AN EXAMINATION OF THE ROLES OF INFRASTRUCTURE LIMITATIONS VERSUS CONSUMER PERCEPTIONS IN ELECTRIC VEHICLE ADOPTION INTENT

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Overview

Consumers adopt battery electric vehicles (BEVs) at higher rates in countries that offer financial incentives and have extensive charging infrastructure (Sierzchula 2014). At the sub-national level, counties in Norway with a larger number of charging stations have higher sales of BEVs (Mersky et al. 2016). This would suggest that rolling out extensive charging infrastructure will be a key driver of BEV sales in future, including for Asia-Pacific nations wishing to increase BEV uptake to reduce transport reliance on petrol. Yet prior work has also found that a BEV with a range of 160 km can meet the needs of 50% of single car households and 80% of multiple car households across cities in the US with a wide range of climates and city layouts (Khan and Kockelman 2012). Prior research in the US and Germany has shown that even previous-generation BEVs, with a range of 100 km rather than the 240 km ranges that are typical today, would be sufficient to meet daily driving needs for most regular travel, such as commute travel, with only overnight charging (Tamor et al. 2015).

Much of the population should thus be able to adopt a BEV for daily commuting without significantly changing current habits, so long as overnight charging at home is possible. Why, then, has prior research found the availability of public charging stations to be a powerful driver of BEV sales, when the majority of BEV users would not find public charging stations essential for using a BEV that could be given a nightly charge at home? Common misperceptions of BEV technological capabilities (Krause et al. 2013) may be limiting adoption intentions among those who could adopt a BEV without significant lifestyle change. We examine this possibility using survey data from individuals in the US cities of Los Angeles and Atlanta to better understand what underlies a person's stated intent to adopt an electric vehicle, with particular focus on the role of range anxiety in adoption intent and the drivers of range anxiety.

Our analysis considers the extent to which BEV adoption decisions are driven by true limitations versus perceptions that BEVs, a relatively new technology, are not yet able to meet the average person's transport needs. Prior work has found that experience in a BEV reduces range anxiety (Rauh, Franke, and Krems 2015), suggesting that range anxiety is at least partially driven by perceptions of BEV limits rather than by actual technological BEV limits. By confirming the effect of range anxiety on BEV adoption intent, then examining the predictors of range anxiety itself, we hope to illuminate the extent to which range anxiety is driven by actual inability of BEVs to meet driving needs versus driven by personal factors that may not be impacted by technological improvements and infrastructure expansion. If the latter is the case, then expansion of urban charging infrastructure may represent a relatively more expensive way to increase BEV adoption. Funds to support BEV adoption may for example be better spent on expansion of long-distance charging networks to allow BEV use outside urban centers, or to support plain-English messaging campaigns to increase general population understanding of how current BEV range capabilities translate into actual driving capabilility. Prior work has already suggested that increasing visibility and familiarity of BEVs may be key in countering the idea that BEVs require significant lifestyle changes in adoption (Silvia and Krause 2016).

Methods

The online survey platform Qualtrics was used to recruit a sample of 913 respondents who stated that they intend to purchase a vehicle within the next 5 years. Respondents were sampled from the US metropolitan areas of Los Angeles, California, and Atlanta, Georgia, to capture stated BEV adoption intent in two areas with different climates and different voting patterns. Respondents answered a series of questions including sets of questions aggregated to form measures of range anxiety and perceived needs for a car to meet mobility needs, and single-item self-reports of actual daily driving needs in miles. Cronbach's alpha and factor analysis are used to confirm that aggregated items all measure the same construct.

Ordinary Least Squares (OLS) regression is used to examine predictors of BEV adoption. Predictors examined are: range anxiety; perceived BEV fuel cost relative to petrol vehicles; perceived BEV maintenance cost relative to petrol vehicles; perceived BEV total cost of ownership relative to petrol vehicles; the number of publicly available chargers within each person's zip code; reported perception of reliance on cars to move between locations

on a daily basis; reported perception of importance of occasionally using cars for long-distance trips; reported perception of BEVs being able to meet current driving practices; reported daily driving distances (weekday and weekend averages); reported number of annual long-distance trips (trips over 2 hours driving); access to an electrical outlet in home garage; number of cars owned by the household; perceived BEV range; political affiliation; and level of concern about climate change.

OLS regression is next used to examine predictors of range anxiety. Predictors examined are: the number of publicly available chargers within each person's zip code; reported perception of reliance on cars to move between locations; reported perception of importance of occasionally using cars for long-distance trips; reported perception of BEVs being able to meet current driving practices; reported risk aversion; reported daily driving distances (weekday and weekend averages); reported number of annual long-distance trips (trips over 2 hours driving); access to an electrical outlet in home garage; and perceived BEV range.

Results

Higher BEV adoption intent is most strongly correlated with lower range anxiety and greater concern about climate change. Greater numbers of local public charging stations are also correlated to higher BEV adoption intent, though to a lesser degree. In constrast to expectations, greater reported daily driving distance positively correlates with BEV adoption intent, while the number of reported long-distance trips has no correlation. Higher perceived BEV maintenance cost relative to petrol vehicles negatively correlates with BEV adoption intent. Other variables included in the model do not significantly correlate with BEV adoption intent. Total model R^2 is 0.22, N=913.

Considering range anxiety as the dependent variable, we unexpectedly find that range anxiety is not correlated with access to public charging stations. Greater range anxiety is most strongly correlated with higher reported perception that BEVs will not be able to meet current driving practices, whereas the overall amount of driving or car dependence present in a person's current lifestyle is not correlated. Greater range anxiety is also strongly correlated with higher reported risk aversion. Actual driving distance and access to charging infrastructure, either public or private, are not significantly correlated with levels of range anxiety. Total model R^2 is 0.21, N=913.

Conclusions

While higher BEV adoption intent is somewhat correlated with greater access to public charging infrastructure, correlation is far stronger with range anxiety, concern about climate change, and access to in-home charging stations. Range anxiety itself is not correlated at all with access to charging infrastructure in public, and is predominantly predicted by perceptions about BEV ability to meet lifestyle needs yet not by actual differences in lifestyle. This suggests that the technological capabilities of current BEVs are not well understood, and that further improvements in battery technology or expansion of instracture may not achieve large increases in BEV adoption intent if misperceptions persist. Policy makers could meaningfully focus on tactics such as messaging to convey the driving time and amount of trips possible to complete on current BEV ranges in non-technical fashion, as a potentially cheaper alternative to installing urban public charging stations as a way to increase BEV adoption.

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