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Household fleet adaptation as reaction to price regulations: A stated adaptation experiment

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Gefördert durch:



aufgrund eines Beschlusses des Deutschen Bundestages



Transport decarbonization required

► **Status quo**

transport sector is one of the largest sources of the total greenhouse gas emissions

▣ **Goals** (among others)

- reduction of internal combustion engine (ICE) vehicles
- shift from ICE vehicles to electric vehicles (EV)

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Which
push and pull factors
can foster the
integration of
electric vehicles in
household fleets

Stated adaptation experiment

A stated response technique (Lee-Gosselin, 1996, p. 124)

behavioral outcomes	situational constraints	
	pre-defined	elicited freely
pre-defined	stated preference <i>Given the levels..., which would you prefer...?</i>	stated tolerance <i>Under what circumstances could you imagine yourself doing...?</i>
elicited freely	stated adaptation <i>What would you do differently, if you were faced with ...?</i>	stated prospect <i>Under what circumstances would you be likely to change your behavior?</i>

Computer-assisted personal interviews in 2020

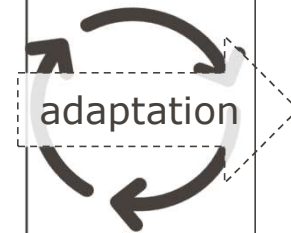
444 respondents providing information for the household

Person & household
location, income, age, gender, education, driver's licence, etc.
revealed preferences (RP):
vehicles
engine, segment class, annual km
motorcycles
engine, annual KM
persons
PT subscription, age, gender, education, driver's licence, etc.

stated adaptation experiment

price attributes	levels
fuel price (€/l)	1.50* / 3.00 / 4.50
CO ₂ surcharge (€/l fuel)	0.00* / 0.20 / 0.60
electricity price (€/100km)	0.00 / 3.50* / 7.00
purchase bonus for EVs (€)	2,000 / 6,000* / 10,000
public transport (PT)	-100% / -50% / as today*

Note: * = value at time of fieldwork



optimal
mobility
tools



Choice task example

#4 choice tasks per respondent

before adaptation

Price regulations	
fuel price (€/l)	4.50 €
CO ₂ surcharge (€/liter fuel)	0.00 €
electricity price (€/100km)	0.00 €
purchase bonus for EVs (€)	2,000 €
public transport	50% of today's price

Changes in costs to actual mobility costs	
yearly:	+2,879.45 €
monthly:	+239.95 €

vehicles	vehicle	vehicle
segment class	large	small
cubic capacity	1500 - <2000	-
drive-train	Gasoline	BEV
buy as new	<input type="checkbox"/>	<input type="checkbox"/>
annual kilometres travelled	15,000	6,000
changes in costs (yearly)	+3,285.00 €	-436.25 €
	remove	remove
add a vehicle		

- hypothetical price regulations (scenario)
- changes in costs for the RP mobility tools
- respondent is asked to adapt the mobility tools for the household

vehicle:

- **segment class:** mini, small, medium, large, executive, luxury, sports utility vehicle, sports coupé, multi purpose
- **cubic capacity:** <1500 , 1500 - <2000, 2000 - <2500, 2500 - <3000, >3000
- **drive-train:** Gasoline, Diesel, battery EV (BEV), plug-in hybrid vehicle (PHEV)
- **annual kilometres travelled**

Choice task example

#4 choice tasks per respondent

before adaptation

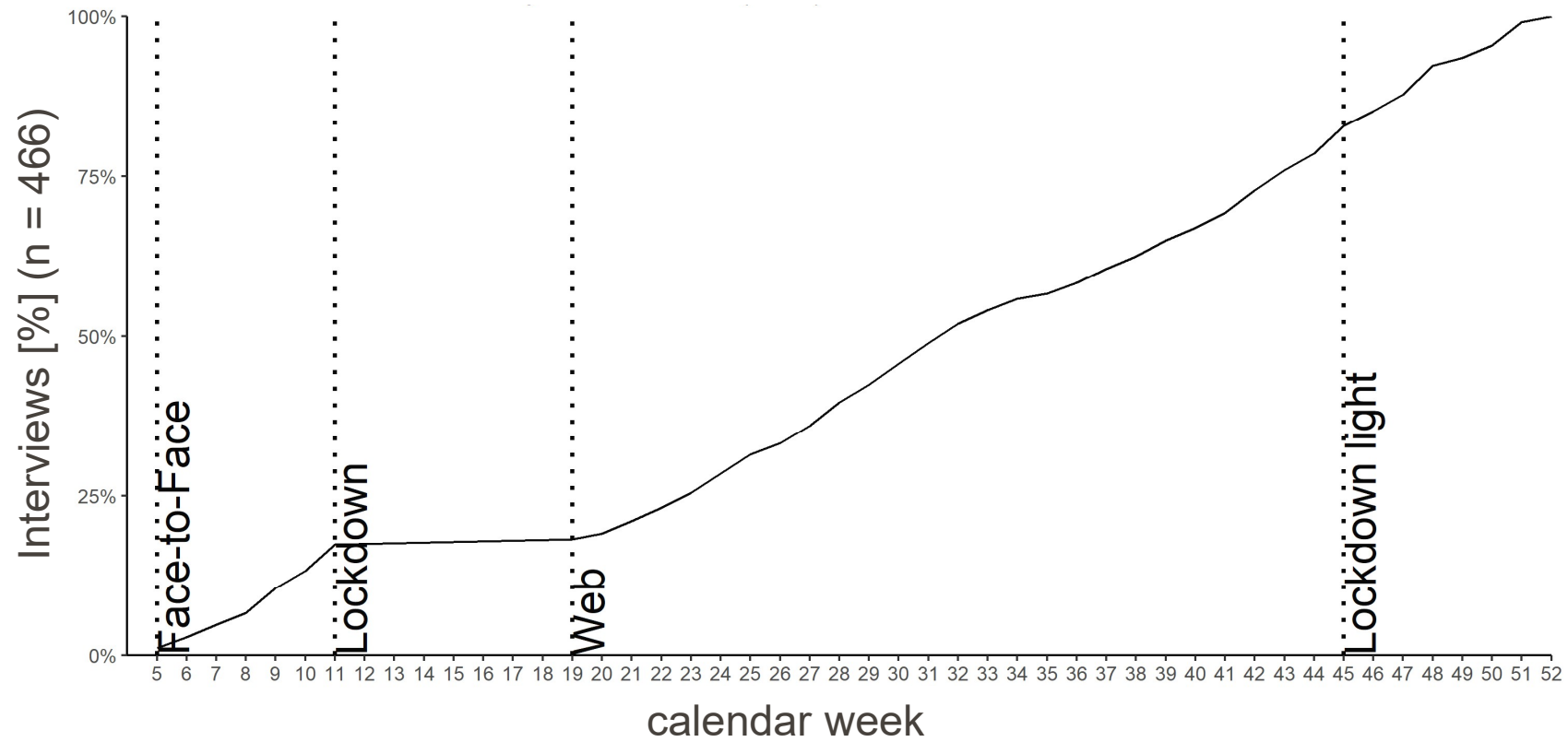
Price regulations		
fuel price (€/l)	4.50 €	
CO ₂ surcharge (€/liter fuel)	0.00 €	
electricity price (€/100km)	0.00 €	
purchase bonus for EVs (€)	2,000 €	
public transport	50% of today's price	
Changes in costs to actual mobility costs		
yearly: +2,879.45 €		
monthly: +239.95 €		
vehicles	vehicle	vehicle
segment class	large	small
cubic capacity	1500 - <2000	-
drive-train	Gasoline	BEV
buy as new	<input type="checkbox"/>	<input type="checkbox"/>
annual kilometres travelled	15,000	6,000
changes in costs (yearly)	+3,285.00 €	-436.25 €
	remove	remove
add a vehicle		

after adaptation

Price regulations	
fuel price (€/l)	4.50 €
CO ₂ surcharge (€/liter fuel)	0.00 €
electricity price (€/100km)	0.00 €
purchase bonus for EVs (€)	2,000 €
public transport	50% of today's price
Changes in costs to actual mobility costs	
yearly: -4,879.45 €	
monthly: -409.25 €	
vehicles	vehicle
segment class	middle
cubic capacity	-
drive-train	BEV
buy as new	<input checked="" type="checkbox"/>
annual kilometres travelled	15,000
changes in costs (yearly)	
	remove
add a vehicle	

Computer Assisted Personal Interviews (CAPI)

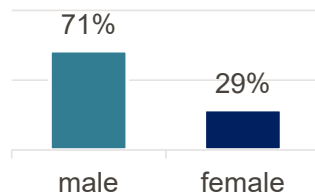
Feb – Dec 2020



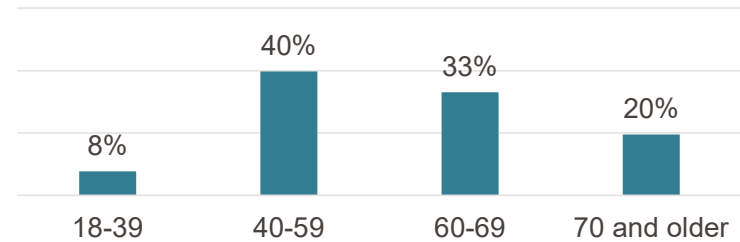
Sample population (n = 466)

Feb – Dec 2020

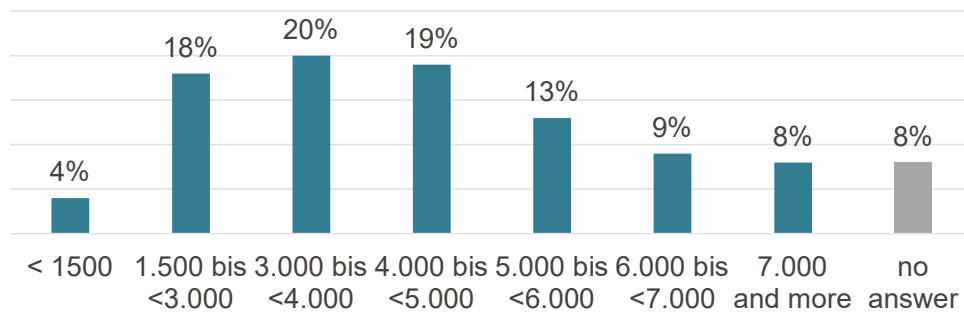
Gender



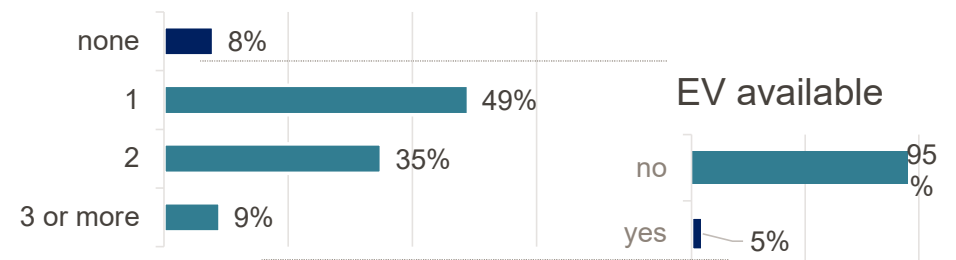
Age



Monthly household income







Vehicles in household



Changes in mobility tools (RP-SA difference)

444 respondents; 1737 choices

Changes [abs.]	no	add EV	remove ICE	replace ICE by EV	Remove & replace ICE
					
	all	all	min 1 ICE	min 1 ICE	min 2 ICEs
possible (households)	444	444	411	411	179
chosen (choices)	1191	74	123	306	43

Note: changes not modelled due to small #observations ($n \leq 10$): add ICE, remove EV, replace ICE by EV & add EV

Adaptation of household vehicle fleet

Multinomial Logit Model

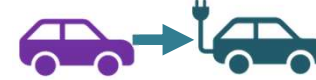
add EV



remove ICE



replace ICE by
EV



Remove & replace
ICE



	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio
fuel price	-		0.613	6.042	0.659	9.543	0.561	3.083
<i>x income</i>	-		-0.172	-1.922			-0.469	-1.356
<i>x vehicle km</i>	-		0.193	1.292	0.083	0.873	0.476	2.159
electricity price (ref: no change)								
- 3.50€	-0.205	-0.343	-		1.235	5.868	2.504	4.662
<i>x income</i>	0.356	2.304					-0.333	-1.639
+ 3.50€	0.097	0.208	-		-0.605	-2.388	n.s. -> fix	
<i>x vehicle km</i>	-0.071	-2.634						

Adaptation of household vehicle fleet

Multinomial Logit Model

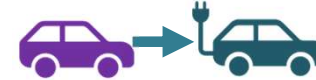
add EV



remove ICE



replace ICE by
EV



Remove & replace
ICE



	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio	Estimate	Rob. t-ratio
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purchase bonus (ref: no change)





-4,000€ (2k)	-1.816	-2.378	-		n.s. -> fix		-0.578	-1.731
<i>x income</i>	0.432	1.950						
+4,000€ (10k)	n.s. -> fix		-		0.295	1.638	n.s. -> fix	

Public transport (ref: no change)

-50%	-		n.s. -> fix		-		n.s. -> fix	
-100%	-		-0.578	-1.731	-		0.429	1.275
<i>x vehicle km</i>			-0.023	-1.580				

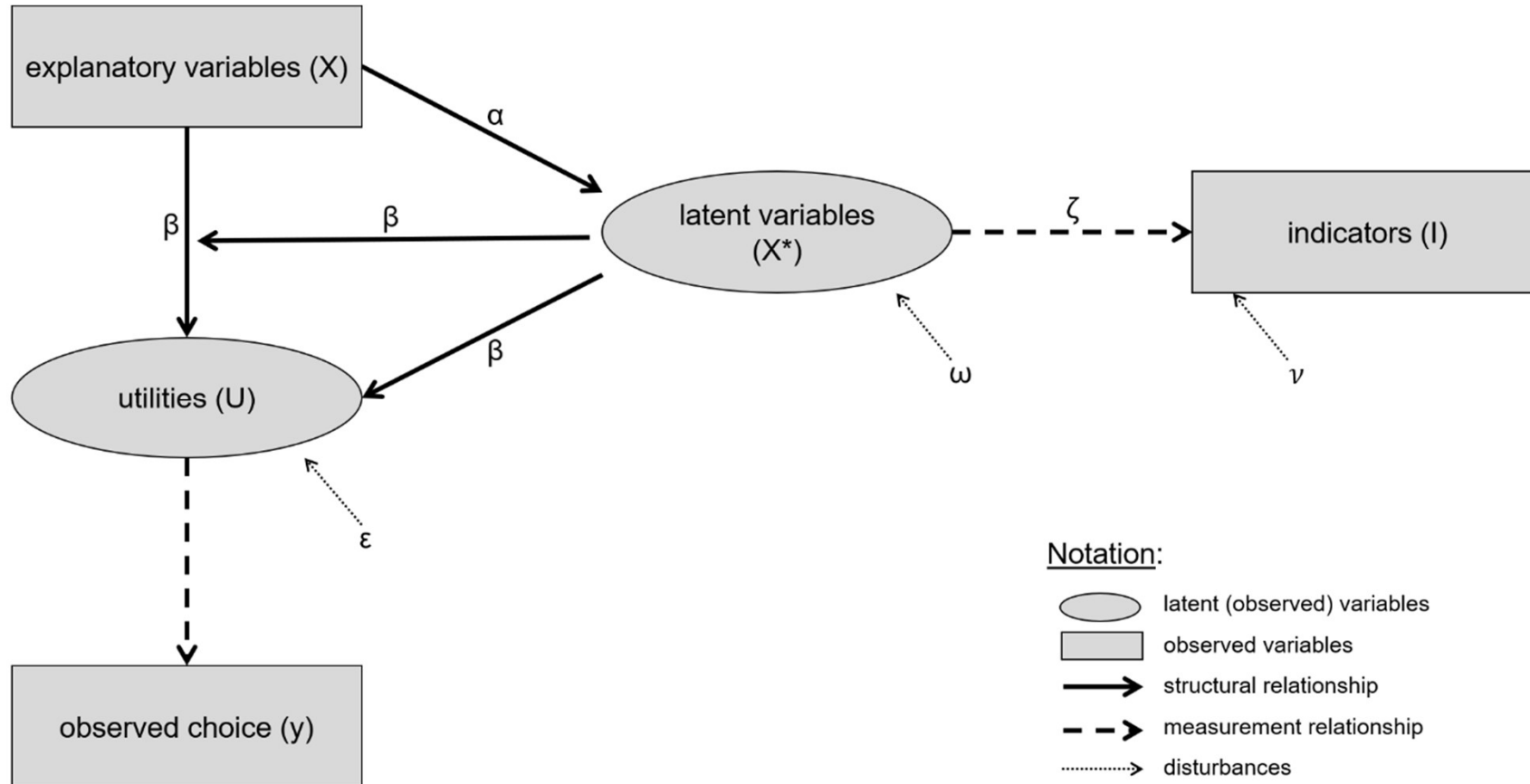
Adaptation of household vehicle fleet

Socio-demographic effects

	add EV 	remove ICE 	replace ICE by EV 	Remove & replace ICE 
	preferred by	preferred by	preferred by	preferred by
gender	n.s.	males	n.s.	n.s.
educational level	low	high	high	high
age	young	young	young	young
urban vs. suburban	suburban	n.s.	suburban	n.s.
n vehicles / n driving licenses	less vehicles	equal & more vehicles	equal & more vehicles	n.s.

Integrated choice latent variable model framework (ICLV)

(own illustration based on Walker and Ben-Akiva (2002))



Confirmatory factor analyses on latent constructs

Constructs & items	factor loadings			model fit		
	β	B	t-value	CFI	RMSEAR	SRMR
Intention				0.996	0.049	0.012
...switching to an EV	0.939	1.000				
...considering to buy an EV as next car	0.715	0.746	20.386			
...strong intention to buy EV	0.715	0.829	22.721			
...gathered information on buying an EV	0.503	0.584	22.721			
Environmental cognition				0.991	0.033	0.018
...industrialized world reached growth limits	0.563	1.000				
...should restrict our current standard of living	0.487	0.743	4.876			
... economic growth is needed even with pollution	0.472	0.742	5.970			
...environmental protection means life quality	0.536	0.678	4.910			

Summary

- Increasing fuel prices increase the utility of removing & replacing an ICE by EV
 - With higher VKM more sensitive towards fuel prices for removing & replacing
 - With higher income less sensitive towards fuel price for replacing ICE, replacing & removing ICE
- Low (free) electricity price increases the utility of replacing an ICE by EV, removing & replacing, but also for adding an EV (rebound!)
- Cheap / free public transport increases the utility of removing an ICE
- Purchase bonus for EVs without great effect

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**Thank you for
your attention!**

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