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Travel mode choices in a greening market: the impact of electric vehicles and prior investments

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Abstract

Through a choice experiment conducted among 995 Swiss respondents, we study the linkages between prior investment decisions and the choice of travel mode. Our experiment design and empirical framework aims to identify the impact of electric vehicles (EVs) and to test for two behavioural deviations from the rationally optimal usage. Prior investment in a car or public transport pass could be used ex-ante as a commitment device for overcoming self-control issues, or could affect mode choices ex-post through regret effects of sunk costs. We find no evidence to support the sunk cost hypothesis, but our findings provide partial evidence in favour of commitment mechanisms. A prior investment decision decreases the consumer's responsiveness to variation of travel time. However, such commitments do not seem to influence responses to changes in marginal travel cost. Further, we find that EV adoption does not result in a significant step-change in usage patterns above rational marginal cost reactions. Our results thus reinforce the importance of financial incentives in policies aiming at a behavioural change in travel mode choices.

Keywords: Transport; Travel; Behaviour; Choice experiment; Commitment; Sunk cost; Electric vehicles; Environmental policy.

JEL Codes: C25, C91, D01, D90, O33, Q40, Q55

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1 Introduction

Travel mode choices are the outcomes of multiple decisions that occur in different time horizons. While purchasing a vehicle or a travel pass is a relatively long-term decision, the mode choice at the time of travel occurs on a short-term basis. In a rational decision framework, these choices are assumed to be integral parts of a single decision process. However, the behavioural economics literature points to potential deviations from rationality. While these deviations are the subject of a large body of research, there is little empirical research testing such behavioural deviations in the travel choice context. We hypothesise that past long-term decisions (eg. car choice) could influence time-of-use choices. This is particularly important in the current context of a greening transport sector with increasing electric vehicle (EV) options available. Adoption of emerging technology requires relatively important initial investments facing future uncertainties, a favourable context for decisions based on behavioural heuristics and bounded rationality.

The rising proportion of global EV purchases benefits air pollution emissions from the transport sector, however could exacerbate other externalities through a rebound effect in car use (see, for example, Dimitropoulos et al., 2018). Given that the marginal cost of EV use is generally lower than for traditional internal combustion engine vehicles (ICEs), adoption of EVs could induce a higher usage. There is, however, little empirical research on whether EV adopters are likely to change their car use patterns beyond the direct effects of marginal costs.

We use the hierarchical decision structure to develop tests for potential deviations from rational decision-making in the context of personal travel. Our focus is on prior investments and their impact on the choice of travel mode at the time of use. We distinguish two competing hypotheses based on commitment mechanisms (Thaler and Shefrin, 1981) and sunk cost effects (Garland and Newport, 1991). We also include the market for green vehicles and test the impact of these on travel mode choices. Building on the preliminary work of Simma and Axhausen (2001, 2003), we provide the the first tests of these theories in the context of travel mode choices through a choice experiment. Our experiment design aims to identify the possible impacts of EV adoption on usage patterns independently of marginal travel costs.

An experimental approach avoids selection issues inherent in revealed transport choice data (as in, for example: Simma and Axhausen, 2001; Ho et al., 2018). It additionally allows us to investigate consumer behaviour in relation to new vehicle types, when the market share of EVs is small. We surveyed a sample of 995 respondents across German- and French-speaking regions of Switzerland. Exploiting the hierarchical structure of transport decisions, we analyse trade-offs between each of three decision levels: long-term car purchase, medium-term public transport pass purchase, and time-of-travel transport mode choice. This setup allows us to analyse how respondents react differently to marginal travel costs, if they use commitment devices, if there is evidence of a sunk cost fallacy, and if EV owners travel differently or use their cars more than marginal costs would dictate.

We provide the first experimental evidence that consumers do largely act rationally in their travel decisions. In particular, we do not find any evidence of sunk cost effects. Moreover, our results do not point to any commitment mechanisms that could distort the rational effect of marginal travel cost. However, we find evidence that prior investments distort the responsiveness to changes in trip duration, hence indicating a commitment effect to specific travel modes at this level. We finally find that purchasers of EVs do not behave differently to those with other car engine types. EV owners do not inherently use their car more, and still react the same to marginal trip costs as ICE car purchasers. One exception here is a slight dampening of plug-in hybrid electric vehicle (PHEV) purchaser reactions to marginal car trip cost, and a slightly larger reaction to car trip durations.

Our findings indicate the importance of marginal travel costs in personal mobility decisions. It also shows that the advent of new green car technologies does not automatically lead to a step-change in car use and transport mode decisions above changing marginal travel costs. Our findings have repercussions for government policy-making around transport, especially over the transition to more sustainable transport consumption patterns. We reinforce the fact that consumers can be incentivised to change mobility patterns through marginal cost adjustments such as fuel taxes, and fees for parking and road use.

The remainder of this paper is structured as follows. Section 2 provides an overview of the relevant literature and details the behaviours we test. Section 3 outlines our methodology, including the experimental design and econometric framework, and develops an empirical implementation of the specific hypotheses. Section 4 then summarises our data, section 5 presents our estimation results, and, finally, section 6 concludes.

2 Background

A range of behavioural literature in economics and psychology indicates that consumers may use commitment devices to lock themselves into particular future choices (eg. Thaler and Shefrin, 1981; Gul and Pesendorfer, 2004; DellaVigna and Malmendier, 2004; Laran, 2010; Kivetz and Simonson, 2002), or may take account of sunk costs (eg. Friedman et al., 2007; Just and Wansink, 2011; Garland and Newport, 1991; Arkes and Blumer, 1985; Thaler, 1980; Staw, 1976). In the context of travel choices, the long- to medium-term ownership of a car or public transport pass may provide consumers with a commitment device to engage in specific mode choices at the time of travel. A car purchase could provide a pre-commitment (or an allowance) to car-use at the time of travel even if such use is non-optimal from a marginal cost perspective, given the available alternatives (Steg, 2005). A public transport pass, on the other hand, could be purchased to commit oneself to using that mode in light of potential future temptation to indulge in driving a car (Kivetz and Simonson, 2002). The sunk cost effect would indicate that a consumer would overuse their car (compared to what relative marginal costs would dictate) due to regret about its purchase or self-justification (Aronson, 1968; Arkes and Blumer, 1985). Importantly, this effect would rise the greater the 'investment', i.e. the cost of the car (Garland and Newport, 1991).

Choice of travel mode, a seemingly simple decision at the time of travel, is in fact the result of a sequence of decisions at different time horizons. This sequence starts from relatively long-term investment decisions (occurring once every few years), such as purchasing a particular car. This is followed by intermediate-term decisions such as the purchase of a public transport pass/subscription (occurring once or a few times a year). The sequence ends with the choice of travel mode at the time of travel, occurring at a high frequency (eg. on a daily basis).

Much research has been conducted on car purchase choice[1] and on travel mode choice[2] separately. We combine these into a joint framework of the inter-dependent mobility choice structure. To date, in the mobility domain, little attention has been devoted to the potential deviations from the standard assumptions of rational expected utility maximisation. The hierarchical, inter-temporal transport decision-making structure and the interdependencies between choices gives this sector prime opportunity for the appearance of such behavioural deviations.

The existence of commitment devices in other areas has long been demonstrated and fundamentally stems from the work on consumers' self-control by eg. Schelling (1978, 1984) or Thaler and Shefrin (1981). They showed that individuals restrict their future self's choice set by pre-committing to a certain course of action, if they believe they will face a future lack of self-control, or be tempted into short-run gratification.

Only few authors (Simma and Axhausen, 2001, 2003; Loder and Axhausen, 2018) have discussed commitment devices within transport choices. Simma and Axhausen (2001, 2003) look into the difference in car and public transport use between those who own a car or a transport pass. Loder and Axhausen (2018) additionally include data on trips made by soft transport (cycling or walking). The authors conclude that they find evidence of commitments to transport modes as the consumers who own or have access to a particular mobility device (i.e. a car or public transport using a discount pass), use that mode relatively more. However, this fails to account for the impact of marginal trip costs, which are reduced for a given mode by purchase of the relevant transport device. Therefore the increased usage of a mode by device holders could be justified through rational decision theory. The authors state that this is indeed the case.

Our focus in this paper is on a commitment effect beyond the rational response to lowered marginal costs. We argue that for evidence of a commitment effect, variations in marginal trip costs would engender a significantly smaller behavioural response among device owners

[1] See for example: Lave and Train (1979); Hess et al. (2012); Brownstone et al. (2000); Bunch et al. (1993); Spissu et al. (2009); Bhat and Sen (2006); Choo and Mokhtarian (2004); and Tompkins et al. (1998)

[2] See for example: Vovsha (1997); Schwanen and Mokhtarian (2005); Shen (2009); Richter and Keuchel (2012); Hess et al. (2018); and Waerden and Waerden (2018).

than for non-device owning individuals. To our knowledge there is no empirical study that robustly tests such an impact and therefore credibly identifies the existence of commitment devices in the transport sector.

We contribute to the broader commitment effect literature, which has shown evidence for its existence in a wide range of sectors. Laran (2010) experimentally demonstrates it with healthy versus indulgent food consumption and money saving versus spending. DellaVigna and Malmendier (2004) explore the implications of the effect for contract design in gym memberships, credit cards and more. Kivetz and Simonson (2002) show that some consumers commit themselves to future indulgences if they are presently more prone towards saving.

The sunk cost effect, also known as the 'sunk cost fallacy', represents a behavioural tendency to consume more of a good, the larger the investments they have previously made in relation to the good, even though the investments are 'sunk' and should have no bearing on the consumption decision. In rational theory consumers should base their consumption decisions on marginal benefits and costs, regardless of the sunk cost. Deviations from this have been explained in that people feel a level of regret about their past investment and now continue to consume the good as self-justification for the previous expenditure (Aronson, 1968), or out of a desire to not appear wasteful (Arkes and Blumer, 1985). Some of the original studies of sunk costs include Staw (1976), Thaler (1980), and Arkes and Blumer (1985). The last, for example, demonstrates that sunk costs have an impact on theatre attendance - the more paid for season tickets, the higher the rate of attendance across the season. Further studies reinforce that the greater the sum invested, the greater the impact it has on later decisions (Garland and Newport, 1991) in a range of areas, including food consumption (Just and Wansink, 2011), and business investments (Putten et al., 2010). However, the evidence is not always positive. Friedman et al. (2007) show a mixture of findings across the broader literature, and their own computer-based lab experiment found a small and inconsistent sunk cost effect.

The transport sector is well-suited to the study of the impact of sunk costs given the large and variable investments in mobility devices and infrastructure, and the frequent, repeated transport decisions made. Ho et al. (2018) use data on car odometer readings across a number of years and changes in car registration costs in Singapore and Hong Kong, and show that the higher the amount invested in registering a car, the more it gets driven. However, this could be due to selection bias, as the higher registration costs leave only those with the greatest benefit from having a car (those who use it more). It could also be due to a non-psychological path – higher registration costs could induce more car sharing, at a minimum amongst family and friends, generating a reduction in the average number of cars per household but increasing the use of existing ones. Our experimental approach avoids such selection issues. Additionally, we again focus on marginal trip costs. Existence of a sunk cost fallacy would mean that larger sunk costs lead consumers to react less to variations in marginal costs.

3 Methodology

3.1 Experimental design

We design a sequential choice experiment embedded within the annual Swiss Household Energy Demand Survey (SHEDS) 2018.[3] In total 5514 individual households took part in the 2018 survey wave, and 995 of these were randomly assigned to take our experiment. This assignment targets a representative sample along gender, age, region, and housing status.

The choice experiment is organised in a sequential structure to mimic the natural decision-making process. We first ask respondents to make a 'long-term' choice regarding a transport investment – car purchase. This is followed by the 'medium-term' choice of a public transport pass. Finally, the immediate, time-of-travel mode decisions is made.

The choice tasks are designed with attribute levels of the car and transport mode tasks depending on the respondent's previous choices. This setup allows us to obtain accurate and reliable responses, and to accurately estimate the effect of past investments on consumers' transport mode choices. The questionnaire is provided in Appendix A for reference.

In more detail, the experiment proceeds as follows. We initially prime the respondents by providing a script to encourage accurate and truthful responses, in line with the literature

[3] For more details on SHEDS see Weber et al. (2017).

on preference elicitation in stated preference studies (Vossler et al., 2012). We additionally include a reminder about the respondents' household budget constraints, and indicate that the decisions here would require trade-offs to be made (as per, for example, Johnston et al., 2017).[4] Following this, we ask respondents to imagine that they have to make a choice about purchasing a primary household car "within the next year". This is a relatively common task for Swiss households as our data show an average car replacement period of about 5.5 years.[5]

The first choice task, then, is to choose the car size, between 'micro', 'small', 'small-medium', 'mid-size', 'large' and 'SUV'.[6] We also give respondents the option of choosing not to buy a car. Those who choose some car size proceed on to the second choice task, which asks respondents to choose a specific car. This task is a labelled choice table with 6 options and 5 attributes, as illustrated in figure A.3. The labels are each car engine type, with two options as 'electric' (i.e. BEV), two 'plug-in hybrid' (PHEV), one 'hybrid', and one 'internal combustion engine' (ICE). The attributes are 'price', 'driving cost per 100km', 'battery range', 'max. speed', and 'CO_2 emissions (g/km)'. Levels were set using data from the Touring Club Switzerland (TCS) on all cars currently available in Switzerland (TCS, 2018).

Next, all respondents answer the medium-term question of whether to buy a public transport pass. Such passes are ordinarily renewable on a monthly or yearly basis and give unlimited access to public transport across the entire country or a specific region.[7] The following pass options are provided: '1st class GA', '2nd class GA', a local 'regional pass', or 'none'. Both GA (*General Abonnement*) passes provide unlimited access to all public transport in the country, while regional passes offer the same within a defined region (usually a Swiss canton). The single attribute in this task is the pass price.

Finally, all respondents receive a series of choice tasks regarding the transport mode for specific trips. We repeat the transport mode task three times for each of three trip types (commute, local leisure, and weekend trip), giving nine choice situations per respondent in

4 See Appendix A, figure A.1 for the script.

5 This number is also externally validated by a Comparis (2013) survey which finds Swiss households replace their car every 5 years.

6 These categories are based on the standards given by the Touring Club Switzerland (TCS, 2018).

7 Detailed information regarding the existing public transport tickets is available from the Swiss Federal Railways company: www.sbb.ch/en/travelcards-and-tickets.html

total. Respondents who do not ordinarily commute (do not work or work from home) are only given leisure and weekend trip choice situations. Choice tasks are composed of two attributes, trip cost and trip duration, and are labelled with the transport mode (see figure A.5). There is a maximum of five mode alternatives available: public transport (PT), respondent's private car (CR), soft transport ('bike or foot' - ST), car sharing (CS), and 'car with a driver' eg. taxi (CD), with available alternatives and attribute levels depending on previous choices and responses. Irrelevant options are not displayed. For instance, respondents who choose not to purchase a car in the first step do not receive the option to use one at this stage. For trip distances longer than 10km soft transport is not realistic and therefore not offered. The levels of the cost attribute is further tailored to the device decisions previously made by the respondents. For example, respondents who choose to buy a GA public transport pass have a cost of 0 for using this mode. Those who buy a car receive different trip cost values depending on the efficiency of the car they purchase and the trip distance. In order to introduce some variability in the experimental design, the displayed attribute levels for each alternative additionally vary randomly between respondents and choice tasks, applying weights of 0.5, 1, or 1.5 to the calculated average values.

3.2 Econometric framework

Our primary objective is to analyse the impact of the sequential, hierarchical transport decisions on the transport mode choice at the time of travel, while controlling for respondents' various socio-demographic and behavioural characteristics. To do this we propose a comprehensive choice model that considers the various choice-level decisions and the final outcomes simultaneously.

Using a standard random utility model (RUM) framework as the basis of our estimations (McFadden, 1974), we estimate the choice of transport mode, between public transport (PT), private car (CR), and soft transport (ST). The two alternatives 'car with driver' and 'car sharing' are selected in less than 3 percent of choice tasks. Due to the low share, we exclude these two modes from the estimation.[8]

Using the following utility function, respondent n's utility for mode i in choice task t is estimated by:

$$U_{nit} = \alpha A_{nit} + \beta_i + \gamma_i T_{it} + \delta_i X_n + \varepsilon_{nit} \tag{1}$$

where mode i is an element of P (public transport), C (car), and S (soft transport). The vector of coefficients of the choice task-mode-respondent specific attributes A_{nit} is given by α. Specifically this includes the cost (CHF) and duration (minutes) of the trip. The alternative specific constants (ASC) for each mode are represented by β_i. We estimate coefficients γ_i for each trip type T_{it} (commute, leisure, and weekend) and allow the trip type utility to vary by mode. We also include the respondent's individual characteristics and responses to the previous levels of transport choices through X_n. The impact of these choices and characteristics varies by transport mode, therefore the set of coefficients is given as δ_i. Finally, the error term ε_{nit} is a type I extreme value term, identically and independently distributed (IID) across respondents and alternatives.

Respondents select the transport mode i that maximises their level of utility - i.e. $U_{nit} > U_{njt}$ $(\forall j \neq i)$. We conduct this estimation using a standard multinomial logit (MNL) model, where the probability of a respondent selecting a particular transport mode is given by:

$$P_{nit} = \frac{e^{U_{nit}}}{\sum\limits_{j \in E} e^{U_{njt}}} \tag{2}$$

where E is the set of possible mode alternatives.

In our estimations we set PT as the base travel mode, that is:

$$\beta_i = \gamma_i = \delta_i = 0 \quad \text{for} \quad i = P \tag{3}$$

[8] This leads us to drop 230 choice tasks from 123 respondents, including one respondent who always chooses these alternatives. This additionally means that 372 choice sets were left with only one mode alternative, PT, thus we also exclude these. Out of 8259 travel mode choice sets, we therefore remove 7.3 percent. We test this restriction with the Hausman test of IIA and see that it does not significantly alter the results.

The variables in X_n include the respondent attributes: commute distance (natural log); residential location (city, agglomeration, rural); linguistic region (French/German-speaking); household size (1 person, 2 people, 3 or more people); biospheric values; and car and PT pass ownership in real life. We additionally include the responses to their previous transport choices: car yes/no; car size; car engine type; car price (natural log); and purchase of a PT pass.

In A_{nit} we further add variables for the cost and duration of the trip by car (if available), and the duration of the same trip by PT.[9] In this way we allow the impact of these trip costs/times on utility to vary from the average for those with specific mode alternatives available. We additionally interact the above variables with a public transport pass dummy to detect whether pass holders react still differently. We finally also interact the car price with the above car trip costs.

The biospheric values measure the importance respondents attribute to environmental protection and pollution prevention. Respondents rated four values (respecting the earth, unity with nature, protecting the environment, and preserving nature) as "guiding principles in their lives" on a 5-point scale ranging from 1 "not important" to 5 "extremely important" (Steg et al., 2014). Aggregating the four answers gives the respondent's average biospheric value. We further create a binary variable with a value of 1 if respondents have an average biospheric value of 4 or more.

3.3 Empirical behavioural tests

To investigate the existence of mode-commitment device usage and a reaction to sunk costs among respondents, we focus on a few key variable interactions. We summarise these tests in table 1. We additionally test the effect of EV ownership on mode choice, compared to ICEs, both in absolute terms, and in terms of the purchasers' reactivity to marginal trip costs. Overall, we naturally expect negative coefficients for *trip cost* and *trip time*. The tests we

[9] We do not also use PT trip cost because of the lack of variation in PT trip costs due to the number of respondents selecting public transport passes rendering the trip cost 0.

implement rely on interaction terms that capture divergence around the overall coefficients for some respondents.

If respondents were to display evidence of purchasing a car as a commitment device, we would expect them to be less reactive to differences in the marginal travel costs than average respondents. Specifically, car purchasers should react less to variation in the costs of a trip by car as they are committed to using their car. Our primary car commitment tests are therefore if the coefficients of *CR trip cost*$_C$ and *CR trip time*$_C$ are positive. This would effectively indicate a reduced marginal disutility resulting from *trip cost* and *trip time* variables for car trips.[10] Additionally, we would expect car purchasers to react less to changes in the costs of the alternative transport mode, *PT trip time*. As P is the base alternative with the reference utility (0), an increase in trip duration by public transport corresponds to a relative rise in the marginal utility of the other modes, namely car and soft transport. Therefore, our secondary test for a car commitment effect is for negative coefficients on the corresponding terms *PT trip time*$_C$ and $Car \times$ *PT trip time*$_S$, which would effectively reduce the magnitude of the car-owner's reaction to PT travel times.[11]

As for respondents opting for a PT pass, if it were to function as a commitment device their marginal disutility of the trip duration using public transport should be lower than those without a pass. Thus the interaction term *PT pass* $\times$ *PT trip time*$_P$ would be expected to be positive. However, as above, P is the base alternative, thus our primary PT pass commitment device test is the inverse of this, meaning we would expect negative coefficients for *PT pass* $\times$ *PT trip time*$_C$ and *PT pass* $\times$ *PT trip time*$_S$. Furthermore, among the respondents who opt to purchase a car, those who additionally choose a PT pass should be less responsive to car trip attributes - namely, car trip cost and duration. Therefore, our secondary test is for an expected positive sign for the two interaction terms *PT pass* $\times$ *CR trip cost*$_C$ and *PT pass* $\times$ *CR trip time*$_C$.

[10] As the car alternative is only offered to respondents who chose to 'buy' a car in the experiment, the utility of this travel mode is only relevant for this group.

[11] The same reasoning applies to *PT trip cost*, however we do not apply this due to its limited variation in the experimental design.

Table 1: Summary of behavioural tests

	Primary tests		**Secondary tests**	
	Variables	Expected direction	Variables	Expected direction
Car commitment	*CR trip cost*$_C$	>0	*PT trip time*$_C$	<0
	CR trip time$_C$	>0	$Car \times$ *PT trip time*$_S$	<0
Pass commitment	*PT pass* $\times$ *PT trip time*$_C$	<0	*PT pass* $\times$ *CR trip cost*$_C$	>0
	PT pass $\times$ *PT trip time*$_S$	<0	*PT pass* $\times$ *CR trip time*$_C$	>0
Sunk costs	*ln(car price)*$_C$	>0	*ln(car price)* $\times$ *CR trip cost*$_C$	>0
			ln(car price) $\times$ *CR trip time*$_C$	>0

Note: The subscripts C and S denote the mode alternative to which the given alternative specific variable is relevant, based on equation 3.2. *Car* and *PT pass* are respectively binary indicators for adoption of a car and public transport pass in the experiment.

The logic for evidence of consumer attention to sunk costs follows a similar pattern to the above, however, car use depends on the amount invested, i.e. the car price. If respondents were to display evidence of the sunk cost fallacy we would expect consumers to use their car more the greater the amount they paid for it. Therefore, the consumers' utility gained from using the private car mode should rise the greater the price of the car. Thus our primary test is *ln(car price)*$_C > 0$. We would also expect car owners' reaction to the trip costs from using the car alternative to be increasingly dampened the greater the car price. Thus we would secondarily expect *ln(car price)* $\times$ *CR trip cost*$_C$ to be positive. The same idea holds for trip duration, thus we should also see a positive impact of *ln(car price)* $\times$ *CR trip time*$_C$.

4 Data

4.1 Descriptive respondent statistics

The SHEDS sample is designed to be representative of the population at the national Swiss-level (excluding Ticino) (Weber et al., 2017). Our choice experiment respondents broadly match this requirement, and we summarise here the data for the 994 respondents used for analysis (see also Appendix B, table B1). Specifically, the age group targets are 18-34: 30%, 35-54: 40%, 55+: 30%. We slightly under-sample the youngest group and over-sample the older, with 24 and 35 percent, respectively. Further, we achieve sample proportions for renting versus owning that are close to the target of 63 percent tenants and 38 percent owners.

For our analysis, we also specifically targeted nine segments based on household size and region. We segment by single, 2-person and multi-person households, and city, agglomeration, and rural locations, as shown in table B1. Over half of respondents live in the city, compared to 21 percent that are rural inhabitants and 28 in an agglomeration.

Respondents clearly vary in their real-life transport decisions, providing a good starting point for our experiment. About 26 percent of respondents do not own a car (table B1). This is slightly more than in the last Swiss Mobility and Transport Microcensus, which shows nearly 80 percent household car ownership in 2015 (FSO, 2017). Further, 45 percent of respondents own a public transport pass, slightly less than the 57 percent observed in the 2015 Microcensus, however the latter also includes some additional forms of passes (FSO, 2017). The majority of the public transport passes in our sample are GA travelcards of either 2$^{\text{nd}}$ or 1$^{\text{st}}$ class - 24 percent of all respondents.

4.2 Descriptive choice statistics

From the choice task responses, we gain an idea of the decision distribution and variation. Table B2 summarises the choices. Overall, 89 percent of respondents choose to buy a car. This is slightly more than the historically stable Swiss car ownership rate of around 80 percent (FSO, 2017) and above the rate of 74 percent in our sample. Among the 882 respondents who decide to purchase a car, the majority choose a small or small-medium sized car. Over a third (34 percent) of respondents choose to buy a pure-electric vehicle (BEV), and a similar proportion choose an ICE. In total 17 percent choose a PHEV and 15 percent a traditional hybrid.

Importantly for estimation of the impact of sunk costs, respondents who choose to purchase a car 'spend' 35 000 CHF at the median. The prices range from 24 000 to 53 000 CHF at the 25$^{\text{th}}$ and 75$^{\text{th}}$ percentiles, respectively. The car prices selected naturally vary between fuel-types, and on average respondents buying a BEV or PHEV are willing to spend more. The median BEV price is 40 000 CHF and PHEV price is 51 000 CHF. By comparison, the median ICE price is 24 000 CHF.

For the public transport pass choice, 53 percent choose not to buy one, while 25 percent choose a regional pass, and 23 percent a GA of either class. About 45 percent of respondents who choose to buy a car also choose to purchase a PT pass, allowing for analysis of the two potential commitment device behaviours together.

Pearson's chi-squared tests show that the choices made in the experiment about car size and fuel type, and PT passes are significantly related to the real life situation of respondents. That is, the stated car and PT pass preferences correspond with their revealed preferences. To some extent, this finding also illustrates consumer inertia. When faced with an important decision such as purchasing a car, consumers tend to favour a technology with which they are familiar. This has already been observed for example for heating system replacement (Lang et al., 2020), and broadly for repeated car ownership (Weis et al., 2010).

Following from the relatively high purchasing of transport devices (a car and/or PT pass), most respondents choose to use these two modes in the experiment. Overall, the private car is the most selected transport mode, around 49 percent, followed closely by public transport at 34 percent.

Slight differences emerge between trip types. Among commuters, public transport is the chosen transport mode 41 percent of the time, followed by the respondent's own car at 40 percent. Respondents choose to use soft transport 16 percent of the time for commuting. For local leisure trips, public transport, private car, and soft transport are each chosen around a third of the time. For longer distance, weekend trips, the car is by far the most popular travel mode chosen at 60 percent, with 36 percent for public transport.

These results further hint at some differences in mode choice based on the trip distance. Focusing on commuting behaviour, we observe significant differences by the household location. In the city most respondents choose to commute with public transport, 51 percent, while private cars are chosen about 27 percent of the time. Conversely, among respondents living in agglomerations and in the countryside, the majority choose to use their own car. Commuting by public transport is chosen around 30 and 32 percent in agglomeration and rural households, respectively. City-based respondents choose the highest proportion of soft transport at 19 percent, compared to 14 percent of agglomeration respondents, and 11 percent among rural respondents.

We also see that the transport mode chosen varies according to the car chosen. BEV purchasers are much less likely to use their car to commute (37 percent) than those who chose an ICE (56 percent). ICE owners are correspondingly less likely to use public or soft transport compared to the other car buyers.

5 Results

We estimate four models based on equation 1: (1) including respondent characteristics and the car choice; (2) adding car-choice interactions to test the behavioural impact of green cars; (3) adding our primary behavioural tests; and (4) adding our secondary behavioural tests. The estimation results are shown in table 2, where the upper panel shows the utility coefficients for the trip attributes, namely the cost and duration of the trip, and the lower panel shows the estimated coefficients for the alternative specific variables.

The trip attribute coefficients are both significant and of the correct sign in all models. Specifically, higher travel costs in money and time both lead to decreases in utility. This means that increases in the costs of any particular transport mode alternative renders the selection of that mode less likely.

From the results of model (1), we focus on the impact of respondent characteristics on mode choices. We find that compared to city-dwellers, those living in an agglomeration or the countryside gain more utility from using a car. Additionally, rural-inhabitants are more likely to walk or cycle on average than those in other regions. Respondents from French-speaking Switzerland are shown to be more predisposed to using cars than those from the German-speaking region.

Commute distance naturally exerts a negative impact on the probability of taking soft transport, however does not influence car usage when controlling for other factors. Respondents who place a high importance on the environment obtain a disutility from car-use and higher utility from soft transport. Finally, respondents who own a car in real life are signif-

Table 2: Estimation results

	(1)		(2)		(3)		(4)	
Trip attributes								
Trip cost (CHF)	-0.050^{***}		-0.054^{***}		-0.036^{***}		-0.039^{***}	
	(0.005)		(0.006)		(0.006)		(0.006)	
Trip time (minutes)	-0.020^{***}		-0.020^{***}		-0.020^{***}		-0.030^{***}	
	(0.001)		(0.001)		(0.002)		(0.002)	
Alternative specific variables	C	S	C	S	C	S	C	S
ASC	-1.052***	0.829***	-1.081***	0.792***	2.201	1.773	1.475	1.801
	(0.280)	(0.301)	(0.293)	(0.305)	(2.699)	(3.378)	(2.859)	(3.503)
Trip: Commute	*base*	*base*	*base*	*base*	*base*	*base*	*base*	*base*
Trip: Leisure	0.410*	-0.606**	0.310	-0.650***	0.374	-0.623**	0.507**	-0.588**
	(0.224)	(0.247)	(0.242)	(0.251)	(0.235)	(0.249)	(0.238)	(0.254)
Trip: Weekend	0.517**	–	0.157	–	0.417	–	0.750**	–
	(0.240)		(0.403)		(0.378)		(0.382)	
City	*base*	*base*	*base*	*base*	*base*	*base*	*base*	*base*
Agglomeration	0.384***	0.062	0.390***	0.066	0.345***	0.041	0.334***	0.034
	(0.110)	(0.137)	(0.110)	(0.137)	(0.111)	(0.138)	(0.110)	(0.143)
Countryside	0.336***	0.330**	0.335***	0.331**	0.328***	0.321**	0.315**	0.329**
	(0.124)	(0.155)	(0.125)	(0.155)	(0.124)	(0.155)	(0.122)	(0.159)
French-swiss region	0.347***	-0.173	0.341***	-0.175	0.351***	-0.156	0.341***	-0.165
	(0.113)	(0.141)	(0.113)	(0.141)	(0.115)	(0.142)	(0.114)	(0.146)
Single person household	0.202*	-0.046	0.210*	-0.038	0.237**	-0.023	0.225**	-0.025
	(0.114)	(0.133)	(0.114)	(0.133)	(0.115)	(0.134)	(0.113)	(0.138)
2 person household	*base*	*base*	*base*	*base*	*base*	*base*	*base*	*base*
3+ person household	-0.117	0.132	-0.120	0.130	-0.126	0.133	-0.130	0.143
	(0.113)	(0.132)	(0.114)	(0.132)	(0.114)	(0.132)	(0.113)	(0.136)
ln(commute distance)	0.026	-0.660***	-0.033	-0.687***	0.012	-0.667***	0.071	-0.660***
	(0.073)	(0.116)	(0.088)	(0.118)	(0.085)	(0.117)	(0.085)	(0.119)
Strong biospheric values	-0.237**	0.208*	-0.230**	0.211*	-0.217**	0.218*	-0.221**	0.225*
	(0.097)	(0.121)	(0.098)	(0.121)	(0.098)	(0.122)	(0.097)	(0.125)
Car in household	1.337***	0.065	1.331***	0.082	1.439***	0.110	1.413***	0.087
	(0.136)	(0.139)	(0.136)	(0.140)	(0.139)	(0.142)	(0.135)	(0.147)
PT pass in household	-1.068***	-0.962***	-1.052***	-0.951***	-0.504***	-0.789***	-0.517***	-0.809***
	(0.103)	(0.123)	(0.104)	(0.123)	(0.132)	(0.155)	(0.131)	(0.159)
Car: None	–	0.114	–	0.168	–	-0.695	–	-0.519
		(0.222)		(0.223)		(3.362)		(3.487)
Car: Micro–Small	-0.131	0.236	-0.122	0.237	-0.202	0.218	-0.208	0.241
	(0.122)	(0.149)	(0.122)	(0.149)	(0.148)	(0.179)	(0.146)	(0.184)
Car: Small-medium	*base*	*base*	*base*	*base*	*base*	*base*	*base*	*base*
Car: Mid–Large	0.417***	0.774***	0.405***	0.772***	0.505***	0.791***	0.508***	0.806***
	(0.134)	(0.168)	(0.135)	(0.168)	(0.173)	(0.220)	(0.171)	(0.227)
Car: SUV	0.667***	0.565***	0.622***	0.540***	0.847***	0.599*	0.826***	0.603*
	(0.151)	(0.195)	(0.153)	(0.195)	(0.248)	(0.313)	(0.243)	(0.320)
Car: BEV	-0.350***	0.076	-0.077	0.183	-0.11	0.148	-0.092	0.153
	(0.113)	(0.135)	(0.146)	(0.139)	(0.176)	(0.213)	(0.173)	(0.218)
Car: PHEV	-0.286**	-0.018	-0.157	0.023	-0.107	0.033	-0.090	0.021
	(0.127)	(0.161)	(0.180)	(0.166)	(0.165)	(0.208)	(0.162)	(0.213)

Continued on next page

Table 2 – *Continued from previous page*

	C	S	C	S	C	S	C	S
Car: ICE	*base*	*base*	*base*	*base*	*base*	*base*	*base*	*base*
Car-purchaser behaviour								
Car: BEV × CR trip cost			0.011	–				
			(0.040)					
Car: PHEV × CR trip cost			0.062*	–				
			(0.035)					
Car: ICE × CR trip cost			0.028	–				
			(0.020)					
Car: BEV × CR trip time			-0.003	–				
			(0.002)					
Car: PHEV × CR trip time			-0.006*	–				
			(0.003)					
Car: ICE × CR trip time			0.002	–				
			(0.002)					
PT pass					-0.995***	-0.394**	-1.306***	-0.461**
					(0.159)	(0.197)	(0.168)	(0.221)
Primary tests								
CR trip cost					0.027	–	-0.077	–
					(0.019)		(0.253)	
CR trip time					-0.002	–	0.042	–
					(0.002)		(0.030)	
PT pass × PT trip time					0.002	0.000	0.001	-0.002
					(0.002)	(0.006)	(0.003)	(0.007)
ln(car price)					-0.303	-0.079	-0.217	-0.030
					(0.263)	(0.329)	(0.278)	(0.341)
Secondary tests								
Car: yes × PT trip time							-0.016***	-0.016***
							(0.003)	(0.005)
PT pass × CR trip cost							0.000	–
							(0.023)	
PT pass × CR trip time							0.010***	–
							(0.003)	
ln(car price) × CR trip cost							0.011	–
							(0.024)	
ln(car price) × CR trip time							-0.004	–
							(0.003)	
N observations	7,657		7,657		7,657		7,657	
N respondent-trip types	2,604		2,604		2,604		2,604	

Notes: The dependent variable is U_{nit} – from equation 1. C and S denote the mode alternative to which the given alternative specific variable coefficient is relevant, respectively, car and soft transport. *Car: yes* and *PT pass* are respectively binary indicators for adoption of a car and public transport pass in the experiment. Standard errors clustered at the respondent-trip type level reported in parentheses. *, ** and *** respectively denote significance at 10%, 5% and 1% levels. PT: public transport; CR: car. We aggregate chosen car sizes, combining 'Micro' and 'Small', and 'Mid-size' and 'Large'. We also aggregate 'Hybrid' and 'ICE' car engine types together. This does not change any results compared to a disaggregated estimation. We additionally estimated the impact of car engine type by trip type, which was insignificant (not shown).

icantly more likely to choose the private car mode, and those with a PT pass in real life are also much more predisposed to using that mode.

We consistently find that compared to those who choose to buy a small-medium-sized car, respondents who choose larger cars are significantly less likely to use public transport.[12] They gained greater utility from both car and soft transport use. In model (1) we find some impact of electric car purchasers decreasing their car-use, however, this disappears once we further control for marginal car trip costs in models (2)-(4).[13][14]

In model (2), we additionally interact the chosen car engine type with the marginal trip cost and trip time for the given trip with the car alternative. These indicate a slightly significant increase (decrease) in utility for PHEV purchasers for using their car, the more costly (the longer) the trip. This indicates a slightly dampened reaction of PHEV owners to trip cost, and a slightly heightened reaction to trip duration.

We find no other evidence, however, of EV owners being more or less reactive to marginal trip costs compared to traditional ICE car owners. Overall, we observe no real step-change in car-use patterns due to green vehicle purchases beyond varied marginal trip costs.

Model (3) shows that consumers who purchase a public transport pass (GA or regional pass) are significantly more likely to use public transport than a car or soft transport – seen through the significant negative alternative specific variable coefficients on the *PT pass* dummy of both these modes. This matches the findings of Simma and Axhausen (2001, 2003). However, our primary behavioural tests from table 1 do not support the hypothesis of commitment device use.

Specifically, the primary car commitment device test variables, *CR trip cost*$_C$ and *CR trip time*$_C$ are insignificant. We thus reject the primary tests for car commitment device usage (summarised in table 3). The primary tests for PT pass commitment are also insignificant – *PT pass* $\times$ *PT trip time* for both car and soft transport modes. We therefore also reject the primary PT pass commitment device tests. The final primary behavioural test, is also rejected. We find the sunk cost (car price) has no impact on mode-utility and car-use.

[12] We aggregate car sizes, combining 'Micro' and 'Small', and 'Mid-size' and 'Large'. This does not alter results significantly compared to a disaggregated estimation.

[13] We also aggregate 'Hybrid' and 'ICE' car engine types together. This does not significantly alter any results compared to a disaggregated estimation

[14] We additionally estimated the impact of car engine choice by trip type, all of which turns out to be insignificant.

Table 3: Summary of test results

	Primary tests			Secondary tests		
	Variables	Hypothesis	Decision	Variables	Hypothesis	Decision
Car commitment	*CR trip cost*$_C$	>0	Reject	*PT trip time*$_C$	<0	Accept
	CR trip time$_C$	>0	Reject	*Car* × *PT trip time*$_S$	<0	Accept
Pass commitment	*PT pass* × *PT trip time*$_C$	<0	Reject	*PT pass* × *CR trip cost*$_C$	>0	Reject
	PT pass × *PT trip time*$_S$	<0	Reject	*PT pass* × *CR trip time*$_C$	>0	Accept
Sunk costs	*ln(car price)*$_C$	>0	Reject	*ln(car price)* × *CR trip cost*$_C$	>0	Reject
				ln(car price) × *CR trip time*$_C$	>0	Reject

Note: From model (4) above, we do one-sided T-tests of the listed variables and interaction terms. "Reject" ("Accept") means that we fail to find (do find) evidence to support the hypothesised sign. For variable definitions see table 1 notes.

As table 3 further summarises, the secondary tests in model (4) nuance the behavioural test findings. We find that a car purchase does decrease the respondents' reactivity to variation in the trip duration for public transport. We further find that, while respondents choosing to buy a car and a PT pass do not react differently to the cost of the trip by car, they exhibit a diminished reaction to variations in the trip time by car, as hypothesised. Finally, the secondary tests for sunk costs are rejected. We find no evidence that sunk costs have any effect on mode choices.

We are further satisfied that our results are not subject to a hypothetical situation bias and that the respondents are making realistic, informed choices. Restricting all estimates for choices and behavioural tests to those who also owned the particular transport device (car or PT pass) in real life, did not change our results or test decisions.

6 Conclusion

In this study we conduct a sequential choice experiment and analyse transport consumers' hierarchical decision-making process. We investigate the existence of travel mode commitment devices, the impact of sunk costs among car owners, and the differing choices of 'green' car consumers. By reducing the selection biases inherent in revealed transport data, our experimental approach allows a better estimation of future travel tendencies in a growing EV market. We find that what mostly drives consumer travel mode decisions is marginal trip costs and respondent characteristics, and build a nuanced response to our behavioural tests.

Despite level differences in car and public transport use by the car size and PT pass owned, we observed few changes to consumer responses to marginal costs.

We confirm that the purchase of a larger car or a public transport pass does lead consumers to use relatively more of that mode, as similarly shown by Simma and Axhausen (2001, 2003). However, we provide the first tests of stronger commitment device usage based on reactivity to marginal trip costs, and specifically show that there is only partial evidence for this. Those who choose to purchase these long- and medium-term transport investments still respond largely rationally to variation in marginal costs. Car purchasers do not react any less strongly to variation in the cost and duration of trips by car. However, they do display a lower reactivity to changes in the trip duration of the key alternative, public transport. Essentially we estimate no deviation in own-mode trip cost elasticity from average, and a smaller cross-mode trip time elasticity. Similarly for PT pass purchasers, our primary tests reveal no commitment effect. However, we do again see an altered cross-mode trip time elasticity. PT pass purchase is associated with a slight reduction in car-owner reactivity to marginal car trip duration.

We additionally provide the first robust tests in the literature for the sunk cost fallacy in private transport and contribute to the mixed results found across past studies of other sectors (see Friedman et al., 2007). We experimentally isolate the effect of car purchase price on transport mode choices and find that the magnitude of the sunk cost does not influence travel mode decisions. We further find no change in consumer reactivity to marginal trip costs linked to sunk costs.

While adoption of new technologies could be associated with a different usage pattern resulting in a potential rebound effect, our analysis provides little evidence of statistically significant difference in car usage between EV adopters and non-adopters. Electric vehicle purchasers are also no more or less reactive to marginal trip costs. One exception to this, however, is a slightly smaller reaction to car trip costs, and a slightly larger one to car trip duration, among PHEV purchasers. Overall, we find that increasing uptake of EVs in the market does not lead to any step-change in transport patterns, but this will remain largely dependent on marginal costs and demographics.

As we find supportive evidence that prior investments could have a partial mode committing effect in relation to travel duration, the effects of reducing this (eg. by more frequent public transport) can be moderated by prior decisions (eg. car ownership). This highlights the policy relevance of relatively long-term investment decisions and their effects on travel behaviour. An indirect policy implication is that influencing a consumer's investment decision (for instance not owning a car, or buying a public transport travel pass) can be achieved through long-term changes in trip time and other comfort attributes. However, this paper's main result hinges on the largely rational choices observed in our experiment, suggesting that behavioural deviations if any, are not greatly important in policy design of financial instruments. There is little evidence of any distortion of responses to marginal costs based on prior decisions.

In conclusion, our paper demonstrates the overwhelming importance of marginal costs in travel decisions. We find that transport consumers largely do not deviate from the traditional rational decision framework, as shown in other sectors. We do indicate, however, a partial commitment device effect via travel time. These findings are highly relevant for public policy makers. They highlight the importance of marginal travel costs in policy measures, such as fuel taxes, and road usage and parking fees.

Appendix A Choice experiment questionnaire

Figure A.1: Priming script

In this part of the survey, we focus on **your transport choices** for different trip types. We will collect information on your current transport choices and ask you to choose amongst hypothetical future options.

The information that we collect will be used to **inform Swiss energy and transport policy**, and it is therefore important that **your answers reflect your specific situation and your personal tastes**. In particular, some of the following questions will involve costs to your own household; please give careful consideration to how these costs would affect your financial budget.

Figure A.2: Choice 1 car size

For the next set of questions, please imagine that you decide to purchase a car or replace your car within the next year.

Which of the following options best describes your most preferred choice of primary car?

None	Micro	Small	Small-medium	Mid-size	Large	SUV
○	○	○	○	○	○	○

Figure A.3: Choice 2 car type choice set (example)

Which of the following car options would you purchase?

Additional information is provided if you place the mouse over the column or row headers.

	1	2	3	4	5	6
	Electric	**Electric**	**Plug-in hybrid**	**Plug-in hybrid**	**Hybrid**	**ICE**
Price (CHF)	79,000	95,000	75,000	92,000	84,000	53,000
Driving cost (CHF/100km)	3.30	2.80	5.30	6.00	9.50	10.5
Range of battery (km)	400	450	30	35	-	-
Max speed (km/h)	230	180	250	250	250	250
CO_2 emissions (g/km)	0	0	50	45	165	150

	1 Electric	**2 Electric**	**3 Plug-in hybrid**	**4 Plug-in hybrid**	**5 Hybrid**	**6 ICE**
Your choice:	○	○	○	○	○	○

Figure A.4: Choice 3 public transport pass (example)

You have stated that you have the following public transport pass: General abonnement 2nd class.

Given your purchase of the chosen car above, which of the following passes would you choose to buy?

GA 1st class CHF 6,300	GA 2nd class CHF 3,860	Regional Pass CHF 1,000	None CHF 0
○	○	○	○

Figure A.5: Choice 4 transport mode choice set (example)

Among the following options, which transport method would you choose to **commute to your workplace**?

Additional information is provided if you place the mouse over the column or row headers.

	Public transport	Car sharing	Car with driver	Your car	Bike or foot
Trip cost (CHF)	0	5	11.25	0.38	0
Trip time (minutes)	20	29	10	21	60

	Public transport	Car sharing	Car with driver	Your car	Bike or foot
Your choice:	○	○	○	○	○

Appendix B Descriptive supplements

Table B1: Descriptive statistics - respondent characteristics

	Frequency	Percent	SHEDS target (%)
Age group			
18-34	239	24.0	30
35-54	405	40.7	40
55+	350	35.2	30
Gender			
Female	483	48.6	51
Male	511	51.4	49
Housing			
Rent	605	60.9	63
Own	389	39.1	38
Location			
City	505	50.8	
Agglomeration	282	28.4	
Rural	207	20.8	
Linguistic region			
French-swiss	229	23.0	
German-swiss	765	77.0	
Household size			
1	277	27.9	
2	426	42.9	
3+	291	29.3	
Public transport passes			
General abonnement	236	23.8	
Regional pass	211	21.2	
None	547	55.0	
Car ownership			
Car owner	732	73.6	
No car	262	26.4	

Note: Percentages may not sum to 100 due to rounding. Includes the 994 respondents used for analysis.

Table B2: Descriptive statistics - choices

	Frequency	Percent
Car size		
None	112	11.3
Micro	20	2.0
Small	287	28.9
Small-medium	225	22.6
Mid-size	161	16.2
Large	39	3.9
SUV	150	15.1
Car engine		
Electric	303	34.4
Plug-in hybrid	149	16.9
Hybrid	133	15.1
ICE	297	33.7
Public transport pass		
General abonnement	225	22.6
Regional pass	243	24.5
None	526	52.9
Travel mode choice		
Public transport	2612	34.1
Car	3744	48.9
Soft transport	1301	17.0

Note: Percentages may not sum to 100 due to rounding.

References

Arkes, H. R. and C. Blumer (1985) "The psychology of sunk cost," *Organizational Behavior and Human Decision Processes*, 35, 1, pp. 124–140.

Aronson, E. (1968) "Dissonance theory: Progress and problems," in R. P. Abelson, E. Aronson, W. J. McGuire, T. M. Newcomb, M. J. Rosenberg, and P. H. Tannenbaum eds. *Theories of cognitive consistency: A Sourcebook*, Chicago: Rand McNally and Co. pp. 5–27.

Bhat, C. R. and S. Sen (2006) "Household vehicle type holdings and usage: An application of the multiple discrete-continuous extreme value (MDCEV) model," *Transportation Research Part B: Methodological*, 40, 1, pp. 35–53.

Brownstone, D., D. S. Bunch, and K. Train (2000) "Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles," *Transportation Research Part B: Methodological*, 34, 5, pp. 315–338.

Bunch, D. S., M. Bradley, T. F. Golob, R. Kitamura, and G. P. Occhiuzzo (1993) "Demand for clean-fuel vehicles in California: a discrete-choice stated preference pilot project," *Transportation Research Part A: Policy and Practice*, 27, 3, pp. 237–253.

Choo, S. and P. L. Mokhtarian (2004) "What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice," *Transportation Research Part A: Policy and Practice*, 38, 3, pp. 201–222.

Comparis (2013) "Les Suisses restent fidèles à leur voiture 5 ans."

DellaVigna, S. and U. Malmendier (2004) "Contract design and self-control: Theory and evidence," *Quarterly Journal of Economics*, 119, 2, pp. 353–402.

Dimitropoulos, A., W. Oueslati, and C. Sintek (2018) "The rebound effect in road transport: A meta-analysis of empirical studies," *Energy Economics*, 75, pp. 163–179, sep.

Friedman, D., K. Pommerenke, R. Lukose, G. Milam, and B. A. Huberman (2007) "Searching for the sunk cost fallacy," *Experimental Economics*, 10, 1, pp. 79–104.

FSO (2017) "Population's transport behaviour 2015," technical report, Federal Statistical Office, Neuchatel.

Garland, H. and S. Newport (1991) "Effects of absolute and relative sunk costs on the decision to persist with a course of action," *Organizational Behavior and Human Decision Processes*, 48, pp. 55–69.

Gul, F. and W. Pesendorfer (2004) "Self-control and the theory of consumption," *Econometrica*, 72, 1, pp. 119–158.

Hess, S., M. Fowler, T. Adler, and A. Bahreinian (2012) "A joint model for vehicle type and fuel type choice: Evidence from a cross-nested logit study," *Transportation*, 39, 3, pp. 593–625.

Hess, S., G. Spitz, M. Bradley, and M. Coogan (2018) "Analysis of mode choice for intercity travel: Application of a hybrid choice model to two distinct US corridors," *Transportation Research Part A: Policy and Practice*, 116, pp. 547–567.

Ho, T.-h., I. P. L. Png, and S. Reza (2018) “Sunk Cost Fallacy in Driving the World’s Costliest Cars,” *Management Science*, 64, 4, pp. 1761–1778.

Johnston, R. J., K. J. Boyle, W. V. Adamowicz, J. Bennett, R. Brouwer, T. A. Cameron, W. M. Hanemann, N. Hanley, M. Ryan, R. Scarpa, R. Tourangeau, and C. A. Vossler (2017) “Contemporary Guidance for Stated Preference Studies,” *Journal of the Association of Environmental and Resource Economists*, 4, 2, pp. 319–405, jun.

Just, D. R. and B. Wansink (2011) “The flat-rate pricing paradox: Conflicting effects of "all-you-can-eat" buffet pricing,” *Review of Economics and Statistics*, 93, 1, pp. 193–200.

Kivetz, R. and I. Simonson (2002) “Self-Control for the Righteous: Toward a Theory of Precommitment to Indulgence,” *Journal of Consumer Research*, 29, 2, pp. 199–217.

Lang, G., M. Farsi, B. Lanz, and S. Weber (2020) “Energy efficiency and heating technology investments: Manipulating financial information in a discrete choice experiment,” IRENE Institute of Economic Research.

Laran, J. (2010) “Choosing Your Future: Temporal Distance and the Balance between Self-Control and Indulgence,” *Journal of Consumer Research*, 36, 6, pp. 1002–1015.

Lave, C. A. and K. Train (1979) “A disaggregate model of auto-type choice,” *Transportation Research Part A: General*, 13, 1, pp. 1–9.

Loder, A. and K. W. Axhausen (2018) “Mobility tools and use: Accessibility’s role in Switzerland,” *Journal of Transport and Land Use*, 11, 1, pp. 367–385.

McFadden, D. (1974) “Conditional Logit Analysis of Qualitative Choice Behavior,” in P. Zarembka ed. *Frontiers in Econometrics*, New York: Academic Press, pp. 105–152.

van Putten, M., M. Zeelenberg, and E. van Dijk (2010) “Who throws good money after bad? action vs. state orientation moderates the sunk cost fallacy,” *Judgment and Decision Making*, 5, 1, pp. 33–36.

Richter, C. and S. Keuchel (2012) “Modelling mode choice in passenger transport with Integrated Hierarchical Information Integration,” *Journal of Choice Modelling*, 5, 1, pp. 1–21.

Schelling, T. C. (1978) “Egonomics, or the art of self-management,” *The American Economic Review*, 68, 2, pp. 290–294.

——— (1984) “Self-Command in Practice, in Policy, and in a Theory of Rational Choice,” *The American Economic Review*, 74, 2, pp. 1–11.

Schwanen, T. and P. L. Mokhtarian (2005) “What affects commute mode choice: Neighborhood physical structure or preferences toward neighborhoods?,” *Journal of Transport Geography*, 13, pp. 83–99.

Shen, J. (2009) “Latent class model or mixed logit model? A comparison by transport mode choice data,” *Applied Economics*, 41, 22, pp. 2915–2924.

Simma, A. and K. W. Axhausen (2001) “Structures of commitment in mode use: A comparison of Switzerland, Germany and Great Britain,” *Transport Policy*, 8, 4, pp. 279–288.

——— (2003) “Commitments and Modal Usage: Analysis of German and Dutch Panels,” *Transportation Research Record*, 1854, pp. 22–31.

Spissu, E., A. R. Pinjari, R. M. Pendyala, and C. R. Bhat (2009) “A copula-based joint multinomial discrete–continuous model of vehicle type choice and miles of travel,” *Transportation*, 36, 4, pp. 403–422.

Staw, B. M. (1976) “Knee-deep in the big muddy: a study of escalating commitment to a chosen course of action,” *Organizational Behavior and Human Performance*, 16, 1, pp. 27–44.

Steg, L. (2005) “Car use: Lust and must. Instrumental, symbolic and affective motives for car use,” *Transportation Research Part A: Policy and Practice*, 39, pp. 147–162.

Steg, L., G. Perlaviciute, E. van der Werff, and J. Lurvink (2014) “The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions,” *Environment and Behavior*, 46, 2, pp. 163–192.

TCS (2018) “Quelle voiture vous convient le mieux et à quel prix ?.”

Thaler, R. (1980) “Toward a positive theory of consumer choice,” *Journal of Economic Behavior and Organization*, 1, pp. 39–60.

Thaler, R. H. and H. M. Shefrin (1981) “An economic theory of self-control,” *Journal of political Economy*, 89, 2, pp. 392–406.

Tompkins, M., D. Bunch, D. Santini, M. Bradley, A. Vyas, and D. Poyer (1998) “Determinants of alternative fuel vehicle choice in the continental United States,” *Transportation Research Record*, 1641, 1, pp. 130–138.

Vossler, C. A., M. Doyon, and D. Rondeau (2012) “Truth in Consequentiality: Theory and Field Evidence on Discrete Choice Experiments,” *American Economic Journal: Microeconomics*, 4, 4, pp. 145–171, nov.

Vovsha, P. (1997) “Application of Cross-Nested Logit Model to Mode Choice in Tel Aviv, Israel, Metropolitan Area,” *Transportation Research Record*, 1607, 1, pp. 6–15.

Waerden, P. V. D. and J. V. D. Waerden (2018) “The Relation between Train Access Mode Attributes and Travelers ’ Transport Mode-Choice Decisions in the Context of Medium- and Long-Distance Trips in the Netherlands,” *Transportation Research Record*, 2672, 8, pp. 719–730.

Weber, S., P. Burger, M. Farsi, A. L. Martinez-Cruz, M. Puntiroli, I. Schubert, and B. Volland (2017) “Swiss Household Energy Demand Survey (SHEDS): Objectives, design, and implementation,” IRENE Working Papers 17-14, IRENE Institute of Economic Research.

Weis, C., K. W. Axhausen, R. Schlich, and R. Zbinden (2010) “Models of mode choice and mobility tool ownership beyond 2008 fuel prices,” *Transportation Research Record*, 2157, pp. 86–94.