Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Department of the Environment,
Transport, Energy and Communication DETEC

Swiss Federal Office of Energy SFOE
Energy Research

Intermediate/Annual report from 30.11.2018

Fostering the Transition Towards More Fuel-Efficient Cars

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Institute of Science, Technology and Policy
Institut für Wissenschaft, Technogie und Politik

Date: 30 November 2018

Place: Bern

Publisher:
Swiss Federal Office of Energy SFOE
Research Programme Energy-Economy-Society (EES)
CH-3003 Bern
www.bfe.admin.ch
energieforschung@bfe.admin.ch

Co-financed by:
ETH Zurich
CH-8092 Zurich

www.ethz.ch

Agent:
ETH Zurich
Institute of Science, Technology and Policy

Universitätsstrasse 41
CH-8092 Zurich, Switzerland
http://www.istp.ethz.ch
Author:
Prof. Dr. Thomas Bernauer, ETH Zurich, thbe0520@ethz.ch
Gracia Brückmann, ETH Zurich, bgracia@ehtz.ch

SFOE head of domain: Dr. Anne-Kathrin Faust, Anne-Kathrin.Faust@bfe.admin.ch
SFOE programme manager: Dr. Yuliya Blondiau, Yuliya.blondiau@bfe.admin.ch
SFOE contract number: SI/8100087-00-01-05

Summary

This research project examines policy preferences and consumer choice within the individual motorized transportation industry. Recognized as a major source of greenhouse gas emissions, to this date, the industry still maintains a high decarbonisation potential despite foregoing advocacy. Year after year, the newly registered Swiss car fleet produces the highest emissions compared to neighbouring European countries. Therefore, in an effort to mitigate climate change, reducing the country's transportation's emissions is of utmost importance. Currently, available car models, notably electric vehicles (EV), have the potential to reduce transport-related emissions in Switzerland, however, demand is deficient. The latter might be attributed to low political incentives and consumers' psychological distance to these new vehicles. In this project, we create unique survey data on a random sample of Swiss car holders to study their policy preferences as well as their EV purchase intentions. We conduct survey experiments on policy preferences and use a randomized controlled trial field-experiment in order to estimate how the provision of information and a 48-hours test-drive of fully electric vehicles influence policy preferences and purchase intentions. At the current stage, we have conducted a baseline questionnaire that includes a survey experiment on EV policy preferences and have started initial test drives. New technologies, such as electric vehicles, are distant to consumers and voters alike and eco-innovations, again, such as EVs, require policy support due to eminent market failures. Altogether, this project attempts to close the gap in evidence-based research on policy preferences after the exposure to these new technologies in an attempt to facilitate policy development.

Zusammenfassung

Dieses Forschungsprojekt untersucht Politikpräferenzen sowie Konsumentscheidungen in einem Sektor mit grossem Dekarbonisierungspotenzial, dem motorisierten Individualverkehr. Als eine der Hauptquellen für Treibhausgasemissionen ist es unbedingt erforderlich, die Emissionen des Verkehrs zu senken, um den Klimawandel zu mildern. Die neuzugelassene Schweizer Autoflotte hat Jahr für Jahr die höchsten Emissionswerte im europäischen Vergleich. Derzeit verfügbare Fahrzeugmodelle, insbesondere Elektrofahrzeuge, hätten das Potenzial, die verkehrsbedingten Emissionen in der Schweiz zu reduzieren. Sie werden von den Konsumenten jedoch noch nicht gekauft. Letzteres könnte auf geringe politische Anreize und die psychologische Distanz der Verbraucher zu diesen neuen Fahrzeugen zurückzuführen sein. In diesem Projekt generieren wir Umfragedaten aus einer Zufallsstichprobe von Schweizer Autohaltern und untersuchen ihre politischen Präferenzen sowie ihre Kaufabsichten für Elektrofahrzeuge. Wir verwenden Umfrage-Experimente zu Politikpräferenzen und führen ein randomisiert kontrolliertes Feldexperiment durch, um die Auswirkungen des Testfahrens eines vollelektrischen Autos für etwa 48 Stunden und Informationen auf Politikpräferenzen und Kaufabsichten abschätzen zu können. Aktuell haben wir bereits eine erste Befragung durchgeführt, welche ein Umfrage-Experiment zu den Präferenzen von Autohaltern für verschiedene Elektromobilitätspolikten beinhaltet. Des Weiteren haben wir mit der Durchführung der Testfahrten begonnen. Diese Arbeit schliesst die Lücke in der evidenzbasierten Erforschung von Politikpräferenzen nach der Erfahrung mit neuen Technologien, die von Verbrauchern und Wählern psychologisch distanziert sind und gleichzeitig aufgrund von Marktversagen politische Unterstützung rechtfertigen.

Contents

List of abbreviations

BEV	Battery Electric Vehicle
EV	Electric Vehicle
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
SFOE	Swiss Federal Office of Energy

1 Introduction

This research project examines the decarbonisation of individual motorized transportation. As a major source of greenhouse gas emissions, it becomes imperative to reduce transportation's emissions in an effort to mitigate climate change. In contrast to other sectors, which already reduced emissions, the transportation sector continues to provide for the largest decarbonisation potential. The adoption of new technologies, such as electric vehicles (EVs), is therefore essential for the widespread decarbonisation of the industry. However, given the absence of complete markets for negative externalities, technology-driven innovation for reducing greenhouse gas emissions, local air pollution, and noise remains prone to market failures. This justifies governmental intervention in the form of policies which support EV uptake. In this research project, we propose a study on the degree of political support for those interventions as well as individuals' car choice.

This project aims to generate unique insights on how policy financing and its characteristics, as well as information and experience, affect public support for technology policies. Additionally, we attempt to identify what factors drive individual car choice. Altogether, we aim to contribute to the overcoming of political hurdles and individual barriers in the transition to sustainable mobility.

2 Context

2.1 Background

While many sectors of the Swiss economy have in recent years increased their energy efficiency and reduced their greenhouse gas (GHG) emissions and fossil fuel dependence, the transportation sector, which accounts for around 33% of Switzerland's GHG emissions is falling behind. One key part of the Swiss energy strategy thus aims to reduce vehicle emissions (and by implication fossil fuel consumption) to an average of 95 g/CO2 for new cars by the year 2021. This would help not only in reducing GHG emissions, but also in reducing local air pollution and noise. Based on currently available car models, this target could be achieved today. However, weak consumer demand for fuel-efficient cars remains a major obstacle. Previous studies on the demand for fuel-efficient cars have mostly used conventional surveys, stated choice experiments, and computational simulations to characterize the efficiency gap in car purchasing behaviour. Building on that research, the project proposed here focuses on examining policy options to encourage the adoption of more fuel-efficient cars. In contrast to many previous studies, and in particular to those in Switzerland, this project employs an experimental approach.

2.2 Motivation of the project

Since public opinion in Western Democracies is vital in policy design, especially in environmental matters (Anderson, Böhmelt, and Ward 2017), an informed public is the desired outcome (Page and Shapiro 1992). Therefore, in order for the public opinion to be shaped by accurate information rather than rumours or prejudice, the populace requires readily available information. However, mainstream consumers (and thus also voters) appear to be rather uninformed about topics, such as electric vehicles (Axsen, Langman, and Goldberg 2017). Despite lack of collective knowledge, research also suggests that the perception of EVs undergoes a substantial change after direct EV experience and is thus expected to change with higher EV market shares and easier access to EV experience (Axsen, Goldberg, and Bailey 2016).

Given that Eco-innovations, such as electric vehicles, can lead to market failures (Rennings 2000) and that neo-classical economics provides strong arguments for governments to intervene in such cases, we explore the viabilities . Knowledge spill over, which is the ability of firms to profit from technologies others have developed in R&D, can ultimately lower innovation incentives for all firms. The second market failure is induced by a positive externality of an eco-innovation, namely reduced abatement, which is not priced in accordingly, as the (negative) externality from competing products is not priced in (correctly), or put differently, abatement markets are missing. In this study, we propose studying newly emerging technologies that have strong political, economic, and environmental impacts. As Schmidt and Sewerin (2017) argue, it is very important to study the link between technological change and politics. Overall, this study intends to understand citizens' demand for policies targeted at novel technologies that are new to consumers and voters and how their policy demand changes with experience. To do so, the case of fuel-efficient cars, precisely electric vehicles, in Switzerland is studied.

2.3 Goals

This research begins with a baseline survey administered to a random sample of 3'500 car owners in Switzerland. Survey participants are then randomly assigned to one of three experimental treatment conditions: (1) information on fuel-efficient cars, pertaining to car attributes that buyers typically pay attention to; (2) information on fuel-efficient cars, pertaining to car attributes that buyers typically pay attention to, plus test-driving of a fully-electric car; (3) a control group with neither (1) nor (2). Two follow-up surveys, ca. three weeks and one year after the treatments, will assess whether these interventions (treatments) have had positive effects on desirable attributes respondents associate with more fuel-efficient cars, on their intentions to switch to more fuel-efficient cars, and how the treatments affect preferences towards a wide range of government interventions intended to increase the vehicle fuel-economy (e.g. subsidies, regulation, and financing of these policies). The results of the project will provide important insights into how the government and the private sector could foster the transition towards more fuel-efficient cars.

3 Approach and methodology

3.1 Motivation for test drives and information treatment

This research question asks how familiarity with plug-in electric vehicles, via information or test drive with information, changes car holder preferences for policies that aim to increase the overall energy efficiency of the Swiss car fleet. Additionally, a second research question looks into car preferences (i.e. willingness to switch to an EV) and preferences for certain (electric) car attributes.

Since information on vehicle energy efficiency could make environmental benefits more salient to voters and therefore change their opinion towards fuel-saving vehicles and emission regulating policies, test-driving is expected to have the same effect with greater magnitude. For example, during the test-driving of an electric vehicle, the need for recharging infrastructure could be experienced. Therefore, the perception of psychological distance (Liberman, Trope, and Stephan 2007; Skippon and Garwood 2011) towards this new technology might have changed. On the other hand, the test drive could potentially generate interest in electric vehicles as a consumption good, which might also increase support for policies due to egocentric motives. We use an experimental approach here, where we randomly allocate test drives and information to study participants, but not to the participants in the control group.

Following established findings in the literature (e.g. Bühler et al. 2014; Burgess et al. 2013; Egbue and Long 2012; Graham-Rowe et al. 2012; Jensen, Cherchi, and Mabit 2013; Plötz et al. 2014; Schmalfuß, Mühl, and Krems 2017; Schneider, Dütschke, and Peters 2014) experience matters for stated interest in EV. So far only a few studies have used test drives (Bühler et al. 2014; Graham-Rowe et al. 2012; Jensen, Cherchi, and Mabit 2013; Schmalfuß, Mühl, and Krems 2017; Skippon and Garwood 2011) and all of them have encountered limitations when it comes to the potential of causal inference. For example Schmalfuß, Mühl, and Krems (2017) only provided 30 test-drives to people, who were interested in a 24h trial, Graham-Rowe et al. (2012) only provided 20 test drives and Schmalfuß, Mühl, and Krems (2017) only used a convenient sample, as they offered EV test drives for study participation in newspapers and online.

Notwithstanding, only one study (Bennett and Vijaygopal 2018) directly tackled the issue of EV experience and public support for policies fostering the transition towards more BEVs but only provided the "experience" to a random sample of their study population by offering them an online EV driving experience game.

Dumortier et al. (2015) provided information about fuel-costs and total-cost-of-ownership in a survey experiment and found higher interest for purchase of different kinds of EVs for some consumer groups. They ultimately called for further research on the provision of these kinds of information for emerging energy-saving technologies with high costs up-front but low running costs.

By now, none of these studies has used a random sample combined with an experimental approach. Furthermore, to our knowledge, no study yet has assessed policy and personal car preferences combined, before and after the test-driving of an EV. Thus, with the use of a random sample of car holders as the study population, this project utilizes a controlled experimental study design to investigate how information on energy-efficient cars and test-driving of a fully-electric passenger vehicle affect preference towards government interventions that might be used to increase the energy efficiency of cars throughout Switzerland.

3.2 Administered baseline survey

In order to test our theoretical argument, we rely on original and representative survey data. The survey population is a random sample of Swiss car holders with cars registered in the Cantons of Aargau, Schwyz, Zug, and Zurich. We selected the following cantons due to their differences on existing policies that foster the use of energy efficient cars.

Besides the random sample of 5000 ICEV holders (that do not have an electric vehicle registered on their name yet) in each Canton, we survey a census (a random sample with p=1 of inclusion in the sample) of all BEV owners.1 Note that motorization is high in Switzerland. In 2017, there were on average 543 cars per 1000 inhabitants (Bundesamt für Statistik 2018).

We have invited the samples provided from official sources (car registration) to fill in a survey either online or on print (PAPI). The link to the online survey was sent via regular mail, as the car registries did not provide email addresses. People were encouraged to fill in the survey online since they would have had to contact the research team in order to obtain a printed version; a drawback we attempted to minimize.

Focussing on the random sample of ICEV owners, this survey started on May 31, 2018, after the first invitations were sent out on May, 24. The invitations were delivered in 10 waves in order to deal with potential outpours of participants that wished to contact the research team by telephone, email, and

1 Excluding car holders who opted out of data transfer when registering their car. Those people who opted-out (max. 5%) provide for an under-coverage error, as they have no chance to enter the sample in the first place. This is part of sampling error more generally.

letters immediately after receiving the survey invitation. We later send out up to 2 reminders to invitees, that have not been responding. Only one reminder was sent in Aargau, due to their data protection policy.

At least 4809 people out of 20'000 contacted us, constituting a contact rate of 24.04%. However, postcards declining participation in the survey are not digitalized yet. 3470 respondents filled out the survey online and 462 did so through print versions (of 519 ordered with us). This implies a response rate of slightly below 20% (19.66 %).

The survey started after informed consent with questions on demographics (age, nationality, education, household members), work status, mobility usage, environmental and technological attitudes, as well as car preferences. Thereafter, the survey questions turned to political questions, dealing with the individuals' support for mobility policies. After the stated choice experiment, they were asked about general political beliefs and positions, as well as their income. In the appendix A1 we provide some descriptive figures. The table of attributes for the stated choice experiment can be found in the appendix A2. The method is described in section 3.3. and results can be found in the results section 4.

The survey invitation process for the electric vehicle sample was the same and, thus, was comparable. Notwithstanding, this survey included additional questions on current charging behaviour. On segment, we observed a higher response rate of nearly 43% (1133 of 2636 invited EV owners). Lastly, these respondents were also asked if they could be contacted once again at the end of their survey. These participants, however, do not enter the experimental study described in the next section (3.3).

Data obtained from the baseline survey is hardly comparable to official statistics, as there are no comprehensive statistics on car owners of Swiss cantons that are differentiated by their drivetrain. We attempted to compare our data with age and gender distributions in the different cantons, whenever available to us. We cannot, however, fully neglect statistical differences with population means (see table 1.)

Canton	**Criteria**	**Population mean**	**Survey mean**	**Significant difference (95%)**
Aargau	Share Female	.4024255	.4663609	*
	Birthyear	1967.163	1960.829	*
Schwyz	Share Female	.3917659	.3569024	*
	Birthyear	1967.574	1966.998	
Zurich	Share Female	.3937131	.3719705	
	Birthyear	1966.618	1963.575	*
Zug	Share Female	Data not yet made available	.3110668	Comparison not yet possible
	Birthyear		1964.575	
All four cantons	Share Female		.3683157	
	Birthyear		1964.221	

Table 1: Comparison of our (online) data with car holder statistics from cantonal car registries

3.3 Method for EV policy preferences (stated choice conjoint experiment)

Using a conjoint experiment, which is a stated preference response method, allows us to determine which policy measures have the highest support. It further allows us to assess how these preferences change given the disclosure, or omission, of financing options for these measures. First, we randomize whether a respondent will be disclosed information on financing for costly EV policies (such as governmental investment in charging infrastructure or a car purchase subsidy). Second, we randomize

the levels of attributes to all participants in each choice task. The full list of attributes can be found in the appendix A1.

This means that conjoints are identical for all respondents except for financing, which is only displayed randomly to half of the respondents. Consequently, not only the attribute levels of the attribute finance are randomly assigned, but also, whether or not financing is included as an attribute at all is randomly assigned to respondents.

To assess whether the pull measures are low in support as a strict regulation, regulatory options are included as well and are displayed to all respondents. There are five choice tasks presented to all respondents where they evaluate ten different policy packages.

Methodologically, the experiment follows Hainmueller, Hopkins, & Yamamoto (2014) with one exception. For all possible attributes, in our case four (or five, if financing is revealed) attribute levels for all the attributes are randomly displayed, which follows the standard conjoint procedure. Respondents, then, decide which proposal they prefer over the other and rank them accordingly. Our design only differs in that the attribute “financing” (with all its attribute levels) is only displayed to half of the respondents. This is similar to a study implemented by Kirkland and Coppock (2018).

The decision for using a stated-preference conjoint experiment with binary choice and rating for this research is due to several reasons. First of all, the respondents face a trade-off, as the forced choice between two alternative policies bears “the cost of the foregone alternative”. Thus, rating each proposed bundle, irrespectively if it was chosen or not, provides further information. Likewise, since support for policies serves as the dependent variable and different levels of policy attributes (see Table A1) serve as independent variables, randomization allows for causal inference. In order to ensure that all combinations of costly pull measures and their financing, as well as cost-neutral regulation, are perceived as a realistic policy proposal, we use a full-profile design with complete randomization, except for the case that no new costly measures are taken, for which no new financing is needed. Second, a conjoint experiment allows evaluating different policy options jointly at the same time. We use two policy options at the same time. Evidence of real-world behaviour similarities is provided in (Hainmueller, Hangartner, and Yamamoto (2015). For every option, we include the current status-quo as one attribute level (e.g. no purchase subsidies for BEVs). This design allows the respondents to compare each policy measure combination to the current status quo. Additionally, the current status quo serves as an explicit reference option for marginal component effects of each policy attribute and (by chance) some respondents might face a policy proposal consisting of the current policy status. Given that conjoint experiments are resistant to omission and inclusion of irrelevant alternatives, see (Bansak et al. 2018), if the financing of a mobility policy were irrelevant, which is essentially the null for our hypothesis testing, it would not matter that we include it for some participants. This further justifies our choice of the method. A similar approach has already been successfully employed (Kirkland and Coppock 2017). Overall, assuming no implementation costs for regulation, the design of the experiment allows for potential balanced growth in government budget through the inclusion of financed pull measures.

The conjoint experiments have started with an overview of all attributes and all potential attribute levels, however, those people who were randomly allocated to the “finance hidden” group, did not see any information on possible financing for policies. The full table, including financing data, can be found in the appendix with two examples of the questions asked, one which contained financing options and one that did not.

Subsequently, every respondent was displayed five conjoint tables in total (see examples in appendix A2 and A3) and was required to decide between 5 pairs of side-by-side policy proposals. They then had to choose which proposal they preferred and rank, separately, each of the ten proposals.

3.4 Method for test drives and information treatment

We first administered a baseline survey with the sample described above (see Section 3.2 and asked for consent to take part in two future surveys. Thereafter, people enter a panel and are randomly assigned to one of three groups. We make use of a randomized controlled trial at this point.

One group gets an information treatment or information treatment and test-drive of an energy efficient car (EV). The control group will be the only surveyed and will receive no treatment in between survey waves. (See Figure 1.) This design incorporates both, a between- and within-subject design.

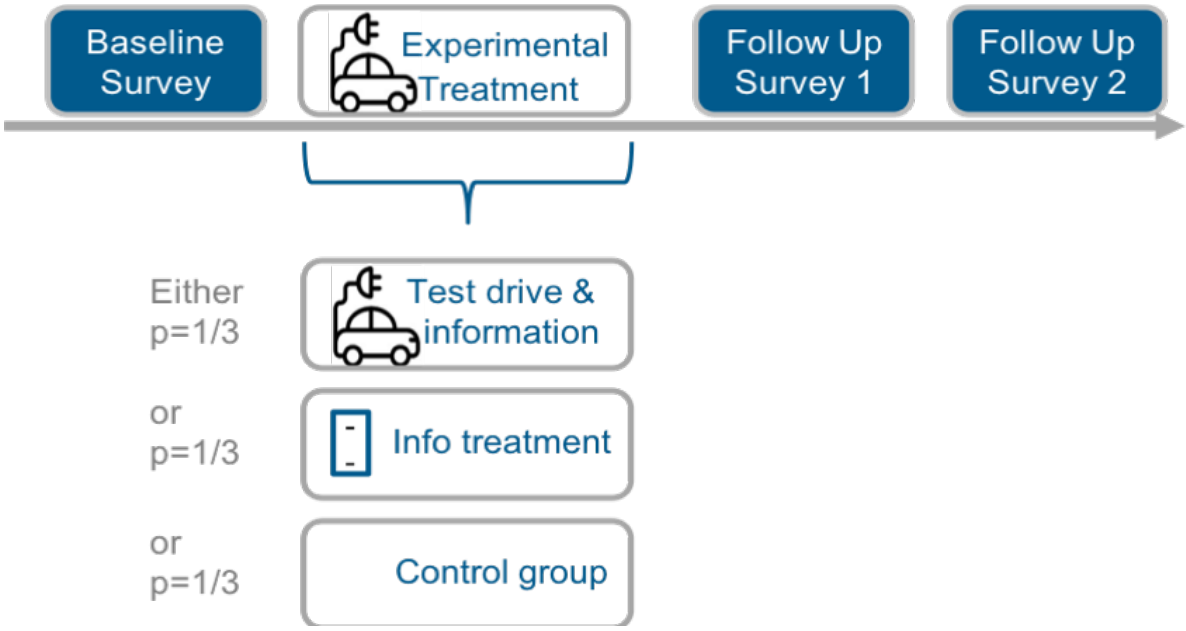


Figure 1: Study Design

At this point, the study administrators inquired to participate in test drives, but only to those who had previously expressed a clear willingness or insecurity about their willingness to do so in the first survey.

When asked, from 1233 survey participants (1078 online and 155 in the print version), nearly 65% have responded positively to the test drive. Including the share of people who are still undecided, there is an 87% likelihood, among participants, to agree to a test drive. An important note to point out is the different response rates among the online submissions and those turned in via print version. For the latter, the “yes”-share for test drives was much lower than in the online version (36% in contrast to 69%), which can be attributed to the higher age of print survey respondents.

3.5 Finalizing information treatment

In order to inform participants assigned to either treatment group, we prepared detailed information on electric vehicles.

We developed the information sheet using the knowledge and experience at the ISTP, that is, talking to transport as well as environmental scholars, supplemented with high-quality information and multiple rounds of feedback with the SFOE.

The information sheet consists of a concise comparison of ICEVs and BEVs and gives details on the energy-efficiency, environmental impacts, and costs of electric cars, as well as information on

recharging. Recharging information consists of information on recharging times, range information for EVs and a map of publicly accessible charging points as well as information about how to navigate to these recharging facilities.

This information sheet is given in print, in a folded version to respondents, who take the test-drive. For respondents in the information-only treatment, the same information is shown online through the follow-up survey.

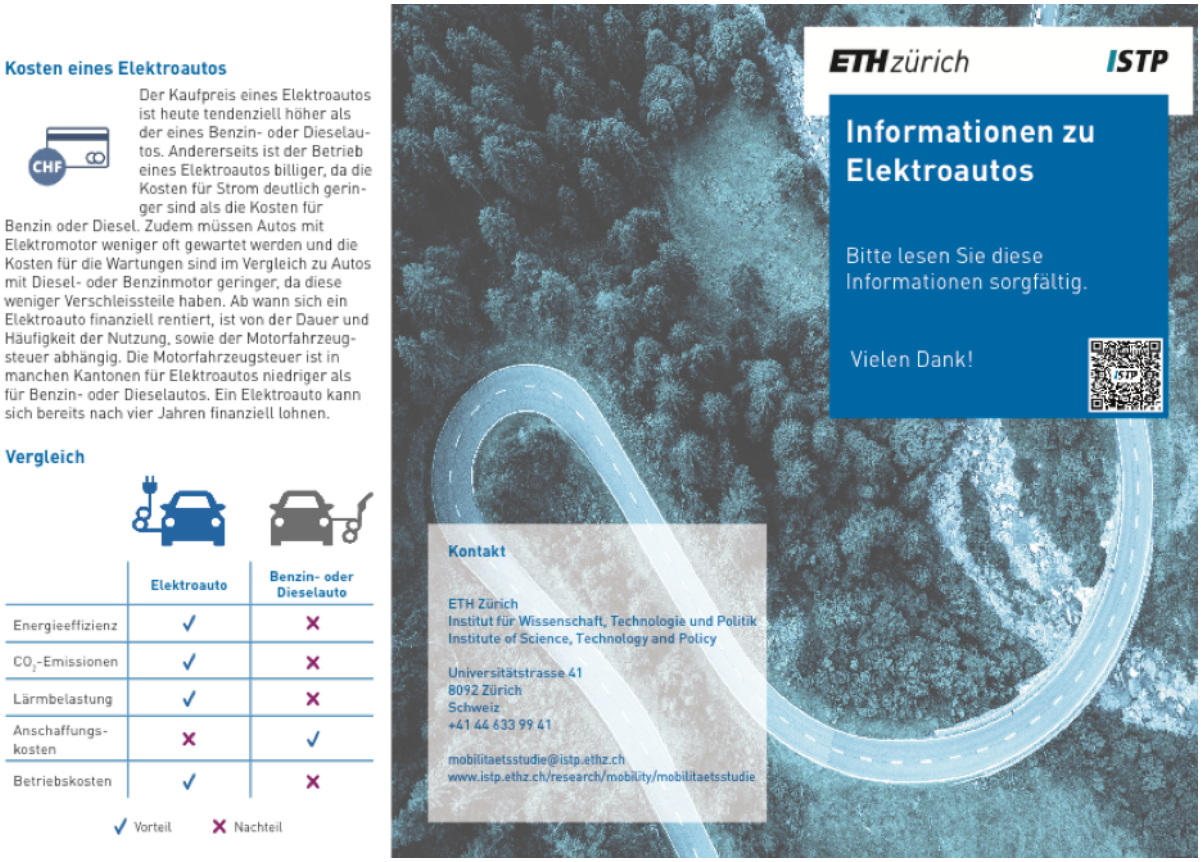
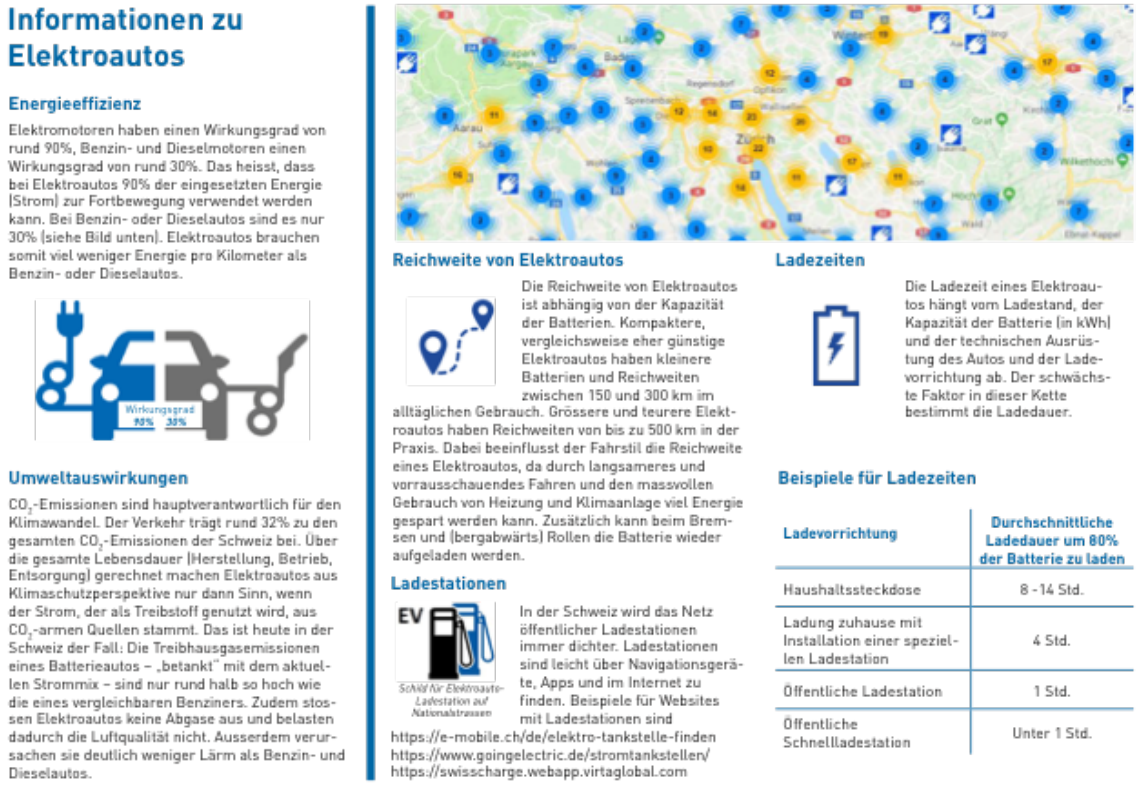


Figure 2: The front side of our folded info sheet on electric mobility



Informationen zu Elektroautos

Energieeffizienz

Elektromotoren haben einen Wirkungsgrad von rund 90%, Benzin- und Dieselmotoren einen Wirkungsgrad von rund 30%. Das heisst, dass bei Elektroautos 90% der eingesetzten Energie (Strom) zur Fortbewegung verwendet werden kann. Bei Benzin- oder Dieselautos sind es nur 30% (siehe Bild unten). Elektroautos brauchen somit viel weniger Energie pro Kilometer als Benzin- oder Dieselautos.

Umweltauswirkungen

CO_2-Emissionen sind hauptverantwortlich für den Klimawandel. Der Verkehr trägt rund 32% zu den gesamten CO_2-Emissionen der Schweiz bei. Über die gesamte Lebensdauer (Herstellung, Betrieb, Entsorgung) gerechnet machen Elektroautos aus Klimaschutzperspektive nur dann Sinn, wenn der Strom, der als Treibstoff genutzt wird, aus CO_2-armen Quellen stammt. Das ist heute in der Schweiz der Fall: Die Treibhausgasemissionen eines Batterieautos – „betankt" mit dem aktuellen Strommix – sind nur rund halb so hoch wie die eines vergleichbaren Benziners. Zudem stossen Elektroautos keine Abgase aus und belasten dadurch die Luftqualität nicht. Ausserdem verursachen sie deutlich weniger Lärm als Benzin- und Dieselautos.

Reichweite von Elektroautos

Die Reichweite von Elektroautos ist abhängig von der Kapazität der Batterien. Kompaktere, vergleichsweise eher günstige Elektroautos haben kleinere Batterien und Reichweiten zwischen 150 und 300 km im alltäglichen Gebrauch. Grössere und teurere Elektroautos haben Reichweiten von bis zu 500 km in der Praxis. Dabei beeinflusst der Fahrstil die Reichweite eines Elektroautos, da durch langsameres und vorrausschauendes Fahren und den massvollen Gebrauch von Heizung und Klimaanlage viel Energie gespart werden kann. Zusätzlich kann beim Bremsen und (bergabwärts) Rollen die Batterie wieder aufgeladen werden.

Ladestationen

Schild für Elektroauto-Ladestation auf Nationalstrassen

In der Schweiz wird das Netz öffentlicher Ladestationen immer dichter. Ladestationen sind leicht über Navigationsgeräte, Apps und im Internet zu finden. Beispiele für Websites mit Ladestationen sind
https://e-mobile.ch/de/elektro-tankstelle-finden
https://www.goingelectric.de/stromtankstellen/
https://swisscharge.webapp.virtaglobal.com

Ladezeiten

Die Ladezeit eines Elektroautos hängt vom Ladestand, der Kapazität der Batterie (in kWh) und der technischen Ausrüstung des Autos und der Ladevorrichtung ab. Der schwächste Faktor in dieser Kette bestimmt die Ladedauer.

Beispiele für Ladezeiten

Ladevorrichtung	Durchschnittliche Ladedauer um 80% der Batterie zu laden
Haushaltssteckdose	8 -14 Std.
Ladung zuhause mit Installation einer speziellen Ladestation	4 Std.
Öffentliche Ladestation	1 Std.
Öffentliche Schnellladestation	Unter 1 Std.

Figure 2: The back side of our folded info sheet on electric mobility

3.6 Preparation of test-drives and information treatment

Preparation of test-drives went through many stages. At first, cooperation with car importers, that have at least one fully electric vehicle on sale in Switzerland in 2018 or early 2019, were set up. We acknowledge help from e-mobil züri who kindly supported our letters sent to the relevant car importers. The negotiations were extensive with plenty of telephone calls and meetings at ETH Zurich as well as at dealerships. Given that we desire to obtain the cars for free, negotiations are difficult and are still ongoing.

So far, we have at our disposal a BMW i3 from BMW Switzerland as well as an ETH-owned Renault Zoé, which ETH transport services arranged for us to use. In January we shall acquire more cars, most likely a VW e-golf, Hyundai Kona, Mitsubishi, and a Kia electrical car.

The legal department of ETH Zurich as well as the transport division of ETH Zurich were directly involved in this process. The legal department helped with generating a contract with the dealers and offered a contract to the survey participants. These contracts were not available before September 2018, respectively October 2018, but a start of this study phase without these contracts were impossible. ETH Zurich transport services provides support to the project by arranging number plates for the cars, contacting car insurance companies, and providing access to their car wash machine. Without their support, the project would have been impossible, and we greatly acknowledge their support.

Similarly, the training of the procedure used to explain the electric car, as well as its particularities, was an integral part of our achievements this year. By instruction through the car import companies,

studying the manuals and training with uninformed colleagues, Gracia Brückmann as well as three research assistants involved in the project, learned to prepare a test drive. These “mock” test-drives with the colleagues took place in September and October, 2018.

Test-drives with study participants started in November 2018. To accommodate time preferences of study participants, as well as our working hours, we have decided to arrange test drives for approximately 48 hours, with extended hours over weekend test-drives, while also accepting shorter test-driving times at the respondents’ request. To slightly compensate for the loss of time due to traveling to ETH Zurich to pick up the car, we offer 20 CHF to each participant.

So far, we have only arranged for 9 test drives. This is due to tire changes and car damage, that took place right before extending our invitation to study participants. In order to prevent further damage, we abstained from lending the car to participants, while the vehicle was damaged. Ultimately, we were forced to wait a long period of time until all repairs were finalized.

3.7 Follow-up survey after treatments

Every survey participant who was first assigned a test drive by randomization has now been invited or will be invited soon for a test drive. If agreed on a 48h period, the test drive will eventually take place. Three weeks after the start of the test-drive, the survey participant is then invited to take a survey. The survey, so far, is completed online (the print version is under development)and has the following elements depending on the respondents’ treatment status:

- Welcome page, consent
- Information treatment (if treatment status is information treatment)
- Knowledge questions on the comparison between electric and conventional cars
- Questions on the experience with the electric car (if treatment status is test-driving)
- preferences concerning (un)desirable attributes car owners associate with more fuel-efficient cars,
- next car purchase intentions
- stated-choice experiment on EV policy preferences
- opinion on EV policies
- list experiment on EV policies
- consent to take part in the next survey, end of the survey

For respondents that are in the control group, or whose treatment is information only, this survey will be administered around February 2019.

4 Results

4.1 Preferences for EV policies when financing is revealed

In the baseline survey (see section 3.2), we conducted a stated choice experiment on different possible policies that have the potential to decrease the Swiss car fleets’ CO2 emissions and make individual transport more sustainable altogether.

Subsidies, as well as charging infrastructure, are regarded as major influencing factors for EV uptake (Sierzchula et al. 2014). As voluntary measures, both subsidies and charging infrastructure (Rhodes, Axsen, and Jaccard 2017) are policies that do not disincentivise the use of regular cars. Those policies are characterized as pull measures (Steg, Dreijerink, and Abrahamse 2006). For instance, the most popular form of governmental actions in climate change are subsidies (Drews and van den Bergh 2016). However, currently, evidence supports the notion that information on the financing for pull measures can decrease their support (Heres, Kallbekken, and Galarraga 2017).

We argue that the support for pull measures is too high, as the financing for these measures is not salient. Through the experimental inclusion and concealing financing, we aim to test this theoretical proposition. We will ultimately benchmark the results on the pull measures with two regulatory options, as a car ban or as changes in the information provided on energy labels. Since changing the legislative settings and executing the new rules have very little costs in comparison to the costly pull measures, the support for these regulatory options should hardly be affected by the inclusion or omission of financing information.

From the average marginal component effects, two things in regard to the above-mentioned theory can be easily observed. First, according to theory, the regulatory options, that is, the information and the new registration restriction, are hardly affected by the omission or inclusion of financing. This follows our theoretical predictions. Second, when financing is revealed, the charger build-up is demanded at a lower level, which is in line with theory as well. However, surprisingly, there is no significant effect on the option of a governmental purchase premium.

Overall, we observe support for the provision of charging stations, while car purchase subsidies are rather unpopular. There is also no support for ICE car registration bans, but there is support for stricter energy labels. Most support financing, if displayed, through government budget without a tax increase or higher road vignette prices.

All of our results are robust to the inclusion of control variables in models estimating AMCEs.

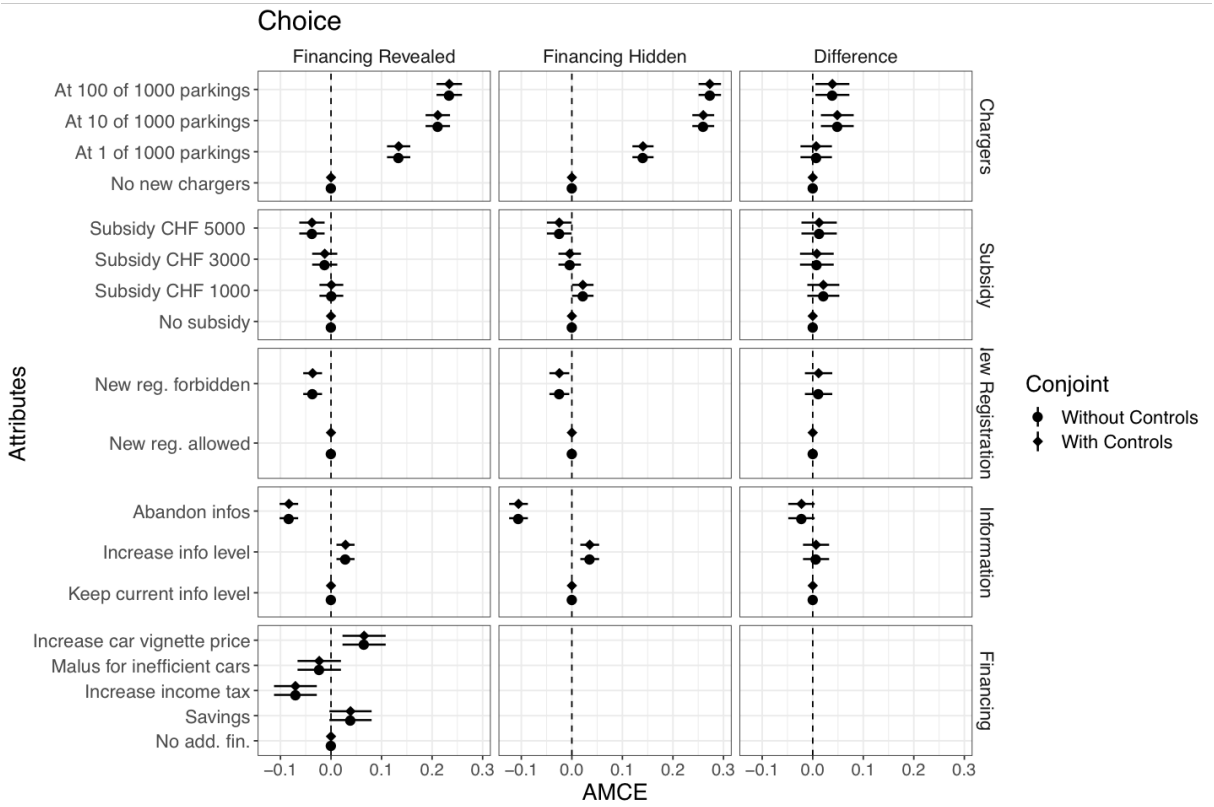


Figure 3: Average marginal component effects from the choice task

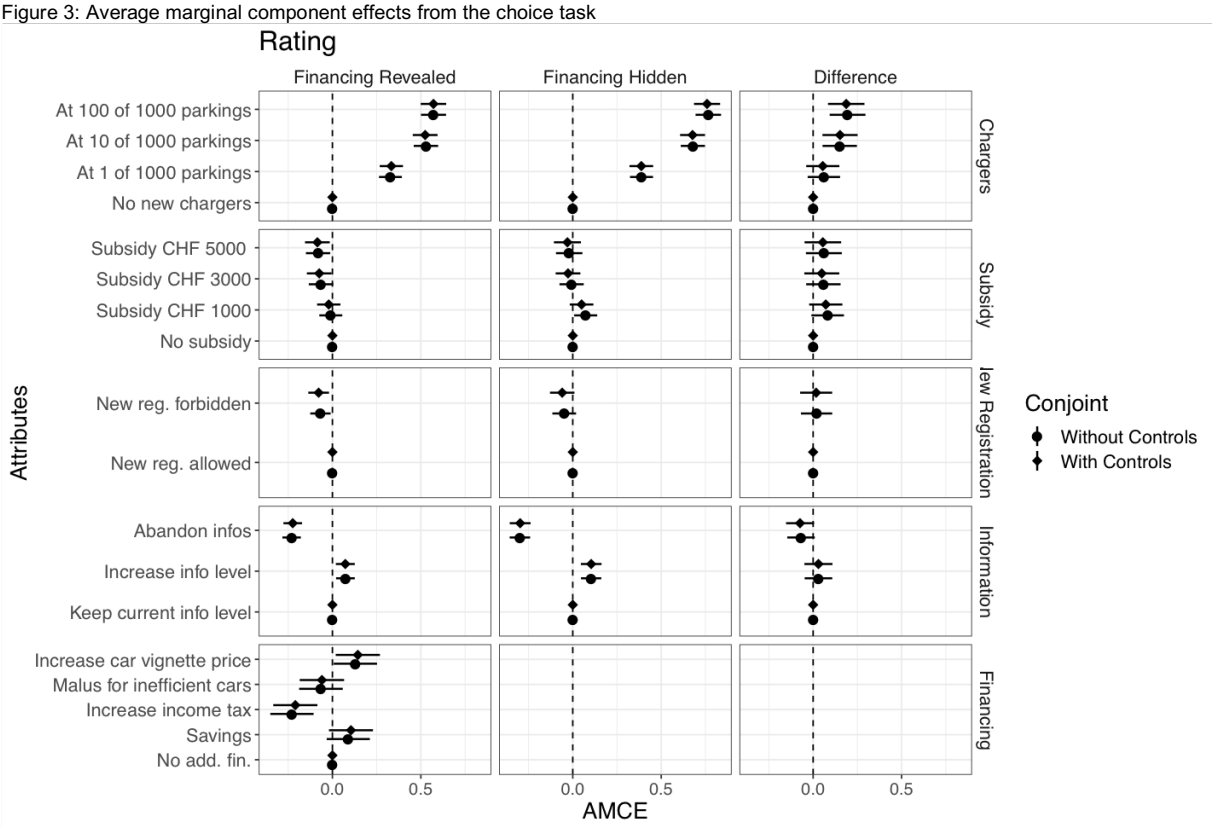


Figure 4: Average marginal component effects from the rating of each policy proposal on a 7 Likert scale

5 Discussion of results

5.1 Preferences for EV policies when financing is revealed

While some of our findings completely match theory, one could be surprised in discovering that the support for EV purchase subsidies is not decreasing, as theory might predict. We attribute this finding to the low support for EV purchase subsidies also when financing was revealed. There are plausible reasons for this finding. On the one hand, the word “subsidy” as such, is very much salient as it is used in many popular initiatives. Ultimately, this notoriety comes at a cost in Switzerland. On the other hand, it could simply be disregarded as an effective or fair way of reducing transport-related emissions, see e.g. Huber, Wicki, and Bernauer (2018). Aside from this, whether the build-up of charging infrastructure is a voluntary measure or not remains debatable. Perhaps survey respondents, especially ICEV owners might have regarded it as a disincentive in the use of their regular vehicles. This might be the case if they thought parking space near chargers is solely available for EV drivers. However, in which way parking and recharging on recharging facilities at public parking space is organized is not yet obvious. For different possibilities see e.g. Wolbertus et al. (2018). Nonetheless, as the charging infrastructure build-up is much more supported than the purchase subsidies, this could also shine a light on whether the recharging infrastructure is regarded as a network good or whether market distortion through purchase subsidies is disliked. Regardless, this is still open for further research.

However, conjoint choice experiments, in general, are not free from drawbacks. They only perform reasonably well in certain circumstances, e.g. given familiarity with the topic (Hainmueller, Hangartner, and Yamamoto 2015). This familiarity might be limited in the context of possible future policies, as presented to our respondents.

We, nonetheless, plan to tackle these questions in the following steps of our research project.

6 Evaluation 2018 and outlook for 2019

In 2018 our achievements of two surveys set the ground for further achievements in 2019.

Through data collection in the surveys we are able to publish two to three papers and, thus, it allows us to continue with the test driving for the treatment groups.

In the first paper, we will use the Baseline Survey of ICEV owners as well as EV owners and elaborate on current EV policy preferences when financing is hidden or revealed.

A second paper will look into charging behaviour of current Swiss EV holders. This is relevant from an energy grid stability perspective because it informs policy on the necessities of recharging infrastructure for current users in contrast to studies on possible future EV users’ preferences.

A third paper might reveal differences in personal characteristics (demographics, home location) and mobility preferences between current EV holders and current ICEV holders, that have no EV yet.

The data collection after the car test and information treatment will subsequently enable us to develop further papers on the aforementioned study.

7 References

Anderson, Brilé, Tobias Böhmelt, and Hugh Ward. 2017. “Public Opinion and Environmental Policy Output: A Cross-National Analysis of Energy Policies in Europe.” *Environmental Research Letters* 12(11): 1–10.

Axsen, Jonn, Suzanne Goldberg, and Joseph Bailey. 2016. “How Might Potential Future Plug-in Electric Vehicle Buyers Differ from Current ‘Pioneer’ Owners?” *Transportation Research Part D: Transport and Environment* 47: 357–70.

Axsen, Jonn, Brad Langman, and Suzanne Goldberg. 2017. “Confusion of Innovations: Mainstream Consumer Perceptions and Misperceptions of Electric-Drive Vehicles and Charging Programs in Canada.” *Energy Research and Social Science* 27: 163–73.

Bansak, Kirk, Jens Hainmueller, Daniel J. Hopkins, and Teppei Yamamoto. 2018. “The Number of Choice Tasks and Survey Satisficing in Conjoint Experiments.” *Political Analysis* 26(1): 112–19.

Bennett, Roger, and Rohini Vijaygopal. 2018. “An Assessment of UK Drivers’ Attitudes Regarding the Forthcoming Ban on the Sale of Petrol and Diesel Vehicles.” *Transportation Research Part D: Transport and Environment* 62: 330–44.

Bühler, Franziska et al. 2014. “Is EV Experience Related to EV Acceptance? Results from a German Field Study.” *Transportation Research Part F: Psychology and Behaviour* 25: 34–49.

Bundesamt für Statistik, BFS. 2018. “Motorisierungsgrad (Schweiz/Kantone) | Karte |.” https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/verkehrsinfrastruktur-fahrzeuge/fahrzeuge/strassenfahrzeuge-bestand-motorisierungsgrad.assetdetail.4402739.html (April 28, 2018).

Burgess, Mark, Naomi King, Margaret Harris, and Elisa Lewis. 2013. “Electric Vehicle Drivers’ Reported Interactions with the Public: Driving Stereotype Change?” *Transportation Research Part F: Psychology and Behaviour* 17: 33–44.

Drews, Stefan, and Jeroen C.J.M. van den Bergh. 2016. “What Explains Public Support for Climate Policies? A Review of Empirical and Experimental Studies.” *Climate Policy* 16(7): 855–76.

Dumortier, Jerome et al. 2015. “Effects of Providing Total Cost of Ownership Information on Consumers’ Intent to Purchase a Hybrid or Plug-in Electric Vehicle.” *Transportation Research Part A: Policy and Practice* 72: 71–86.

Egbue, Ona, and Suzanna Long. 2012. “Barriers to Widespread Adoption of Electric Vehicles: An Analysis of Consumer Attitudes and Perceptions.” *Energy Policy* 48: 717–29.

Graham-Rowe, Ella et al. 2012. “Mainstream Consumers Driving Plug-in Battery-Electric and Plug-in Hybrid Electric Cars: A Qualitative Analysis of Responses and Evaluations.” *Transportation Research Part A: Policy and Practice* 46(1): 140–53.

Hainmueller, Jens, Dominik Hangartner, and Teppei Yamamoto. 2015. “Validating Vignette and Conjoint Survey Experiments against Real-World Behavior.” *Proceedings of the National Academy of Sciences of the United States of America* 112(8): 2395–2400.

Heres, David R., Steffen Kallbekken, and Ibon Galarraga. 2017. “The Role of Budgetary Information in the Preference for Externality-Correcting Subsidies over Taxes: A Lab Experiment on Public Support.” *Environmental and Resource Economics* 66(1): 1–15.

Huber, Robert A., Michael L. Wicki, and Thomas Bernauer. 2018. *Mass Public Support for Environmental Policy Depends on Beliefs Concerning Effectiveness, Intrusiveness, and Fairness*. Zurich.

Jensen, Anders Fjendbo, Elisabetta Cherchi, and Stefan Lindhard Mabit. 2013. “On the Stability of

Preferences and Attitudes before and after Experiencing an Electric Vehicle." *Transportation Research Part D: Transport and Environment* 25: 24–32.

Kirkland, Patricia A, and Alexander Coppock. 2017. "Candidate Choice Without Party Labels:: New Insights from Conjoint Survey Experiments." *Political Behavior* 40: 1–21.

Liberman, Nira, Yaacov Trope, and Elena Stephan. 2007. "Psychological Distance." In *Social Psychology: Handbook of Basic Principles*, New York: Guilford Press, 353–81.

Page, Benjamin I., and Robert Y. Shapiro. 1992. *The Rational Public: Fifty Years of Trends in Americans' Policy Preferences*. University of Chicago Press.

Plötz, Patrick, Uta Schneider, Joachim Globisch, and Elisabeth Dütschke. 2014. "Who Will Buy Electric Vehicles? Identifying Early Adopters in Germany." *Transportation Research Part A: Policy and Practice* 67: 96–109.

Rennings, Klaus. 2000. "Redefining Innovation - Eco-Innovation Research and the Contribution from Ecological Economics." *Ecological Economics* 32(2): 319–32.

Rhodes, Ekaterina, Jonn Axsen, and Mark Jaccard. 2017. "Exploring Citizen Support for Different Types of Climate Policy." *Ecological Economics* 137: 56–69.

Schmalfuß, Franziska, Kristin Mühl, and Josef F. Krems. 2017. "Direct Experience with Battery Electric Vehicles (BEVs) Matters When Evaluating Vehicle Attributes, Attitude and Purchase Intention." *Transportation Research Part F: Psychology and Behaviour* 46: 47–69.

Schmidt, Tobias S., and Sebastian Sewerin. 2017. "Technology as a Driver of Climate and Energy Politics." *Nature Energy* 2: 1–3.

Schneider, Uta, Elisabeth Dütschke, and Anja Peters. 2014. "How Does the Actual Usage of Electric Vehicles Influence Consumer Acceptance?" *Evolutionary Paths Towards the Mobility Patterns of the Future* (2003): 49–66.

Sierzchula, William, Sjoerd Bakker, Kees Maat, and Bert Van Wee. 2014. "The Influence of Financial Incentives and Other Socio-Economic Factors on Electric Vehicle Adoption." *Energy Policy* 68: 183–94.

Skippon, Stephen, and Mike Garwood. 2011. "Responses to Battery Electric Vehicles: UK Consumer Attitudes and Attributions of Symbolic Meaning Following Direct Experience to Reduce Psychological Distance." *Transportation Research Part D: Transport and Environment* 16(7): 525–31.

Steg, Linda, Lieke Dreijerink, and Wokje Abrahamse. 2006. "Why Are Energy Policies Acceptable and Effective?" *Environment and Behavior* 38(1): 92–111.

Wolbertus, Rick, Maarten Kroesen, Robert van den Hoed, and Caspar G. Chorus. 2018. "Policy Effects on Charging Behaviour of Electric Vehicle Owners and on Purchase Intentions of Prospective Owners: Natural and Stated Choice Experiments." *Transportation Research Part D: Transport and Environment* 62: 283–97.

8 Appendix

8.1 Appendix 1: Selected descriptive figures for car holders without BEV

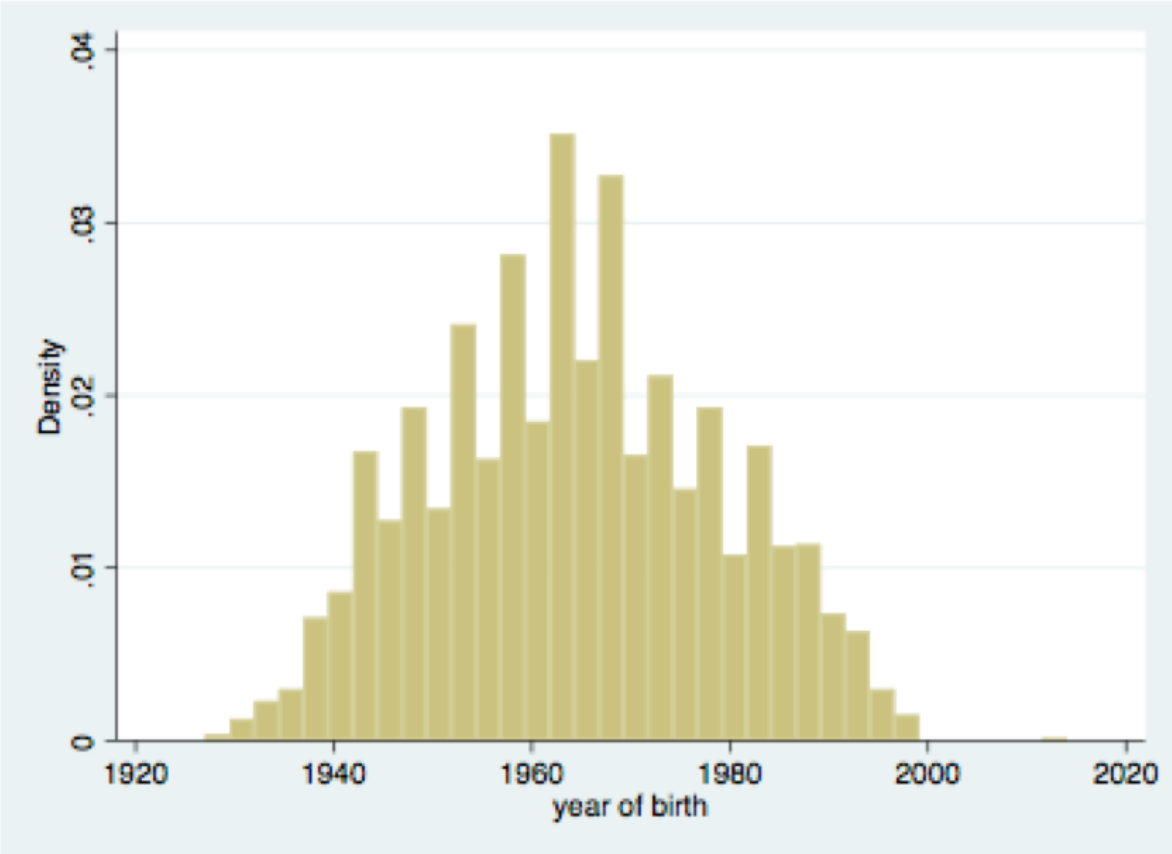


Figure A1: The age distribution (birthyear) in our online sample of car holders with no BEV registered

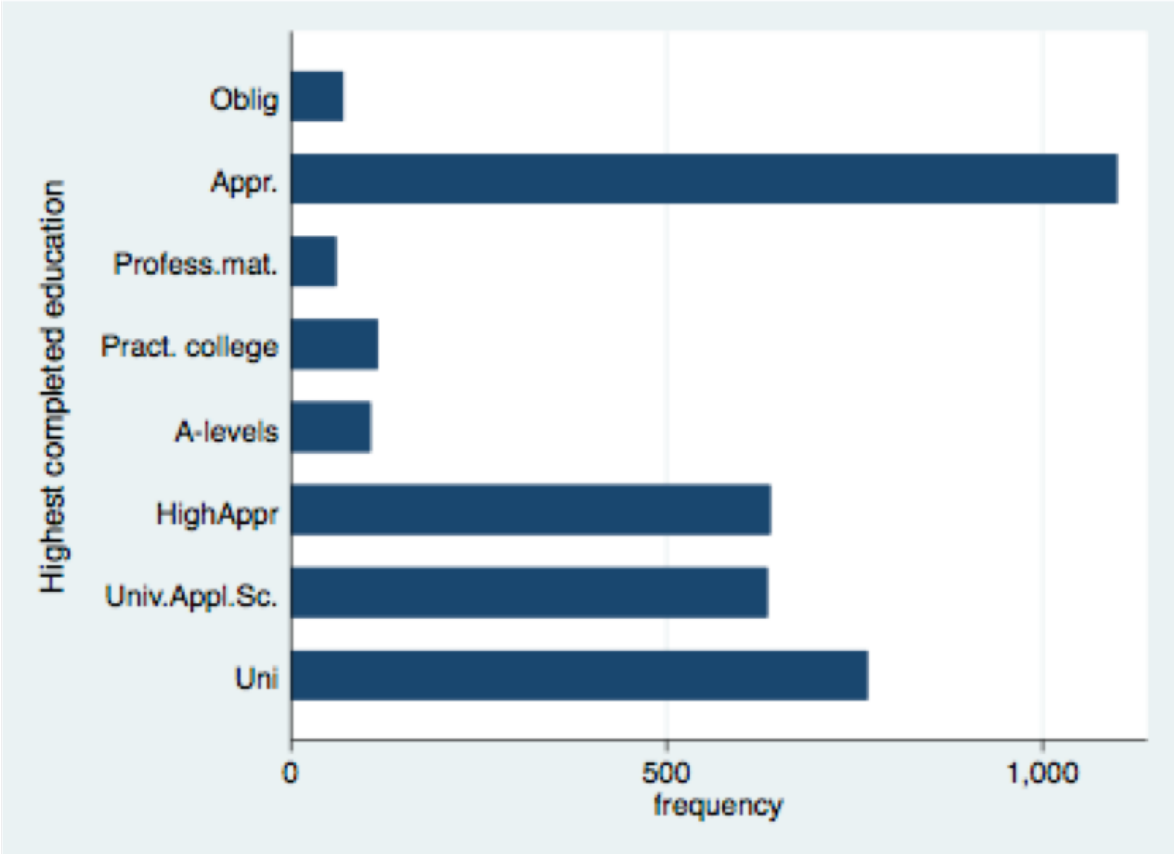


Figure A2: The distribution of highest completed education in our online sample of car holders with no BEV registered

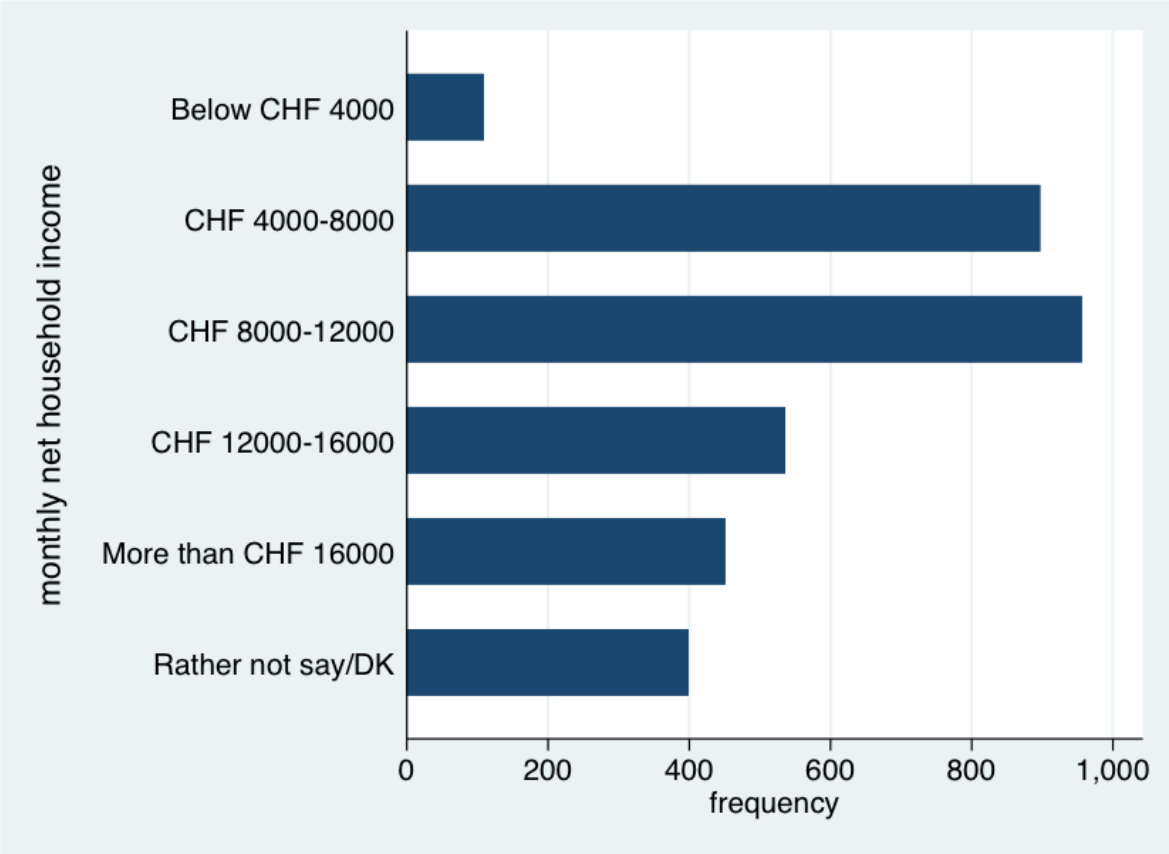


Figure A3: The distribution of household income in our online sample of car holders with no BEV registered

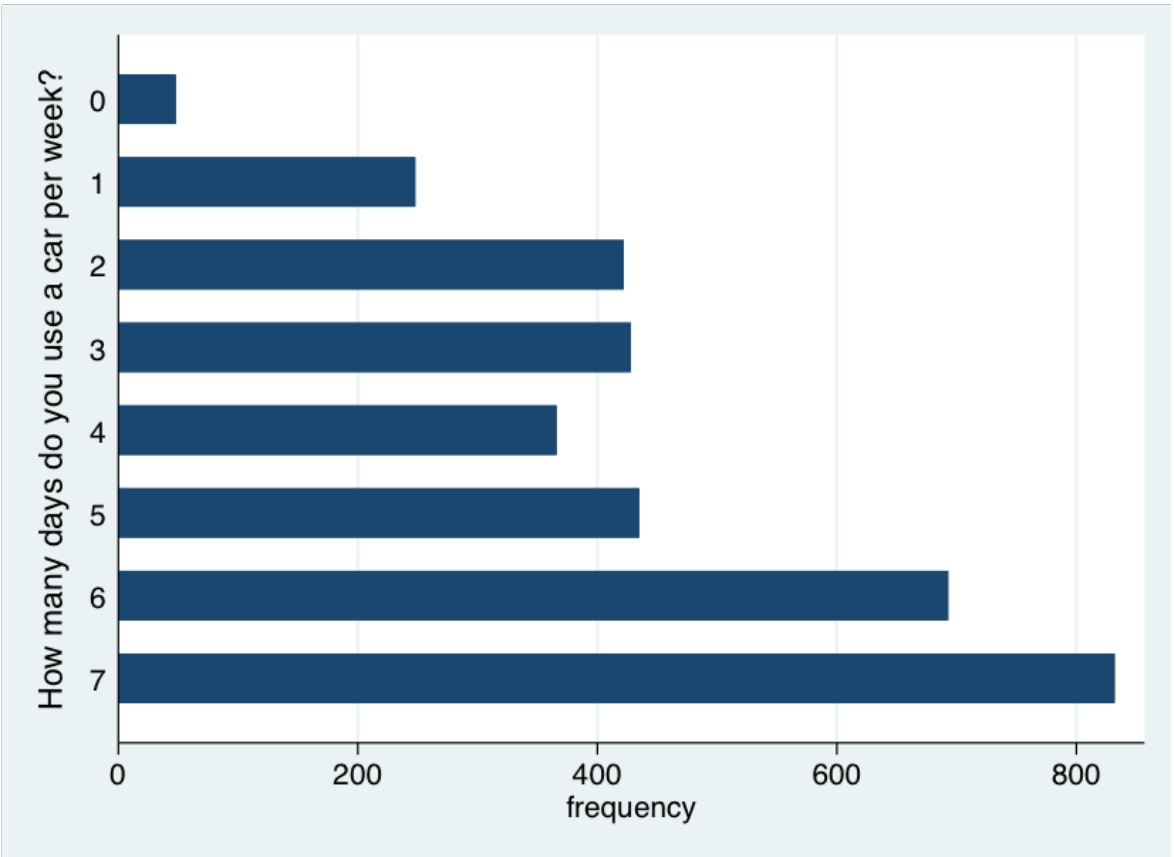


Figure A4: The distribution of car driving days per week in our online sample of car holders with no BEV registered

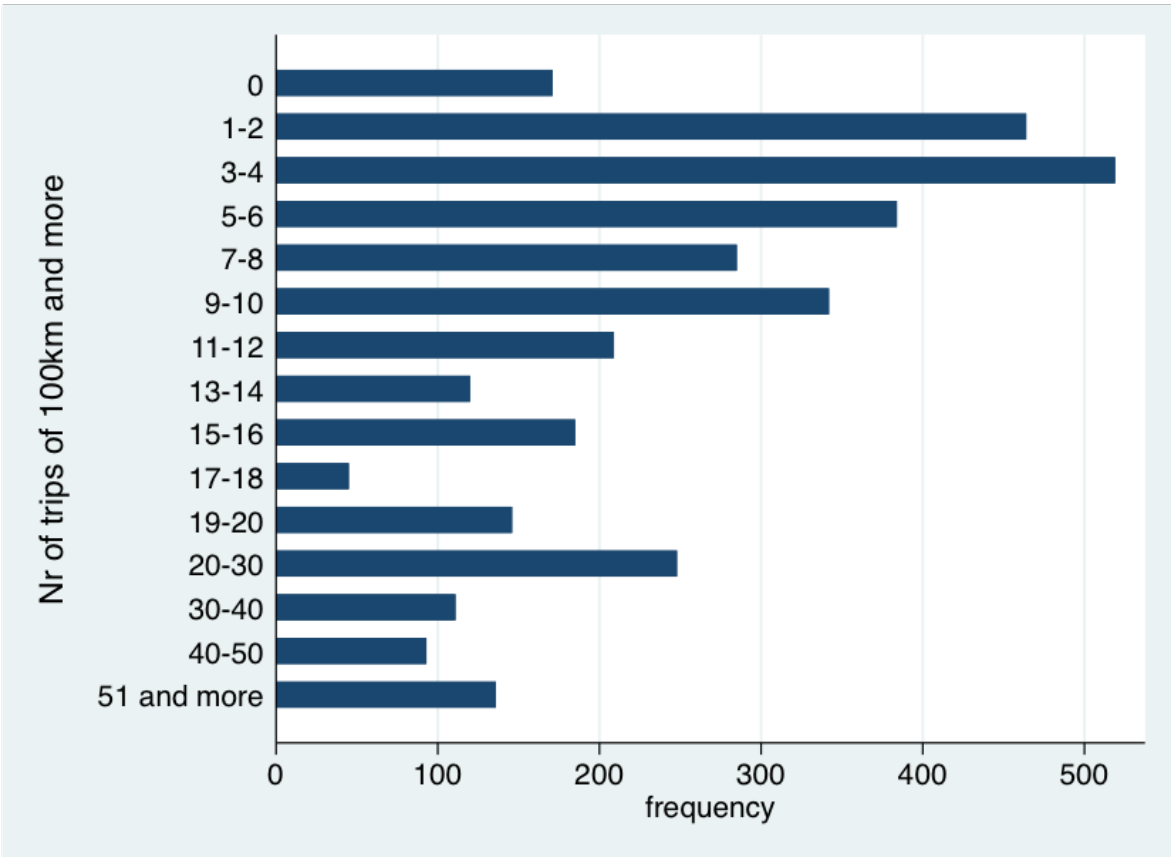


Figure A5: The distribution of trips over 100km in our online sample of car holders with no BEV registered

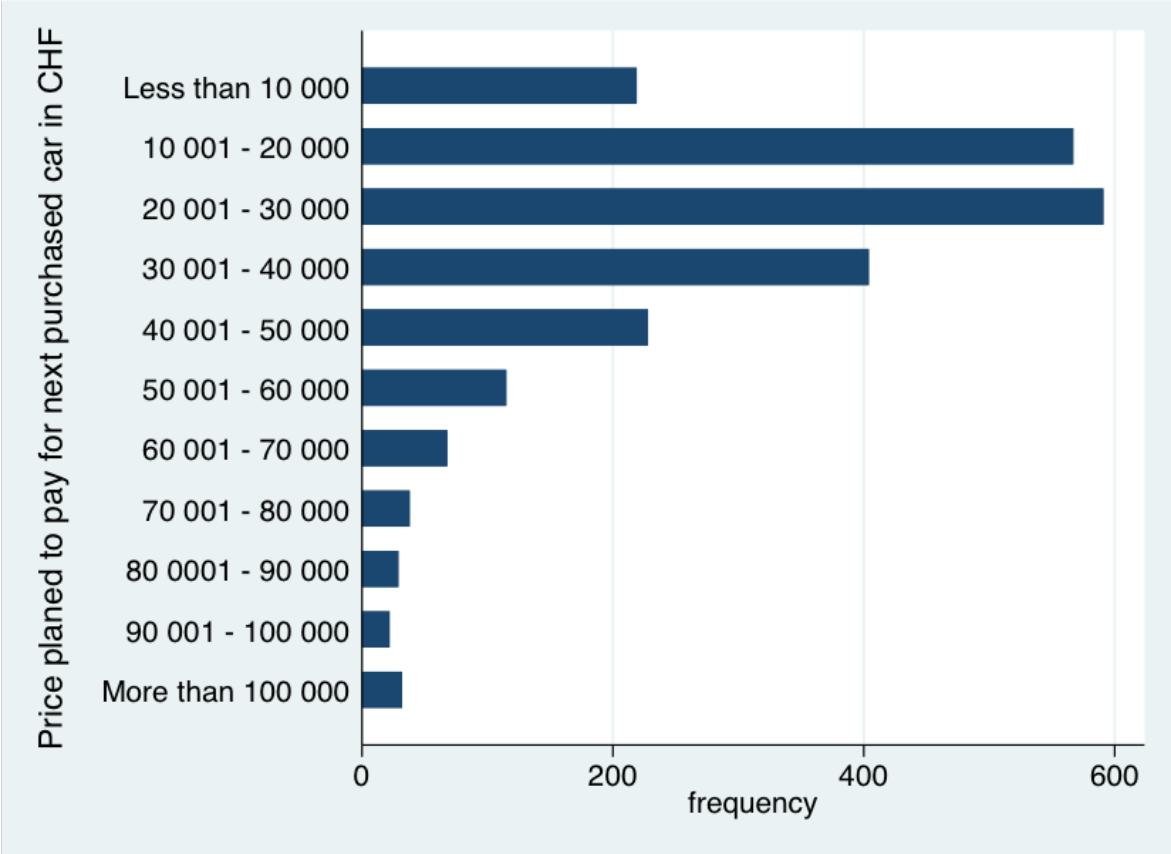


Figure A6: The distribution of planned purchase prices for next vehicle in our online sample of car holders with no BEV registered (Note: 82.51 % plan to buy there next car, while 6.74 % plan to lease, while 10.75 percent do not know yet.97.62 % want to replace their car, while only 2.38 % state, that they will buy an additional car.)

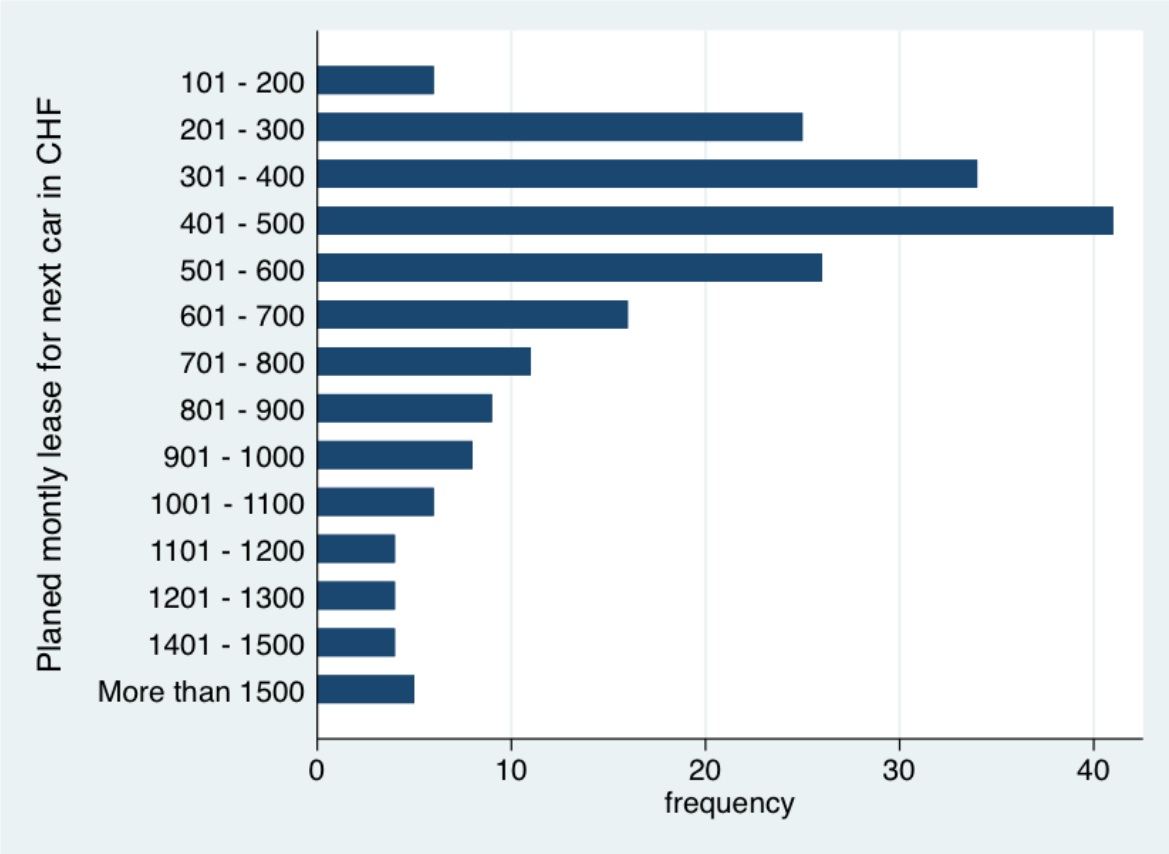


Figure A7: The distribution of planned leasing prices for next vehicle in our online sample of car holders with no BEV registered (Note: 82.51 % plan to buy there next car, while 6.74 % plan to lease, while 10.75 percent do not know yet.97.62 % want to replace their car, while only 2.38 % state, that they will buy an additional car.)

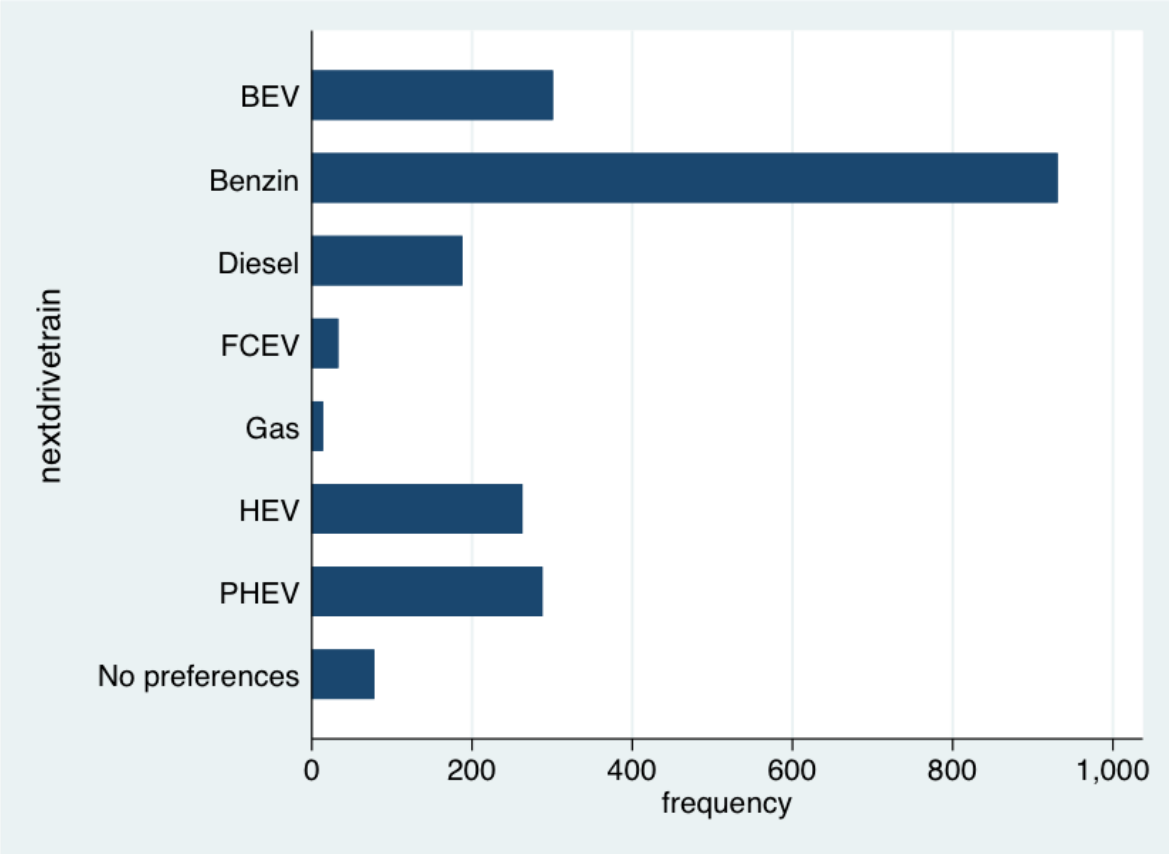


Figure A8: The distribution of the next drivetrain stated in our online sample of car holders with no BEV registered

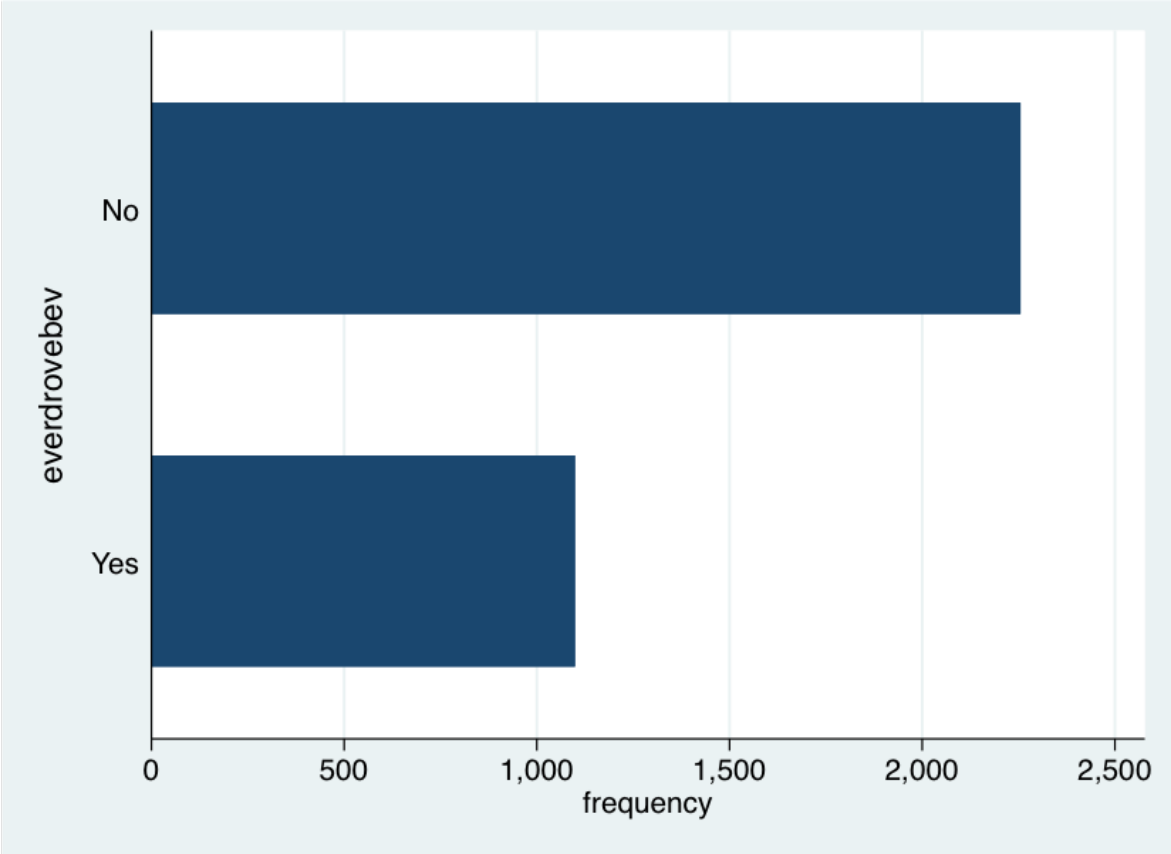


Figure A9: The distribution of EV driving experience in our online sample of car holders with no BEV registered

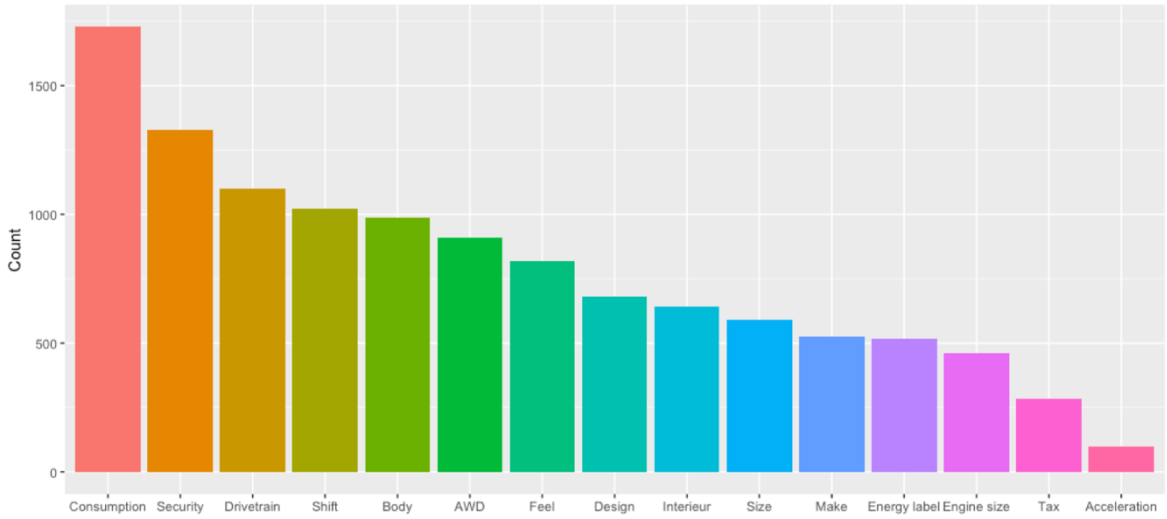


Figure A10: The distribution of importance of car attributes in our online sample of car holders with no BEV registered

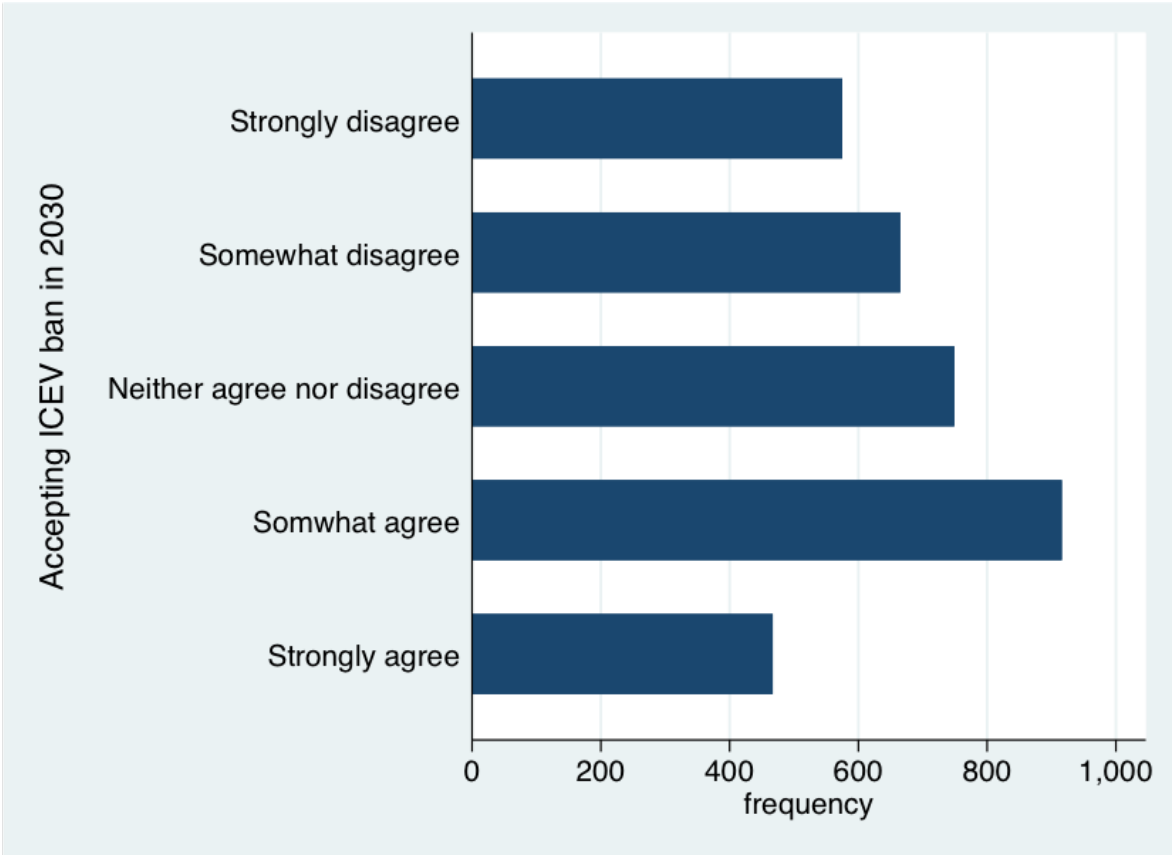


Figure A11: The distribution of car ban acceptance in our online sample of car holders with no BEV registered

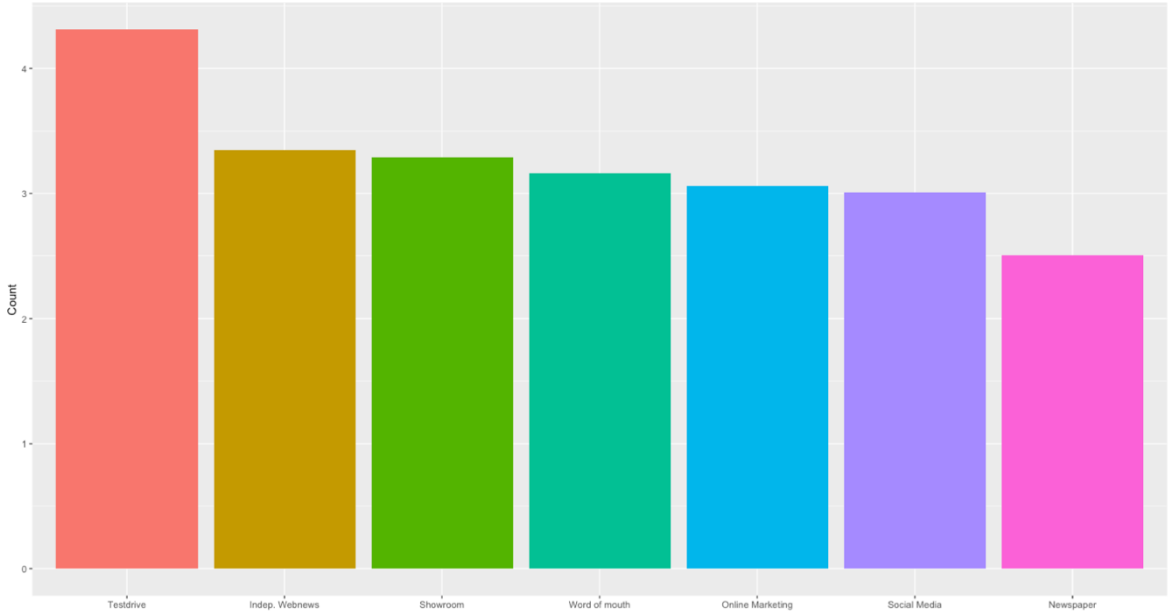


Figure A12: The distribution of importance of different means of gathering information in a car purchase process in our online sample of car holders with no BEV registered

8.2 Appendix 2: Attributes of conjoint experiment

Attributes	**Attribute levels**
Building up charging **infrastructure** for electric vehicles at public parking lots (e.g., Blue Zone)	• No infrastructure build-up • At 1 out of 1000 parking • At 10 out of 1000 parking • At 100 out of 1000 parking
Purchase **subsidy** for new electric vehicles	• No subsidy • Subsidy of 1000 CHF • Subsidy of 3000 CHF • Subsidy of 5000 CHF
Registration of cars with high fuel consumption (above 7 litre gasoline/diesel per 100km)	• Allow registration from 2020 onward • Stop registration from 2020 onward
Information on the consumption, CO2 and energy efficiency of cars to support the purchase decision (e.g., energy labels, info in advertisements and sales brochures)	• Keep current energy labels • Stricter energy labels • Abolish energy labels
Funding the measures through *(only displayed with p=0.5)*	• No additional funding • General federal budget without an increase in income tax (savings in other areas of the budget) • General federal budget with an increase in income tax (with current progression) • Fee of CHF 4000 for the purchase of cars with gasoline/diesel engine • Price increase for motorway vignette from 40 to 100 CHF

Table A2: Overview of conjoint attributes and attribute levels as used in baseline survey as well as follow up surveys in order to measure EV policy preferences

8.3 Appendix 3: Example of conjoint choice task with financing

Attribute	**Proposal A**	**Proposal B**
Infrastructure provision (charging stations)	No such provision	Provision at 10 out of 1000 parking spaces
Purchase subsidy	3000 CHF	No subsidy
Registration of cars with high fuel-consumption	Continue to allow registration from 2020 onward	Stop registration from 2020 onward
Energy labels for cars	Stricter energy labels	Abolish energy labels
Financing of measures through	Income tax increase	Fee for registration of ICE cars

Which policy proposal do you prefer?

○ **Proposal A** ○ **Proposal B 2**

Please now rate each proposal separately.

How much are you in favour or opposing Proposal A?

- ○ Very much in favour
- ○ In favour
- ○ Slightly in favour
- ○ Partly in favour partly opposing
- ○ Slightly opposing
- ○ Opposing
- ○ Very much opposing

How much are you in favour or opposing Proposal B?

- ○ Very much in favour
- ○ In favour
- ○ Slightly in favour
- ○ Partly in favour partly opposing
- ○ Slightly opposing
- ○ Opposing
- ○ Very much opposing

8.4 Appendix 4: Example of conjoint choice task without financing

Attribute	Proposal A	Proposal B
Infrastructure provision (charging stations)	No such provision	Provision at 10 out of 1000 parking spaces
Purchase subsidy	3000 CHF	No subsidy
Registration of cars with high fuel-consumption	Continue to allow registration from 2020 onward	Stop registration from 2020 onward
Energy labels for cars	Stricter energy labels	Abolish energy labels

Which policy proposal do you prefer?

○ **Proposal A** ○ **Proposal B 2**

Please now rate each proposal separately.

How much are you in favour or opposing Proposal A?

- ○ Very much in favour
- ○ In favour
- ○ Slightly in favour
- ○ Partly in favour partly opposing
- ○ Slightly opposing
- ○ Opposing
- ○ Very much opposing

How much are you in favour or opposing Proposal B?

- ○ Very much in favour
- ○ In favour
- ○ Slightly in favour
- ○ Partly in favour partly opposing
- ○ Slightly opposing
- ○ Opposing
- ○ Very much opposing