COVID, AND CLIMATE CHANGE

1st IAEE Online Conference, 7th - 9th June 2021

Session 6 – Electric Vehicle and Consumer Preferences

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CONSUMER PREFERENCES FOR INNOVATIVE MOBILITY CONCEPTS IN GERMANY

Research Objectives

- The still **relatively low market share of Battery Electric Vehicles (BEV) in Germany** and the strong growth rates since 2014 in combination with expected future growth rates illustrate **high potential** for the automotive industry and for providers of mobility services.
- Sustainable supply of BEV and electro mobility services require
  1. detailed knowledge on **individual preference structures for single attributes** of products and services for electro mobility, and
  2. investments in those attributes with currently **weak performance**.
- International research illustrates some attributes of electro-mobility such as **charging infrastructure** and **range** which are crucial determinants of market development.

Research Objectives

- Between 2017 and 2020 the number of battery electric vehicles in Germany has **increased more than twice** compared to the number of charging points.
- High preferences for these attributes in combination with **insufficient infrastructure** require further clarification.
- In particular, **range, charging infrastructure, and price** hinder the majority of consumers to use electro mobility. A better performance of these attributes requires targeted investments and efficient marketing.
- **A Discrete Choice Experiment** (DCE) is used to estimate **marginal WTP** for changes of single attributes of mobility products and services related to electric vehicles and other alternatives to conventional vehicles.
- The results of this survey identify **the drivers and obstacles** for the uptake of electro mobility.

Research Goal and Method

- The goal of this research is to use information on **consumer preferences for single attributes of mobility**. The main research questions are:
  1. can **additional WTP** for BEV be sufficient to cover higher costs for technological solutions such as battery technology and charging infrastructure?
  2. What are **implications for policy support** and marketing to close the gap between the growth rate of BEV and the growth rate of charging infrastructure?

Research Goal and Method

- Consumer´s preferences on markets for BEV is analysed based on a DCE conducted online with a random sample of **405 completed questionnaires** from respondents in Germany.
- The emphasis is on the willingness to pay for single **attributes** of products on markets for **electro mobility**.
- The choice is between several types of vehicles and services in different combination of mobility systems. **12 choice cards** were presented to each respondent with a sum of **4,860 choices**.
- The DCE constructs a **hypothetical market situation** and therefore provides approximate parameters for the demand function which can be used for **public support and marketing** of BEV and other alternative vehicles.

Choice Model

The **theoretical model of choice** is based on the assumption that the total utility of a vehicle is the sum of the utilities from each attribute plus a constant utility for the vehicle type.

$$U_{EV} = \beta_{EV} + \beta_1 Price + \beta_2 Power + \beta_3 RunCost + \beta_4 ParkRide + \beta_5 FreePark + \beta_6 BusLane + \beta_7 Range + \beta_8 Avail$$

- Where U_{EV} represents **utility** a respondent receives from this specific configuration of the BEV,
- β_{BEV} represents the **change in utility** of a BEV in its base configuration compared to no car, the remaining β parameters represent the utility derived from the attributes.
- For each vehicle type presented in the choice set, the respondent chooses the vehicle type that provides the **highest level of utility**.
- To increase the number of observations, each respondent was asked to make this **choice twelve times** with different values of the attributes.

Choice Design

- **Selection of attributes and levels** based on expert interviews.
- The choice cards include **six attributes** for **five different vehicle types** plus the option Car Sharing.
- The vehicle types cover the **range of available options** on German car markets: conventional vehicles (CV), hybrid electric vehicles (HEV), battery electric vehicles (BEV).

Attributes and Levels of the Vehicle Types

Table 1: Attributes and vehicle types

Attribute	CV	HEV	BEV	RE	PHEV	CS
Price in % of reference level	100	80 100 120 140	120 140 160	120 140 160	80 100 120 140	120 140 160
Power in % of reference level	100	80 100 120	80 100 120	80 100 120	80 100 120	80 100 120
Running costs (€ct/km)	1 13 16	1 13 16	8 11 14	8 11 14	8 11 14	1 13 16
Bonus	No	no	No Park&Ride Free parking city center Usage of bus lane	No Park&Ride Free parking city center Usage of bus lane	No Park&Ride Free parking city center Usage of bus lane	No Park&Ride Free parking city center Usage of bus lane
Range (km)	700	700	150 200 240	200 300 400	700	350 450 550
Availability of petrol/char-ging stations	High	high	Low medium	Low medium	high	Medium High

Choice Set Example

Attributes and levels for four alternative options and for CS

Table 2: Choice Set example

	CV	HEV	BEV	RE	PHEV	CS	No
Price in % of reference level	100%	100%	140%	160%	100%	160%	
Power in % of reference level	100%	100%	100%	100%	100%	100%	
Running costs (€ct/km)	13 ct/km	16 ct/km	14 ct/km	14 ct/km	8 ct/km	16 ct/km	
Bonus	No Bonus	No Bonus	Usage of bus lane	Park & Ride	Free parking in city center	No Bonus	
Range (km)	700 km	700 km	200 km	300 km	700 km	450 km	
Availability of petrol/ charging stations	high	high	low	low	high	medium	
I choose...	☐	☐	☐	☐	☐	☐	☐

Results

Latent Class Model – Socio Economic Determinants

Table 3: Class probabilities

Covariates class probability	
Gender	-0,0856
	(-0,40)
Age	-0,0141**
	(-2,32)
Rent	0,439*
	(1,90)
Income	-0,0164
	(-0,54)
Constant	1,166**
	(2,51)
Observations	4860
Respondents	405

- The class membership probability is **partly influenced by the socio-demographic** variables. While gender and income do not have a statistically significant impact on class membership, **age** and **rent** do.
- Younger respondents and those who have rented an apartment are more likely to be **member of class 1**.
- **Preference heterogeneity** is present due to differences in covariates between the classes.

Results

Latent Class Model – Vehicle Type

Table 4: Class comparison

	Class 1 (63%)	Class 2 (37%)
Alternative specific constants (Standard errors in parentheses)		
Conventional vehicle (CV)	3,124***	6,200***
	(5,19)	(4,64)
Hybrid (HEV)	3,273***	3,814***
	(5,42)	(2,75)
Electric vehicle (BEV)	3,886***	1,420
	(12,12)	(1,58)
Range Extender (RE)	3,249***	-0,0933
	(8,65)	(-0,08)
Plug-in-Hybrid (PHEV)	3,415***	2,849**
	(5,61)	(2,05)
Car Sharing (CS)	2,390***	4,332***
	(4,61)	(3,96)

- The **first class** has a **slightly higher share** than class 2 with 63%, i.e. it is more likely that a randomly selected respondent falls into class 1.

Thus, the main distinguishing factor between the two classes is the acceptance of BEV.

Results

Willingness to Pay

Table 5: WTP in Percent for significant attributes

	Class 1	Class 2
Usage costs	-10,2 [-11,9;-8,9]	-8,6 [-25,5;-4,0]
Boni: Park & Ride	-14,8 [-24,2;-5,7]	-87,2 [-203,5;-39,0]
Boni: Usage of bus lanes	-10,2 [-18,8;-1,9]	-41,7 [-107,3;-2,5]
Range	9,0 [3,1;15,9]	n. s.
Availability of petrol stations (Low → High)	27,4 [10,0;47,0]	n. s.

- For a decrease in **usage costs** by one Eurocent per kilometer, people are **willing to pay** between **10 and 8%** more for purchasing.
- For an **increase in range by 100 kilometers**, people in class 1 are **willing to pay 9% more** and for a **high availability of petrol stations**, the additional **WTP** amounts to even **27%**.

Results

Latent Class Model - Attributes

Table 6: Preference differences between classes

Attributes		
Price (change to conventional in %)	-2,139***	-1,190***
	(-16,75)	(-3,09)
Power (in %)	-0,131	-0,131
	(-0,90)	(-0,35)
Usage costs	-0,219***	-0,102***
	(-23,41)	(-5,38)
Boni: Park & Ride	-0,316***	-1,037***
	(-3,13)	(-3,60)
Boni: Free parking	0,118	-0,422
	(1,19)	(-1,63)
Boni: Usage of bus lanes	-0,218**	-0,496*
	(-2,18)	(-1,95)
Range	0,192***	-0,135
	(2,91)	(-1,13)
Availability of petrol stations	0,292***	-0,0252
	(2,95)	(-0,11)

- Preferences vary between classes **mainly in magnitude and significance**, but not in direction.
- In both classes, people **prefer lower purchasing prices and running costs**.
- **Class 2** members are not interested in BEV.
- **Preferences for BEV are lower** than expected based on findings in literature.
- Non-financial support is with low or **negative effects**.
- **Lower prices** are still the most convincing argument to buy an BEV.
- **Younger people** and **tenants** are more likely to opt for alternative vehicles.

Impacts

- **Distinct availability of charging stations** is with high priority for consumers as illustrated in the results of our DCE
- The results of the DCE illustrate a great need to **communicate various advantages of improvements in grid infrastructure** for electro mobility.
- The levy of additional WTP requires **intelligent business models** capable to increase market shares of BEV and other alternative vehicles and mobility services with transparent measures to invest in the preferred attributes.
- The financial support granted by the German Government has **shifted** the **demand curve** for BEV and PHEV upwards.
- The growing market size **increases the gap** between the high priority of available charging points and range on one hand and the number of BEV and PHEV on the other.

Impacts

- Outstanding WTP values of **young tenants** can be activated with specified marketing activities.
- Expanding charging infrastructure for electro-mobility will lead to higher number of batteries produced. This has **negative effects** on resource consumption and **environmental quality**.
- Low impacts of public incentives indicate that public measures such as boni are limited and should be **substituted by alternative measures to increase market shares** of electro mobility, for example with public investments in charging-infrastructure.

Highlights

- Since 2017, the number of BEV has increased more than the number of charging points.
- Younger respondents and tenants have stronger preferences for electric vehicles.
- For a high availability of petrol stations, the additional WTP amounts to 27 %.
- The market efficiency of publicly financed bonuses as used in Germany is limited as long as the heterogeneous preferences for attributes of BEV and PHEV are not fully taken into account.
- For the attribute range consumer´s desires can be met less costly in urban areas due to the growing demand for BEV with a range between 200 and 400 kilometers.
- Investments for improvements in available technology are required to reduce loading time.

Literature

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Thank you for your interest!