Evaluating mode-shift potentials to cycling based on individual capabilities

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1 Abstract

The work presented in this poster shows the importance of individual physical capabilities for cycling in Switzerland, as well as introducing a routing-tool that integrates these capabilities in the estimation of cycling potentials. It does so for the first time for a national large-scale sample. Its results will help inform the upcoming work for the E-Bike City Project, especially those of Subproject C and H.

A binary logit model of daily cycling was estimated, using data from the Swiss Health Survey. It is found that the frequency of exercise explains most of the variability of the choice to cycle or not. Since previous work in the literature has shown a clear link between exercise frequency and physical strength, one valid, although so far not directly observable hypothesis in micro data, is the simple one, that more physical power leads to faster speeds and more competitiveness of bicycling with cars. There are no direct observations in place to quantify mode-shift potentials that account for such factors.

Here, a first attempt is made to impute physical cycling capabilities of Swiss Mobility Microcensus (i.e. national travel diary) respondents so that individual cycling potentials are calculated. An R-Package was written for the purpose of routing different bicycle and micromobility vehicle types, which also accounts for electric assistance motors. Finally, the resulting mode-shares are estimated for conventional bikes, pedelecs (e-bikes) and s-pedelecs (fast e-bikes) in Switzerland.

2 Reasons for cycling in Switzerland?

To find out how much physical capabilities affect the choice for cycling in Switzerland, the Swiss National Health Survey was used. This survey asks respondents whether they cycle on a daily basis or not. This response was applied as a dependant variable of a binomial model. The results of the ANOVA of the estimated model is available in Fig. 1.

Variable	Degrees of freedom	Deviance	Resid. Df
Null Model	-	-	13333
Exercise Frequency	4	308.0	13297
Region	6	285.1	13291
Age^2	1	228.1	13315
Daily travel with public transport	1	199.9	13322
Daily travel with motor vehicle	1	199.2	13321
Settlement structure	8	182.1	13324
Nation category	4	175.0	13305
Smoker	2	150.3	13317
BMI	1	137.0	13323
Energy and vitality	2	102.4	13319
Fruits and vegetables consumption	3	70.5	13311
Daily travel PT Yes x Settl. Structure	8	66.2	13283
Gender	1	60.4	13309
Education	4	34.3	13301
Age	1	12.5	13316
log(Age)	1	6.4	13314
Children under 15 in household	1	2.3	13310
Income	1	0.7	13332

Abb. 3 ANOVA of binomial regression model. A higher deviance means the variable has a stronger influence on daily cycling.

Exercise frequency is the most influential variable for daily cycling. While it is obvious that more physically active individuals will also be more prone to getting around by bike, the scale of this influence is comparatively very large. The region (lower values being found in western Switzerland) as well as age also describe most of the variation in cycling preferences. Interestingly, socioeconomic variables play a very little role, which is not necessarily the case in developing countries. The model shows therefore, how important it is to account for physical capabilities for estimating cycling potentials.

3 Mode-shift potentials to cycling

Based on estimations of physical power, the cycling power of individuals interviewed for the Swiss mobility microcensus was estimated. Based on the recorded trips of these individuals and their estimated physical power, the travel times that they could achieve by bike was calculated. For these purposes, the open-source cycling router “brouter” was modified to incorporate individual cycling power and weight. The bike travel times are also based on topographic and cycling infrastructure availability. Fig. 2 shows the travel time differences between cycling and the mode chosen by individuals in the survey (either public transport or car) for different types of bikes.

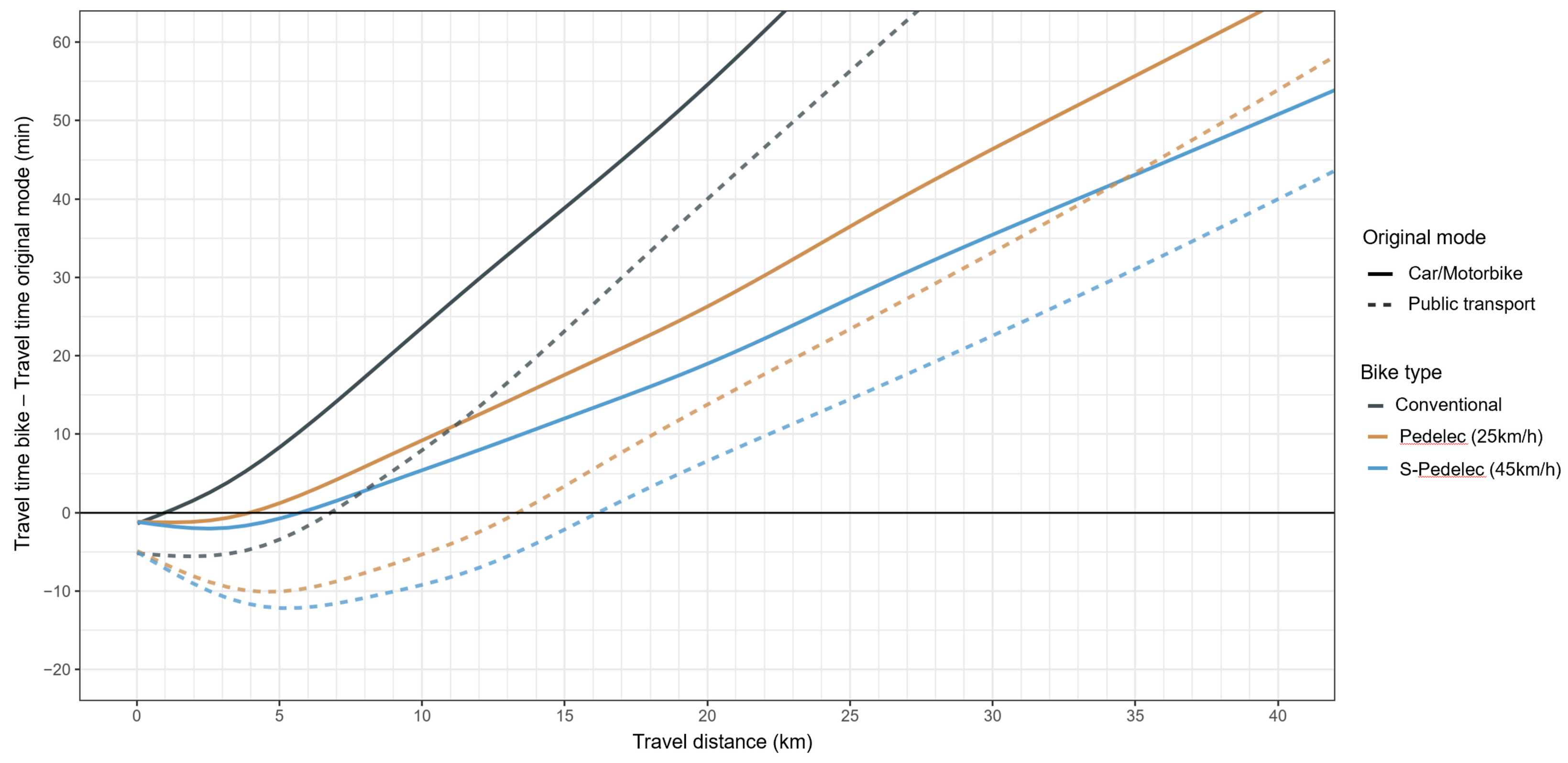

Fig. 2 Cycling potential by distance, original transport mode and bike type (results of non-parametrical GAM regressions)

The results show the clear advantages that E-bikes can bring in the realm of making cycling more of an attractive mode. Against cars, they can make most trips up to 5km faster, while conventional bicycles are in average faster only within the first kilometer of travel. To further illustrate the regional differences in potentials, Fig. 6 also shows the maximum reduction potentials (assuming a mode-shift is given if bike travel time is not more than 110% of car travel times) across different urban typologies. An interesting finding here is that the relative distances that can be covered by e-bikes in urban areas decreases when compared to more rural areas. This is because urban dwellers travel longer distances in average and that the gains of faster bikes in urban areas are more limited because of the denser networks which require more stopping at intersections.

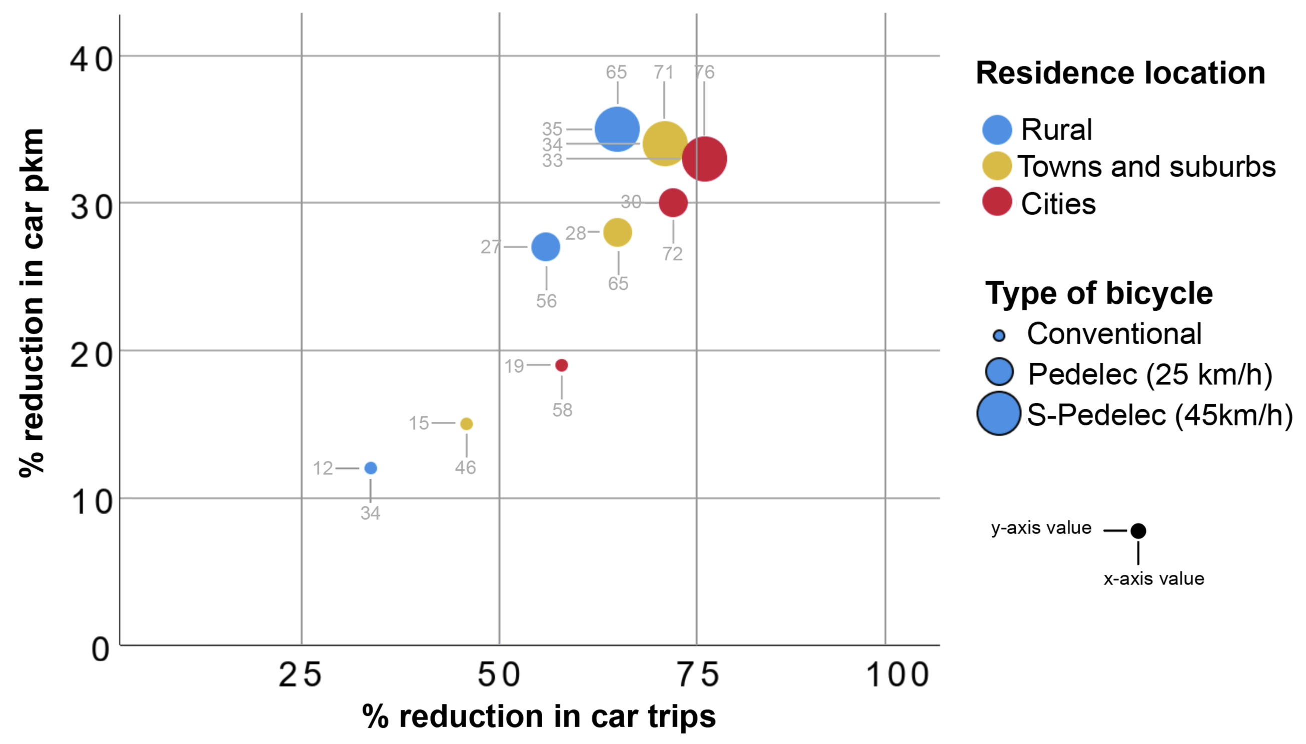

Fig. 3 Scatterplot of % average reduction of car-pkm by % average reduction of car-trips by location type and bicycle type

5 Further work

The present work focused on accounting for individual capabilities to evaluate cycling potentials in more detail. Further work will focus on other dimensions that encompass the choice to cycle, especially on subjective safety perceptions due to cycling infrastructure improvements. For these purposes a stated-preference survey is planned.

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