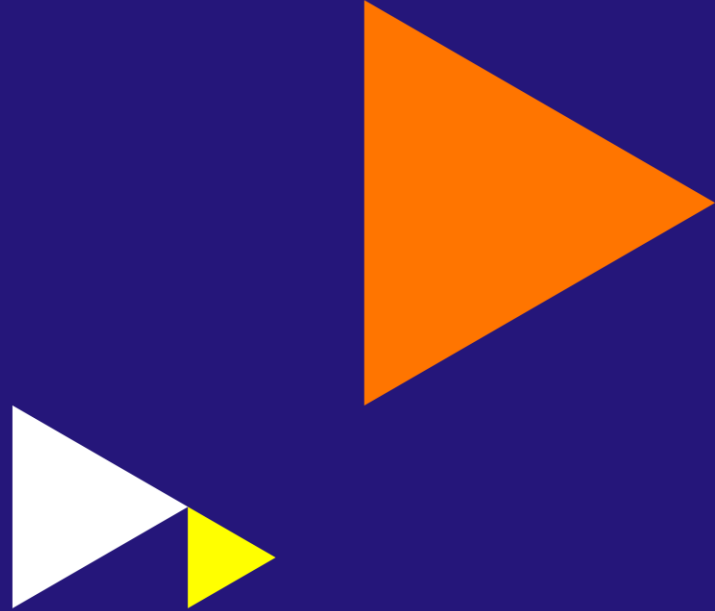


Price elasticity among Plug-in Hybrid Electric Vehicle drivers

Urban transport conference 2023 - Frankfurt

Rick Wolbertus PhD



Introduction

- Amsterdam University of Applied Sciences
 - Research group on energy and innovation
 - Charging infrastructure for electric vehicles
-
- Future Charging research program

~~×~~ Gemeente
~~×~~ Amsterdam



CoE
City Net Zero 



Pricing to steer urban mobility choices

- Effective method to steer towards cleaner air in the city
- Congestion zones (London, Stockholm, Gothenburg)
- 9 euro ticket – Germany
- Parking
 - Park + ride systems



The case of the plug-in hybrid vehicle

- Transition vehicle to full electric
- Electric range sufficient for most daily trips
- Ideal for urban environment
 - Implementation with geo-fencing (BMW)

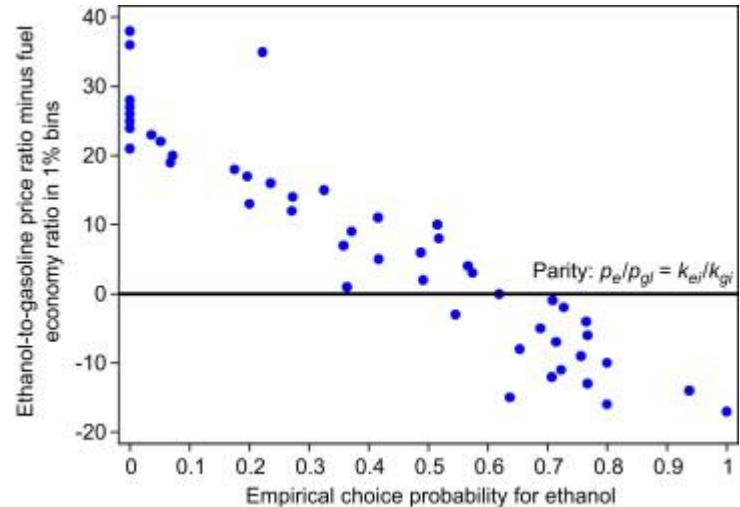
Reality is different

- Charging is less frequent than expected
- Emissions far higher than testing (WLTP)
 - 200% more
- Lack of infrastructure
 - But also lack of motivation

Plug-in hybrids 2.0: A dangerous distraction, not a climate solution

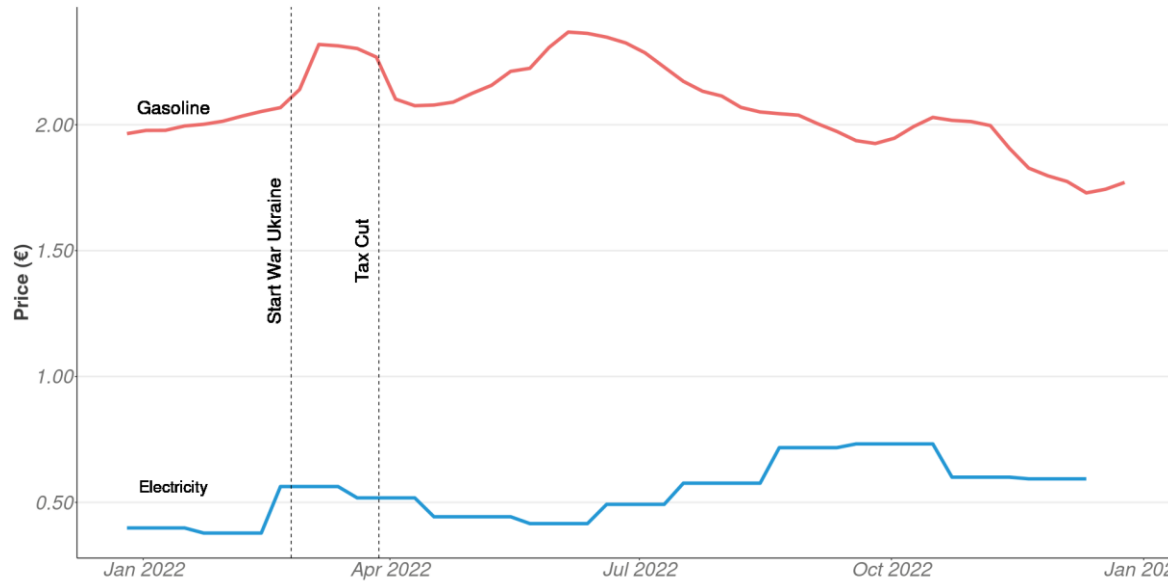
Fuel pricing for consumer vehicles

- Price elasticity for gasoline is low
 - -0.25 to -0.35 (i.e. a 10% increase in price would lead to 2.5 to 3.5% decrease in volume)
 - Sunk costs
 - No alternatives
- Price elasticity in bi-fuel cars
 - Little research
 - Evidence from ethanol/gasoline cars in Brazil
 - Near perfect substitution



Plug-in hybrids price elasticity in 2022

- Plug-in hybrid drivers have a possibility to shift fuels
- Large potential to increase electricity use
- Not direct substitution (availability of charging infrastructure, limited range)
- 2022 showed large variations in gasoline and electricity prices



Research

- Price elasticity among plug-in hybrid drivers at public charging stations in 4 cities in the Netherlands
- Data: 5.7 million charging sessions
 - Selection frequent PHEV Drivers
 - Active all year
- 5500 PHEV Drivers
- 550.000 charging sessions
- Amount charged per week

G4
elektrisch



Data gathering

- Gasoline prices
 - Hypothesis: Higher gasoline prices lead to more charging (kWh/week)
- Electricity price (consumer)
 - Hypothesis: Higher prices lead to more charging (switch from private to public)
- Electricity price (Charging station)
 - Hypothesis: Higher prices lead to less charging

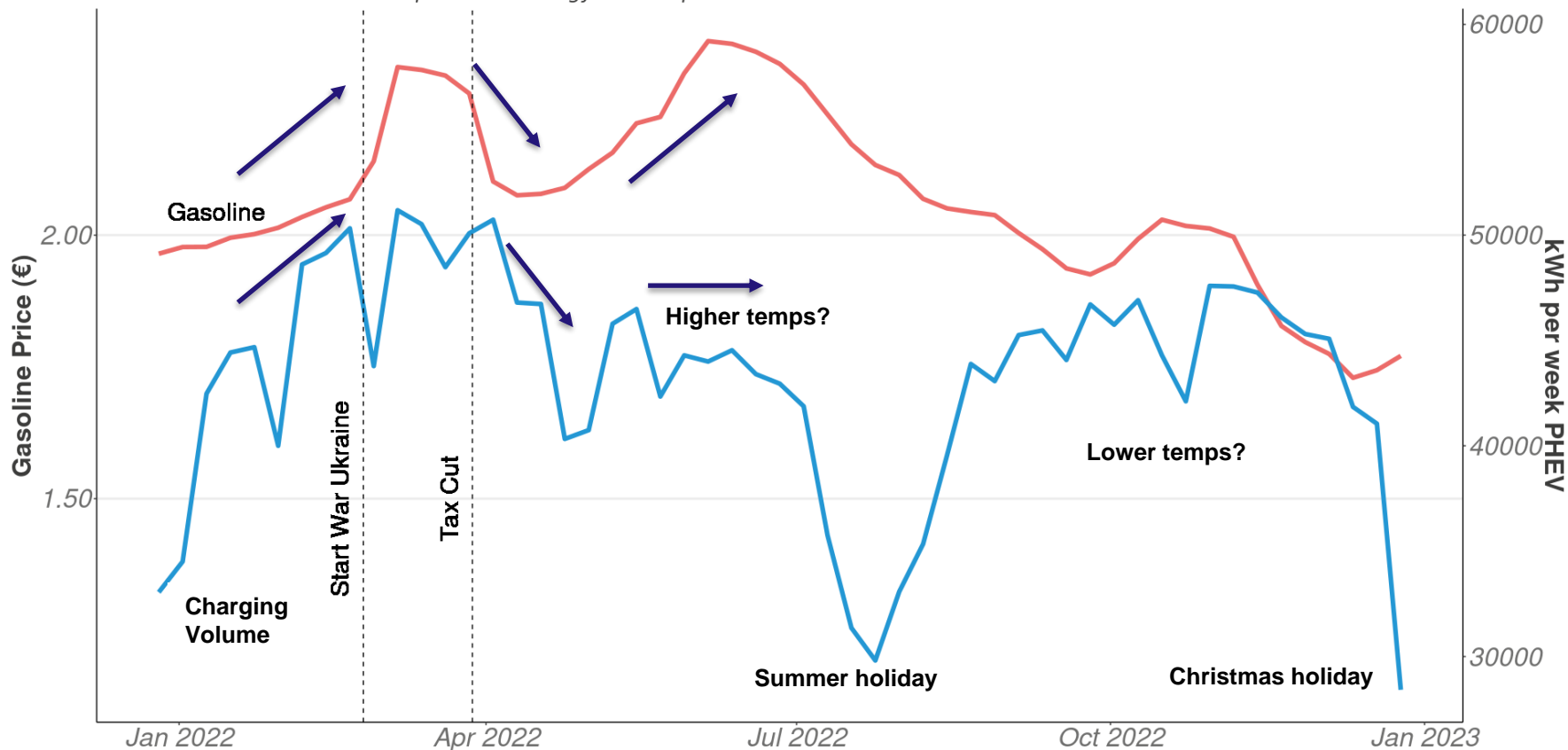
Control variables

- Weather: Lower temperatures lead to more charging
- Covid-19 restrictions : More restrictions lead to less charging
- Holidays: Holidays lead to less charging



Results

Correlation between Gasoline price and Energy consumption PHEV



Results: Modelling

Linear regression model: Prediction kWh per week PHEV users

<i>Predictors</i>	<i>Estimates</i>	<i>Confidence Interval</i>	<i>P-value</i>
(Intercept)	15.52	-8.32 – 39.35	0.196
Economic variables			
Gasoline Price	13.08	3.73 – 22.43	0.007
Electricity Price	16.02	2.68 – 29.37	0.020
Control Variables			
Temperature	-0.51	-0.76 – -0.27	<0.001
Holiday	-5.20	-7.78 – -2.62	<0.001
Covid measures	-0.76	-3.11 – 1.59	0.519

Observations

51

R² / R² adjusted

0.566 / 0.518

Results: Modelling include charging prices

City of Utrecht only

Linear regression model: Prediction kWh per week PHEV users

<i>Predictors</i>	<i>Estimates</i>	<i>Confidence Interval</i>	<i>P-value</i>
(Intercept)	118.12	29.03 – 207.21	0.011
Economic variables			
Gasoline Price	0.72	-1.23 – 2.66	0.461
Electricity Price	1.51	-0.43 – 3.44	0.123
Charging Price	-2.45	-5.34 – 0.43	0.093
Control Variables			
Temperature	-0.05	-0.08 – -0.01	0.012
Holiday	-0.85	-1.26 – -0.45	<0.001
Covid measures	0.27	-0.18 – 0.72	0.236
Observations	51		
R² / R² adjusted	0.570 / 0.510		

Results

- Price elasticity – note that we actually measure electricity use - an inverse of gasoline usage among PHEV drivers

Type	Research	Literature
Gasoline	-0.48	-0.25 - -0.35
Electricity	-0.18	-0.07 - -0.08
Charging price	-0.23	-0.40 - -0.50

Conclusions

- **Higher gasoline prices lead to more charging from PHEV drivers**
 - Locally effects may differ – results are not always robust
- **Short-term price rally's have more influence than long term trends**
- **Higher electricity prices might steer users from private charging to public charging**
- **Higher charging prices did not impact PHEV charging**
 - Lack of price transparency might play a role
- **Price elasticities found to be greater than in case of single fuel cars – but not much higher**