**Household Preferences for Electric and Hybrid Cars**

 [Doina Radulescu, University of Bern, +41 31 631 40 07, doina.radulescu@kpm.unibe.ch]

[Patrick Bigler, University of Bern, +41 31 631 53 20, patrick.bigler@kpm.unibe.ch]

## Overview

The private transport sector still accounts for a large share of worldwide CO2 emmissions. Despite generous subsidy programs and ambitious policy goals, the adoption rate of electric (EV) and hybrid (HV) vehicles remains low. In order to achieve globel emission reduction goals and to make road transport more energy efficient and environmentally friendly a significant increase in EV adoption is necessary.

We study an extensive dataset of socio economic and car specific characteristics as well as energy preferences of individuals to assess which factors drive household preferences for and subsequently decisions to adopt an EV or HV instead of a gasoline or diesel driven car. Our dataset for the canton of Bern includes around 133000 car registrations over a timespan of ten years between 2008 and 2019. Furthermore, we resord to individual tax records and electricity consumption and product choice data as well as car specific characteristics and prices as explanatory variables in our discrete choice models.

We find that car prices have a strong negative and significant impact on fuel type choice. Income positively affects the likelihood to choose a diesel or hybrid car in comparison to a gasoline driven car, and wealthier individuals are more likely to adopt an electric vehicle. Moreover, we also find evidence for what we label “green preferences”. Households that have their own PV installed and households that choose an electricity mix that is based on renewable energy sources are more likely to purchase an EV or HV.

## Methods

We use a discrete choice model to analyse the different factors that drive consumers preferences towards the different cars and fuel types. The underlying random utility model assumes an additive structure of car specific characteristics such as price or engine power and invariant characteristics such as income, age and green preferences of the individual. Agents choose the option that maximises their utility. In a first step, we model and analyse this choice structure with a multinomial logit model. In short, the probability that individual i, chooses car type j, given the individual specific attributes zi and the car specific attributes xij can be summarised in the following way:

One important assumption of the multinomial logit model is the independence of irrelevant alternatives (IIA). This implies that the probability of choosing one particular type of vehicle should not be change by removing or adding one additional option j. In our example, the addition of plug-in hybrid cars to the choice set of gasoline, diesel, electric and hybrid cars should not significantly change the probability that individual i chooses the other options. To relax this assumption, we also allow for random parameters and estimate a mixed logit model (sometimes also called random parameters logit model). Instead of estimating a fixed parameter β, some coefficinets are now assumed to differ between individuals based on random preference shocks in the following way:

We estimate the mixed logit model with a random parameter coefficient for the price covariate and assume a normal distribution. Hence, we estimate both the mean and the standard deviation to completely identify the distribution of the coefficient.

In a last step, we also observe households’ previous car choice, and thus identify agents that switched from a fossil fuel types to an electric or hybrid vehicle. We also perform a logit model for the “switchers” to estimate the socio economic characteristics that predict a household’s likelihood to switch.

## Results

We analyse the choice and switching behaviors of individuals in the car market. Socio economic characteristics as well as car specific attributes are important predictors for the likelihood to choose a diesel, electric or hybrid car relative to a gasoline driven car. An increase in prices negatively impacts the probability of any car being chosen. Households with higher incomes are more likely to buy a hybrid or diesel driven car relative to a gasoline driven car, while wealthier households have a higher probability to purchase an electric vehicle. While being older or a smaller household increases the likelihood to have a hybrid rather than a gasoline driven car, diesel and electric cars are preferred by younger and relatively larger households.

We also find evidence for what we label “green preferences”. Households that receive from their energy provider electricity based on renewable sources or have their own photovoltaic installation are more likely to choose an electric car or a hybrid car relative a gasoline driven car.

In general we find a verly large negative and significant effect of car prices on vehicle choice. We also fnd evidence for a preference towards “more powerful” cars, meaning that higher engine power in terms of KW is a positive predictor of a car being chosen.

For the “switchers”, we find that higher income and wealth increase the likelihood to switch towards more environmentally friendly vehicles. We also find a positive coefficient for age and a negative coefficient for householdsize. Again green preferences in terms of owning a solar panel or choosing a renewable electricity mix increases the likelihood of switching from a fossil driven engine type to an electric or hybrid car.

## Conclusions

Increasing concerns about greenhouse gas emissions from the road transport sector coupled with a very low uptake of environmentally friendly technologies such as electric vehicles call for a deeper analysis and understanding of consumers’ choices in the car market. We employ revealed preferences data around 133000 households living in the canton of Bern including socio demographic characteristics and informations on car attributes to analyse car choice and switching behaviour. Higher income and wealth positively affect the probability to acquire an electric vehicle and the price of a car is one of the main predictors of car choice. We also find evidence for a preference for more powerful engines. In addition households with so-called, “green preferences” are more likely to purchase an electric or hybrid car relative to a gasoline driven car.

## References (Selection)

Bento, A. M., L.H. Goulder, M.R. Jacobsen and R.H. von Haefen (2009), Distributional and Efciency Impacts of Increased US Gasoline Taxes, American Economic Review, 99(3) , 667-699.

Beresteanu, A. and S. Li (2011), Gasoline Prices, Government Support, and the Demand for Hybrid Vehicles in the United States, International Economic Review, 52(1), 161-182.

Gallagher, K.S. and E. Muehlegger (2011), Giving Green to Get Green? Incentives and Consumer Adoption of Hybrid Vehicle Technology, Journal of Environmental Economics and Management, 61(1), 1-15.

McFadden, D. and K. Train (2000), Mixed MNL Models for Discrete Response, Journal of Applied Econometrics, 15(5), 447-70.

Muehlegger E. and D.S. Rapson (2018), Subsidizing Mass Adoption of Electric Vehicles: Quasi-Experimental Evidence from California, working paper