

Pre-commitment and usage

Season tickets, cars and travel

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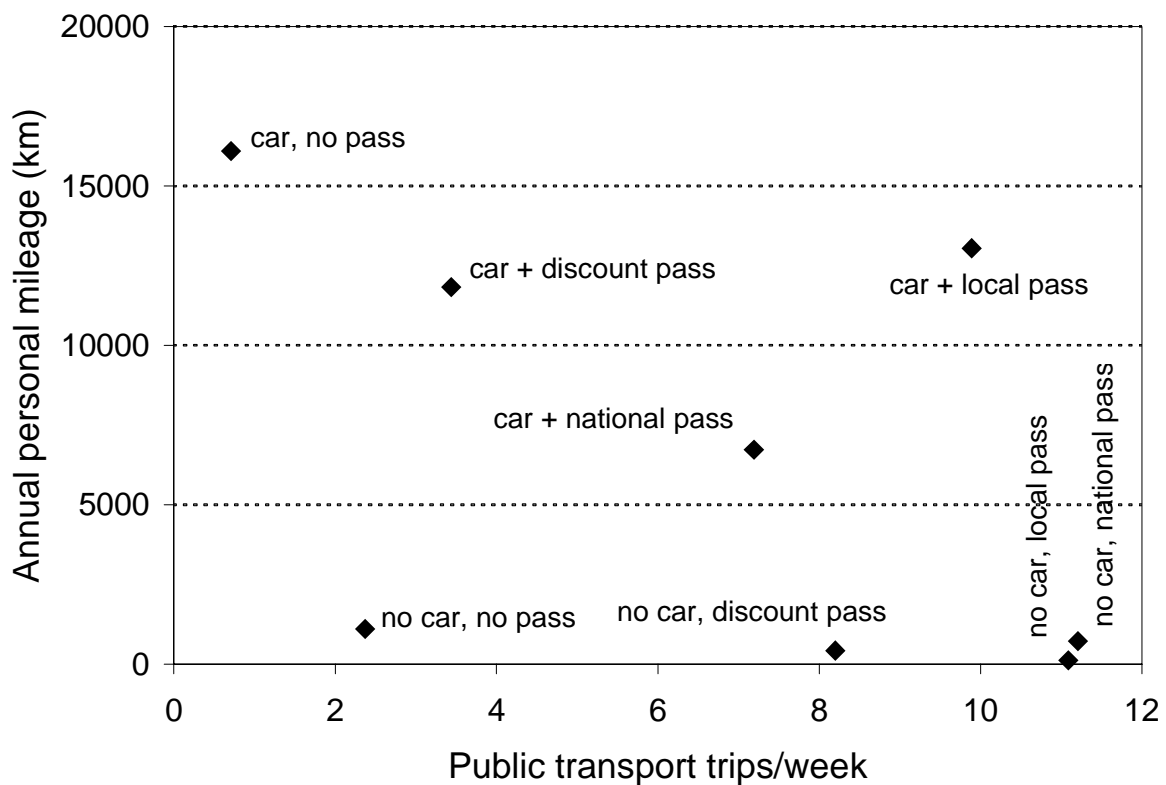
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ABSTRACT

Travellers commit themselves to particular behaviours through the ownership of cars and season tickets. They trade a large one-off payment for low or zero marginal cost at the point of use. To the knowledge of the authors there is no literature which addresses this joint decision. The paper presents an initial model based on a small Swiss 1999 representative sample survey.

Using a structural equation model to test a-priori hypotheses on the paths linking car ownership, season ticket ownership and modal usage. The results confirm the dominance of car ownership, which drives the other variables, in particular season ticket ownership. Still, car usage is complementary with public transport usage through direct positive links to season ticket ownership and public transport usage.

The paper concludes with research questions raised by results so far.

KEYWORDS

Car ownership – Season ticket ownership – Travel intensities – Interactions – Structural equation model - Switzerland

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1 INTRODUCTION

The *Generalabonnement* of the Swiss Federal Railroads, which allows the owner to use just about all public transport in Switzerland free at the point of use, is at 2800 to 4400 sFr per person and year the financial equivalent of mid-sized car³. We can therefore expect, that the owners will show a different allocation of their travel between modes than non-owners, in particular than car owners. Equally, the combination of a local annual season ticket and a rail discount card, such as the Swiss *Halbtaxabo*⁴ and similar cards elsewhere, is likely to have similar, if weaker effects. While models of car ownership are abundant in the literature, models of season ticket ownership are rare and joint models, to the knowledge of the authors, non-existent. In Europe and in other countries with well used public transport this omission is hard to understand. It is idle to speculate about the reason for this important omission, but the dominance of US modelling practice, where the issue is non-existent, and a habit of not asking about the season ticket ownership of respondents, even in European travel surveys, are good first guesses. This paper presents a first joint model of the ownership of a season ticket and, or of a car using it to enquire into the effects of these commitments on travel behaviour. It aims to contribute to the growing literature, which wants to understand, how individuals' long term decisions influence their daily or short term behaviour. This can help us to understand whether the current practice of estimating models of longer term choices based on samples of daily behaviour are appropriate (see for example Ben-Akiva and Bowman, 1996 or Bradley, Bowman and Lawton, 2000). The results also help us to understand the trade-offs of the travellers better and to identify new policy perspectives.

The paper is structured as follows. The first section after this introduction describes the survey on which the analysis is based. The next two sections describe the modelling approach, the behavioural hypotheses and the estimation results. The concluding section summarizes the results and outlines both future work and the policy conclusions.

2 DESCRIPTION OF THE SAMPLE

The Swiss *Gesellschaft für Sozialforschung (GfS)*, Zürich, organizes an annual multi-client study, Univox, for which it provides a nationally representative sample of face-to-face interviews, while its university-based collaborators formulate the questions and analyse the results. The Institut für

³ For details of the pricing, including rebates for families and the elderly see:

http://s26282.sbb.ch:80/pv/gapreis_e.htm

⁴ The *Halbtaxabo* gives a 50% rebate on all rail travel plus many boat services and cable cars for 111 sFr/year.

Verkehrsplanung und Transporttechnik has been in charge of the transport related survey elements since the inception of Univox in the 1980's.

The nature of study limits each subject area to a set of about 10-15 questions depending on their complexity. A proper travel survey is not possible under these circumstances. Still, the research issue only requires four questions: car ownership, season ticket ownership, intensity of personal car use and usage of public transport. The first two are simple factual questions, even including the grey zone of company sponsored cars, but the second two are normally deemed problematic. Still, recent experiences have shown that summary questions about travel behaviour are reasonably accurate. Pickrell and Schimek (1999) showed that four estimates of annual vehicle miles travelled (vmt) derived from different questions in the US national Passenger Transport survey are reasonably close together or – if one wishes – similarly different from the true value. Axhausen, Köll and Bader (1998) showed in a sample survey in Innsbruck that the question about the total number of public transport trips during the last week was understood by the respondents and that two implementations of it⁵ gave statistically equal results and that those results were consistent with other estimates of the number derived from an earlier full travel diary survey.

The other questions were mostly concerned with licence ownership and the staging of its acquisition and of the first car. Those result are reported elsewhere (Axhausen, 1999).

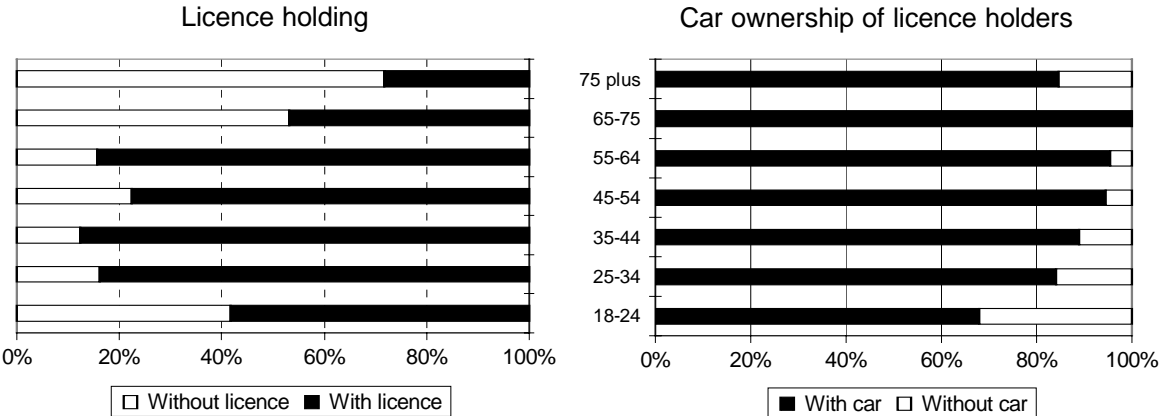
The survey was conducted during the summer of 1999. The sample of 867 is representative of the adult residents of Switzerland in its German and French speaking parts. It excludes the Italian and Romanch speaking parts of the country, about 10% of the population. The GfS checked for the representativeness of the sample and concluded that no weights were necessary to adjust the socio-demographic variables.

The sample mean of 13'900 km/year of personal vmt is consistent with the estimate of the last national personal travel survey (Mikrozensus Verkehr 1994) (GVF, 1996). The sample mean of 4.43 public transport trips/week is higher than the Mikrozensus number, but comparable to the most recent number given in the 1998 Statistical Yearbook for Switzerland.

⁵ The two implementations were: How many trips did you make last week and what types of tickets did you use ? and How many trips did you make on each of the days of the last week and what types of tickets did you use on each ?

Figure 1 shows the share of licence holding respondents by age cohort and the share of car owners among those. While licence holding is clearly age dependent with two oldest and the youngest cohort showing less the average licence holding rates, car ownership rates among the licence holders is less age dependent. Here the range is smaller and the ownership rates of elder respondents only drop of for those over 71 years. In addition, the youngest cohort is clearly still in the process of car acquisition..

Figure 1 Licence holding and car ownership by age in Switzerland

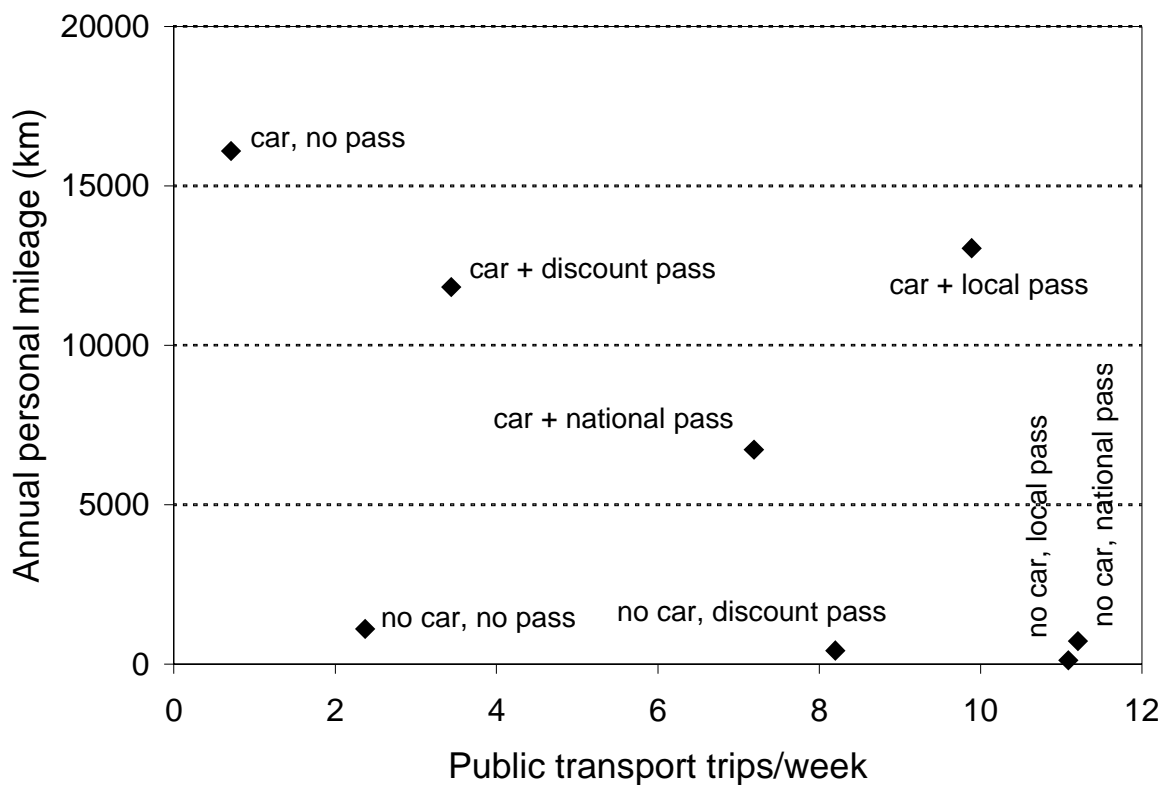


The impact of both car and season ticket ownership on usage is evident in Table 1 and the associated Figure 1. The trade-off (self-selection) between the two forms of travel along the level of pre-commitment to the one of other form is obvious. The exception are those persons which have only a discount ticket, which are relatively active users of both forms of travel. It is clear, but will be formally tested below, that a knowledge of the amount of pre-commitment helps the analyst very much in understanding the patterns of travel behaviour.

Table 1 Mean personal vmt and mean number of public transport trips/week by car and season ticket ownership (sample used for estimation)

Season ticket type	Mean personal vmt [km]			Public transport usage [Trips/Week] by car ownership		
	by car ownership			by car ownership		
	Yes	No	All	Yes	No	All
None	16090	1100	13100	0.71	2.37	1.05
Halbtaxabo	11830	420	7100	3.44	8.20	5.41
Local season	13040	120	5880	9.89	11.09	10.55
National season	6720	720	2460	7.19	11.21	10.04
All	14140	590	9290	2.58	7.75	4.43

Figure 2 Mean personal vmt and mean number of public transport trips/week by car and season ticket ownership



The sample used for modelling removes persons with missing values in any of the variables used. Therefore the differences between the sample means and the values reported in Table 1 and shown in Figure 2.

3 MODELLING APPROACH

The four variables of interest: car and season ticket ownership, vmt and public transport usage can both be cause and effect of each other. Car ownership induces higher vmt, but higher vmt increases the likelihood of car ownership. The modelling approach used has to be able to disentangle both the strength and the direction of these cause-effect relationships. Structural equation models have been developed for this task (described in detail in Bollen, 1989). The approach is based on matching model-replicated variance-covariances to observed variance-covariances. This method has found increasing application in transport in recent years (see for example Golob and Van Wissen (1989) or Golob (1996).

A structural equation model (SEM) is a set of simultaneous equations specifying the direct links between variables (paths). A full SEM with latent variables has at most three components: a measurement submodel for the endogenous variables, a similar measurement submodel for the exogenous variables, and a structural submodel. In the work reported here, only the structural model is used.

The structural model captures the relationships between the endogenous variables themselves and with the exogenous variables. It is defined by

$$\eta = B\eta + \Gamma x + \xi$$

in which the (m) endogenous variables are a function of each other and of the (q) exogenous variables (denoted by the q-dimensional column vector x). The unexplained portions of the endogenous variables (the errors in equations), have a variance-covariance matrix defined by $\Psi = E[\xi \xi']$. The modeller specifies which elements of the Λ , B, Γ and Ψ matrices are free parameters, and these parameters are estimated simultaneously, together with their standard errors. Identification requires, among other conditions, that the matrix (I - B) must be non-singular. By solving the system in terms of the exogenous variables, the total effects of these variables on the endogenous variables are given by the reduced-form equations:

$$\eta = (I - B)^{-1} \Gamma x \tag{3}$$

Estimation of an SEM with variables can be accomplished in several ways, Here we use the weighted least square approach, as it is best suited to binary data, such as car and season ticket ownership. In this form SEM estimate the equivalent of probit models.

4 MODELLING RESULTS

4.1 Hypotheses

The research interest of the study is to understand the interaction between the four variables of interest. Season ticket ownership is divided into two variables: ownership of a Generalabonnement or monthly ticket, and the ownership of a Halbtaxabo, the annual discount card. The combination of the two annual commitments was necessary due to the small numbers of GA owners in the sample. A share of 8% is actually substantial. In principle every variable could influence the other, some simultaneously, such as the pairs, car and season ticket ownership and vmt and public transport usage, some lagged, such as vmt and car ownership or public transport usage and season ticket ownership, some hierarchically, such as the ownership variables the usage variables. Accepting the dominance of the commitment to the car due to its expense and prominence in daily life, it was assumed that there are direct link from car ownership to the other variables. The Halbtaxabo and the Season ticket are supplements. A link between these two follows from this relationships. The commitments influence their respective modal usage. There are various ways of specifying the interaction between the different modal usages. Given the low costs of monthly tickets, the dominant form of season ticket ownership observed, the link was specified through the ownership of a season ticket. The elements of the resulting B matrix are indicated with thicker lines in the path diagram (Figure 3).

The formulation of the Γ matrix was guided by earlier exploratory work using various regression approaches (Two stage least square for the continuous variables and probit models for the ownership variables).

4.2 Estimation results

The model was estimated using LISREL using the Weighted Least Squares method, which is able to estimate proper standard errors of the parameter estimates and goodness of fit statistics, if the endogenous variables are non-multivariate normal. This is the case for the binary variables considered here.

Table 2 Description of the variables used in the estimation sample

Variable	Description	Share/Mean	St. Deviation
Car	Dummy variable for car ownership	64%	
Season ticket	Dummy variable for season ticket ownership (excluding ownership of discount card only)	20%	
Halbtax	Dummy variable for ownership of a annual heavy rail 50% discount ticket	35%	
VMT	Personal annual mileage [thousand km]	9'290 km	13'163 km
PT trips	Public transport trips undertaken during the last week	4.43	6.70
Male	Dummy for male respondents	49%	
Income	Income [k sFr] (estimated at midpoint of response categories; imputed where required)	6.00	3.03
A18	Dummy for age 18-30 years	25%	
A51	Dummy for age 51-60 years	16%	
Midlevel	Dummy for a midlevel position	8%	
Management	Dummy for managerial position	2%	
Rural	Dummy for rural residence	49%	
SR	Dummy for residence in the Suisse Romande	26%	

Table 2 lists the variables used and their means, shares respectively. Table 3 gives the estimates of the parameter matrices and their total effects. All parameters estimated are significant. The overall fits of the model is good, but the total explanatory power of the models is not very large.

The parameter estimate of the link between car usage and season ticket ownership is the most interesting result. In principle both supplementary and complementary relationships are theoretically feasible. The complementary relation could arise, if vmt measures the overall level of mobility, which in turn predisposes highly mobile persons to lower their costs through the acquisition of a season ticket. The supplementary relation could arise from a replacement of car and public transport trips at the point of use. The estimate indicates that the complementary relation is supported by the data available. The complementarity is highlighted as well by the positive direct path between car ownership and public transport usage. The parameters of the exogenous variables have the expected signs. The residents of the Suisse romande (French speaking part of Switzerland) show both a higher car ownership, lower commitment to public transport and a lower public transport usage (see total effect) than the residents of the Deutschschweiz (German speaking part of the country).

The total effects sum the impact of a variable across all paths in the model. For example car ownership negatively impacts season ticket ownership in this model directly, via the ownership of the Halbtaxabo

and the car usage. The total effect is negative, as on the ownership of the Halbtaxabo. Car ownership in total reduces public transport use. Still, controlling for car ownership, actual car driving is complementary with public transport pre-commitment and usage indicating that across the sample the two modes both compete and complement each other. The total effect of the Halbtaxabo on public transport usage is not significant. The number of long-distance journeys most directly affected by the price reduction bought with this discount card is not large enough to detect any influence. The one-week period of the question is too short for this.

Alternative hypothesis structures were tested. None was found to be satisfactory due to a lack of fit.

5 CONCLUSIONS AND OUTLOOK

The results above have shown that the interactions between car and public transport usage and their associated pre-commitments are more complicated than generally assumed. While car ownership does reduce the pre-commitment to the competing mode, actual car usage does increase it. The mobile, in particular, highly mobile, persons make use of both to satisfy their needs. These results hold across the sample as a whole, but they raise a whole range of questions, which cannot be addressed with the current survey due to its sample size.

The existing data show substantial differences between the two parts of Switzerland. Are those a sampling effect in this study or do they exist? If so, why? Is the public transport supply worse in the French speaking part of the country, or do the residents there have different attitudes towards it?

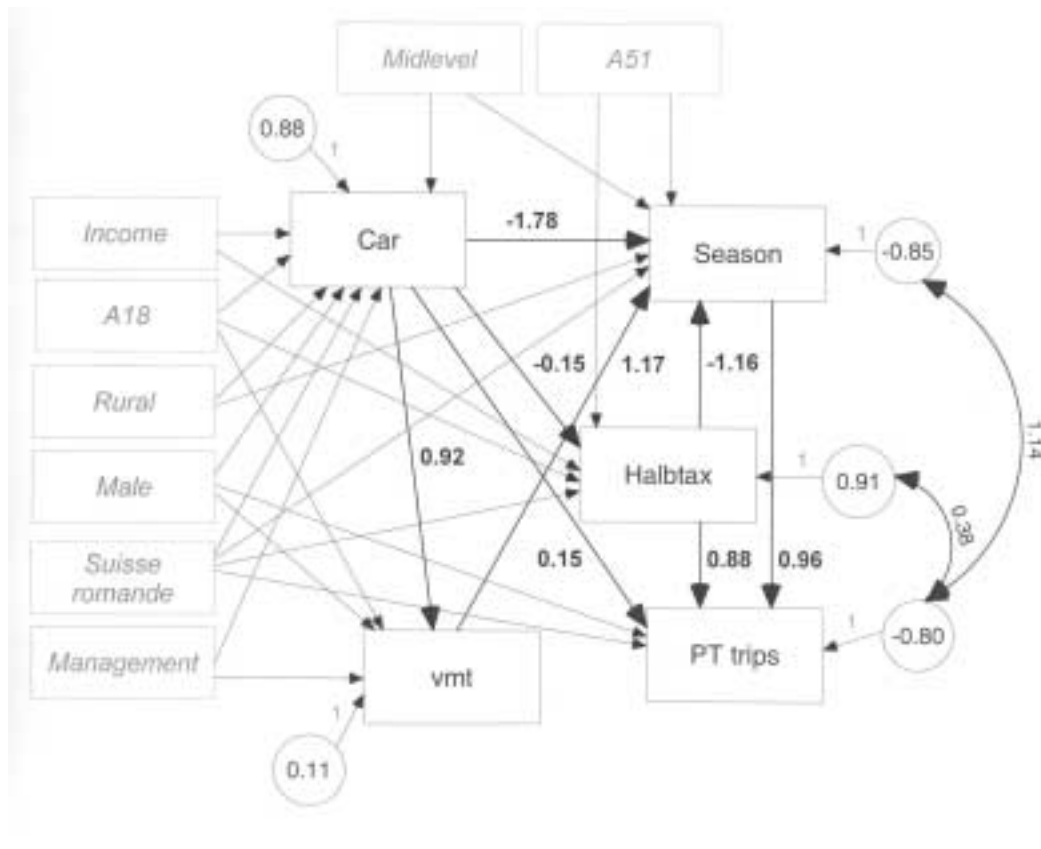
The aggregate complementarity hides substantial differences within the group of car users. Why do they exist and can they be influenced? The cross-sectional data used here (could) confound dynamic effects to produce the complementarity. Is it detectable also in longitudinal observations? The results indicate that the car is the primary commitment. Is this true for the whole population? and if yes, why.

The study compared a measure of daily usage (public transport trips per week) with a measure, which includes both daily needs and long distance travel. At what level is the complementarity working: the daily level or the long-distance level? Will it persist, if only measures of daily usage are employed?

Variable	Beta Total effects					Gamma Total effects								
	Car	Halb Tax	Season Ticket	VMT	PT trips	Male	Income	A18	A51	Mid- level	Man- age- ment	Rural	SR	
Car	--	--	--	--	--	0.15 **	0.14 **	-0.15 **	0.03 **	0.13 **	0.12 **	0.08 **	0.11 **	
	--	--	--	--	--	0.15 **	0.14 **	-0.15 **	0.03 **	0.13 **	0.12 **	0.08 **	0.11 **	
Halbtax	-0.15 **	--	--	--	--	--	-0.05 **	-0.06 **	-0.13 **	-0.07 **	--	--	-0.18 **	
	-0.15 **	--	--	--	--	-0.02 **	-0.07 **	-0.04 **	-0.13 **	-0.09 **	-0.02 **	-0.01 **	-0.20 **	
Season Ticket	-1.78 **	-1.16 **	--	1.17 **	--	--	--	--	--	--	--	-0.33 **	-0.31 **	
	-0.53 **	-1.16 **	--	1.17 **	--	n.s.	n.s.	0.29 **	0.13 **	n.s.	0.03 **	-0.37 **	-0.16 **	
VMT	0.92 **	--	--	--	--	0.08 **	--	0.12 **	--	--	0.08 **	--	--	
	0.92 **	--	--	--	--	0.22 **	0.13 **	n.s.	0.03 **	0.12 **	0.19 **	0.07 **	0.10 **	
PT trips	0.25 **	0.88 **	0.96 **	--	--	-0.10 **	--	--	--	--	--	--	0.19 **	
	-0.49 **	n.s.	0.96 **	1.13 **	--	-0.08 **	-0.06 **	0.22 **	n.s.	-0.05 **	0.03 **	-0.36 **	-0.12 **	
Multiple Squared correla- tions	0.13	0.07	0.23	0.15	0.17	$\chi^2 = 18.06$ (p=0.58) N = 687				Goodness of Fit Index (GFI) = 1.00 Adjusted GFI = 1.00 Parsimony GFI = 0.22				

Table 3 Estimates of the parameters and the total effects

Figure 3 Path diagram of the estimated model



The questions raised point to the need for a panel study of modal usage and pre-commitment, which traces especially younger and older cohorts, which are either in the process of committing themselves or dissolving the commitment. The comparatively small set of questions required should make the recruiting for the panel and its conduct relatively simple.

The results make clear, that a model of the pre-commitments of the travellers should be an essential part of any modelling system of daily travel. Modelling only car ownership, as is current practise, tells only half the story in any spatial context, where travellers can commit themselves to public transport over longer periods: most of Europe, Asia and a surprising number of North American cities. The results also indicate the need to reconsider the current modelling structures in a deeper sense. The structure just proposed, implies a division between the longer-term and the individual journey or trip, where the journey/trip is conditional of the longer-term choices. Given the gap between the specific individual choices and the longer term choices, one might ask, if it is sensible to construct long-term forecasting model systems on the basis of one-day diaries with all their random noise due to the specifics of the individual days reported. One might rather want to focus on the matching long-term commitments in terms of home, second home, work, schooling and shopping locations.

While the results indicate that public transport will grow jointly with car usage, they do not indicate that a large scale replacement of car usage by public transport usage is possible, at least not at a national level. The need to address the pre-commitment to the car is again highlighted with these results. Currently discussed instruments, such as raised gasoline prices or motorway tolls, can reduce and modify the total daily demand, it is unclear at the moment, whether they change the balance in the commitment process and therefore the long-term structural choices involved in the relative location of work and home. Policy makers interested in reducing “car dependence” at the root should think about different instruments, which directly address the question of car and season ticket ownership.

6 ACKNOWLEDGEMENTS

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