Effects of local policies on charging behaviour of Electric Vehicle owners and on purchase intentions of prospective owners. Cross-pollination based on a unique combination of natural and stated choice experiments

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This study is the first to combine revealed and stated preference data to estimate the effect of charging infrastructure and EV adoption policies on both charging and purchase behaviour.

Charging infrastructure development has been at the centre of attention for municipal policy makers to promote the adoption of electric vehicles (EV). Efficient planning of charging infrastructure is considered important to meet drivers' refuelling needs (Frade, Ribeiro, Gonçalves, & Antunes, 2011) but also to satisfy interests of stakeholders involved (Wirges, 2016). An increase in parking pressure, a problematic business case and potential grid overload are among the conflicts among stakeholders policy makers encounter (Bakker, Maat, & van Wee, 2014). On the other hand, municipalities look for other ways to promote EVs including measures such as free parking, access to HOV/Bus lanes and monetary incentives (Bjerkan, Nørbech, & Nordtømme, 2016). With a growing market for EVs, interest in studies that measure the effectiveness of policies for EV adoption and on the deployment and management of charging infrastructure is growing.

Currently available studies focus either on EV adoption or public charging infrastructure management. A growing body of literature uses stated (Liao, Molin, & Wee, 2015) and revealed preference data (Bjerkan et al., 2016; Sierzchula, Bakker, Maat, & Wee, 2014) to estimate the factors that drive electric vehicle purchases. Studies find three main barriers to EV adoption: driving range, purchase price and lack of refuelling infrastructure. Policies related to charging stations have also been subject of study in relation to EV adoption but with a main focus on availability (Egbue & Long, 2015; Krupa et al., 2014). Charging infrastructure deployment and utilization literature has mainly come in mathematical optimization studies (Frade et al., 2011; He, Yin, & Zhou, 2015) or more recently with a focus on revealed preference (Franke & Krems, 2013; Morrissey, Weldon, & Mahony, 2016). Although progress is made on understanding the effects of policies aimed at EV adoption or charging behaviour solely, cross-pollination between these fields is lacking.

This study uniquely combines stated and revealed preference data on the same policy measures aimed at EV adoption and charging infrastructure management to estimate the effects on both EV adoption and charging behaviour. Using a large dataset on charging behaviour on public charging infrastructure in the Netherlands the effects of *daytime-parking* (to manage parking pressure, 40.000+ sessions) and *free parking* (to promote EVs, 175.000+ sessions) policy on charging behaviour. Policies were implemented in unique experimental conditions allowing comparison of charging behaviour using analysis of covariance and logistic regression models. To estimate the effects of the same policies on EV purchase intention we conducted a stated choice experiment among car owners (n=149) that rely on public charging infrastructure for EVs. Abovementioned policies were presented as context variables in which respondents were asked to choose between full electric, plug-in hybrid electric or gasoline driven vehicles while varying the price and driving range. Data were analysed using mixed logit models to capture the choice heterogeneity among the respondents.

The results of the three experiments are summarised as follows:

- Data suggests that daytime-parking between 10:00-19:00 prohibits EV drivers from charging beyond these hours as other fuel type cars are also allowed to park at these spots. Expanding daytime-charging to 10:00-22:00 hardly influences the potential to charge, while potentially providing a relief in parking pressure.
- Evidence is provided that free parking at charging stations leads to significant longer connection times. Logistic regression models indicate that this is mainly driven by an increase in long (24+ hours) charging sessions.
- The results from the SP experiment indicate that free parking positively and daytime-charging negatively affect the adoption of full electric vehicles but that these policies have no effect on plug-in hybrid purchase intention.

References

Bakker, S., Maat, K., & van Wee, B. (2014). Stakeholders interests, expectations, and strategies regarding the development and implementation of electric vehicles: The case of the Netherlands. *Transportation Research Part A: Policy and Practice*, *66*(1), 52–64.

Bjerkan, K. Y., Nørbech, T. E., & Nordtømme, M. E. (2016). Incentives for promoting Battery Electric Vehicle (BEV) adoption in Norway. *Transportation Research Part D: Transport and Environment*, *43*, 169–180.

Egbue, O., & Long, S. (2015). Barriers to widespread adoption of electric vehicles : An analysis of consumer attitudes and perceptions. *Energy Policy*, *48*, 717–729.

Frade, I., Ribeiro, A., Gonçalves, G., & Antunes, A. (2011). Optimal Location of Charging Stations for Electric Vehicles in a Neighborhood in Lisbon, Portugal. *Transportation Research Record: Journal of the Transportation Research Board*, *2252*, 91–98.

Franke, T., & Krems, J. F. (2013). Understanding charging behaviour of electric vehicle users.

Transportation Research Part F: Traffic Psychology and Behaviour, *21*, 75–89.

He, F., Yin, Y., & Zhou, J. (2015). Deploying public charging stations for electric vehicles on urban road networks. *Transportation Research Part C: Emerging Technologies*, *60*, 227–240.

Krupa, J. S., Rizzo, D. M., Eppstein, M. J., Lanute, D. B., Gaalema, D. E., Lakkaraju, K., & Warrender, C. E. (2014). Analysis of a consumer survey on plug-in hybrid electric vehicles. *Transportation Research Part A*, *64*, 14–31.

Liao, F., Molin, E., & Wee, B. Van. (2015). Consumer Preferences for Electric Vehicles : a Literature Review. *Transport Reviews*, 1–24.

Morrissey, P., Weldon, P., & Mahony, M. O. (2016). Future standard and fast charging infrastructure planning : An analysis of electric vehicle charging behaviour. *Energy Policy*, *89*, 257–270.

Sierzchula, W., Bakker, S., Maat, K., & Wee, B. Van. (2014). The in fluence of financial incentives and other socio-economic factors on electric vehicle adoption. *Energy Policy*, *68*, 183–194.

Wirges, J. (2016). *Planning the Charging Infrastructure for Electric Vehicles in Cities and Regions (Doctoral dissertation)*. Karlsruher Institut für Technologie.