

The ownership of mobility tools during the life course

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THE OWNERSHIP OF MOBILITY TOOLS DURING THE LIFE COURSE

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ABSTRACT

Decisions concerning the ownership of the various mobility tools have long-term effects since corresponding changes involve substantial amounts of resources (costs, time, etc.). Therefore, ownership forms a commitment to particular travel behaviors as people trade large one-time costs for a low marginal cost at the time of usage. In this context habits and routines are very important, which make changes difficult for the traveler. How, when and why such changes might happen, are questions of large interest for the formulation of transport policies. A longitudinal perspective, which contributes to the understanding of the dynamics of travel behavior, is available from people's life courses, which link different dimensions of life together.

In order to study the dynamics of mobility tool ownership, a retrospective survey covering the 20 year period from 1985 to 2004 was carried out at the beginning of 2005 in a stratified sample of municipalities in the Zurich region, Switzerland.

The paper shows that car ownership and public transport season ticket ownership substitute one another. Car ownership is highest among those who are 35 to 55 years old today. At the same time, men have noticeably more frequently a car at their disposal than women of the same age. The most changes in mobility tool ownership occur between the ages of 15 and 25 years. In this context increasing age has overall a negative influence on variations in car availability and public transport season ticket ownership. Events in other life course dimensions also play an important role.

INTRODUCTION

Decisions concerning the ownership of mobility tools, such as cars and different public transport season tickets, have long-term effects since corresponding changes involve substantial amounts of resources (costs, time, etc.). Therefore, ownership forms a commitment to particular travel behaviors as people trade large one-time costs for a low marginal cost at the time of usage. In this context habits and routines are very important, which make changes difficult for the traveler. How, when and why such changes might happen, are questions of large interest for the formulation of transport policies.

A longitudinal perspective, which contributes to the understanding of the dynamics of travel behavior, is available from people's life courses, which link different dimensions of life together. These life course dimensions are usually not independent from one another. Events in one area are frequently connected to changes in other areas. At the same time, this longitudinal approach provides the possibility to observe developments over time and identify state dependencies (1; 2; 3; 4).

In order to study the dynamics of mobility tool ownership, a retrospective survey covering the 20 year period from 1985 to 2004 was carried out at the beginning of 2005 in a stratified sample of municipalities in the Zurich region, Switzerland.

In the following, the ownership of mobility tools as well as the longitudinal data collected in the retrospective survey is described. The paper then concentrates on the analysis of mobility tool ownership during the life course, using the method of discrete choice modeling. Furthermore, the occurring changes are examined. Finally the results are summarized in the conclusions.

THE OWNERSHIP OF MOBILITY TOOLS

Mobility tools include driving licenses and available cars as well as different public transport season tickets, such as national and regional tickets for different time periods and half-fare discount tickets. Through the ownership of those mobility tools people commit themselves to particular travel behaviors as they trade large one-time costs for a low marginal cost at the time of usage. Simma and Axhausen found that the ownership of the different mobility tools influences the usage of the same mode positively and the usage of the other mode negatively (5). This means that the relationship between the private and the public transport mode is a substitutive one (5). In general the commitment to car availability is higher than that to season ticket ownership. In this context the ownership of cars and the related commitment are widely covered in the literature (3; 6; 7; 8), whereas the commitment to public transport is seldom considered in studies as they mostly only emphasize its supply. Models taking into account both the ownership of cars and the ownership of different public transport season tickets are rarer (5; 9; 10; 11).

Different variables influence the ownership of the various mobility tools (5; 10). The relationship between age and ownership is nonlinear. Men are more likely to own driving licenses and cars, whereas women show a higher public transport season ticket ownership. Education and employment status as well as income have positive effects on the driving license and car ownership. A higher income also promotes the ownership of public transport season tickets. The location of the place of residence influences the ownership in such a way that people living in more urban areas tend to have less cars and more public transport season tickets at their disposal as they have better access to public transport in comparison to rural areas.

Overall the ownership of mobility tools is relatively stable over longer periods of time (5; 12). This is especially true for the ownership of cars. Bjørner and Leth-Petersen give two possible explanations for the strong persistence of car ownership over time (13). On the one hand past car ownership has impacts on preferences or constraints that influence future car ownership. This is described as "true" state dependence. On the other hand persons or households differ in certain unobserved characteristics that influence their probability of car ownership. When these unobservables are correlated over time, past car ownership is correlated with future car ownership. This correlation derived from unobserved heterogeneity is generally labeled as "spurious" state dependence. Bjørner and Leth-Petersen found that state dependence is more important and contributes more than unobserved time invariant heterogeneity (13).

METHODOLOGY

Discrete choice models are used to analyze decisions, where persons choose from a finite set of mutually exclusive and collectively exhaustive alternatives. These models are based upon the assumption of utility maximization, i.e., an individual chooses that one alternative with the highest utility (14; 15). The complexity of human behavior and incomplete information suggest that uncertainty needs to be taken into account. The random utility models reflect this uncertainty as the utility U of the alternative j for the individual n is given by

$$U_{jn} = V_{jn} + \varepsilon_{jn},$$

where V_{jn} is the deterministic part of the utility and ε_{jn} the probabilistic part, capturing the uncertainty.

For the logit models it is assumed that the error component of the utility function is independently and identically extreme-value or Gumbel distributed (16). The simplest and most widely used model is the multinomial logit model. The nested and the cross-nested logit model are extensions of this model designed to capture correlations among alternatives and to relax the criterion of independence from irrelevant alternatives (17; 18).

The probit model is based on the assumption that the error component of the utility function is normally distributed (17). The main advantage of the probit model is its ability to explicitly capture all correlations among alternatives.

DATA

For the estimation of dynamic models on the ownership of mobility tools longitudinal data is required. Essentially, there are two ways of collecting such data. The most obvious and well-recognized method is to conduct a panel survey. Data collected this way is very reliable since events are observed as they happen. However, panel surveys are difficult and expensive to carry out as well as rather effort and time consuming. The second method approximating a panel survey is to use a retrospective approach that relies on individual's recall capacity and, hence, is subject to the limitations of the human memory. With increasing time elapsed since an event the amount of information retained decreases in a logarithmic relationship (3; 19). People tend to remember major events, such as residential moves or personal and familial events, better. Therefore, those can be used as support for the memory by further linking different dimensions of life together and in doing so placing single events into a larger context (19). Experiences from Hollingworth and Miller showed that a retrospective survey proved to be a favorable alternative to a panel survey (3).

In order to collect longitudinal data concerning the ownership of mobility tools, a retrospective survey covering the 20 year period from 1985 to 2004 was carried out at the beginning of the year 2005 in a stratified sample of municipalities in the Zurich region, Switzerland, taking different spatial and transport related municipality types into account (20).

The survey was conducted as a written self-completion questionnaire consisting of two parts, a household form and a person form. The household form asked for the current address, a short description of all persons living in the household and the household income. In the person form socio-demographic and socio-economic characteristics of the respondents were collected. The essential part of this form was a multidimensional life course calendar for the years from 1985 to 2004. For this 20 year period retrospective information about the personal and familial history, the household size as well as data on moves and corresponding places of residence we collected. Furthermore, the respondents were asked to indicate their changing ownership of cars and different public transport season tickets, such as national and regional tickets as well as half-fare discount tickets. Data on the places of education and employment, on the main mode of transport for the commuting trip as well as on the personal income was collected for the period from 1985 to 2004. Each household received two person forms that were to be filled in by persons aged 18 years and older.

The questionnaire was sent out by mail to 3600 households. The response rate amounts to only 23.1%, which is primarily due to the relative length and complexity of the

questionnaire (21). Overall 780 household forms and 1166 person forms are available for further statistical analyses.

RESULTS

The ownership of mobility tools during the life course

In FIGURE 1 the ownership of mobility tools during the life course is shown for all respondents. Car ownership includes always and partially available cars. The denoted abbreviations stand for national tickets (Nat T), regional tickets (Reg T) and half-fare discount tickets (HF T). Regarding the age of the respondents there is, as expected, a strong increase in car ownership after reaching the age of 18 years. Persons aged from 25 to 50 years show the highest share with about 75%. Then a slow decrease is visible. The ownership of national tickets increases over the life course, whereas the share of regional tickets decreases. The half-fare discount tickets have growing shares. About one third of the respondents own a car and public transport season tickets at the same time. Overall the ownership of mobility tools increases at the beginning and then remains relatively stable over the life course with only approximately 10% of persons not having any mobility tool at their disposal.

FIGURE 1 The ownership of mobility tools during the life course

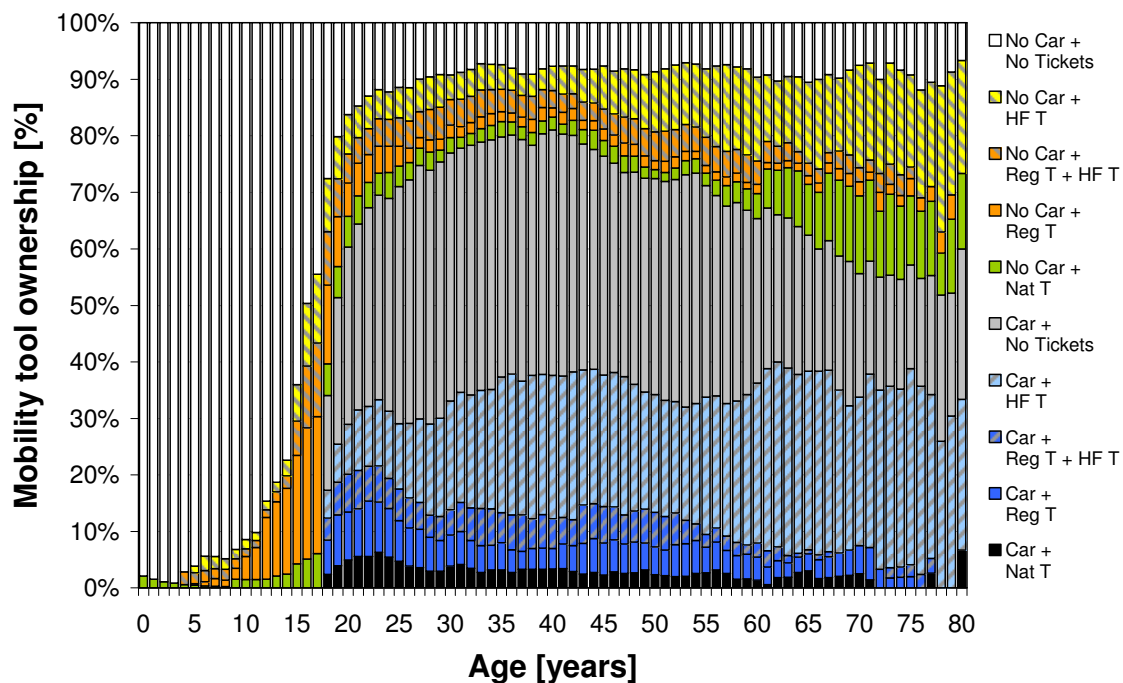
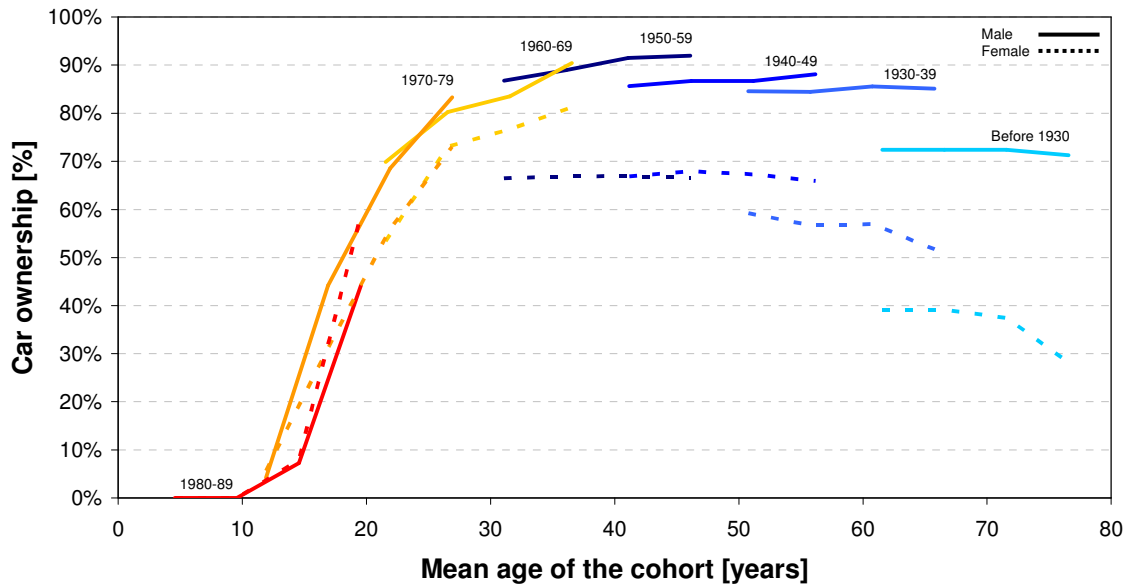


FIGURE 2 The ownership of mobility tools by gender, age and birth cohort membership

Car ownership by gender, age and birth cohort membership



National and regional ticket ownership by gender, age and birth cohort membership

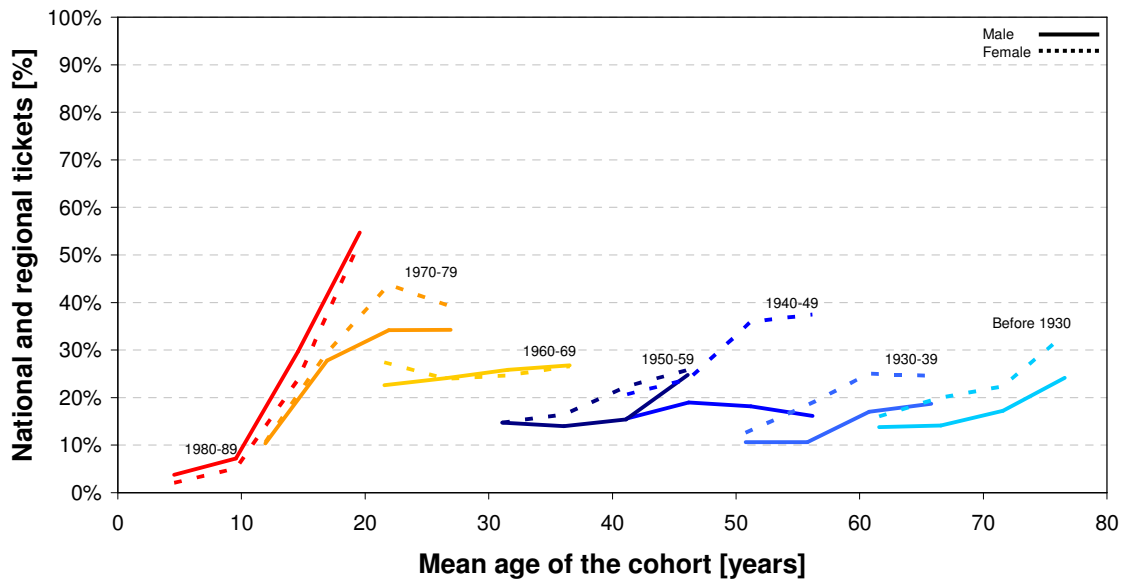
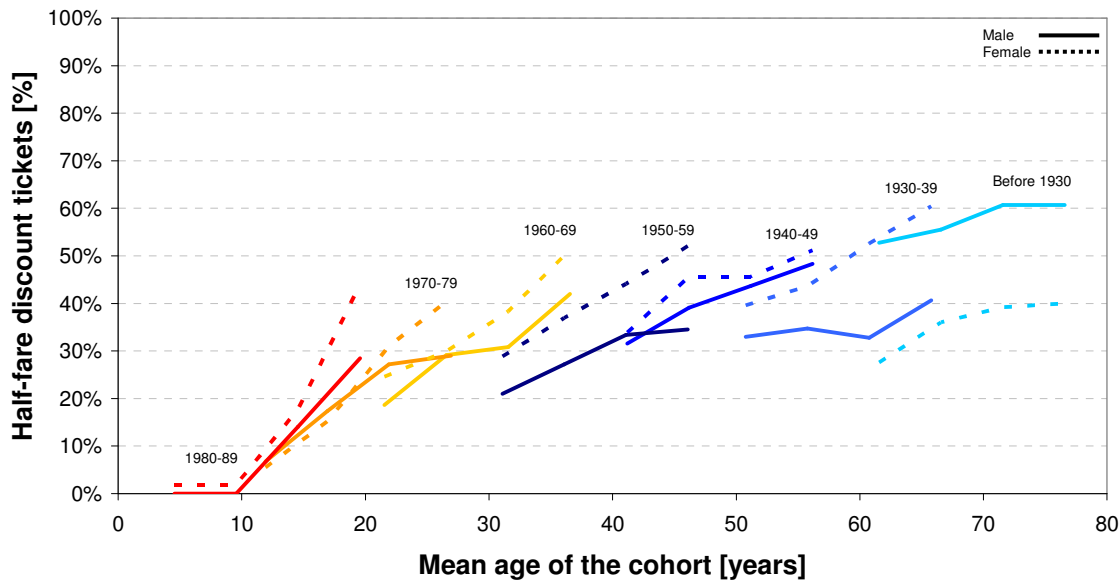


FIGURE 2 is continued ...

FIGURE 2 continued ...

Half-fare discount ticket ownership by gender, age and birth cohort membership



Above, the ownership of mobility tools is analyzed by age of the respondents and their membership in birth cohorts. Thereby it is possible to take into account changes during the life course of a person as well as cohort effects which specify intra- and intergenerational similarities and varieties in one generation or between different generations (22; 23). In this context it is assumed that people born in the same time interval and, therefore, ageing together also share a common life experience due to the fact that general changes have differing impacts for persons of unlike age and that the consequences of these changes persist in the subsequent behavior of these individuals and, thus, of their cohorts (23). A third temporal dimension includes period effects indicating the impact of the global context and which are independent from the persons (22; 24). FIGURE 2 illustrates the ownership of the various mobility tools by gender, age and birth cohort membership. For all three variables significant differences occur. The oldest cohort group comprises of people which are born before 1930. The following cohorts span a period of ten years in each case. It is noticeable that the oldest cohort group owns considerably fewer cars than the younger cohorts. Highest is the ownership among those who are 35 to 55 years old today. At the same time, men have noticeably more frequently a car at their disposal than women of the same age. However, for the younger generations this difference diminishes. Except for the oldest group, there are still increases in ownership observable within the different cohorts. This means that the level of saturation is not necessarily reached yet. The same patterns are observed for Switzerland (10) and the United Kingdom (25) using national survey data and the so-called pseudo-panel approach, in which panel data is constructed by tracing cohorts in the cross-sectional data and treating the cohort averages for each point in time as observations (25). Dargay shows that the age and cohort effects are largely explained by differences in income over the life course and differences in income between generations (25). Concerning the ownership of national and regional season tickets, a different trend is visible compared to car ownership. The cohorts with a current age between 35 and 55 years now show the lowest ownership rates.

Furthermore, women generally own more public transport season tickets than men. Therefore, both car ownership on the one side and national and regional season ticket ownership on the other side substitute one another. The ownership of half-fare discount tickets increases relatively strongly over the life course. With the exception of the oldest cohort group, the female respondents tend to own more half-fare discount tickets than the male respondents of the same age.

In the following, various discrete choice models are estimated for the ownership of mobility tools between 1985 and 2004. For this time period observations on a semi-annual basis are included. Only persons that are 18 years and older are considered. Overall 28808 observations are in the data set. In this context it is necessary to take into account that each respondent appears several times as observation and, therefore, to control for unobserved characteristics of the individuals. Thus, an error term is added in the model, which allows individuals who are homogeneous in their observed characteristics to be heterogeneous in their response probabilities (26). Within the model specification a random parameter is introduced, which is normally distributed across the entire sample, but invariant for each individual. For this parameter the standard deviation is estimated, while the mean value is set to zero (27).

In TABLE 1 the results of different binomial logit models for the availability of cars and the ownership of public transport season tickets during the 20 year period are represented. All relevant explanatory variables are used and a corresponding indication of their significance is shown, since estimating these models requires a lot of computational time and effort. As measure for the goodness of fit the adjusted ρ^2 is shown in the table. It is calculated as follows

$$\rho^2 = 1 - \frac{L(\max) - K}{L(0)},$$

where $L(0)$ and $L(\max)$ represent the initial and the final log-likelihoods, respectively, and K denotes the number of estimated parameters (27). Overall the goodness of fit is relatively high, only in the model for the half-fare discount ticket ownership a slightly lower ρ^2 is observed. The probability of disposing of a car which is available at all times increases until the age of 54 years and then slowly declines. At the same time, male respondents are more often in this position than female respondents. Employment as well as income has a positive influence. The ownership of season tickets is related to a lower proportion of always available cars. In larger households these cars are less likely. With reference to the urban areas persons having their own car live more often in rural areas. Rather opposed tendencies are noticeable for partially available cars. For instance, men tend to have a car less frequently only part time at their disposal than women. Furthermore, the monthly income has a negative effect. Persons owning public transport season tickets are in general more likely to simultaneously have a partially available car. The ownership of national and regional tickets for public transport is reduced with increasing age, while the utility for half-fare discount tickets also increases. Men tend to own less public transport season tickets than women. The Swiss nationality as well as a college or university degree and being in education lead to a higher ownership of these mobility tools. Only for the national tickets the distance to the place of employment has a positive influence. Concurrent with the expectations, simultaneous car availability decreases the ownership of public transport season tickets. Persons with national and regional tickets live more often in urban areas. In the cases where the place of residence is abroad, season ticket ownership tends to be lower. The index of

purchasing power in the region of residence measures the changes in consumer prices in a country in Euro, making an adjustment for changes in exchange rates (28). It has a positive influence on the public transport season ticket ownership. All these results are in general consistent with other analyses concerning the ownership of mobility tools (5; 10). The high values for the standard deviation σ of the individual-specific error term indicate a substantial heterogeneity in the sample (26). The sign of the random parameter is not relevant.

Below, the ownership of the various mobility tools is assigned to six different groups, which cover all possible combinations.

In TABLE 2 the results of a corresponding multinomial logit model for the ownership of mobility tools in the 20 year period from 1985 to 2004 are shown. No individual-specific random parameter is incorporated, since the consideration of the panel effect is not feasible for the nested and cross-nested models as their estimation runs into numerical problems. So a comparison of the MNL, NL and CNL models remains possible. Overall age has a positive effect with reference to the group of mere car owners, especially for the older respondents. Only the alternatives including national and regional season tickets show a slight decrease of the utility for younger persons. Gender has a negative influence. This means that men tend to merely own a car more frequently than women. Respondents without any mobility tools are more likely to be foreign national as well as not to hold a college or university degree. The opposite tendency is visible for the other groups which own mobility tools. For these groups being in education, a change in education and the corresponding distance show a positive influence. Persons with no mobility tools or with a half-fare discount ticket are less likely to be employed, whereas employment and a change in employment increases the probability of having a car and public transport season tickets simultaneously at disposal. At the same time, the distance between the place of residence and the place of employment has a negative effect for these last two groups. With increasing income the propensity to not have a mobility tool or to not have a car decreases. For the respondents with an available car and public transport season tickets the mean elasticity concerning the monthly income in 1000 CHF is positive and amounts to approximately 0.2. Mere car owners tend to live in more rural areas as well as not in Switzerland. Thereby the index of purchasing power in the residential region has a negative influence on car ownership.

TABLE 3 presents the parameters of a nested logit model with two nests regarding the ownership and non-ownership of a car. Other possible specifications include a model with nests for national and regional tickets and no national and regional tickets as well as a model with nests for half-fare discount tickets and no half-fare discount tickets. The model shown in the table fits the data best. For the alternatives including the national and regional tickets age has a negative effect until the age of about 50 years. Afterwards the utility increases with increasing age. With regards to the other alternatives age leads to a higher propensity to choose one of these. Overall men are considerably more likely to be mere car owners than women. With the exception of the persons with no mobility tools, being a Swiss national as well as holding a college or university degree has a positive influence. This also applies to education and employment as well as to changes occurring in education and employment. The distance between the places of residence and education increases the probability of mobility tool ownership, except for the half-fare discount tickets, in reference to only car owners. Concerning the place of employment, the distance has in general a negative effect. A higher income enhances the simultaneous availability of cars and public transport season tickets. The birth of a person in the household as well as the household size and accommodation size increase the ownership of a car. These owners are primarily found in

more rural areas. Overall the nested logit model is relatively similar to the corresponding multinomial logit model shown in TABLE 2. At the same time, the measure for the goodness of fit only shows a minor rise. The scale parameters estimated in the NL model are both significant. They indicate that the correlations in the nest with the alternatives including a car are slightly smaller than in the other nest.

A corresponding cross-nested logit model, differentiating between four nests for car, national and regional tickets, half-fare discount tickets as well as no mobility tools, is for lack of space not represented here.

When considering the initial and final log-likelihood as well as the number of estimated parameters, the different logit models are relatively similar to one another, with the nested logit model being the best model overall.

TABLE 4 shows the results of a multivariate probit model for the mobility tool ownership in the six different groups. Concerning the respondents without any mobility tools at their disposal, age has a negative effect until a minimum is reached at the age of 45 years. Afterwards the utility increases with increasing age. This also applies to the other alternatives, with the groups not owning and owning a car reaching this minimum earlier and later during the life course, respectively. Gender has a negative influence. This means that men more frequently tend to merely own a car than women. Persons having both a car and public transport season tickets available are more likely to be Swiss and to have a college or university degree with reference to the group of mere car owners. In contrast respondents with no mobility tools tend to be foreign nationals, not holding a higher educational degree. In this group education, employment and corresponding changes as well as the income per month show a negative influence. Regarding the other alternatives education, employment and income do not have such a distinct effect. Employment increases the probability of having a car and public transport season tickets simultaneously at disposal. At the same time, the income tends to be higher in these two groups. Mere car owners are more likely to live in more rural areas as well as abroad. Thereby the index of purchasing power in the residential region has a negative influence on car ownership. The correlations between the different groups, which are incorporated in the model, are in all cases significant. In this context the largest values are observed among the alternatives including a car. In comparison to the logit models, the goodness of fit measure ρ^2 has considerably improved.

TABLE 1 Binomial logit models for the ownership of mobility tools during the life course

Explanatory variable	Car availability: Always	Car availability: Partially	National ticket ownership	Regional ticket ownership	Half-fare discount ticket ownership
Age in years	+ 0.538 *	- 0.089	- 0.474 *	- 0.140 *	+ 0.128 *
Age in years squared	- 0.005 *	- 0.000	+ 0.006 *	+ 0.001	- 0.001
Gender: Male	+ 3.595 *	- 0.842 *	+ 0.972 *	- 0.114	- 1.710 *
Nationality: Swiss national	- 0.147	+ 1.724 *	+ 4.309 *	- 0.053	+ 3.560 *
College or university degree	- 0.245	+ 2.021 *	+ 2.848 *	+ 1.609 *	+ 2.590 *
In education	+ 0.000	- 0.757 *	+ 0.708 *	+ 1.119 *	+ 0.562 *
Change in education	- 0.340 *	+ 0.096	+ 0.186	+ 0.138	+ 0.185
Distance between the place of residence and the place of education in 1000 kilometers	+ 0.227	- 0.145	+ 5.479	+ 0.468	- 3.810
In employment	+ 1.063 *	- 0.317	- 0.109	+ 1.109 *	+ 0.282
Change in employment	+ 0.069	+ 0.181	+ 0.017	+ 0.167 *	+ 0.120
Distance between the place of residence and the place of employment in 1000 kilometers	- 0.493 *	- 0.217	+ 1.222 *	- 8.174 *	- 1.364 *
Monthly income in 1000 CHF	+ 0.511 *	- 0.345 *	+ 0.030	- 0.111	+ 0.228 *
Monthly income in 1000 CHF squared	- 0.024 *	+ 0.014 *	- 0.000	+ 0.011	- 0.012 *
Car availability: Always			- 2.243 *	- 2.370 *	- 1.720 *
Car availability: Partially			- 0.927 *	- 0.120	- 1.039 *
National ticket ownership	- 3.799 *	+ 0.486			
Regional ticket ownership	- 3.076 *	+ 1.220 *			+ 1.080 *
Half-fare discount ticket ownership	- 2.173 *	+ 0.096		+ 0.878 *	
Moving out of parents' house	+ 0.408	+ 0.062	+ 0.061	+ 0.020	+ 0.118
Change in residence	- 0.015	- 0.054	+ 0.212	- 0.195 *	- 0.007
Birth of a person in the household	+ 0.340	+ 0.119	- 0.567	- 0.073	- 0.269
Number of persons in the household	- 0.286 *	+ 0.150	- 0.163	- 0.131	- 0.009
Number of rooms in the accommodation	+ 0.078	+ 0.038	- 0.050	+ 0.065	+ 0.006
Degree of urbanization:					
Urban (referential category)					
Urban to rural	- 0.115	+ 0.479 *	- 0.436	- 0.572 *	+ 0.152
Rural	+ 0.933 *	- 0.379	- 1.863 *	- 0.989 *	+ 0.611
Place of residence abroad	+ 0.573	- 0.395	- 2.705 *	- 2.104 *	- 3.002 *
Purchasing power index in the residential region	- 0.003	+ 0.028 *	+ 0.116 *	+ 0.028 *	+ 0.025 *
Constant	- 11.866 *	- 6.331 *	- 15.689 *	- 3.048 *	- 10.609 *
Standard deviation of the individual-specific random parameter	+ 6.999 *	- 5.288 *	+ 7.962 *	- 5.339 *	- 5.550 *
Number of persons	1043	1043	1043	1043	1043
Number of observations	28808	28808	28808	28808	28808
ρ^2 (adjusted)	0.759	0.744	0.859	0.728	0.582

* Level of significance ≤ 0.10

TABLE 2 Multinomial logit model for the ownership of mobility tools during the life course

Explanatory variable	No Car + No Tickets	No Car + HF T	No Car + Nat T / Reg T	Car + No Tickets	Car + HF T	Car + Nat T / Reg T
Age in years	-0.038 *	-0.028 *	-0.163 *		-0.015 *	-0.090 *
Age in years squared	+0.001 *	+0.001 *	+0.002 *		+0.000 *	+0.001 *
Gender: Male	-0.999 *	-0.939 *	-1.029 *		-0.517 *	-0.552 *
Nationality: Swiss national	-0.691 *	+0.544 *	+0.183 *		+1.249 *	+0.818 *
College or university degree	-0.095	+0.549 *	+0.700 *		+0.994 *	+0.956 *
In education	+0.225	+0.742 *	+0.866 *		+0.481 *	+1.036 *
Change in education	+0.205	+0.378 *	+0.320 *		+0.214 *	+0.236 *
Distance between the place of residence and the place of education in 1000 kilometers	+1.072	-4.769	+1.985 *		+2.253 *	+2.355 *
In employment	-0.887 *	-0.195 *	-0.088		+0.226 *	+0.371 *
Change in employment	-0.233	-0.047	+0.105		+0.105	+0.257 *
Distance between the place of residence and the place of employment in 1000 kilometers	+0.015	+0.012	-1.395		-0.144 *	-0.261 *
Monthly income in 1000 CHF	-0.088	-0.075 *	-0.069 *		+0.022	+0.058 *
Monthly income in 1000 CHF squared	-0.037 *	-0.006 *	+0.003 *		+0.003 *	-0.001
Moving out of parents' house				+0.146		
Change in residence				-0.040		
Birth of a person in the household				+0.236 *		
Number of persons in the household				-0.020		
Number of rooms in the accommodation				+0.071 *		
Degree of urbanization:						
Urban (referential category)						
Urban to rural				+0.728 *		
Rural				+0.920 *		
Place of residence abroad				+1.906 *		
Purchasing power index in the residential region				-0.014 *		
Constant	-0.318	-1.954 *	+1.514 *		-2.905 *	-0.962 *
Number of observations						28808
ρ^2 (adjusted)						0.214

* Level of significance ≤ 0.10

TABLE 3 Nested logit model for the ownership of mobility tools during the life course with two nests for car and no car

Explanatory variable	No Car + No Tickets	No Car + HF T	No Car + Nat T / Reg T	Car + No Tickets	Car + HF T	Car + Nat T / Reg T
Age in years	-0.056	+0.107 *	-0.420 *		-0.081 *	-0.297 *
Age in years squared	+0.001 *	-0.000	+0.005 *		+0.002 *	+0.003 *
Gender: Male	-1.645 *	-1.866 *	-1.532 *		-1.309 *	-2.138 *
Nationality: Swiss national	-1.264 *	+2.656 *	+1.530 *		+4.678 *	+2.943 *
College or university degree	-0.361	+2.162 *	+2.308 *		+3.663 *	+3.206 *
In education	-0.746	+2.211 *	+2.224 *		+1.203 *	+3.719 *
Change in education	+0.317	+1.143 *	+0.895 *		+0.953 *	+1.263 *
Distance between the place of residence and the place of education in 1000 kilometers	+5.341	-27.082 *	+7.436 *		+8.128 *	+8.036 *
In employment	-1.787 *	+0.452 *	+0.566 *		+0.709 *	+1.332 *
Change in employment	-0.810 *	+0.286	+0.564 *		+0.348	+1.102 *
Distance between the place of residence and the place of employment in 1000 kilometers	+0.292	-0.089	-3.598 *		-0.186	-1.129 *
Monthly income in 1000 CHF	-0.551 *	+0.199 *	+0.049		+0.008	+0.256 *
Monthly income in 1000 CHF squared	-0.025	-0.028 *	+0.012 *		+0.014 *	-0.005
Moving out of parents' house				+0.627 *		
Change in residence				+0.010		
Birth of a person in the household				+0.815 *		
Number of persons in the household				+0.009		
Number of rooms in the accommodation				+0.199 *		
Degree of urbanization:						
Urban (referential category)						
Urban to rural				+1.961 *		
Rural				+2.214 *		
Place of residence abroad				+3.148 *		
Purchasing power index in the residential region				-0.007 *		
Constant	+2.463 *	-7.216 *	+6.611 *		-6.798 *	-0.583
Model parameters for the two nests:						
Nest: Car						0.247 *
Nest: No Car						0.305 *
Number of observations						28808
ρ^2 (adjusted)						0.217

* Level of significance ≤ 0.10

TABLE 4 Multivariate probit model for the ownership of mobility tools during the life course

Explanatory variable	No Car + No Tickets	No Car + HF T	No Car + Nat T / Reg T	Car + No Tickets	Car + HF T	Car + Nat T / Reg T
Age in years	-0.022 *	-0.052 *	-0.062 *		-0.060 *	-0.078 *
Age in years squared	+0.000 *	+0.001 *	+0.001 *		+0.001 *	+0.001 *
Gender: Male	-0.299 *	-0.297 *	-0.298 *		-0.093 *	-0.097 *
Nationality: Swiss national	-0.502 *	+0.001	-0.001		+0.300 *	+0.199 *
College or university degree	-0.301 *	-0.001	+0.097 *		+0.297 *	+0.296 *
In education	-0.301 *	-0.201 *	+0.298 *		-0.303 *	+0.198 *
Change in education	-0.000	+0.000 *	+0.100 *		-0.100 *	-0.000
Distance between the place of residence and the place of education in 1000 kilometers	-0.540	-0.503	-2.288 *		-0.479	+0.038
In employment	-0.500 *	-0.098 *	-0.098 *		+0.102 *	+0.201 *
Change in employment	-0.200 *	-0.100 *	-0.000		-0.102 *	+0.099 *
Distance between the place of residence and the place of employment in 1000 kilometers	+0.062	-6.982 *	-0.069		+0.661 *	-0.287
Monthly income in 1000 CHF	-0.103 *	-0.091 *	+0.005		+0.009 *	+0.097 *
Monthly income in 1000 CHF squared	-0.000	+0.002 *	-0.001		+0.003 *	-0.007 *
Moving out of parents' house				-0.100		
Change in residence				+0.000		
Birth of a person in the household				+0.201 *		
Number of persons in the household				+0.003		
Number of rooms in the accommodation				-0.016 *		
Degree of urbanization: Urban (referential category)						
Urban to rural				+0.398 *		
Rural				+0.497 *		
Population in the residential municipality in 1000 inhabitants				+0.001 *		
Population density in the residential municipality in 1000 inhabitants per square kilometer				-0.080 *		
Place of residence abroad				+0.898 *		
Purchasing power index in the residential region				-0.008 *		
Constant				+0.299 *		
Correlation matrix:						
No Car + No Tickets	+ 1.000	-0.093 *	-0.094 *	-0.195 *	-0.090 *	-0.089 *
No Car + HF T		+ 1.000	-0.097 *	-0.202 *	-0.193 *	-0.093 *
No Car + Nat T / Reg T			+ 1.000	-0.300 *	-0.203 *	-0.197 *
Car + No Tickets				+ 1.000	-0.422 *	-0.311 *
Car + HF T					+ 1.000	-0.207 *
Car + Nat T / Reg T						+ 1.000
Number of observations						28808
ρ^2 (adjusted)						0.510

* Level of significance ≤ 0.10

Changes in the ownership of mobility tools during the life course

Furthermore, the changes in car availability and public transport season ticket ownership are analyzed. FIGURE 3 shows the occurring alterations during the life course. Thereby five years are grouped together, respectively. Comparing the alterations in the ownership of always and partially available cars during the life course, the two maxima are slightly offset from one another, with always following partially car availability. After the age of 40 years both curves become very flat. There are some persons observed who give up their car as they get older, but this happens only to a lesser extent. For the national tickets the share of variations is noticeably lower, with the highest values being surveyed between the ages of 15 and 30 years. Regional tickets behave very similar to the partially available cars with a maximum for persons aged around 18 years. The half-fare discount tickets show larger variations with increasing age compared to the other mobility tools.

FIGURE 3 Changes in the ownership of mobility tools during the life course

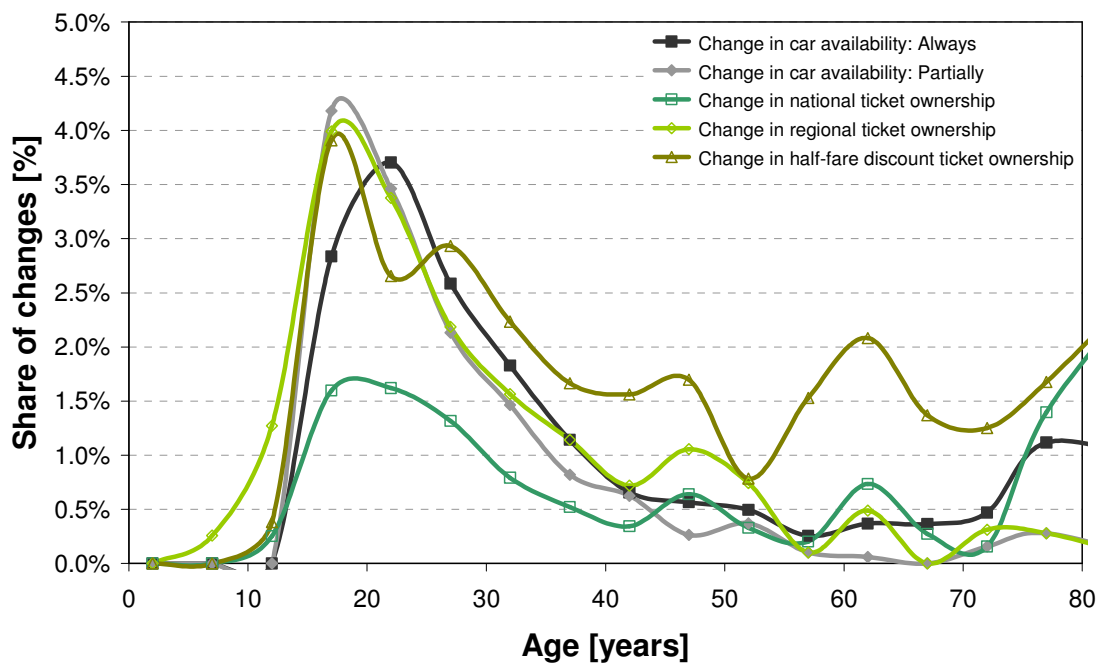


TABLE 5 Binomial logit models for the changes in the ownership of mobility tools during the life course

Explanatory variable	Change in car availability: Always	Change in car availability: Partially	Change in national ticket ownership	Change in regional ticket ownership	Change in half-fare discount ticket ownership
<i>(Difference between the after and before status)</i>					
Age in years	+ 0.064 *	+ 0.084 *	- 0.019	+ 0.021	- 0.008
Age in years squared	- 0.002 *	- 0.002 *	- 0.000	- 0.001 *	- 0.000
Gender: Male	- 0.187 *	- 0.327 *	- 0.313 *	- 0.364 *	- 0.277 *
Nationality: Swiss national	+ 0.030	+ 0.289 *	+ 0.731 *	+ 0.149	+ 0.358 *
College or university degree	- 0.019	+ 0.315 *	+ 1.076 *	+ 0.004	+ 0.457 *
Increase in distance between place of residence and place of education in 1000 kilometers	- 0.413 *	- 0.155	- 0.068	+ 0.105	+ 0.031
Increase in distance between place of residence and place of employment in 1000 kilometers	+ 0.051 *	+ 0.066 *	+ 0.087	+ 0.277 *	+ 0.080
Increase in monthly income in 1000 CHF	+ 0.257 *	+ 0.335 *	+ 0.041	+ 0.118 *	+ 0.089 *
Increase in monthly income in 1000 CHF squared	+ 0.008	- 0.004	+ 0.034 *	+ 0.028 *	+ 0.034 *
Moving out of parents' house	+ 1.597 *	+ 1.815 *	+ 1.293 *	+ 1.392 *	+ 0.947 *
Birth of a person in the household	+ 0.816 *	+ 0.759 *	- 0.641	+ 0.398	+ 0.445
Increase in number of persons in household	- 0.242 *	- 0.141 *	- 0.075	- 0.045	- 0.169 *
Increase in number of rooms in accommodation	+ 0.061	+ 0.048	+ 0.089	+ 0.120 *	- 0.002
Increase in degree of urbanization (from urban to rural)	- 0.203	- 0.325	+ 0.293	- 0.245	+ 0.171
Increase in population in residential municipality in 1000 inhabitants	+ 0.001	+ 0.000	- 0.000	+ 0.001	+ 0.001 *
Increase in population density in residential municipality in 1000 inhabitants per square kilometer	- 0.025	- 0.051	+ 0.166	- 0.079	+ 0.002
Change in place of residence from or to abroad	- 1.132 *	- 1.753 *	- 0.929	- 0.397	- 2.658 *
Increase in purchasing power index in residential region	+ 0.014	+ 0.023	+ 0.006	+ 0.046 *	+ 0.053 *
Constant	- 4.645 *	- 4.817 *	- 5.681 *	- 3.827 *	- 4.175 *
Individual-specific random parameter	+ 0.188	- 0.422 *	- 1.032 *	- 0.528 *	- 0.202
Number of persons	1045	1045	1045	1045	1045
Number of observations	31695	31695	31695	31695	31695
ρ^2 (adjusted)	0.903	0.898	0.928	0.883	0.861

* Level of significance ≤ 0.10

TABLE 5 shows the results of binomial logit models for the occurrence or non-occurrence of changes in mobility tool ownership. Unfortunately it is not possible to take the direction of the changes, i.e., acquiring or abandoning a mobility tool, into account since the proportion of changes in the data set is not sufficient to be further distinguished. For the explanatory variables used in the models the difference between after and before each point in time is calculated on a semi-annual basis. Increasing age as well as gender, i.e., being

male, has overall a negative influence on variations in car availability and public transport season ticket ownership. Swiss nationals tend to alter their ownership of mobility tools more frequently than foreign nationals. This also applies to persons holding a college or university degree, except for always available cars. An increase in the distance between the place of residence and the place of education decreases the probability of changes in car availability happening, whereas a place of employment which is further away leads to more alterations. The monthly income has a positive effect. The move out of the parents' house results in the occurrence of more changes in the ownership of mobility tools. When a person is born in the household, changes in car availability become more likely, while, at the same time, a growth in household size reduces the respective probability. A move from or to another country leads, contrary to the expectations, to less alterations taking place. An increasing index of purchasing power in the residential region has a positive effect, especially for the variations occurring in public transport season ticket ownership.

CONCLUSIONS

During the life course car ownership is highest among those who are 35 to 55 years old today. At the same time, men have noticeably more frequently a car at their disposal than women of the same age. Concerning the ownership of national and regional season tickets, the opposite trend is visible. This means that car ownership on the one side and national and regional season ticket ownership on the other side substitute one another. The ownership of half-fare discount tickets increases relatively strongly over the life course. Overall car availability has a negative influence on the ownership of public transport season tickets.

A comparison of the various discrete choice models for the mobility tool ownership shows that the logit models are relatively similar to one another, with the best model being the nested logit model. Regarding the probit model the goodness of fit measure has considerably improved compared to the logit models.

Concerning the changes in mobility tool ownership over the life course, the most alterations occur between the ages of 15 and 25 years. In this context increasing age as well as gender, i.e., being male, has overall a negative influence on variations in car availability and public transport season ticket ownership. Events in other life course dimensions also play an important role.

With respect to the implementation of policy instruments, these so called key events provide opportunities to significantly influence travel behavior, as habits and routines are broken or at least weakened, and individuals reconsider their behavior and consciously reflect their decisions. Such policy instruments, e.g., in order to encourage a shift from cars towards more sustainable means of transport, like public transport, cycling and walking, can include the provision of information about these alternatives, temporary free public transport tickets, etc.

So far the analyses concentrate on the individual. A further step is the consideration of the entire household, since lives are linked and lived interdependently among members of a family and kin (29). However, it is difficult to trace households over longer period of time, as they emerge and dissolve continuously.

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