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Investigating the preferences for the use of urban ridepooling

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Short summary

This study investigates the preferences for the use of the urban ridepooling service MOIA in Hamburg, Germany. A survey with over 4,000 (non-)users was conducted and a discrete choice model was estimated to understand users' preferences to use the service. The study provides insights into the sociodemographic characteristics of ridepooling users, their preferences towards the service and first findings on the preferences towards an intermodal combination with public transportation. The results show that factors such as travel cost, time, trip distance and purpose are significant in influencing the use of ridepooling services. According to the choice experiment, intermodal travel is a viable choice for trip distances above 10 km, primarily for public transport subscription holders. The findings of this study can inform the design and marketing of future ridepooling services, and contribute to the broader debate on the potential benefits and challenges of shared mobility services in improving urban mobility and reducing the negative impacts of transportation on the environment.

Keywords: ridesharing, shared mobility, public transport, discrete choice modeling, intermodality, multimodality

1 Introduction

Urban ridepooling has emerged as a popular mobility solution, particularly in urban areas, as it provides a more efficient and affordable way for individuals to travel short to medium distances. Ridepooling is a service that allows multiple passengers who are traveling in the same direction to share a vehicle, thus reducing the number of vehicles on the road and decreasing congestion, noise and greenhouse gas emissions (Shaheen & Cohen, 2018; Zwick et al., 2021). In this paper, we investigate the preferences for the use of urban ridepooling on the example of the MOIA service.

MOIA is a ridepooling service launched in 2017 by Volkswagen Group, which uses electric vehicles that can carry up to six passengers. It operates the largest European ridepooling fleet with over 250 vehicles in Hamburg, Germany. The recent service expansion with a larger service area (270 km^2 instead of 200 km^2), integration of wheelchair accessible vehicles and tariff integration into the public transport (PT) system as part of a funding project served as an occasion for a scientific long-term monitoring of these measures, in the context of which this research work took place. We surveyed 4,167 MOIA users and non-users in October and November 2022 to understand their sociodemographics and general mobility behavior, and estimated a discrete mode choice model to analyze their mode preferences. Specifically, we examine how factors such as age, gender, income, and travel distance influence individuals' choices between ridepooling, private cars, PT, and slow modes of transportation. The survey was conducted *before* the introduction of the described measures in January 2023 and will be repeated in fall 2023.

The study builds upon previous scientific investigations of the use of MOIA as part of MOIA's accompanying study by Karlsruhe Institute of Technology and TU Munich from 2019 to 2021 (Kagerbauer et al., 2021). Kostorz et al. (2021) reported the findings of the survey of over 12,000 MOIA (non-)users in 2019. They found that MOIA is used across all age groups and genders, and enriches multimodal travel behavior. A detailed investigation of users with mobility impairments and work-related trips was conducted. In contrast to the previous study, we estimate a discrete choice model and specifically investigate the intermodal use of ridepooling. The intermodal use of ridepooling was also investigated by Diebold et al. (2021) on the example of ioki in Hamburg. The service is designed differently to MOIA and delivers customers for a small fee of 1€ in addition to a PT ticket to the next railway station in a 15 km^2 service area. Thus, it is not surprising that the share of intermodal trips is very high at 72% and that the average age is with 34 rather young.

We contribute to the literature on ridepooling by examining the preferences for the use of urban ridepooling, and identifying the factors that influence individuals' willingness to use these services. The estimated discrete choice models provide novel insights into important level-of-service attributes and values of travel time (VTT) that inform policy-makers and urban transportation planners in their efforts to promote sustainable and efficient transportation systems through new digital and smart mobility services.

2 Methodology

This study employed an online two-stage approach using a combination of revealed and stated preference surveys (RP & SP), which were administered to participants. RP data provide valuable information about mode choices in real markets, but often lack in variability of the underlying variables to construct appropriate models and forecasts (Ortúzar & Willumsen, 2011). To better comprehend the trade-off confronted by individuals in choosing between multiple modes, SP methods such as stated choice experiments (SCE) have been used as these are often richer in trade-off information by design (Louviere et al., 2003; Train, 2009). Hence, the mode choice experiment presented in the SP survey made use of individualized reference trips from data gathered in the RP survey. A pooled RP-SP Multinomial Logit (MNL) model was then applied to examine the influence of level-of-service (LOS) and sociodemographic attributes on the choice between the alternatives presented. In addition, population weighted willingness-to-pay indicators were derived to complement the analysis of mode choices in a multimodal setting.

Recruitment and survey design

Given that MOIA operates predominantly in the city of Hamburg, we focused on participants residing in the city and its surrounding areas. The recruitment process included two distribution channels, with current MOIA members being internally recruited by MOIA's marketing department and other respondents being externally sourced via two regional panel providers. Ultimately, the sample size for the RP survey amounted to 4,167 individuals. Comprehensive data cleaning and participants not filling out the SCE reduced the sample size to 3,823 individuals for the SP survey. Both surveys were conducted using the survey software Qualtrics.

The RP survey entailed questions about the participants' sociodemographic profile on personal and household level, their mobility tools and behavior as well as a ridepooling assessment with respect to MOIA. The sociodemographic questions were standardized in accordance with the German transport census 2017 (MiD - Mobilität in Deutschland; Nobis & Kuhnimhof (2019)) to allow for reweighting to population level after model estimation. For the purpose of this study, reference values for home-based work and leisure trips were generated via the Google API for each participant.
The modes considered in the choice experiment and model were walking (W), cycling (B), car (C), public transport (PT), taxi (T), MOIA (M) and an intermodal alternative (MPT) consisting of MOIA and PT, where MOIA was assumed to be feeder for PT. A typical ride with MOIA can be characterized as a sequence of three stages: Walking to the pick-up location, traveling in a MOIA vehicle and walking from the drop-off location to the final destination. To simulate this process, MOIA's internal virtual stop network with over 12,000 stops was utilized to effectively route these trips. The RP data contained MOIA as an option only if all of the specified locations were located within the MOIA service area as of 2023. In addition, level-of-service attributes (e.g. an arrival window due to ridepooling or wait time for the vehicle to arrive) were included in the choice experiment.

The overall mode choice experiment entailed six experimental designs which include seven alternatives displayed to a respondent. Dependent on the trip distance, purpose, driver's license ownership and car availability, each respondent was assigned to a block of eight choice situations of one of those designs. In the end, six D-efficient pivot designs were implemented using NGene (Rose & Bliemer, 2009; ChoiceMetrics, 2021).

Modeling approach

The data gathered allowed for the estimation of pooled RP-SP MNL choice models. The utility functions are depicted in Equations 1 to 3. For ease of readability, the subscripts for choice task t are omitted.

$$\begin{aligned} V_{i,n,s} = \alpha_{i,s} + \delta_{shift,i,s} \cdot z_{shift,n,s} + \beta_{LOS,i} \cdot x_{LOS,n} + \gamma_{socio,i} \cdot x_{socio,n} + \\ f_c(x_{dist,n,s}, z_{leis,n,s}) \cdot x_{cost,i,n,s} + \\ f_{tt,i}(x_{dist,n,s}, z_{leis,n,s}) \cdot x_{tt,i,n,s} \end{aligned} \tag{1}$$

$$f_c(x_{dist,n,s}, z_{leis,n,s}) = (\beta_{cost,com} + \beta_{cost,leis} \cdot z_{leis,n,s}) \cdot \left(\frac{x_{dist,n,s}}{8\text{km}}\right)^{\lambda_{cost,dist}} \tag{2}$$

$$f_{tt,i}(x_{dist,n,s}, z_{leis,n,s}) = (\beta_{tt,com,i} + \beta_{tt,leis,i} \cdot z_{leis,n,s}) \cdot \left(\frac{x_{dist,n,s}}{8\text{km}}\right)^{\lambda_{tt,dist,i}}, \tag{3}$$

where alternative $i \in J = \{W, B, C, PT, T, M, MPT\}$ and data source $s \in \{RP, SP\}$. $\alpha_{i,s}$ represents the alternative-specific constants (ASC) and $\delta_{shift,i,s}$ denotes shifts on the ASCs (trip purpose and MOIA membership) for both the RP & SP model component. $\beta_{LOS,i}$ denotes the influence of alternative-specific LOS attributes like access/eggress time ($\beta_{i,aet}$) and arrival time window for M ($\beta_{M,latewin}$). Wait time while transferring ($\beta_{waittime}$), wait time for the vehicle ($\beta_{waitveh}$) and number of transfers (β_{trans}) were estimated jointly where applicable for alternatives PT, T, M and MPT. $\gamma_{socio,i}$ captures alternative-specific sociodemographic characteristics for age, gender and household income. The travel time and cost coefficient ($\beta_{tt,com,i}$, $\beta_{cost,com}$) is modeled as a non-linear function of beeline distance, which also includes a shift for leisure trips ($\beta_{tt,leis,i}$, $\beta_{cost,leis}$) to account differences in sensitivities across these trip purposes.

Since an intermodal alternative was introduced in the choice experiment, where MOIA is assumed to be an access mode to PT (even though that this might already be a use case for MOIA in reality, the RP survey did not capture it), two model specifications were tested. While MNL 1 treated the in-vehicle travel times for MOIA as separate effects (main mode:$\beta_{M,tt,com}$ and access mode:$\beta_{MPT,M,tt}$), MNL 2 estimated these two effects jointly in $\beta_{M,tt,com}$ (see Table 1). As a consequence, this affects the VTT for MOIA, which is discussed in the next section. The proposed modeling approach accounts for the impact of trip purpose and distance, various LOS and sociodemographic attributes on mode choice in the presence of ridepooling. The models were estimated in preference space, using R and the Apollo package (R Core Team, 2020; Hess & Palma, 2019).

3 Results and discussion

An analysis of the sample in comparison with the German MiD, which was restricted to Hamburg, uncovered two noteworthy observations: Firstly, the sample was representative in terms of gender and holders of a driver's license. Secondly, it demonstrated a slight inclination towards younger participants, as well as an over-representation of individuals with a high degree of education (university or diploma) and high-income households (more than 6,500 Euro per month). Consequently, post-estimation reweighting was necessary for the measures of interest using sample enumeration.

In the sample, 90% of participants (3,715) responded affirmatively to having booked a ride with MOIA within the past year, which might be an artefact of the recruitment process, but also demonstrates the popularity of MOIA's ridepooling service in Hamburg. The sample's sociodemographic profile in general is very similar compared to the work done in 2019 by Kagerbauer et al. (2021). MOIA users are on average 44 years old, well educated and mostly live in one-person, high-income households. With regard to their last trip booked, two insights were relevant for the choice experiment. It was found that 60% of the participants reported their last trip as being for leisure, 12.9% for travel to a train station or the airport, and 10.6% for work. Additionally, 14% of the trips were combined with other modes of transportation, with 70% of those including PT. This indicated the necessity of incorporating and testing an intermodal alternative in the DCE, also because the survey did not differentiate between a combination with short-distance and long-distance PT modes.

Model results

Figure–1 shows the choice frequencies (market shares) divided by data source. Examining the RP data, car and PT were the most commonly chosen alternatives (33.8% and 33% respectively), followed by bike and walk (18.2% & 13.4%). MOIA exhibits a market share of 1.6%, which is higher than MOIA's actual share of roughly 0.1%. This might be related to the large proportion of MOIA users in the sample. The SP data illustrates a decrease in car, PT and walk market shares, in favor of the intermodal alternative and MOIA. Taxi was the least chosen mode with 0.1% and 0.7% market shares in the RP and SP data, respectively. This is unsurprising as taxis are not often the first choice for commutes or frequent leisure trips. It is important to note that the SP modal splits presented here are an artefact of the experimental design and the associated distance classes, and should not be compared to real-world modal splits (Glerum et al., 2013). A closer investigation of non-trading and lexicographic choice behavior revealed that in 42% of all choice tasks the least expensive option was chosen, which either indicates a highly price-sensitive sample or an experimental design that transparently exposed all fares. However, this can be attributed to the assumption of zero costs for PT season ticket subscribers. On an individual level, 18% of all participants always (i.e. 8 times) chose the least expensive mode. As a result, in terms of cost, both PT and the intermodal alternative were viable options, which could explain the observed popularity of the latter.

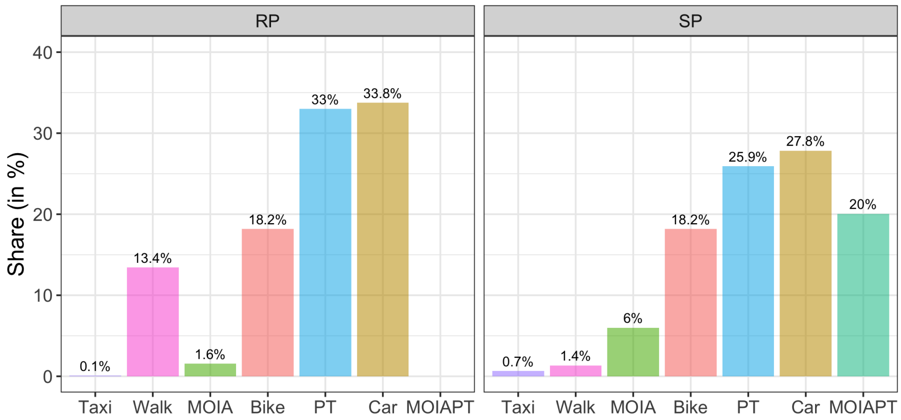

Figure 1: Choice frequencies

The model estimates are presented in Table 1. The units of the temporal variables are minutes, while those of the costs are Euros. Building upon the recommendations of Wasserstein et al. (2019), the table does not present associated p-values. Thus, researchers should recognize the presence of uncertainty and should not assume that effects exist simply due to the statistical significance or lack thereof. The model fit, $Adj.\rho^2$, of both models is almost equal, although slightly higher for MNL 1, which likely is a consequence of not pooling the travel time attribute for MOIA of the intermodal alternative ($\beta_{MPT,tt,com}$). However, the VTT differ between the two models, as shown in Figures 2 & 3 and discussed after examining the estimates.

The most substantial shifts on the ASC's were given by $\delta_{M,s,nonuser}$ and thus controlling for MOIA membership, demonstrating that non-users were less prone to choose MOIA and MOIAPT. Furthermore, it was important to also account for trip purpose related shifts on the ASC as they influence the subsequent calculation of the VTT. Noteworthy findings concerning the sociodemographical variables considered are the following: With respect to gender, a substantial effect was only observed for the choice of bicycles. Men were more likely to do so than women. An effect for high income households was only apparent for private cars. As such, this does not seem to be the case for choosing a ridepooling service like MOIA. The strongest impact among all variables was observed for education. While a high education degree has a positive impact on the probability of choosing a bicycle, it has negative one for all other modes. This finding might be related to the fact that cycling is a more sustainable way of traveling compared to motorized modes and thus appeals more to well educated people.

Table 1: Estimation results

Reference: Walking	MNL 1		MNL 2	
Parameter	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio
$\alpha_{W,RP}$	0.000	(NA)	0.000	(NA)
$\alpha_{B,RP}$	−1.712	(−2.038)	−1.727	(−2.053)
$\alpha_{C,RP}$	−2.442	(−2.961)	−2.538	(−3.069)
$\alpha_{PT,RP}$	−1.455	(−1.765)	−1.509	(−1.831)
$\alpha_{T,RP}$	−5.499	(−7.951)	−5.616	(−8.203)
$\alpha_{M,RP}$	−3.253	(−3.557)	−3.237	(−3.526)
$\delta_{B,RP,leis}$	−0.904	(−1.609)	−0.922	(−1.644)
$\delta_{C,RP,leis}$	−0.121	(−0.212)	−0.079	(−0.139)
$\delta_{PT,RP,leis}$	−0.597	(−1.053)	−0.552	(−0.976)
$\delta_{M,RP,leis}$	−0.044	(−0.070)	−0.579	(−0.931)
$\delta_{M,RP,nonuser}$	−1.495	(−1.456)	−1.487	(−1.443)
$\alpha_{W,SP}$	0.000	(NA)	0.000	(NA)
$\alpha_{B,SP}$	−1.268	(−1.476)	−1.266	(−1.469)
$\alpha_{C,SP}$	−2.729	(−3.236)	−2.814	(−3.320)
$\alpha_{PT,SP}$	−1.796	(−2.134)	−1.845	(−2.189)
$\alpha_{T,SP}$	−3.154	(−5.944)	−3.250	(−6.210)
$\alpha_{M,SP}$	−0.846	(−0.921)	−0.832	(−0.902)
$\alpha_{MPT,SP}$	−3.275	(−3.760)	−2.672	(−3.080)
$\delta_{B,SP,leis}$	0.296	(0.491)	0.267	(0.443)
$\delta_{C,SP,leis}$	0.364	(0.601)	0.437	(0.725)
$\delta_{PT,SP,leis}$	0.259	(0.434)	0.314	(0.524)
$\delta_{M,SP,leis}$	0.182	(0.286)	−0.329	(−0.526)
$\delta_{M,SP,nonuser}$	−1.571	(−4.100)	−1.592	(−4.165)
$\delta_{MPT,SP,leis}$	1.119	(1.741)	0.737	(1.150)
$\delta_{MPT,SP,nonuser}$	−0.781	(−5.017)	−0.777	(−4.915)
$\gamma_{B,male}$	0.157	(1.012)	0.157	(1.006)
$\gamma_{B,age31-65}$	0.072	(0.360)	0.075	(0.375)
$\gamma_{B,age66-86}$	−0.412	(−1.082)	−0.422	(−1.098)
$\gamma_{B,educhigh}$	0.189	(1.178)	0.195	(1.207)
$\gamma_{B,inc1.7-5.5k}$	0.059	(0.134)	0.060	(0.135)
$\gamma_{B,inc6.5k+}$	0.163	(0.350)	0.163	(0.346)
$\gamma_{C,male}$	−0.037	(−0.254)	−0.037	(−0.252)
$\gamma_{C,age31-65}$	0.232	(1.243)	0.236	(1.260)
$\gamma_{C,age66-86}$	0.187	(0.522)	0.179	(0.499)
$\gamma_{C,educhigh}$	−0.514	(−3.438)	−0.523	(−3.487)
$\gamma_{C,inc1.7-5.5k}$	0.566	(1.344)	0.561	(1.321)
$\gamma_{C,inc6.5k+}$	0.650	(1.455)	0.645	(1.434)
$\gamma_{PT,male}$	−0.047	(−0.319)	−0.051	(−0.341)
$\gamma_{PT,age31-65}$	−0.026	(−0.139)	−0.027	(−0.145)
$\gamma_{PT,age66-86}$	−0.191	(−0.536)	−0.213	(−0.598)
$\gamma_{PT,educhigh}$	−0.288	(−1.910)	−0.294	(−1.942)
$\gamma_{PT,inc1.7-5.5k}$	−0.112	(−0.272)	−0.122	(−0.295)
$\gamma_{PT,inc6.5k+}$	−0.430	(−0.978)	−0.443	(−1.002)
$\gamma_{M,male}$	−0.044	(−0.251)	−0.048	(−0.270)
$\gamma_{M,age31-65}$	0.139	(0.655)	0.149	(0.692)
$\gamma_{M,age66-86}$	0.917	(1.431)	0.964	(1.469)
$\gamma_{M,educhigh}$	−0.638	(−3.627)	−0.639	(−3.588)
$\gamma_{M,inc1.7-5.5k}$	0.047	(0.084)	0.053	(0.093)
$\gamma_{M,inc6.5k+}$	0.007	(0.012)	0.003	(0.005)
$\gamma_{MPT,male}$	−0.153	(−0.984)	−0.157	(−0.998)
$\gamma_{MPT,age31-65}$	0.290	(1.458)	0.295	(1.473)
$\gamma_{MPT,age66-86}$	0.490	(1.303)	0.490	(1.297)
$\gamma_{MPT,educhigh}$	−0.497	(−3.127)	−0.508	(−3.179)
$\gamma_{MPT,inc1.7-5.5k}$	0.105	(0.256)	0.093	(0.226)
$\gamma_{MPT,inc6.5k+}$	0.029	(0.066)	0.015	(0.035)
$\beta_{cost,com}$	−0.292	(−14.970)	−0.301	(−15.438)
$\beta_{cost,leis}$	0.127	(7.165)	0.139	(7.809)
$\beta_{W,tt,com}$	−0.130	(−7.736)	−0.133	(−7.842)
$\beta_{B,tt,com}$	−0.144	(−12.704)	−0.148	(−13.089)
$\beta_{C,tt,com}$	−0.037	(−3.537)	−0.035	(−3.327)
$\beta_{C,aet}$	−0.086	(−12.696)	−0.087	(−12.828)

Reference: Walking	MNL 1		MNL 2	
Parameter	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio
$\beta_{PT,tt,com}$	−0.061	(−10.903)	−0.062	(−11.107)
$\beta_{PT,aet}$	−0.052	(−9.911)	−0.053	(−10.085)
$\beta_{T,tt,com}$	−0.015	(−0.686)	−0.012	(−0.571)
$\beta_{M,tt,com}$	−0.087	(−8.255)	−0.092	(−8.893)
$\beta_{M,aet}$	−0.022	(−2.309)	−0.018	(−1.819)
$\beta_{M,latewin}$	−0.039	(−7.818)	−0.039	(−7.810)
$\beta_{MPT,M,tt}$	−0.018	(−2.823)	(NA)	(NA)
$\beta_{waittime}$	−0.020	(−2.532)	−0.019	(−2.362)
β_{trans}	−0.269	(−12.445)	−0.268	(−12.350)
$\beta_{waitveh}$	−0.021	(−4.934)	−0.022	(−5.000)
$\beta_{W,tt,leis}$	0.009	(0.476)	0.010	(0.567)
$\beta_{B,tt,leis}$	0.016	(1.382)	0.022	(1.875)
$\beta_{C,tt,leis}$	−0.014	(−1.420)	−0.014	(−1.384)
$\beta_{PT,tt,leis}$	0.019	(2.608)	0.022	(3.116)
$\beta_{T,tt,leis}$	−0.016	(−0.559)	−0.018	(−0.604)
$\beta_{M,tt,leis}$	0.025	(1.791)	0.057	(5.079)
$\lambda_{cost,dist}$	−0.531	(−14.592)	−0.502	(−14.057)
$\lambda_{W,tt,dist}$	−0.212	(−2.780)	−0.206	(−2.684)
$\lambda_{B,tt,dist}$	−0.276	(−6.043)	−0.270	(−5.891)
$\lambda_{C,tt,dist}$	−0.254	(−3.311)	−0.216	(−1.987)
$\lambda_{PT,tt,dist}$	−0.077	(−0.777)	−0.033	(−0.325)
$\lambda_{T,tt,dist}$	0.357	(1.146)	0.373	(1.097)
$\lambda_{M,tt,dist}$	0.090	(1.074)	0.017	(0.220)
μ_{RP}	1.000	(NA)	1.000	(NA)
μ_{SP}	1.053	(0.982)	1.034	(0.658)
LL(0,RP)		−8147.186		−8147.186
LL(0,SP)		−34631.630		−34631.630
LL(final,RP)		−4728.957		−4724.122
LL(final,SP)		−23942.468		−23967.600
LL(final,model)		−28671.426		−28691.722
Adj. ρ^2 (model)		0.330		0.329
Number of respondents		3823		3823
Number of observations		28907		28907
Number of parameters		86		85

Figures–2 and 2 present the VTTs for all main modes of both models. As can be inferred from the corresponding legend, the VTT for MOIAPT is not displayed since the main mode is PT, whose parameter was jointly modeled with the PT alternative. Moreover, the VTTs are only modeled for the range of distance the modes were available in the data. The Delta method was used to estimate the VTTs and their 95%-confidence interval (Daly et al., 2012). Despite a very similar pattern of VTT for commute trips, contrastingly, the two models yield notable differences in the VTT for leisure trips. The models showed that, in general, travel cost tends to have a more substantial influence on mode choice than travel time. This also holds for the corresponding shift of the parameter for leisure trips and distance elasticity. A non-linear interaction of cost with household income was also tested, but turned out to have no effect. However, the difference in VTTs among the modes is primarily the result of the different travel time parameters (and their respective shifts), as the cost coefficient is generic (i.e. the same for all modes). Interestingly, for bicycle, public transport, and MOIA, leisure travel time sensitivities are less negative compared to their commutes, suggesting that participants find the time spent using these modes more enjoyable. This manifests even more in MNL 2, where the VTT for MOIA is much lower due to the joint estimation of MOIA as a main and access mode. In addition, the distance elasticitiy of travel time for MOIA is positive (but not significant), indicating that travel time sensitivity is barely influenced by distance. As such, for MNL 1, this suggests that the VTT for MOIA is comparatively more driven by travel cost rather than time in relation to the other modes, and hence for shorter distances more similar to car and PT. For MNL 2, the leisure effect induced by pooling the travel time parameters seemed to affect the VTT more strongly than cost, resulting in a substantially lower value. This might also be a result of the rather simply constructed intermodal alternative, and needs further investigation in the future. Another interesting outcome from the models regarding MOIA is that a larger window of arrival time (e.g. late arrival due to pooling and hence possible rerouting) is perceived as almost twice as worse than waiting for the vehicle or accessing/eggressing it.

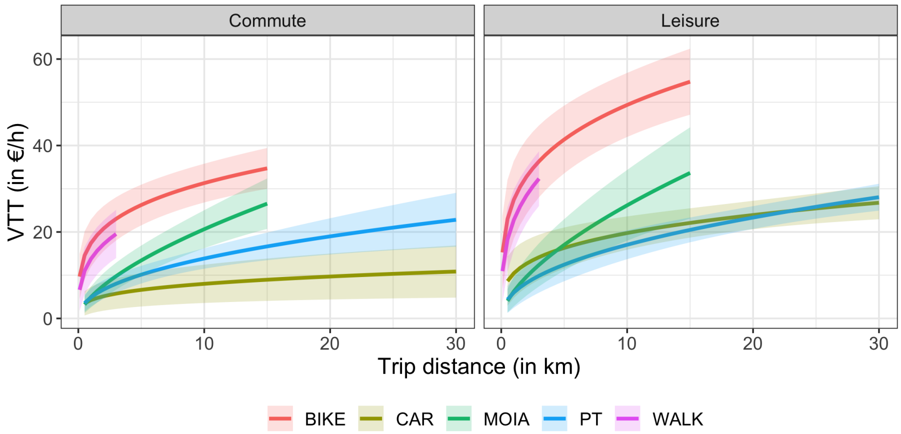

Figure 2: Values of travel time by Beeline-distance (MNL 1)

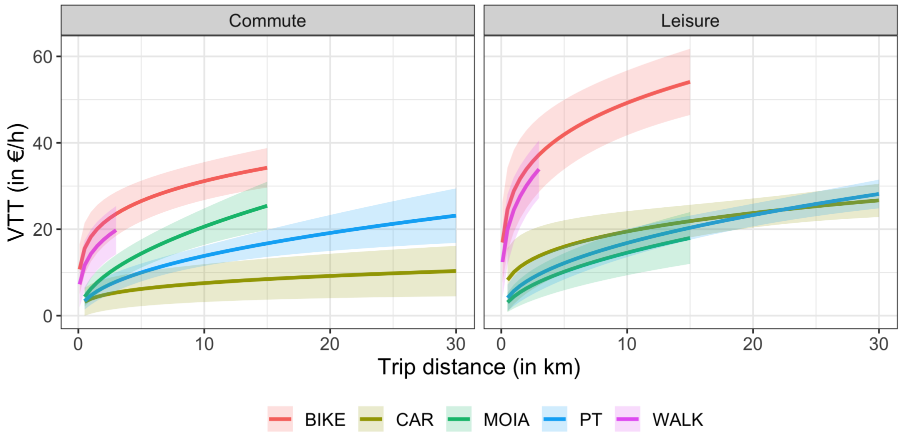

Figure 3: Values of travel time by Beeline-distance (MNL 2)

4 Conclusions

This study presents a comprehensive investigation of mode choice preferences in the presence of ridepooling for the city of Hamburg. A combination of RP and SP surveys was employed to examine the effect of sociodemographic characteristics and level-of-service attributes on the choice between walking, cycling, cars, PT, taxi, MOIA and an intermodal alternative for commute and leisure trips. Insights from the RP survey were used and tested in the subsequent mode choice experiment and model. Key drivers in choosing a ridepooling service like MOIA and its associated VTT are primarily level-of-service attributes such travel cost and time as well as trip purpose. There are notable differences in the VTT for leisure, however, if the travel time parameter is separately estimated for MOIA as a main and access mode, or jointly. Even if the hypothetically introduced intermodal alternative provides novel insights, the rather simple construction of it can be considered as a limitation of the study and needs further research. In addition, more complex models such as for example Mixed Multinomial or Nested Logit models could be estimated to examine unobserved taste heterogeneity and nesting structures between the modes.

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