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Automated Vehicles – Game Changer For Urban Mode Choice?

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1. Problem statement

The progressive automation in traffic up to the introduction of automated driving vehicles and associated new mobility services is capable of disrupting existing transport systems and is expected to have a significant impact on travel behavior, mode choice, car ownership and in the long run on residential location choice (e.g. Chapin et al., 2016; Milakis et al., 2017). Mobility needs, the resulting traffic as well as the physical shape of urban space are in close correlation (Cervero & Kockelmann, 1997). The city structure with its built environment and the location of residential and activity locations forms the basis for mobility decisions of households and companies and has a significant influence on the design of traffic (Heinrichs, 2015) as a compact urban structure with a high density and mix of uses promotes short distances, the use of active transport modes like walking or cycling, and provides a basis for public transport through concentrated traffic demand. In return, the availability and use of transport means can influence the urban structure (e.g. Apel, 2003; Steierwald, 2005). Therefore it is expected, that the availability of automated vehicles will have an impact on traffic demand patterns and the built environment with the greatest impact expected on the highest level of automation, where the system can autonomously manage all aspects of driving the vehicle (Kornhauser, 2014).

However, both the expected usage as well as the spatial impact are yet highly uncertain (Heinrichs & Cyganski, 2015) and will depend heavily on a variety of factors. Besides the level of automation and the share of such vehicles in the total stock, the regional context, the perception of these vehicles and the newly offered transport options, changes in travel time and their perception as well as user preferences in general are sure to play a crucial role when it comes to analyzing prospect changes (Fraedrich & Lenz, 2016). Recent studies on mode choices in the present of

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autonomous driving considering geographical characteristics suggest differences in the perception of the autonomous vehicle concepts depending on geographical context (Fraedrich et al., 2016).

2. Research objectives

This contribution targets the question of prospect changes in mode choice to be expected as consequence of the introduction of automated vehicles. Special focus of the analysis is set on whether differences in the anticipated usage can be shown depending on the geographical setting in general as well as on the perceived parking situation in specific. Hereby, a differentiation between privately owned automated vehicles and new mobility services in form of individually used or shared vehicles on demand is made. Based on the current mode choice, the study explores prospect changes with respect to regularly undertaken trips.

3. Methodological approach

The presented work is based on an online survey conducted in Germany in 2017 and a sample size of nearly 500 reported trips. Focusing on current and prospect mode choice, survey design included a combination of revealed and stated preference methods. Two concepts of autonomous driving – a private vehicle able to drive autonomous and a vehicle on demand – were presented to the respondents in form of short animated videos. In the revealed preference part, the participants had to report details on a habitual trip, including mode of transportation, distance and purpose as well as number of companions. Additionally, the survey included questions on socio-demographics, individual mobility characteristics, as well as residential geographical characteristics: Based on zip codes provided, three spatial area types could be used for statistical analysis: urban areas (more than 100.000 residents), towns (between 20.000 and 100.000 residents), and rural area (less than 20.000 residents).

The stated preference part of the survey included a stated choice experiment on mode choices. Here, participants had to choose between different modes of transportation including currently existing options (walk, bicycle and public transportation) and the two autonomous vehicles concepts. The information on the trip reported in the revealed part of the survey was used to create individual decision situations for each participant by reducing or increasing the travel time and cost around the reference trip values. The attributes of the alternatives included in-vehicle time and cost for all modes of transportation, access/egress time for the public transportation as well as waiting time for the public transportation and for both autonomous vehicles.

To analyze the data from the stated choice experiment, a multinomial logit (MNL) was performed using the software PhytonBiogeme (Bierlaire, 2016). To obtain the final model specification, an iterative procedure was used. The final models included the alternatives attributes described above, individual mobility characteristics, such as public transport pass and availability of a parking lot as well as geographic characteristics related to the residential location of the respondents.

4. Results

First outcomes show clear differences in the stated mode choices with regards to the residential location. In general, trips in urban areas are characterized by short distances and consequentially higher use of active modes of transportation (walking and cycling). When comparing differences in the use of motorized modes of transportation, a higher usage both of autonomous vehicles and private vehicle in general can be seen in nonurban areas compared to cities. Moreover, shared autonomous vehicles are in urban areas preferred rather for short distances. In contrast, anticipated usage of both types of vehicles in rural areas concentrates rather on longer distances (10 km+). Modelling results also show a statistically significant impact of the respondents' residential location characteristics on mode preferences and usage of the presented automated vehicles. Overall, the parameter values and signs, including the values for time and cost parameters, are plausible and in the expected range. Steck et al. (2018) provide details on the results of the estimation of value of travel time savings.

In general, the results provide empirical insights on the differences in the preferences of users with different residential background toward private autonomous vehicle compared to a vehicle on demand (VOD). In urban areas, shared autonomous vehicles (VOD) are perceived as a more attractive option than the private autonomous vehicle,

but are seen as slightly less attractive than using public transport whereas private (autonomous) vehicles are perceived as least attractive compared to all motorized transport options. The high attractiveness of VOD implies a risk of cannibalizing the public transport. These preferences shift considerably if a parking option is available at the place of residence, resulting in strong preferences toward private autonomous vehicles compared to all other modes of transportation. Furthermore, if the person travels on a trip accompanied by someone (e.g. other household member) then all other modes of transportation are perceived as less attractive than using a private autonomous vehicle except shared VOD.

These first results have important implications for analyzing the potential impact of automation on mode choices in different spatial areas. Understanding possible changes resulting from the integration of private or shared autonomous vehicles into the transportation system is becoming more and more important in urban context against the background of the rising transport/traffic related challenges in urban areas. In the full paper, we will describe in more detail the model approach and discuss the results on the impact of residential spatial characteristics on mode choices with respect to autonomous driving. Moreover, we consider including results of previous studies to compare, contrast and discuss our results.

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