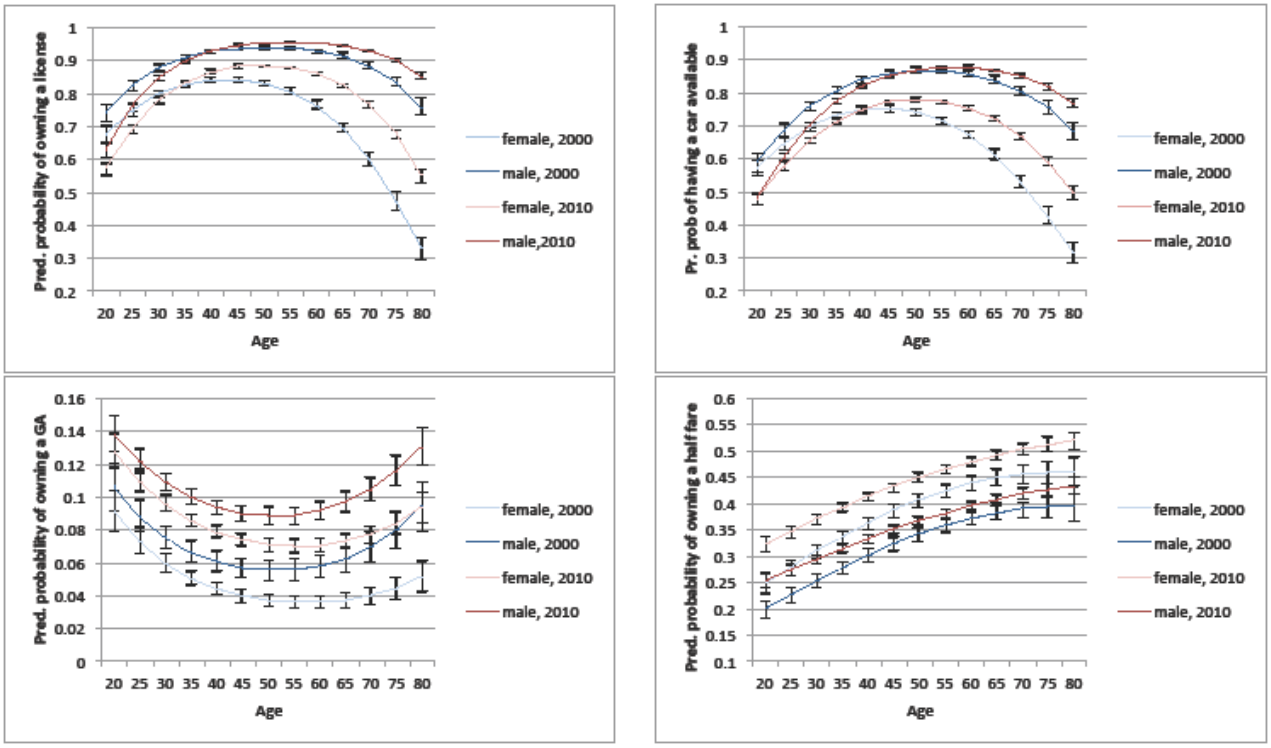

Analysis of mobility tool ownership in Switzerland: A model-based comparison of the years 2000 and 2010

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Abstract

The future development in mobility tool ownership is of great interest as the individual mobility behavior has critical impacts on transport infrastructure use, land use, energy consumption, and the environment. Analysis and forecasts of mobility tool ownership as needed for transport perspectives, however, usually employ data of the latest national travel surveys available. Therefore, changes in mobility tool ownership over time are usually ignored.

In Switzerland a IVT research study focused on mobility tool ownership in 2006, analyzing data of the Swiss Microcensus on Mobility and Transport (MCMT) 2000 (Axhausen et al., 2006). The analysis considered four mobility tools: driving licenses, car availability, general abonnement travel tickets ("GA"), and half fare travel tickets ("Halbtax"). The predictor variables comprise socio-economic and socio-demographic variables, spatial structure features, and mobility tool specific characteristics.

Building on this study a research team of ARE and the University of Neuchâtel reproduced the analysis with data from the MCMT 2010 (first model). The analysis aims to detect possible differences in the way the factors influence mobility tool ownership decisions over time. In a second step, the initial (reproduced) model is adapted for the data from the MCMT 2010 (second model). This aims to analyze the impact of additional variables and therefore complements the reproduced model. So, the adapted model leads to additional insights on influencing factors and changes over time.

The paper provides an overview of previous research in the field of mobility tool ownership. The data and variables of both the MCMT 2000 and 2010 are introduced and presented in terms of descriptive statistics. Theoretically expected influences are tested in econometric models. Model results are presented in detail and discussed in the light of the hypothesis by highlighting changes between the years 2000 and 2010. Finally, policy implications of the results are discussed.

Keywords

mobility tools, mobility tool ownership, logit model, MCMT

1. Introduction

Mobility tools are prerequisites to be mobile. By acquiring mobility tools, "individuals and households fix the perceived short-run marginal costs of their kilometres travelled" (Scott and Axhausen, 2006, p.311). Typical mobility tools are driving licenses, cars, and public transport season tickets, but also vans, motorcycles, bicycles, car sharing memberships, parking spots, and even one's own feet can be considered as mobility tools.

The ownership of mobility tools greatly inuences the usage of mobility tools, as many studies show (for example Simma and Axhausen (2001), Nolan (2010), or de Jong et al. (2004)). Given that the mobility behaviour of individuals has a critical impact on land use, energy consumption, and the environment (Whelan, 2007, p.206), the future development in mobility tool ownership is of great interest.

Included in this paper are four mobility tools: driving licenses, cars, general abonnement travel tickets ("GA"), and half fare travel tickets ("Halbtax"). GA travel tickets allow free and unlimited use of most of the public transport network in Switzerland, while half fare travel tickets offer a price reduction of about 50 percent on most public transport connections. The ownership of the four mobility tools is analysed in a series of binary logit models. The predictor variables comprise socio-economic and socio-demographic variables, spatial structure features, and mobility tool specific characteristics.

All analysis are based on data of the Swiss Microcensus on Mobility and Transport (MCMT). This nation-wide survey on the population's travel behavior has been conducted every five years since 1974 on behalf of the Federal Statistical Office (BFS) and the Federal Office for Spatial Development (ARE). The computer-assisted telephone interviews contain questions regarding people's mobility such as possession of mobility tools, daily travel distances, or annual mobility, but also regarding socio-economic factors such as income, age, employment, place of residence, or structure of the household. Whereas for the first MCMT in 1974 only 2'114 households have been questioned, in 2010 nearly 60'000 households answered the survey, thereby doubling the size of 2000's survey (Federal Statistical Office and Federal Office for Spatial Development, 2012a, p.27).

The analysis of the two datasets MCMT 2000 and 2010 revealed that most variables exert the influence expected by theoretical considerations, are statistically significant, and robust across different model specifications. The variables age, sex, and income prove to have a highly significant, strong, and stable impact on the ownership probability of the four mobility tools. The combined effects of age and sex illustrate the closing of the gap between men and women regarding mobility tool ownership. The separate analysis of the six greater regions of

Switzerland exposes a large and significant difference between the Italian-speaking and the Swiss German-speaking part of the country regarding the possession of public transport tickets.

The crosswise inclusion of the four mobility tools themselves as predictor variables reveals a strong and highly significant substitution effect between car availability and public transport tickets ownership. A modified specification of the initial model confirms these findings and additionally shows an important impact of education, employment status, and the household structure. The extended model is found to report a better fit than the initial model.

Section 2 provides an overview of previous research in this field. Section 3 introduces the data and the variables. Section 4 presents the econometric models. Section 5 describes and interprets the results of the initial and the extended model. Section 6 discusses policy implications of the results. Section 7 concludes.

The paper is an excerpt of a master thesis at the faculty of economics and business of the University of Neuchâtel, Switzerland (for the whole thesis see Kieser, 2014).

2. Literature Review

Studies on car ownership are widespread, while studies that consider car ownership and public transport tickets simultaneously are rarer. De Jong et al. (2004) provide a good overview on car ownership models. Nolan (2010) analyses factors influencing the availability of cars at the household level for Ireland. Other studies additionally consider cost variables, for example the one by Whelan (2007).

Simma and Axhausen (2001) jointly estimate commitment variables (ownership of season tickets and availability of a car) and usage variables (number of trips and distance travelled by car/public transport) for Switzerland, Germany, and Great Britain. Using a structural equation model, the authors can confirm the hypothesized negative impact of car availability on season ticket ownership in all three countries.

Another publication that jointly includes car and public transport tickets is the study by Scott and Axhausen (2006) on the German city Karlsruhe. The authors evaluate the effect on car and season tickets ownership of several household and residential location characteristics, such as the number of household members with daily travel commitments, household income, housing costs, location of the house, or the distance to the nearest public transit stop. The authors suggest that car and travel ticket ownership have to be considered jointly since households, under a budget constraint, are forced to make trade-offs between different mobility tools.

Axhausen et al. (2006) argue that the approach of jointly considering car and travel ticket ownership is especially important in Switzerland where public transport season and discount tickets are widespread (Axhausen et al., 2006, p.3). This statement is confirmed by the latest national travel survey MCMT analyzed in this paper: In 2010, more than half of the population owned some kind of travel ticket. Nearly 40% of the population owned a Halbtax, 14% owned a regional travel ticket and 10% owned a GA travel ticket (Swiss Federal Statistical Office, 2012a, p. 35).

In a first step, Axhausen et al. (2006) analyze the factors influencing mobility tool ownership, using a binary logit model. In a second step, they model the use of mobility tools (measured in daily travel distance and travel time), using a linear regression model. In both cases, they consider socio-economic variables (e.g. sex, age, income), spatial structure variables (e.g. characteristics of the municipality of residence), and mobility tool specific variables (e.g. travel time by car and public transport) as predictor variables. Based on the results of these two models and the forecast on the explanatory variable age, employment, and income of the Swiss population, the authors predict the ownership and use of mobility tools for the years 2000, 2005, 2010, 2020, and 2030. The results of the ownership models are reproduced in the following and are therefore not commented on at this point.

3. Data, variables and descriptive statistics

Most of the data stem from the MCMT 2000 and 2010. They are employed in micro format, meaning the analysis focusses on the weighted target persons. The analysis is cross-sectional for the year 2000 and the year 2010. The selection of variables is strongly guided by the variable set of the study for 2000. The variables have been constructed as similar as possible, so as to be able to compare the effects. In some cases, though, changes had to be made, due to data constraints. In the following, the variables and their characteristics are presented.

Dependent variables

Four mobility tools are considered as dependent variables: driving licenses, cars, general abonnement travel tickets (GA), and half fare travel tickets (Halbtax). All dependent variables are dichotomous. Driving licenses are somewhat different from the other mobility tools. First of all, a large proportion of the Swiss population owns a license. In the MCMT data set used in this paper, nearly 80% of all survey respondents that are 18 years or older own a driving license. The possession of driving licenses is also very stable: once one owns it, hardly anyone gives it up. And it is not independent of car ownership: whoever wants to drive a car, needs a driving license.

This interdependence poses a problem for the car variable, as it was constructed by Axhausen et al. (2006). Not car ownership is modelled but car availability. In a given household, a car is defined as available when the ratio of cars to licenses equals or exceeds 0.5 and the target person owns himself a license. Thus, when a target person does not have a license, he or she will by construction never have a car available and the car variable will always take the value 0. This is problematic when the ownership of a driving license is regressed on car availability, as it was done by Axhausen et al. (2006). The license variable is said to predict the failure, i.e. the absence of car availability, perfectly. In that case, no well defined maximum likelihood estimator exists (Winkelmann and Boes, 2006, p. 113f.). Axhausen et al. (2006) did include the variable in the estimation, yet in this paper the results for car availability will be presented without the driving license variable.

Concerning the public transport sector there are two sorts of GA travel tickets, either allowing the utilization of the 1. or 2. class train wagons. The two types of tickets are added up.

Independent variables

The probability of owning a mobility tool depends on individual specific and choice specific attributes: the predictor variables. Choice specific attributes vary for different mobility tools. Two choice specific variables are considered: the travel time by car and by public transport to the nearest centre. These two variables measure the time it takes an individual to reach the next agglomeration centre or the next isolated city from his/her community, by car and by public transport.

Individual specific variables such as sex, age, income, or place of residence reflect the socioeconomic and residential status of the people. Spatial attributes, i.e. the characteristics of the particular municipality that determine the transport connections, are assumed to have an influence on the probability of owning a mobility tool. To capture the influence of spatial differences, the number of inhabitants by municipality, divided by 1'000, is included in the model.

Scott and Axhausen (2006) found a large and significant substitution effect between car and public transport ticket ownership. Axhausen et al. (2006) took account of the possibility of such an effect by including car availability and license ownership as predictor variables in the models of GA and half fare travel ticket ownership. In the second part of this paper, the analysis will be expanded by also including the predictor variables GA and half fare ownership in the car and license model since the effect is expected to work in this direction, too.

Monthly household income is considered as a predictor variable for all four mobility tools. The incomes are grouped in nine categories reaching from 0 to 2'000 Swiss francs, from 2'000 to

4'000, from 4'000 to 6'000 and so on up to 16'000 Swiss francs and more (14'000 and more in the data set of 2000). Axhausen et al. (2006) recoded the variable to be able to treat it as continuous by using the mid-point value of each category, e.g. households that indicated an income between 2'000 and 4'000 Swiss francs were registered as having a monthly income of 3'000 Swiss francs. All values were then divided by 1'000. To take account of a possible non-linear relationship, the logarithmised income is included as well. In the first part, the data of 2010 is recoded equally. In the second part, the variable is included the way it was initially categorized in the MCMT, i.e. treating it as categorical (limiting the analysis to the cases of minimum, median, and maximum income, however). Whelan (2007, p.208) notes that the decision about buying a car is "more likely to depend upon disposable income after the deduction of tax and essential living expenses" than on overall household income. Unfortunately, the MCMT does not provide such information.

The variable employment is correlated with income, yet it is included since it is likely that employment affects mobility tool ownership not only through its financial aspect but also through the necessity to drive to a workplace (Whelan, 2007, p.208). Axhausen et al. (2006) distinguished employed/not employed, counting inactive people (retired, house wives and students) as not employed. In the first part, the same categorization will be applied. In the second part, inactive people will be considered as a third category, taking into account that many students and retired persons are also highly mobile. Additionally, full-time and part-time work will be distinguished.

Several studies (e.g Nolan (2010) and Potoglou and Kanaroglou (2008)) found a significant inuence of household characteristics such as the presence of children or the number of household members on car ownership. A variable distinguishing single household, couples without children, couples with children, single parent with children, and extended families or non-related individuals is therefore included in the second part of the analysis.

The original dataset in 2010 contains 62'868 observations on the target persons. When dropping respondents of less than 18 years old, the dataset is reduced to 55'060. The listwise deletion of all missing values leads to a final dataset of 45'796 observations, albeit this number is changing slightly depending on the variables included in the four models. In 2000, the final data set contains 25'318 observations.

Descriptive statistics

Table 1 displays the summary statistics of selected binary and continuous variables for the year 2010 (information on all included variables can be found in Kieser, 2014). 81.2 percent of all respondents own a driving license, 71.8 percent dispose of a car, 9.4 percent own a GA, and 41.1 percent own a Halbtax. Slightly more women than men have been questioned (46.4 percent

male) and 62.5 percent are employed. The mean age is 52 years. Connections by car are generally faster than by public transport: The average travel time by public transport is 11 minutes compared to 7 minutes by car, and the respective maximum is 125 minutes compared to 58 minutes.

Table 1: Summary statistics for binary and continuous variables, 2010

Variable	Mean	Std. Dev.	Min	Max
license	0.812	0.391	0.000	1.000
car available	0.718	0.450	0.000	1.000
GA	0.094	0.292	0.000	1.000
half fare	0.411	0.492	0.000	1.000
age	51.869	17.706	18.000	99.000
male	0.464	0.499	0.000	1.000
employed	0.625	0.484	0.000	1.000
Inhabitants 1000	38.820	80.086	0.031	368.677
log(inhabitants)	9.224	1.601	3.434	12.818
travel time public	11.256	13.111	0.000	125.000
log(travel time public)	1.719	1.352	0.000	4.828
travel time car	7.398	7.088	0.000	58.000
log(travel time car)	1.522	1.154	0.000	4.060

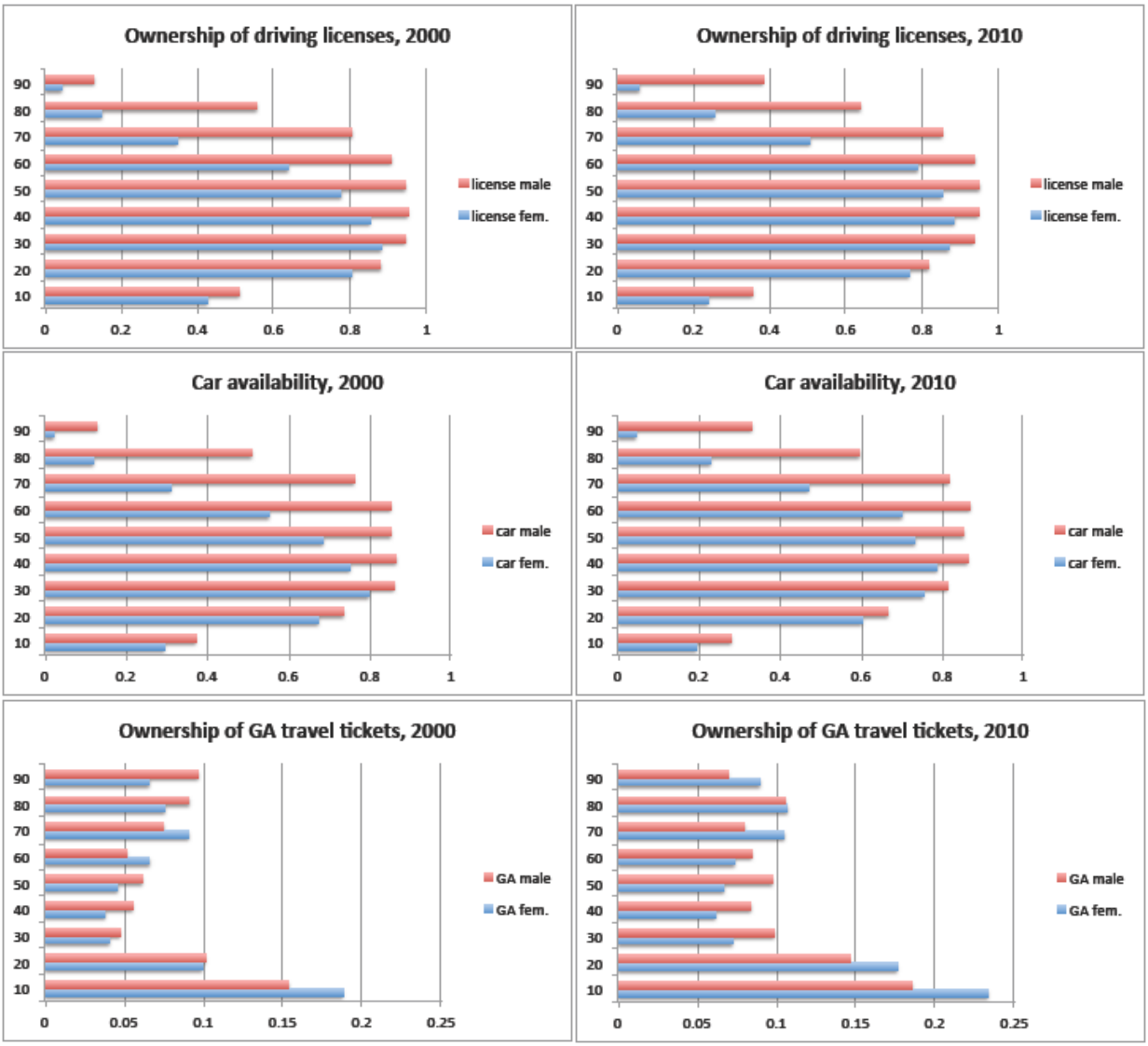
Note: Dataset after listwise deletion of missing data (n = 45796). Travel time of 0 minutes has been recoded to 1 minute before calculating the log of travel time.

In 2000, the longest travel time is 374 minutes by public transport and 266 minutes by car, and the respective means are 20 minutes and 7 minutes. The significant reduction in travel time by public transport between 2000 and 2010 owes to a large extent to the public transport development programme "Bahn 2000" and the opening of the Lötschberg base tunnel (Verband öffentlicher Verkehr, 2012, p.10). The number of employed people is just above 60 percent, as in 2010.

The mean ownership increased for all four mobility tools, with the biggest increase taking place for GA travel tickets (from 6.5 percent to 9.4 percent). The increase varies at different ages, as can be seen in figures 1, comparing the availability of cars and the ownership of driving licenses and GA travel tickets for men and women of different age cohorts, in 2000 and 2010. It has to be kept in mind, however, that the data stem from two different samples (MCMT 2000 and 2010) and therefore cannot be treated like panel data.

It is easy to see that the proportion of 2010's retired persons that own a driving license and dispose of a car is considerably larger than in 2000. While in 2000 around 12 percent of 90- to 99-years-old men called a license their own, it was nearly 40 percent in 2010. A similar increase took place for car availability: In 2000, 12 percent of the oldest male respondents had a car available compared to 33 percent in 2010. The increase for female pensioners was smaller but still remarkable. Figure 1 also illustrates the closing of the gap between male and female mobility tool ownership.

Figure 1 Driving license and GA ownership and car availability, by sex and cohort, in percent (data: MCMT 2000 and 2010)



It is interesting to see that for young people the opposite development is observed: While in the year 2000 50 percent of 18- to 20-years-old men and 42 percent of 18- to 20-years-old women owned a license, it was only 35 percent and 23 percent respectively in 2010. For cars, the respective numbers dropped from 37 to 28 percent for men, and from 29 to 19 percent for women. The two bottom graphs show that the decrease in young people's proportion owning a car was accompanied by an increase in the proportion of young people owning a GA travel ticket.

Comparing the actual ownership structure in 2010 with the forecast for 2010 calculated by Axhausen et al. (2006, p. 85) shows that driving license ownership was slightly overestimated, and car availability and public transport ticket ownership underestimated (table 2). Especially the latter increased much stronger than predicted. Obviously, the forecast strongly depends on the data basis available at the time of estimating the model.

Table 2: Comparison of forecast and actual proportion in mobility tool ownership

Mobility tool	forecast 2010	MCMT 2010	difference
Driving license	0.804	0.799	-0.6%
Car availability	0.662	0.709	+7.0%
GA travel ticket	0.059	0.094	+59.3%
Half fare travel ticket	0.281	0.408	+45.2%

Note: Forecast by Axhausen et al. (2006). Only individuals of 18 years or older are considered. Proportion in 2010 as found in the whole dataset (before listwise deletion of missing data).

4. Econometric model

The choice of mobility tools can be treated as a classical case of a discrete choice problem. Discrete choice models are based on the assumption of utility maximization. Formally, an individual chooses alternative i amongst two or more alternatives if U_i is larger or equal U_j for all j are unequal i, where U_i denotes the individual's utility assigned to alternative i. Following the random utility approach (Ben-Akiva and Lerman, 1985, p.55), it is assumed that the utility is not known with certainty.

When dealing with mutually exclusive alternatives (e.g. taking the bus vs. taking the car vs. taking the bicycle to go to work) often multinomial logit is used to analyse the discrete choice problem. The mobility tools considered in this paper are not mutually exclusive, however. For example, it is not unusual to own a car and a half fare travel ticket at the same time, since one might take the car to work but use public transport in his leisure time. For this reason, the

ownership of the four mobility tools was estimated one by one, using a binomial logit model. The dependent variable y is binary, i.e. takes only the two values 0 (="failure") and 1 (="success"). The explanatory variables can be categorical or continuous. For each of the four models, the respective choice specific characteristics (in this case, the travel time) are included as explanatory variables. The unknown parameters are estimated by the maximum likelihood approach.

Coefficients of a logit regression cannot be interpreted directly since the relationship is non-linear and non-additive, i.e. the effect of one regressor on the dependent variable depends on the value of the regressor itself and on the values of the other regressor variables. The coefficients themselves only stand for the change in the logged odds of the dependent variable when the predictor variable changes by one unit. While the coefficients thus have to be treated with care, the direction and the significance can be interpreted as usual.

Since logged odds allow no intuitive interpretation, one can instead calculate predicted probabilities or marginal effects, i.e. the change in the probability that y = 1 for a discrete change in a predictor variable, holding all other variables constant. In the following, first logged odds will be compared, then in a second step predicted probabilities will be interpreted.

In a first step, the models from the study of 2006 will be estimated with the new data. The results using the 2010 data set will then be compared to the results using the 2000 data set, in order to detect possible differences in the way the predictor variables influence the ownership of mobility tools. In a second step, the models will be extended by the inclusion of further variables for the data set of 2010.

Comparison of model results from the MCMT 2000 and 2010

In table 4, the logged odds of owning a driving license, a car, a GA travel ticket, and a half fare travel ticket in 2010 are compared to those of the former study. As pointed out before, comparing the size of the coefficients is of little use. Yet, the sign and the significance can be compared.

Age shows the expected non-linear effect, differing between men and women: In 2010, up to 50 years old (55 years for men), an increase in age increases the probability of owning a driving license, after that the probability decreases. In the car availability model, the turning point is found at 50 years for women and at 57 years for men. In 2000, the effect changed from positive to negative already after 43 years (50) in the license model, confirming the impression that today's elderly people are more mobile than elderly people of earlier generations. The coefficient in the year 2000 car model contradicts this: The turning point from positive to negative comes only after 65 years (86) in 2000 which would mean that today's elderly people

are less likely to have a car available than elderly people in 2000. However, this is due to the model specification: When calculating the year 2000 model without the predictor variable driving license ownership, the turning point is at 43 years (55) and thus comes earlier than in 2010, as expected.

The effect of age on the ownership of a GA travel ticket is a first indicator for a substitution effect. The non-linearity works in the opposite way as for cars and driving licenses: The probability of owning a GA decreases up to 56 years (51 years for men), after that it increases again (2000: 57 and 51 years, respectively). Young and old people are more likely to own a GA travel ticket, while people in between have a higher probability to own a car. The impact of age on half fare ticket ownership is positive for basically all ages: the older, the more likely one is to own a half fare travel ticket.

Men have a higher probability of owning driving licenses, cars, and GA travel tickets, while women are more likely to own half fare travel tickets. The effect of sex for licenses, GA travel tickets and cars increases with age, reflecting the fact that it was rather unusual for women of earlier generations to learn to drive. Regarding direction and significance, the effects did not change between 2000 and 2010, are thus very stable.

Employed people are significantly more likely to own driving licenses and having a car available, just as in 2000. A similar, stable effect is found for income. An increase in income increases the probability of owning a driving license and public transport tickets, with the effect being weaker for high incomes. The car model in 2010 displays a slightly different effect for income than in 2000. While in 2010, the overall effect is positive, being weaker for higher incomes, in 2000 the effect was positive solely for middle and high incomes and negative for small incomes. This difference seems to stem from the inclusion of the predictor variable driving license. Estimating the car model without license variable for the year 2000, shows the overall effect of income is positive for all incomes, just as in 2010.

The impact of the number of inhabitants changed only slightly for driving licenses. In 2000, up to a community size of roughly 116'000 (corresponding to more than 90 percent of all communities covered in the survey), an increase in inhabitants led to a decrease in the probability of owning a driving license. For municipalities larger than 116'000 inhabitants, the probability increased. In 2010, the effect is negative for all municipalities except for the largest. The negative effect of an increasing number of inhabitants is confirmed in the car model: In 2000, the effect is negative except for the largest municipalities, in 2010, the effect is overall negative, a result expected by theory: in larger cities the public transport network is usually better developed, thus one is less dependent on a car, therefore the availability of a car is expected to be of smaller utility. Confirming the same theoretical expectations, the effect is contrary for public transport tickets: the larger the community, the higher the propensity to own

either a GA or a half fare travel ticket. The effect decreases with raising numbers, possibly reflecting the fact that people living in large centres can more easily switch to bicycles, motorcycles, or to regional travel tickets. The effect is not significant for GA travel tickets in 2010.

Living in an agglomeration centre has no significant effect on the probability of owning a driving license, neither in 2000 nor in 2010. In the car availability model, the (significant) effect changes from being negative in 2000 (as expected by theory) to being positive in 2010: people living in an agglomeration center are more likely to dispose of a car. This difference might be partly due to the difference in the variable, as mentioned above. "Centre" is more widely defined in 2010, counting more than 30 percent of all respondents as living in a centre, while in 2000 only 20 percent were counted in that category. Living in a centre increases the probability of owning a GA travel ticket in 2010. The spatial variable included in the half fare model confirms the positive effect for public transport tickets: people living in agglomeration core centres have the highest probability of possessing a half fare ticket. Yet, this effect is only significant compared to municipalities in the agglomeration belt and periurban rural municipalities. In 2000, people living in core centres also had the highest probability of owning a half fare travel ticket. However, the two spatial variable sets are hardly comparable, since the one from 2000 explicitly incorporates the transportation situation (distinguishing centres with and without half-hourly railway connections).

The variable travel time to the nearest centre has no statistically significant effect in the driving license model, neither in 2000 nor in 2010. It has a significant effect in the car availability model, however. An increase in the time it takes to reach the next agglomeration centre by car increases the probability of having a car available, as long as the journey takes less than 13 minutes, corresponding to nearly 80 percent of all respondents (2000: less than 14 minutes; corresponding to 84 percent). For longer trips, the effect becomes negative. This is as expected by theory: Living in or very close to a centre and living in a place where the connections by road are weak, seems to reduce the utility of having a car available.

Travel time to the nearest centre has a significant effect in the public transport models only in 2000. An increase in the travel time by public transport increases the probability of owning a GA and a half fare travel ticket for trips of up to 20 and 29 minutes, respectively, and decreases the probability for longer trips. A reason might be that individuals living just outside centres might be more likely to own a GA or a half fare travel ticket because they profit more from it than urban people who can also walk to work, use bicycles or buy regional public transport tickets. However, the effect was insignificant in 2010.

As pointed out above, an endogenous relationship between travel time and the propensity to own a mobility tool cannot be ruled out: people owning a driving license or a car might be more

likely to move to communities with inferior public transport connections since they are less dependent on good connections and vice versa. The effect of the travel time variables might therefore be overestimated.

In 2010, people living in Tessin had a significantly higher probability of owning a driving license than people living in Northern Switzerland, a region characterized by large cities. There is no statistically significant effect for the other regions of the country, nor had the variable a significant impact in 2000. Both in 2000 and in 2010, people living in the Italian speaking part of Switzerland are significantly more likely to dispose of a car and significantly less likely to own a GA or a half fare travel ticket, a result consistent with expectations.

Of special interest are the variables license and car availability that take into account the possibility of a substitution effect. It is confirmed in the case of car availability: There is a strong negative effect in both the GA and the half fare travel ticket model, both in 2000 and 2010. Having a car at disposal significantly reduces the probability of owning a public transport ticket. The possession of a driving license, on the other hand, increases the probability. This might be a sign for an overall "mobility propensity".

In summary, the comparison of the two datasets reveals that most variables in 2010 work in the same direction as they did ten years ago and that the effects are in most cases as expected by theory. Where there is a difference in the sign, often either the 2010 or the 2000 coefficient is not significant. The variables age, sex, income, and number of inhabitants are very stable across the years and prove to be important factors in the choice of all four mobility tools. Employment has a positive and significant effect in the driving license and the car model. The variables centre and travel time to the nearest centre are less significant which might be due to the fact that they measure, to a certain extent, similar effects. The variable travel time exerts a less significant influence in 2010 than in 2000. The differentiation between six greater regions highlights the special character of the Italian-speaking part of Switzerland, especially regarding public transport tickets. The substitution effect between cars and public transport tickets has been confirmed as an import factor in the choice of mobility tools.

Table 4: Ownership of license, car availability, GA ticket , and half fare ticket: logged odds

Model information	**Driving license**		**Car availability**		**GA ticket**		**Half fare ticket**	
	2000	2010	2000	2010	2000	2010	2000	2010
N	25318	46019	25318	46019	25318	46014	25318	46012
Null log likelihood	-12857.585	-21378.671	-17353.600	-26799.639	-5695.414	-14356.262	-16154.719	-30384.806
Final log likelihood	-9760.581	-16198.538	-6132.300	-21515.346	-5164.857	-13085.704	-15188.995	-28903.452
Adj. Pseudo R2	0.239	0.241	0.647	0.196	0.090	0.087	0.058	0.048
Chi square	2829.250	5587.210	-	5173.100	714.350	1664.880	1126.780	1762.470

Table 4: continued

Variable	Driving license		Car availability		GA ticket		Half fare ticket	
	2000	2010	2000	2010	2000	2010	2000	2010
age	0.166 ***	0.22 ***	0.035 ***	0.17 ***	-0.086 ***	-0.062 ***	0.047 ***	0.030 ***
age square	-0.002 ***	-0.002 ***	0.000 **	-0.002 ***	0.001 ***	0.001 ***	0.000 ***	0.000 ***
male	-0.214	-0.228 **	-0.389 **	-0.452 ***			-0.292 ***	-0.362 ***
age*male	0.028 ***	0.025 ***	0.012 ***	0.023 ***	0.009 ***	0.005 ***		
employed	0.575 ***	0.726 ***	0.175 **	0.413 ***	-0.114	0.102	-0.075	0.076 *
income 1000	0.051 *	0.03 *	0.111 ***	-0.003	0.064 ***	0.079 ***	0.036 **	0.073 ***
log(income)	0.408 ***	0.621 ***	-0.34 ***	0.816 ***			0.166 *	0.007
license			8.133 ***		0.412 ***	0.39 ***	0.217 **	0.369 ***
car available					-1.585 ***	-1.48 ***	-0.583 ***	-0.449 ***
inhabitants 1000	0.002 **	0.001 *	0.002 **	-0.001 *				
log(inhabitants)	-0.198 ***	-0.242 ***	-0.463 ***	-0.328 ***	0.172 ***	0.003	0.081 ***	0.038 **
centre	-0.211	0.125	-0.307 *	0.449 ***	-0.187	0.211 *	-0.246 **	0.082
Eastern Switzerland	0.219	-0.083	-0.795 ***	-0.29 ***	0.607 *	1.086 ***	1.332 ***	0.908 ***
Northern Switzerland	0.15	-0.199 *	-0.503 **	-0.435 ***	0.356	1.019 ***	1.479 ***	1.188 ***
Central Switzerland	0.13	0.024	-0.579 **	-0.182 *	0.32	1.04 ***	1.430 ***	1.222 ***
Espace Mittelland	0.092	-0.107	-0.547 *	-0.381 ***	0.862 ***	1.441 ***	1.253 ***	0.962 ***
Lake Geneva Region	0.205	-0.155	0.014	-0.23 **	0.444	0.737 ***	0.546	0.442
Tessin (reference)								
travel time public	0.002	0.004	0.006	0.003	-0.009 *	0.015	-0.005 *	-0.008
travel time car	0.004	0.004	-0.014 **	-0.037 ***	-0.029	0.06 **	0.023 **	0.010
tr.time car*tr.time public	0.000	0.000					0.000	0.000
log(travel time public)			-0.198 **	-0.054			0.143 **	0.016
log(travel time car)			0.18879 *	0.45024 ***			-0.222 **	0.065
log(tr.t.car)*log(tr.t. public)					0.085 *	-0.15239 *		
Constant	-4.438 ***	-7.163 ***	-7.774 ***	-7.432 ***	-2.718 ***	-2.052 ***	-5.130 ***	-3.263 ***

Notes: * p<0.05, ** p<0.01, *** p<0.001

Logged odds can indicate whether the hypothesized effects are prevalent or not. By calculating predicted probabilities, these effects can additionally be quantified (Winkelmann and Boes, 2006, p.120). In order to estimate predicted probabilities, the values of the predictor variables have to be assumed. One widely used assumption is that all variables are at their means. While it is a very intuitive measure, one might say it is not a very useful assumption since an individual exactly at the mean of all variables hardly exists (e.g. someone being 46.6 percent male and 62.5 percent employed). Another approach, that counters this problem, is to calculate average adjusted predictions. This approach calculates the average probability of owning a mobility tool if, for example, all respondents, including women, were treated as if they were male. All other independent variables are left at their true value. The variables-at-their-means approach therefore gives "the expected probability of a person with average characteristics", while the second is "the average of the probability among actual persons in the data." (StataCorp., 2011, p.1036). In the following, the second approach of average adjusted prediction is chosen, thanks to its feature of leaving the variables at their true values.

The predicted probabilities can be found in the appendix (A). It shows the overall predicted probabilities in the first row. They are increased for all four mobility tools in the year 2010 in comparison to the year 2000. The difference between two particular characteristics (e.g. between male and female) is the marginal effect. These marginal effects, i.e. the absolute change in predicted probabilities, are not reported in a separate table since they can easily be calculated directly from the predicted probabilities. Instead, the relative change in predicted probabilities was calculated and is presented in the appendix (B). This measure is especially useful for the comparison of 2000 and 2010, because the absolute levels in predicted probabilities changed considerably in some cases, making it difficult to compare marginal effects. It is important to note that the significance level that was determined in the logistic regression applies to the predicted probabilities as well. Statistically insignificant probabilities were therefore put in brackets (for a detailed discussion of the relatives changes between 2000 and 2010 and the marginal effects see Kieser, 2014).

Extended model

In the first part of this chapter, the four models of driving license ownership, car availability, GA, and half fare travel ticket ownership, were reproduced after Axhausen et al. (2006) as similar as possible to allow a comparison between 2000 and 2010. In this section, certain variables will be excluded and others will be included. Travel time is excluded since it was neither significant for the license nor the half fare model. Furthermore, its effect is likely to be a simple correlation and not a causal relationship. The spatial structure comprised in the half fare model is excluded as well because it was significant for only two categories and, more importantly, because there are two other variables that measure a similar relationship (centre

and number of inhabitants). Instead, some new variables, that were found to have an influence on mobility tools ownership in other studies, will be included, namely education, household structure, and an extended employment status variable. Income is included as a categorical variable, limiting the interpretation to the minimum, median, and maximum case. The number of inhabitants is included together with the square term of it, taking into account the non-linear effect that was found in the initial model. The interaction term between age and sex is included for license, car, and GA, for which the initial model revealed an increasing gap with increasing age. GA and half fare travel ticket ownership is included as predictor variables in the license and the car model.

To detect possible interdependences between variables, they were introduced step by step. The four final models are presented in table 5. Predicted probabilities and relative change in predicted probabilities are displayed in the appendix (C and D).

A remarkable outcome is found in the car model: the more inhabitants, the lower the probability to have a car available, except for the one largest municipality (Zurich). Despite this positive effect for Zurich, living in a centre generally decreases the probability. In the initial model, the variable centre influenced the probability of having a car available positively. The change in direction might stem from the exclusion of the variable travel time to the next agglomeration centre. These two variables, travel time and living in a centre, are closely related, what might have influenced their respective effect on car availability. In any case, the effect is small: People living in a centre are only 2.3 percent less likely to have a car available than people living outside a centre.

Furthermore, the effect on GA ownership is negative up to a municipality size of 124'000 people. For larger municipalities - what can be considered as large centres - it is positive. The number of inhabitants has no significant effect on half fare travel ticket ownership, unlike in the initial model. Instead, the effect of living in a centre is now statistically significant: it increases the probability of owning a Halbtax by 4.4 percent.

The newly included variables GA and half fare travel ticket ownership show the expected sign: they decrease the probability of owning a driving license and having a car available. As expected, the effect is larger for GA travel tickets than for half fare travel tickets: possessing a GA leads to a reduction in the predicted probability of license ownership of 14.2 percent and of car availability of 37 percent, while the half fare travel tickets decreases the probability by 4.2 and 11.6 percent, respectively. The substitution effect is thus also confirmed in the license and the car model. It is reconfirmed in the public transport models: car availability diminishes the probability of owning a GA by 70.7 percent and the probability of owning a half fare travel ticket by 17.4 percent. Owning a license increases the probability of having a GA by 14.9 percent.

Being unemployed decreases the predicted probability of owning a mobility tool in all four cases: unemployed people are 12.9 percent less likely to own a license, 16.6 percent less likely to have a car available, 30.3 less likely to own a GA, and 11.2 percent less likely to posses a half fare travel ticket than a full-time employee. Economically inactive people (housewives, students, and retired people) as well as people working part time, are less likely to own a driving license or to have a car available than someone working full-time. In addition, higher education increases the predicted probability of owning any of the four mobility tools.

In summary, the variables of the initial model that were kept in the extended model proved to be very robust and highly significant - age, sex, income, number of inhabitants, centre, and the six greater regions of Switzerland seem to have an important influence on the mobility tool ownership probability. The mobility tools themselves also prove to be robust and important predictor variables, establishing a substitutional relationship between car availability and public transport tickets. The newly included variables household structure, employment status, and educational attainment also exert a statistically significant influence on the probability of owning any of the four mobility tools.

The adjusted Pseudo R^2 is in all four cases larger in the extended model than in the initial 2010-model. In the license model, it increased from 0.241 to 0.289, in the car model from 0.196 to 0.246, in the GA model from 0.087 to 0.099 and in the half fare model from 0.048 to 0.070. The extended models can therefore be considered as fitting the data better than the initial model.

Table 5: Extended model (MCMT 2010): logged odds

Model information	**Driving license**	**Car availability**	**GA ticket**	**Half fare ticket**
N	45796	45796	45798	45798
Null log likelihood	-21195.045	-26635.981	-14284.943	-30262.871
Final log likelihood	-15039.073	-20039.498	-12838.607	-28111.605
Adj. Pseudo R2	0.289	0.246	0.099	0.070
Chi square	6503.494	6342.591	1814.139	2546.621
Variable	**Driving license**	**Car availability**	**GA ticket**	**Half fare ticket**
Constant	-1.862***	-2.304***	-1.040***	-1.509***
	(0.188)	(0.168)	(0.278)	(0.148)
age	0.196***	0.152***	-0.073***	0.024***
	(0.005)	(0.005)	(0.006)	(0.004)
age square	-0.002***	-0.001***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
male	-0.057	-0.339***	-0.059	-0.305***
	(0.097)	(0.086)	(0.112)	(0.027)
age*male	0.018***	0.018***	0.006**	
	(0.002)	(0.001)	(0.002)	

Table 5: continued

Variable	Driving license	Car availability	GA ticket	Half fare ticket
min. income (reference)				
median income	0.946***	1.095***	0.695***	0.261***
	(0.094)	(0.088)	(0.138)	(0.077)
max. income	1.347***	1.835***	1.362***	0.799***
	(0.138)	(0.119)	(0.157)	(0.093)
inhabitants 1000	-0.009***	-0.012***	-0.002*	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
inhabitants 1000 square	0.000***	0.000***	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
centre	-0.078	-0.116*	0.348***	0.079*
	(0.054)	(0.046)	(0.058)	(0.037)
Tessin (reference)				
Eastern Switzerland	-0.046	-0.180*	1.063***	0.886***
	(0.102)	(0.090)	(0.195)	(0.081)
Northern Switzerland	-0.223*	-0.322***	0.998***	1.165***
	(0.098)	(0.087)	(0.192)	(0.079)
Central Switzerland	0.003	-0.108	1.002***	1.204***
	(0.107)	(0.094)	(0.198)	(0.083)
Espace Mittelland	-0.034	-0.166	1.397***	0.908***
	(0.096)	(0.085)	(0.190)	(0.078)
Lake Geneva Region	-0.168	-0.125	0.709***	0.378***
	(0.100)	(0.088)	(0.196)	(0.081)
GA	-0.993***	-1.644***		
	(0.058)	(0.051)		
half fare	-0.340***	-0.612***		
	(0.039)	(0.033)		
car available			-1.454***	-0.359***
			(0.056)	(0.044)
license			0.168**	0.098
			(0.065)	(0.052)
single household (reference)				
couple w/o children	0.049	0.586***	-0.265***	-0.219***
	(0.046)	(0.038)	(0.053)	(0.032)
couple with children	-0.126*	0.155***	-0.508***	-0.579***
	(0.058)	(0.046)	(0.060)	(0.036)
single parent with children	-0.333***	-0.016	-0.085	-0.264***
	(0.081)	(0.069)	(0.098)	(0.062)
ext. fam./non-rel. ind.	-0.240*	-0.279**	-0.433***	-0.318***
	(0.121)	(0.095)	(0.128)	(0.084)

Table 5: continued

Variable	Driving license	Car availability	GA ticket	Half fare ticket
full-time work (reference)				
part-time work	-0.188***	-0.151***	0.228***	0.387***
	(0.056)	(0.044)	(0.057)	(0.034)
inactive	-0.716***	-0.479***	0.141*	0.224***
	(0.057)	(0.049)	(0.064)	(0.039)
unemployed	-0.990***	-0.816***	-0.415*	-0.194*
	(0.106)	(0.094)	(0.172)	(0.091)
tertiary education (reference)				
no school attended	-2.582***	-1.566***	-0.593	-1.091***
	(0.225)	(0.226)	(0.332)	(0.212)
compulsory school	-1.815***	-0.974***	-0.796***	-0.893***
	(0.061)	(0.050)	(0.076)	(0.043)
secondary education	-0.626***	-0.027	-0.363***	-0.545***
	(0.054)	(0.038)	(0.047)	(0.028)

Notes: * p<0.05, ** p<0.01, *** p<0.001

5. Discussion and policy implications

Axhausen et al. (2006) combined the results of the ownership analyses with forecasts on the explanatory variables age, income, and employment in Switzerland in order to predict the future ownership of mobility tools. This is behind the scope of this paper. However, some thoughts on future evolutions and, related to them, some policy recommendations can be developed.

The analysis of the combined influence of age and sex shows that both women and elderly people were more likely to own a driving license and have a car available in 2010 than in 2000, whereby the effect for the elderly is also mainly driven by women. A further rise in the mobility of elderly people seems likely (although men seem to be about to reach a saturation level), potentially increasing the pressure on the road and railway network. A main goal has to be to induce elderly people, who usually are no longer bound to typical working hours, to use the transport network aside the peak hours. Public transport offers such as the "9-Uhr-Karte", that allows the use of the public transport network at a favourable price after 9am, are possible solutions. The announced testing of a GA travel ticket only valid in the evening hours has the same goal. In a more distant future, a well-directed mobility pricing model might help to set incentives in that direction: by differentiating prices regarding destination and hour, the pressure might be lifted off the peak hours.

Young people, on the opposite, were found to be less likely to own a driving license and have a car available in 2010 than in 2000. This effect was not expected by Axhausen et al. (2006, p.99) who forecast an increase in car availability of around 5 percent for 20-year-olds until 2010. Future analyses will have to show if the latter effect is temporary or if it signalizes a change in attitude. If it is a change in attitude, it has the potential to significantly change the future mobility behaviour.

Income has a positive but marginally decreasing effect on driving license ownership and car availability. The future development in license and car availability therefore might depend on how income develops: if it increases mainly for lower incomes, the number of cars is likely to grow more than if already high incomes increase.

Part-time employees were found to be more likely to own public transport tickets than fulltime employees and economically inactive individuals. If the trend towards part-time work, as recently found by the Swiss Federal Statistical Office (2014b), keeps up in the coming years, it might reflect in an increase in public transport tickets (if one assumes that those reducing their employment factor sell their cars). An opposite development might be observed, however, if more economically inactive people (especially housewives) participate in the labour market, as is the goal of several initiatives launched in the aftermath of the approval of the popular initiative "Against mass immigration" early 2014. A possible approach to deal with this development and the pressure of the traffic volume caused by commuters in general is the facilitation of flexible work models. Examples are the possibility to work from home, to acknowledge the work done during the way to work (in public transport) or to allow flexible working hours.

Another trend that was confirmed in several recent popular votes is the trend towards increased density in the centres in favour of the protection of the cultivated land. If consequently applied, the number of people living and working in centres is supposed to increase, which, in turn, might lead to a rise in public transport clients, according to the findings. A critical question in this regard concerns the increase in supply, as the public transport network in large cities already today tends towards its limits. All the more important is also the promotion of the non-motorized or "slow" traffic, i.e. by foot or by bicycle. Offering attractive bicycles lanes is an important condition in that matter.

Supply had a strong effect on public transport ticket ownership in the case of the opening of the Lötschbergtunnel (Verband öffentlicher Verkehr, 2012). With the recent approval of a new rail road development program ("Financing and development of the rail road infrastructure FABI") and the opening of the Ceneri and the Gotthard base tunnel, large parts of Switzerland will profit from a reduction in travel time by train and an increase in train capacity. This might have a positive effect on public ticket ownership.

6. Conclusion

The main aim of this paper was to evaluate the ownership model developed by Axhausen et al. (2006) for driving licenses, cars, GA, and half fare travel tickets using the new data of 2010. Comparing the actual ownership structure in 2010 with the forecast for 2010 on the bassis of the MCMT 2000 showed the forecast of mobility tools strongly depends on the data basis available at the time of estimating the model. Therefore, a series of binary logit models, logged odds and predicted probabilities in 2000 and 2010 were compared, in order to assess if the influence of the variables changed over the years. In a second step, the comparison model for the years 2000 and 2010 was extended, excluding certain variables and including new ones.

The analysis revealed that most variables exert the influence expected by theoretical considerations, are statistically significant and robust across the years and different model specifications. Young and elderly people are less likely to own driving licenses and have a car available than people in between. The opposite pattern is found regarding GA ownership: Young and elderly people are most likely to own a GA. Age increases the probability of owning a Halbtax. Men are more likely to possess driving licenses, have a car available, and own a GA travel ticket. Women, on the other hand, have a higher predicted probability of owning a Halbtax. The effects of age and sex illustrate the closing of the gap between men and women regarding mobility tool ownership.

Income and education positively influences the ownership probability of all four mobility tools. Unemployed people are in all four cases the least likely to own a mobility tool. People working full-time have the highest probability of owning a driving license and having a car available. Part-time employees and economically inactive people were found to have the highest probability of owning public transport tickets. People living in single households have the highest predicted probability of owning public transport tickets. Couples with children were found to be more likely to have a car available than single households. However, couples without children had an even higher predicted probability, possibly reflecting an income effect.

The separate analysis of the the six greater regions of Switzerland exposes a large and significant difference between the Italian-speaking and the German-speaking part regarding ownership of public transport tickets: the probability of owning a public transport ticket is significantly lower for people living in Tessin. The cross-wise inclusion of the mobility tools themselves as predictor variables reveals a strong and highly significant substitution effect between car availability and public transport tickets ownership. The possession of a driving licenses, on the other hand, is correlated with a higher probability of owning a public transport ticket, possibly reflecting a general mobility propensity.

The variables number of inhabitants, living in a centre, and travel time to the next centre were found to be less stable across different model specification and less or not significant, which might be due to the fact that they measure, to a certain extent, similar effects. It was found that the larger a municipality regarding inhabitants, the lower the probability of owning a driving license or having a car available, except for the largest municipality. The opposite pattern is found for GA and Halbtax travel tickets, albeit the variable is not statistically significant in certain model specifications. Living in a centre increases the probability of owning a public transport ticket. Travel time had a significant influence in 2010 only on car availability: an increase in the time it takes to reach the centre by car first increases the probability of having a car available, then decreases it quickly. For the other mobility tools, the effects of travel time were no longer found to have a significant impact.

Mobility tool ownership is one of if not the most important driver of mobility tools usage. Given the important impact of the mobility behaviour on land use, energy consumption, environment, health and also government budget, it is crucial to know and understand the factors that influence the ownership decision. This paper shall contribute to this important task.

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Appendix A

Average adjusted predicted probabilities, initial model, 2000 and 2010

Variable	Driving license		Car availability		GA ticket		Half fare ticket	
	2000	2010	2000	2010	2000	2010	2000	2010
average	0.790	0.821	0.709	0.724	0.060	0.096	0.346	0.389
20 years	0.703	0.596	0.580	0.478	0.098	0.133	0.224	0.287
40 years	0.877	0.891	0.788	0.782	0.051	0.086	0.333	0.371
60 years	0.835	0.901	0.757	0.811	0.045	0.081	0.406	0.437
80 years	0.535	0.695	0.493	0.630	0.070	0.111	0.427	0.476
female	0.729	0.773	0.650	0.677	0.051	0.087	0.376	0.430
male	0.872	0.879	0.783	0.778	0.073	0.106	0.315	0.349
unemployed	0.751	0.769	0.671	0.681	(0.064)	(0.090)	(0.356)	0.378
employed	0.825	0.855	0.736	0.747	(0.058)	(0.098)	(0.340)	0.395
min. income	0.631	0.613	0.437	0.437	0.045	0.060	0.253	0.298
median income	0.768	0.822	0.696	0.735	0.056	0.091	0.331	0.395
max. income	0.872	0.902	0.781	0.831	0.098	0.173	0.447	0.569
no centre	(0.794)	(0.816)	0.716	0.698	(0.062)	0.090	0.353	(0.384)
centre	(0.767)	(0.829)	0.668	0.763	(0.053)	0.107	0.303	(0.402)
agglomeration centre							0.382	0.414
rural municipality							0.328	0.356
min. inhabitants	0.876	0.924	0.866	0.928	0.024	(0.090)	0.254	0.348
median inhabitants	0.769	0.810	0.698	0.731	0.056	(0.091)	0.340	0.394
mean inhabitants	0.773	0.809	0.697	0.722	0.058	(0.091)	0.342	0.395
max inhabitants	0.750	0.726	0.586	0.463	0.098	(0.092)	0.405	0.426
Eastern Switzerland	(0.799)	(0.826)	(0.694)	0.729	0.065	0.098	0.376	0.384
Northern Switzerland	(0.791)	0.813	(0.706)	0.706	(0.052)	0.092	0.409	0.449
Central Switzerland	(0.788)	(0.837)	(0.700)	0.745	(0.051)	0.094	0.398	0.457
Espace Mittelland	(0.784)	(0.823)	(0.699)	0.715	0.082	0.131	0.358	0.396
Lake Geneva Region	(0.797)	(0.818)	0.742	0.738	(0.057)	0.072	0.221	0.284
Tessin	(0.772)	0.834	0.705	0.771	0.038	0.037	0.143	0.206
min. travel time car	(0.767)	(0.805)	0.673	0.646	(0.052)	0.110	0.377	(0.360)
mean travel time car	(0.771)	(0.807)	0.704	0.750	(0.056)	0.108	0.318	(0.404)
75th percentile tr. time car	(0.773)	(0.807)	0.707	0.756	(0.054)	0.120	0.316	(0.417)
99th percentile tr. time car	(0.788)	(0.811)	0.692	0.726	(0.030)	0.214	0.399	(0.468)
max. travel time car	(0.874)	(0.817)	0.378	0.591	(0.000)	0.472	0.979	(0.543)
min. travel time public	(0.766)	(0.804)	(0.695)	(0.720)	0.051	(0.140)	0.307	(0.410)
mean travel time public	(0.771)	(0.807)	(0.684)	(0.704)	0.057	(0.100)	0.374	(0.398)
75th percentile tr. time public	(0.774)	(0.809)	(0.685)	(0.703)	0.055	(0.100)	0.376	(0.389)
99th percentile tr. time public	(0.794)	(0.820)	(0.709)	(0.708)	0.035	(0.131)	0.337	(0.323)
max. travel time public	(0.855)	(0.837)	(0.803)	(0.728)	0.005	(0.225)	0.148	(0.225)
no license					0.048	0.076	0.312	0.325
license					0.069	0.106	0.357	0.404
no car available					0.140	0.209	0.437	0.464
car available					0.033	0.059	0.310	0.362

Notes: Predicted probabilities in brackets are not significant compared to the reference level, as it was found in the regression results

Appendix B

Relative changes in predicted probabilities, initial model, 2000 and 2010

Variable	Driving license		Car availability		GA ticket		Half fare ticket	
	2000	2010	2000	2010	2000	2010	2000	2010
20 years (reference)								
40 years	0.248	0.495	0.359	0.636	-0.480	-0.353	0.487	0.293
60 years	0.188	0.512	0.305	0.697	-0.541	-0.391	0.813	0.523
80 years	-0.239	0.166	-0.150	0.318	-0.286	-0.165	0.906	0.659
male	0.196	0.137	0.205	0.149	0.431	0.218	-0.162	-0.188
employed	0.099	0.112	0.097	0.097	(-0.094)	(0.089)	(-0.045)	0.045
centre	(-0.034)	(0.016)	-0.067	0.093	(-0.145)	0.189	-0.142	(0.047)
agglomeration centre								
rural municipality							-0.141	-0.140
min.income (reference)								
median income	0.217	0.341	0.593	0.682	0.244	0.517	0.308	0.326
max. income	0.382	0.471	0.787	0.902	1.178	1.883	0.767	0.909
min. inhabitants (reference)								
median inhabitants	-0.122	-0.123	-0.194	-0.212	1.333	(0.011)	0.339	0.132
mean inhabitants	-0.118	-0.124	-0.195	-0.222	1.417	(0.011)	0.346	0.135
max inhabitants	-0.144	-0.214	-0.323	-0.501	3.083	(0.022)	0.594	0.224
Eastern	(0.035)	(-0.010)	(-0.016)	-0.054	0.711	1.649	1.629	0.864
Northern	(0.025)	-0.025	(0.001)	-0.084	(0.368)	1.486	1.860	1.180
Central	(0.021)	(0.004)	(-0.007)	-0.034	(0.342)	1.541	1.783	1.218
Espace	(0.016)	(-0.013)	(-0.009)	-0.073	1.158	2.541	1.503	0.922
Lake Geneva Region	(0.032)	(-0.019)	0.052	-0.043	(0.500)	0.946	0.545	0.379
Tessin (reference)								
min. travel time car (reference)								
mean travel time car	(0.005)	(0.002)	0.046	0.161	(0.077)	-0.018	-0.156	(0.122)
75th tr.time car	(0.008)	(0.002)	0.051	0.170	(0.038)	0.091	-0.162	(0.158)
99th tr.time car	(0.027)	(0.007)	0.028	0.124	(-0.423)	0.945	0.058	(0.300)
max. travel time car	(0.140)	(0.015)	-0.438	-0.085	(-1.000)	3.291	1.597	(0.508)
min. travel time public								
mean travel time public	(0.007)	(0.004)	(-0.016)	(-0.022)	0.118	(-0.286)	0.218	(-0.029)
75th tr.time public	(0.010)	(0.006)	(-0.014)	(-0.024)	0.078	(-0.286)	0.225	(-0.051)
99th tr.time public	(0.037)	(0.020)	(0.020)	(-0.017)	-0.314	(-0.064)	0.098	(-0.212)
max. travel time public	(0.116)	(0.041)	(0.155)	(0.011)	-0.902	(0.607)	-0.518	(-0.451)
license					0.438	0.395	0.144	0.243
car available					-0.764	-0.718	-0.291	-0.220

Notes: Coefficients display the relative change in predicted probabilities, compared to the base or reference level. Reading example: In 2000, a 40-year-old was 24.9 percent more likely to own a driving license than a 20-year-old. Coefficients in brackets are statistically not significant compared to the reference level, as it was found in the regression results.

Appendix C

Average adjusted predicted probabilities, extended model, 2010

Variable	Driving license	Car availability	GA ticket	Half fare ticket
average	0.822	0.725	0.096	0.390
20 years	0.662	0.530	0.150	0.320
40 years	0.884	0.773	0.087	0.382
60 years	0.890	0.798	0.075	0.420
80 years	0.713	0.646	0.099	0.430
female	0.786	0.691	0.087	0.423
male	0.870	0.766	0.106	0.357
min. income	0.716	0.553	0.052	0.323
median income	0.833	0.738	0.095	0.378
max. income	0.871	0.831	0.161	0.499
min. inhabitants	0.845	0.782	0.102	(0.390)
median inhabitants	0.837	0.765	0.100	(0.390)
mean inhabitants	0.813	0.707	0.095	(0.390)
max. inhabitants	0.763	0.549	0.085	(0.392)
no centre	(0.825)	0.731	0.086	0.385
centre	(0.817)	0.714	0.115	0.402
Eastern Switzerland	(0.829)	0.727	0.098	0.388
Northern Switzerland	0.811	0.707	0.093	0.451
Central Switzerland	(0.834)	(0.738)	0.093	0.460
Espace Mittelland	(0.830)	(0.730)	0.129	0.392
Lake Geneva Region	(0.817)	(0.735)	0.072	0.282
Tessin	0.834	0.752	0.038	0.216
no GA	0.833	0.751		
GA	0.715	0.473		
no half fare	0.834	0.757		
half fare	0.799	0.669		
no car available			0.205	0.447
car available			0.060	0.369
no license			0.087	(0.373)
license			0.100	(0.394)
single household	0.828	0.690	0.123	0.461
couples w/o children	(0.833)	0.773	0.099	0.412
couples with children	0.815	0.713	0.081	0.335
single parent with children	0.793	(0.687)	(0.115)	0.402
extended family/non-related ind.	0.803	0.645	0.086	0.391
full-time work	0.858	0.755	0.089	0.357
part-time work	0.841	0.734	0.108	0.441
inactive	0.782	0.685	0.101	0.405
unemployed	0.747	0.630	0.062	0.317
no school attended	0.550	0.492	(0.075)	0.257
compulsory school	0.686	0.601	0.063	0.294
secondary education	0.844	(0.753)	0.092	0.366
tertiary education	0.899	0.756	0.123	0.489

Notes: Predicted probabilities in brackets are not significant compared to the reference level, as it was found in the regression results.

Appendix D

Relative changes in predicted probabilities, extended model, 2010

Variable	Driving license	Car availability	GA ticket	Half fare ticket
20 years (reference)				
40 years	0.335	0.458	-0.420	0.194
60 years	0.344	0.506	-0.500	0.313
80 years	0.077	0.219	-0.340	0.344
male	0.107	0.109	0.218	-0.156
centre	(-0.010)	-0.023	0.337	0.044
min. income (reference)				
median income	0.163	0.335	0.827	0.170
max. income	0.216	0.503	2.096	0.545
min. inhabitants (reference)				
median inhabitants	-0.009	-0.022	-0.020	(0.000)
mean inhabitants	-0.038	-0.096	-0.069	(0.000)
max inhabitants	-0.097	-0.298	-0.167	(0.005)
Eastern Switzerland	(-0.006)	-0.033	1.579	0.796
Northern Switzerland	-0.028	-0.060	1.447	1.088
Central Switzerland	(0.000)	(-0.019)	1.447	1.130
Espace Mittelland	(-0.005)	(-0.029)	2.395	0.815
Lake Geneva Region	(-0.020)	(-0.023)	0.895	0.306
Tessin (reference)				
GA	-0.142	-0.370		
half fare	-0.042	-0.116		
car			-0.707	-0.174
license			0.149	(0.056)
single household (reference)				
couples w/o children	(0.006)	0.120	-0.195	-0.106
couples with children	-0.016	0.033	-0.341	-0.273
single parents with children	-0.042	(-0.004)	(-0.065)	-0.128
extended fam./non-rel.	-0.030	-0.065	-0.301	-0.152
full-time work (reference)				
part-time work	-0.020	-0.028	0.213	0.235
inactive	-0.089	-0.093	0.135	0.134
unemployed	-0.129	-0.166	-0.303	-0.112
no school attended	-0.388	-0.349	(-0.390)	-0.474
compulsory school	-0.237	-0.205	-0.488	-0.399
secondary education	-0.061	(-0.004)	-0.252	-0.252
tertiary education (reference)				

Notes: Coefficients display the relative change in predicted probabilities, compared to the base or the reference level.