Active Mobility Cultures in Denmark and Germany

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Short summary

This study examines national and regional differences in active mobility in Denmark and Germany, focusing on conventional and electric cycling as well as walking. Using a joint mode choice model based on large-scale survey data, we analyse how material and socioeconomic factors like trip attributes, infrastructure, or age influence mode choice in either country. The findings reveal that Danes prefer active modes, especially cycling, more than Germans, even after accounting for differences in these variables. Regional deviations between observed and modelled active mode shares are minimal. Only Copenhagen and Hamburg showing notable differences, indicating that local mobility cultures can for the most part be accurately captured using material and socioeconomic factors. The study highlights the importance of cultural and infrastructural factors in promoting active mobility through targeted policies.
Keywords: Cycling and walking behaviour and design; Discrete choice modelling; E-bike; Mobility culture; Mode choice

1 Introduction

Increasing active mobility uptake is central to reduce greenhouse gas emissions, foster more liveable cities, and harness public health benefits. To understand which factors influence active mode choice, discrete choice models (DCM) are used frequently. Material (e.g. infrastructure or trip length) and socioeconomic factors (e.g. age or sex) are routinely included. For symbolic factors (e.g. attitudes and cultural norms), however, data is more sparse (Kagerbauer & Magdolen, 2024), leading to less quantitative research on those (Ding et al., 2017; Ramezani et al., 2021).

According to Klinger et al. (2013), mobility culture encompasses all of these influencing factors, namely "complex configurations of material, symbolic and socio-economic elements". For the sake of this work, we adopt a narrower definition, using the terms "symbolic" and "cultural" interchangeably and viewing material and socioeconomic factors as separate elements. We build upon a number of previous works that investigate the impact of mobility culture on active mode choice using discrete choice models and cross-country comparisons. Buehler (2011), Van et al. (2014), and Ramezani et al. (2018) use such an approach to contrast preferences between Germany and the US, six Asian countries, and San Francisco and Rome, respectively. Goetzke & Rave (2011) analyse German travel survey data using a binary logit model to study social spillover effects, where increased bicycle use by others makes cycling more attractive. Haustein et al. (2018) compare Denmark and the Netherlands to examine how foreign origin affects cycling. Later, Haustein et al. (2020) survey residents of Copenhagen and Stockholm. Their results highlight that beyond personal attitudes and infrastructure, a city's cycling culture strongly impacts cycling levels. To the best of our knowledge, no previous work using the above methodology specifically investigated cultural differences regarding e-bike mode choice.

In the case of Denmark and Germany, the former is sometimes described as a "cycling nation" (Agervig Carstensen & Ebert, 2012) and the latter as a "car nation" (Gössling et al., 2023). While such cultural differences at the national level certainly exist, differences between regions in either country regarding active mode share are just as meaningful. In this work, we therefore shed light on two main research questions: firstly, what are differences in preference regarding active mode choice between the two countries, or more pointedly: do Danes cycle more because they have better infrastructure and flatter terrain, or because they are Danes? And secondly, what regions in either country outperform regarding active modes when comparing model results to observed data, or in other words: which regions exhibit special local mobility cultures?

2 Methodology

Data

We use data from the annual Danish National Travel Survey (TU, Technical University of Denmark (2024)) and the B3 local dataset package from the Mobility in Germany survey (MiD, Nobis & Kuhnimhof (2019)). Because the most recent MiD data is from 2017, we restrict the TU dataset to the years 2015-2019. We define six mode choice alternatives: walk, c-bike, e-bike, car as driver (car-d), car as passenger (car-p), and public transport. Bicycle, car, and public transport season ticket ownership as well as age, economic status, level of education, season, sex, trip purpose, and trip distance are explanatory variables.
We also incorporate four external spatial datasets, linked by the locations of trip origin and destination on a cellular grid with cells of 1km by 1km for the MiD and zones of the Danish National Transport Model (Rich & Hansen, 2016) for the TU. Eurostat (2021)'s urban-rural typology is used to account for general differences between urban, intermediate, and rural regions. The density of public transport departures around the origin and destination of each trip is attained from DELFI e.V. (n.d.)'s ZHV dataset for Germany and from an internal dataset for Denmark. We further compute the ratio of the length of dedicated bicycle infrastructure divided by the length of the bicycle-accessible road network based on OpenStreetMap (OpenStreetMap contributors, 2024) for every NUTS3 region in Germany and LAU1 region in Denmark. Lastly, we account for the impact of terrain gradient. For Germany, we build upon a dataset provided by Burgdorf & Pütz (2019). By taking the median gradient value of trips in the very flat states of Schleswig-Holstein and Hamburg, we approximate a perceptibility threshold of 3.6%, which is subtracted from gradient before feeding into the utility function. Because Denmark's flat topography is negligible with respect to bicycle mode choice, we use this threshold also as the implicit gradient value for Danish trips. The final sample consists of 266,979 trips, 28% Danish and 72% German.

Model

As common in the literature, we use a MNL. We tested appropriate nesting structures during model development, none of which improved log-likelihood sufficiently to reject MNL in favour of nested logit in a likelihood ratio test. Since this work is restricted to analysing differences in mode choice behaviour and does not investigate modal substitution, we work with the simpler MNL.
We start model development by estimating two separate models and comparing coefficients between Denmark and Germany. To account for differences in scale parameters between the two datasets, we introduce a scale parameter correction λ. Where coefficient values are significantly different between countries at a p-value of 1%, i.e. $|z_{coef}| > 2.58$ (Equation 1), and at least one coefficient is significantly different from 0 at 5%, the coefficients are kept separate in the joint model. Where this was not the case, we joined the coefficients.

$$z_{coef} = \frac{\beta_{de} - \lambda * \beta_{dk}}{\sqrt{SE(\beta_{de})^2 + \lambda^2 * SE(\beta_{dk})^2}} \tag{1}$$

Equation 2 documents the structure of the resulting utility functions for mode m in choice situation i. The vector $\widehat{\beta}$ contains the respective country-specific coefficients as well as the joint coefficients. The corresponding attribute values are stored in $\widehat{X}$. The Denmark-dummy DK ensures that the scaling parameter λ only applies to the Danish data and that for disjoint coefficients, the correct country-variant (dk or de) is estimated.

$$V_{m,i} = DK * \lambda * \widehat{\beta}_{m,dk} * \widehat{X}_{m,i,dk} + (1 - DK) * \widehat{\beta}_{m,de} * \widehat{X}_{m,i,de} \tag{2}$$

We interact the categorical levels of education with whether the person is 18 or older and remove "no degree (yet)" from the coefficient vectors $\widehat{\beta}$. To account for non-linearities, trip distance and public transport departure density are logarithmised. In contrast to car and public transport season ticket availability, the availability of a bicycle is not part of the utility function but an availability constraint, because this specification resulted in the highest model fit. Since the Danish survey does not differentiate between c-bike and e-bike ownership, no differentiation between the two could be made in our model. We use the Python package Biogeme 3.2.10 by Bierlaire (2023) for model estimation.

3 Results and discussion

National active mobility culture

Table 1 presents the estimated model coefficients. They reveal both shared patterns and culturally specific variations between Denmark and Germany. For example, people in both countries exhibit similar sensitivities to trip distance for all modes but public transport. In the following paragraphs, we will discuss differences regarding active modes.

Table 1: Estimation results of the joint model

Coefficient	**Joint**		**Denmark**		**Germany**	
	Value	P-value	Value	P-value	Value	P-value
Foot						
ASC			5.27	<0.001		
Conventional bicycle						
ASC			4.68	<0.001	-2.67	<0.001
Age 0-17	0.800	<0.001				
Age 18-29			0.157	0.001	-0.13	0.225
Age 30-39	0.021	0.634				
Age 50-59	-0.009	0.826				
Age 60-69	0.059	0.183				
Age 70-79	0.244	<0.001				
Age 80+	0.030	0.794				
Eco. (very) low	0.178	<0.001				
Eco. (very) high	0.097	<0.001				
Edu. 9th grade x age 18+	-0.069	0.282				
Edu. Studentereks./Realschulab. x age 18+	-0.054	0.359				
Edu. university degree x age 18+	-0.048	0.112				
Sex female	-0.136	<0.001				
Purpose business			-0.9	<0.001	0.499	<0.001
Purpose education			-0.85	<0.001	-0.9	<0.001
Purpose shopping			-1.29	<0.001	-0.059	0.544
Purpose errand			-0.92	<0.001	-0.15	0.140
Purpose leisure			-2.27	<0.001	-0.43	<0.001
Purpose escort			-1.12	<0.001	-0.55	0.001
Season spring	0.316	<0.001				
Season summer	0.592	<0.001				
Season autumn	0.359	<0.001				
Urban-rural typ. intermediate			-0.29	<0.001	0.351	<0.001
Urban-rural typ. predominantly rural			-0.27	<0.001	0.416	<0.001
ln(distance)	1.81	<0.001				
Gradient					-0.120	<0.001
Bicycle infrastructure			0.206	0.073	1.24	<0.001
Electric bicycle						
ASC			-0.332	0.150	-6.18	<0.001
Age 0-17			-0.323	0.344	-3.22	<0.001
Age 18-29			-0.922	<0.001	-1.89	0.044
Age 30-39	-0.261	0.163				
Age 50-59	0.449	0.002				
Age 60-69	0.941	<0.001				
Age 70-79	1.34	<0.001				
Age 80+			0.727	0.125	1.54	<0.001
Eco. (very) low	0.186	0.144				
Eco. (very) high	-0.073	0.439				

Table 1: Estimation results of the joint model

Coefficient	**Joint**		**Denmark**		**Germany**	
	Value	P-value	Value	P-value	Value	P-value
Edu. 9th grade x age 18+			1.17	<0.001	0.380	0.058
Edu. Studentereks./Realschulab. x age 18+	0.396	0.015				
Edu. university degree x age 18+	-0.319	0.001				
Sex female			0.589	<0.001	-0.194	0.206
Purpose business	0.382	0.045				
Purpose education	-1.23	0.001				
Purpose shopping			-0.985	<0.001	0.021	0.940
Purpose errand			-1.02	<0.001	0.299	0.258
Purpose leisure			-2.47	<0.001	-0.192	0.443
Purpose escort			-1.56	<0.001	-0.660	0.282
Season spring	0.575	<0.001				
Season summer	0.718	<0.001				
Season autumn	0.588	<0.001				
Urban-rural typ. intermediate	0.427	<0.001				
Urban-rural typ. predominantly rural	0.255	0.089				
ln(distance)	2.39	<0.001				
Gradient					-0.056	0.021
Bicycle infrastructure			0.428	0.271	-1.41	0.068
Car as driver						
ASC			-0.398	<0.001	-3.80	<0.001
Age 0-17	-3.86	<0.001				
Age 18-29			-0.121	0.012	-0.443	<0.001
Age 30-39	0.033	0.396				
Age 50-59	-0.102	0.004				
Age 60-69	-0.176	<0.001				
Age 70-79	-0.007	0.862				
Age 80+	0.145	0.037				
Eco. (very) low	0.299	<0.001				
Eco. (very) high	-0.028	0.212				
Edu. 9th grade x age 18+	-0.034	0.444				
Edu. Studentereks./Realschulab. x age 18+	0.080	0.051				
Edu. university degree x age 18+	-0.199	<0.001				
Sex female			-0.404	<0.001	-0.289	<0.001
Purpose business	0.429	<0.001				
Purpose education			-1.45	<0.001	-1.13	<0.001
Purpose shopping			0.272	<0.001	0.737	<0.001
Purpose errand	0.384	<0.001				
Purpose leisure			-1.86	<0.001	-0.536	<0.001
Purpose escort			0.989	<0.001	1.34	<0.001
Urban-rural typ. intermediate			0.544	<0.001	0.437	<0.001
Urban-rural typ. predominantly rural	0.635	<0.001				
ln(distance)	3.20	<0.001				
Cars 1	3.30	<0.001				
Cars 2+	4.06	<0.001				
Car as passenger						
ASC			-2.49	<0.001	-5.88	<0.001
Age 0-17			2.16	<0.001	0.999	<0.001
Age 18-29	0.430	<0.001				
Age 30-39	0.235	<0.001				
Age 50-59	-0.041	0.308				
Age 60-69	0.161	<0.001				
Age 70-79	0.353	<0.001				
Age 80+	0.613	<0.001				
Eco. (very) low	0.090	0.020				
Eco. (very) high	0.021	0.414				
Edu. 9th grade x age 18+	0.269	<0.001				
Edu. Studentereks./Realschulab. x age 18+	0.159	<0.001				

Table 1: Estimation results of the joint model

Coefficient	Joint		Denmark		Germany	
	Value	P-value	Value	P-value	Value	P-value
Edu. university degree x age 18+	-0.295	<0.001				
Sex female	0.991	<0.001				
Purpose business			0.784	<0.001	1.02	<0.0010
Purpose education	-0.302	<0.001				
Purpose shopping			1.52	<0.001	1.97	<0.001
Purpose errand	1.640	<0.001				
Purpose leisure			-0.116	0.045	1.28	<0.001
Purpose escort			1.07	<0.001	1.63	<0.001
Urban-rural typ. intermediate	0.391	<0.001				
Urban-rural typ. predominantly rural	0.554	<0.001				
ln(distance)	3.400	<0.001				
Cars 1			1.16	<0.001	1.21	<0.001
Cars 2+	1.640	<0.001				
Public transport						
ASC			-6.73	<0.001	-9.55	<0.001
Age 0-17			2.03	<0.001	0.692	<0.001
Age 18-29			0.214	0.004	-0.012	0.842
Age 30-39	0.129	0.010				
Age 50-59	0.006	0.889				
Age 60-69	0.203	<0.001				
Age 70-79	0.559	<0.001				
Age 80+	0.856	<0.001				
Eco. (very) low	0.354	<0.001				
Eco. (very) high	0.132	<0.001				
Edu. 9th grade x age 18+	0.085	0.122				
Edu. Studentereks./Realschulab. x age 18+	0.083	0.086				
Edu. university degree x age 18+	-0.185	<0.001				
Sex female	0.189	<0.001				
Purpose business	-0.240	0.010				
Purpose education	0.010	0.902				
Purpose shopping			-0.746	<0.001	-0.392	<0.001
Purpose errand	-0.200	0.001				
Purpose leisure			-2.19	<0.001	-0.770	<0.001
Purpose escort	-0.825	<0.001				
Urban-rural typ. intermediate			0.084	0.131	0.436	<0.001
Urban-rural typ. predominantly rural	0.715	<0.001				
ln(distance)			4.16	<0.001	3.55	<0.001
ln(pt departure density)			0.566	<0.001	0.804	<0.001
Pt season ticket	2.30	<0.001				
Scale parameter correction						
λ			1.03	0.002[1]		
Sample size: 266979, number of parameters: 178, null-LL: -458871.4, final LL: -181900.6, $\overline{\rho}^2$: 0.603						

A high alternative-specific constant (ASC) for walking in Denmark reflects a stronger inclination towards walking compared to Germany. The contrast is even greater for c-bike and e-bike. Age differences in c-bike preference are minimal between the two countries. For e-bikes, differences are more pronounced. Older age groups favour e-bikes more strongly in Germany than in Denmark. Regarding sex, women in both countries are slightly less inclined to use c-bikes than men. However, for e-bikes, Danish women display a stronger preference than men, while gender differences in Germany are negligible. For Denmark, all trip purpose coefficients are lower than the German ones. This indicates a greater willingness among Danes to commute to work (the reference trip purpose) by c-bike or e-bike. While rural settings boost c-bike utility in Germany, urban environments drive its use in Denmark.
Infrastructure provision is a stronger determinant of c-bike use in Germany, whereas it has minimal impact in Denmark, reflecting the latter's ingrained cycling culture. For e-bike usage, coefficient

[1] $H_0 : \lambda = 1$

values are insignificant. These patterns suggest that the relationship between bicycle infrastructure and cycling is not straight forward. In Denmark, particularly in Copenhagen, cycling is a normalized part of life, reducing reliance on infrastructure as a motivator. While Germans might indeed feel more reliant on bicycle infrastructure, it is also likely that bicycle infrastructure furthermore is an indicator of a region's cycling culture. In Denmark, the highest coverage of bicycle infrastructure according to our metric is found in planned suburbs of Copenhagen developed in the 1960s and 70s, despite the inhabitants of these towns appearing less inclined to cycle than more urban dwellers. In Germany, on the other hand, it is urban centres such as Braunschweig or Bremen that have the most bicycle infrastructure. In such areas with large public support for cycling, policy makers are more likely to invest in bicycle infrastructure. In other words, bicycle infrastructure not only enables more people to cycle, but is also an indicator for how many people are willing to cycle. The latter effect appears to be stronger in Germany, which partially explains the different coefficient values.

Overall, Denmark's higher active mode shares to a large degree reflect cultural phenomena rather than only differences in material or socioeconomic factors. While infrastructure is critical, shifts in public attitudes and perceptions are equally vital for promoting active mobility, as entrenched habits and cultural inertia significantly influence travel behaviours.

Regional active mobility culture

This analysis identifies NUTS3 regions in Denmark and Germany where observed mode shares significantly deviate from modelled predictions. Discrepancies may stem from model limitations regarding material and socioeconomic factors or from unaccounted symbolic influences, i.e. regional mobility cultures. After thoroughly investigating model residuals, which we do not report for brevity's sake, we are confident that the vast majority of regional differences can be attributed to the latter. We use five-fold cross-validation to avoid overfitting.

A two-proportion z-test is applied to regions' observed and modelled mode shares. To take into account that we are calculating z-scores for hundreds of regions, we apply Bonferroni correction (Abdi, 2006) and report the resulting, higher z-score thresholds in Table 2. Fig. 1 visualises these z-scores. Regions with 10 or more observed trips of the respective mode and a z-score of more than 2.81 are labelled and their precise z-scores are reported in Table 3. Here, we see that only few regions exhibit significant (marked by *) deviations. Regarding the non-active modes, there is a very strong polarisation between inner and outer Copenhagen. Stuttgart and Munich also stand out, both of which exhibit significantly less car trips than the model predicted. For public transport, we observe the German cities of Munich, Stuttgart and Schwerin significantly and meaningfully overperforming and Bremen underperforming.

For active modes, only three regions stand out: In Denmark, central Copenhagen outperforms with a 3.4 percentage-point higher active mode share, driven largely by cycling. Conversely, active mode share is 5.8 percentage points lower than expected in Copenhagen's surroundings, despite dense bicycle infrastructure. This may reflect residential self-selection, where those favouring bicycles prefer city life, while car-oriented individuals opt for suburban areas. In Germany, only Hamburg stands out, with a 7.9 percentage-point surplus in active mobility, primarily due to walking. This is despite Hamburg including substantial suburban development.

Considering only three out of 154 analysed regions (i.e. the non-gray zones in Fig. 1, (c)) signifi-

Table 2: Bonferroni corrected two-sided z-score thresholds for regional difference between observed and modelled mode share with an individual level of significance of 5%

Mode	**Regions with** $N_{\mathbf{obs,mode}} \geqq 10$	**Bonferroni corrected level of significance**	**Z-score threshold**
Foot	112	$0.05/112 = 0.00045$	3.50
Bicycle (c-bike, e-bike)	57	$0.05/57 = 0.00088$	3.32
Active modes (foot, c-bike, e-bike)	154	$0.05/154 = 0.00032$	3.60
Car (driver)	404	$0.05/404 = 0.00012$	3.84
Car (passenger)	346	$0.05/346 = 0.00014$	3.81
Public transport	200	$0.05/200 = 0.00025$	3.66

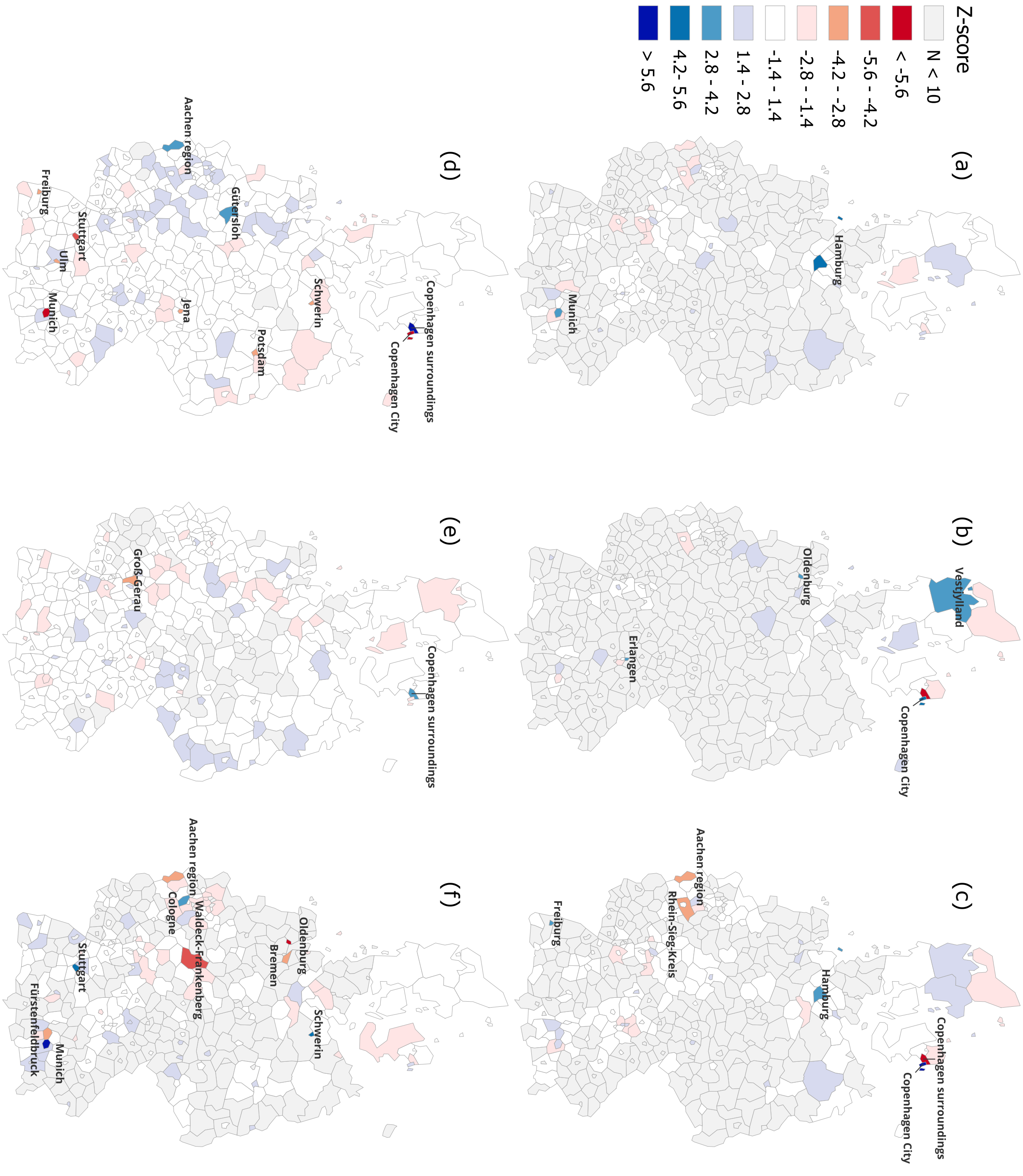

Figure 1: Z-scores of difference between observed and modelled mode share for (a) foot, (b) bicycle (c-bike, e-bike), (c) active mobility (foot, c-bike, e-bike), (d) car (driver), (e) car (passenger), and (f) public transport.

Table 3: Significantly over- and under-performing NUTS3 regions

Mode(s)	NUTS3	Name	Z-score	N_{obs}	Obs. share [%]	Mod. share [%]
Foot	DE600	Hamburg	*4.36	344	31.3	23.6
	DE212	Munich	3.34	341	27.4	22.8
Bicycle (c-bike, e-bike)	DK011	Copenhagen City	*4.61	3697	31.3	28.4
	DE252	Erlangen	2.90	48	24.9	17.8
	DK041	Vestjylland	2.90	763	12.8	11.4
	DE943	Oldenburg	2.84	24	40.4	17.9
	DK012	Copenhagen surroundings	*-6.60	1314	16.9	21.7
Active modes (foot, c-bike, e-bike)	DK011	Copenhagen City	*6.00	6998	59.3	55.9
	DE600	Hamburg	*3.87	479	45.4	37.5
	DE131	Freiburg i. B.	2.83	57	47.2	36.9
	DEA2D	Aachen region	-2.81	105	29.2	37.3
	DEA2C	Rhein-Sieg-Kreis	-2.97	41	25.0	40.5
	DK012	Copenhagen surroundings	*-6.78	2785	37.1	42.9
Car (driver)	DK012	Copenhagen surroundings	*6.17	3466	42.5	37.5
	DEA2D	Aachen region	3.51	3412	45.1	38.3
	DEA42	Gütersloh	3.07	415	60.3	47.2
	DE144	Ulm	-3.12	590	38.3	45.0
	DE804	Schwerin	-3.18	547	38.6	45.2
	DEG03	Jena	-3.55	157	17.1	38.4
	DE404	Potsdam	-3.59	232	28.7	37.4
	DE131	Freiburg i. B.	-3.60	478	25.8	32.0
	DE111	Stuttgart	*-4.37	939	32.4	34.8
	DE212	Munich	*-5.79	5661	24.6	25.0
	DK011	Copenhagen city	*-7.43	2373	19.4	23.2
Car (passenger)	DK012	Copenhagen surroundings	2.87	718	11.1	9.4
	DE717	Groß-Gerau	-3.01	43	8.64	14.1
Public transport	DE212	Munich	*6.73	5379	27.9	25.2
	DE111	Stuttgart	*4.53	666	25.3	20.8
	DE804	Schwerin	*4.27	167	10.7	8.5
	DEA23	Cologne	2.86	887	15.6	16.5
	DE21C	Fürstenfeldbruck	-2.93	178	3.93	7.5
	DE501	Bremen	*-4.01	439	13.3	17.3
	DEA2D	Aachen region	*-4.13	476	10.7	10.8
	DE736	Waldeck-Frankenberg	*-5.30	11	1.60	4.9
	DE943	Oldenburg	*-6.34	30	2.28	11.0

cantly over- or underperform in active mobility, it appears that mobility culture for most regions can be captured adequately using generalisable variables. In other words, only very few regions exhibit a specific active mobility culture that differentiates them from their peers. For Denmark, our analysis confirms that while Denmark culturally can indeed be considered a "cycling nation" (Agervig Carstensen & Ebert, 2012), one even more so needs to consider Copenhagen a "cycling city".

4 Conclusions

We estimated a joint and scaled trip-level mode choice model on large-scale travel survey data from Denmark and Germany. The model reveals highly significant differences in preference regarding active mobility between the two countries, with Danes being more inclined to choose any active mode than Germans, given identical material and socioeconomic factors. Going back to our question at the beginning we can say, therefore, that Danes do indeed cycle more than Germans not just because of more bicycle-friendly circumstances, but also because of cultural reasons. We also looked at which regions in either country outperform the model, in other words in which regions people use more active modes than the national models predict, even after accounting for differences in material and socioeconomic factors. We find that among the 154 regions with sufficient data, only three regions stand out, namely Copenhagen City outperforming regarding cycling, Copenhagen surroundings underperforming regarding cycling, and Hamburg outperforming regarding walking. This indicates that for most regions, local mobility culture is largely captured by generalisable factors such as degree of urbanisation, age structure, etc., and only a few regions exhibit local active mobility cultures, notably differentiating them from their peers. Our results underscore the importance of adopting a holistic approach to promoting active transportation, integrating infrastructure development with tailored cultural strategies to encourage sustainable mobility in varied regional contexts.

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References

Abdi, H. (2006). The Bonferonni and Šidák corrections for multiple comparisons. In N. J. Salkind & K. Rasmussen (Eds.), *Encyclopedia of measurement and statistics.* Thousand Oaks, CA: SAGE Publishing. Retrieved from `https://personal.utdallas.edu/~herve/Abdi-Bonferroni2007-pretty.pdf`

Agervig Carstensen, T., & Ebert, A.-K. (2012). Chapter 2. cycling cultures in northern Europe: From 'golden age' to 'renaissance'. In *Cycling and sustainability* (pp. 23–58). Bingley: Emerald. doi: 10.1108/S2044-9941(2012)0000001004

Bierlaire, M. (2023). *A short introduction to biogeme: Technical report transpo-or 230620.* Retrieved from `https://transp-or.epfl.ch/documents/technicalReports/Bier23.pdf`

Buehler, R. (2011). Determinants of transport mode choice: a comparison of Germany and the USA. *Journal of Transport Geography*, *19*(4), 644-657. Retrieved from `https://www.sciencedirect.com/science/article/pii/S0966692310001171` doi: https://doi.org/10.1016/j.jtrangeo.2010.07.005

Burgdorf, M., & Pütz, T. (2019). *Dokumentation der raumvariablen des bbsr im regionalfile: Annex 5 to the user manual for the MiD 2017.* Retrieved from `https://www.mobilitaet-in-deutschland.de/archive/publikationen2017.html`

DELFI e.V. (n.d.). *Zhv dataset.* Retrieved from `https://zhv.wvigmbh.de/map_osm.aspx`

Ding, C., Chen, Y., Duan, J., Lu, Y., & Cui, J. (2017). Exploring the influence of attitudes to walking and cycling on commute mode choice using a hybrid choice model. *Journal of Advanced Transportation*, *2017*, 1–8. doi: 10.1155/2017/8749040

Eurostat. (2021). *Territorial typologies manual - urban-rural typology.* Retrieved from `https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Territorial_typologies_manual_-_urban-rural_typology#Results`

Goetzke, F., & Rave, T. (2011). Bicycle use in Germany: Explaining differences between municipalities with social network effects. *Urban Studies*, *48*(2), 427-437. Retrieved from `https://doi.org/10.1177/0042098009360681` (PMID: 21275202) doi: 10.1177/0042098009360681

Gössling, S., Kees, J., Litman, T., & Humpe, A. (2023). The economic cost of a 130 kph speed limit in Germany. *Ecological Economics*, *209*, 107850. doi: 10.1016/j.ecolecon.2023.107850

Haustein, S., Koglin, T., Nielsen, T. A. S., & Svensson, Å. (2020). A comparison of cycling cultures in Stockholm and Copenhagen. *International Journal of Sustainable Transportation*, *14*(4), 280–293. doi: 10.1080/15568318.2018.1547463

Haustein, S., Kroesen, M., & Mulalic, I. (2018). Modelling the effect of foreign origin on mode choice in two different cycling cultures. In European Association for Research in Transportation (Ed.), *heart 2018.* Retrieved from `https://research.tudelft.nl/en/publications/modelling-the-effect-of-foreign-origin-on-mode-choice-in-two-diff`

Kagerbauer, M., & Magdolen, M. (2024). Workshop synthesis: Measuring attitudes and perceptions in large scale (quantitative) surveys. *Transportation Research Procedia*, *76*, 617–623. doi: 10.1016/j.trpro.2023.12.082

Klinger, T., Kenworthy, J. R., & Lanzendorf, M. (2013). Dimensions of urban mobility cultures – a comparison of German cities. *Journal of Transport Geography*, *31*, 18-29. Retrieved from `https://www.sciencedirect.com/science/article/pii/S0966692313000793` doi: https://doi.org/10.1016/j.jtrangeo.2013.05.002

Nobis, C., & Kuhnimhof, T. (2019). *Mobilität in Deutschland - MiD: Ergebnisbericht.* Bonn, Berlin. Retrieved from `https://www.mobilitaet-in-deutschland.de/archive/publikationen2017.html`

OpenStreetMap contributors. (2024). *OpenStreetMap database.* Data retrieved from `https://overpass-api.de/api/interpreter`.

Ramezani, S., Laatikainen, T., Hasanzadeh, K., & Kyttä, M. (2021). Shopping trip mode choice of older adults: an application of activity space and hybrid choice models in understanding the effects of built environment and personal goals. *Transportation*, *48*(2), 505–536. doi: 10.1007/s11116-019-10065-z

Ramezani, S., Pizzo, B., & Deakin, E. (2018). Determinants of sustainable mode choice in different socio-cultural contexts: A comparison of rome and san francisco. *International Journal of Sustainable Transportation*, *12*(9), 648–664. doi: 10.1080/15568318.2017.1423137

Rich, J., & Hansen, C. O. (2016). The Danish national passenger model – model specification and results. *European Journal of Transport and Infrastructure Research*(Vol. 16). doi: 10.18757/EJTIR.2016.16.4.3159

Technical University of Denmark. (2024). *Danish national travel survey 2006-2023.* Retrieved from `https://tu2024.dk/meta/?lang=EN` doi: 10.11581/dtu:00000034

Van, H. T., Choocharukul, K., & Fujii, S. (2014). The effect of attitudes toward cars and public transportation on behavioral intention in commuting mode choice — a comparison across six Asian countries. *Transportation Research Part A: Policy and Practice*, *69*, 36-44. Retrieved from `https://www.sciencedirect.com/science/article/pii/S0965856414001888` doi: https://doi.org/10.1016/j.tra.2014.08.008