automation on the city of Brunswick with the demand model TAPAS

- Basis 2010 and 2030 following German federal transport forecast (VP 2030):
 - population
 - fleet composition and size
 - transport mode costs except VOD 0,6 €, shared VOD 0,3 € (current cs price + update)
- Scenarios 2030
 - Modification of vehicle fleet and car ownership
 - Penetration rates adopted from IFMO-Project: very optimistic, German-wide
 - Reduction of car ownership resulting from VOD following Renewbility III
 - Adjustment of mode choice following survey estimates of VOT
- Demand generation: TAPAS; traffic assignment: SUMO



Scenario definition with respect to automation and fleet

Scenario	Abbreviation	Penetration Rate 44% PAV (DEU)	VOD (City)	VOD Shared	Fleet Reduction
Basis 2010	Basis_10				
Basis 2030	Basis_30				
Private fully automated vehicles	PVA	✓			
VOD w/o fleet reduction	VOD_konst		✓		✗
VOD w fleet reduction	VOD_red		✓		✓
Shared VOD w fleet reduction	VOD_shared_red		✓	✓	✓
Combined automation w VOD w fleet reduction	combi_VOD_red	✓	✓		✓
Combined automation w shared VOD w fleet reduction	combi_VOD_shared_red	✓	✓	✓	✓



Integration of VOT changes in the TAPAS mode choice

- TAPAS uses MNL for mode choice, estimated on geocoded region specific data set
- Travel time and egress / assess times amongst parameters
- Different time perception for automated than manual driving considered via time adjustment
- No direct comparison between manual and automated driving possible
- Comparison via public transport:

$$a = \frac{VOT_{normal}}{VOT_{PT1}} \quad b = \frac{VOT_{automat}}{VOT_{PT2}} \quad c = b/a$$

	VOT_{normal}	VOT_{PT1}	$VOT_{automat}$	VOT_{PT2}	c
≤ 10 km	8,03€/h	8,46€/h	3,52€/h	4,28€/h	0,87
> 10 km	10,44€/h	8,42€/h	4,82€/h	4,9€/h	0,79

- Additional assumption: the existence of a „ramp-up time“, no anticipated time saving within the first five minutes

$$t_{automatisiert} = \begin{cases} t_{normal} & | t_{normal} \leq 5Min \\ 5Min + c_{dist} * (t_{normal} - 5Min) & | t_{normal} > 5Min \end{cases}$$



Integration of automated driving in TAPAS mode choice

- Automated vehicles
 - Modification of the travel time (starting from the fifth minute as presented) → “perceived travel time”
 - Access and egress time = 0 min
- Vehicle-on-demand (VOD, automated Carsharing)
 - Introduction of a new mode
 - Costs and trip purpose parameter estimates of a conventional car sharing (combination of private car and public transport)
 - Age parameter estimates adapted to car sharing in Berlin
 - Usage conditions: (age ≥ 20 years, driving license = true)
 - Access time = 2 min
- Shared VOD
 - Half of the price of the VOD offer
 - Waiting time = 5 min

