Sharing is Caring – Understanding the Relationship Between the Sharing Economy and Sustainable Mobility

Research-in-Progress

Christoph Willing
University of Freiburg
Platz der Alten Synagoge
79085 Freiburg, Germany
christoph.willing@is.uni-freiburg.de

Tobias Brandt
University of Freiburg
Platz der Alten Synagoge
79085 Freiburg, Germany
tobias.brandt@is.uni-freiburg.de

Dirk Neumann
University of Freiburg
Platz der Alten Synagoge
79085 Freiburg, Germany
dirk.neumann@is.uni-freiburg.de

Abstract

Electric vehicles (EVs) could play a major role in making personal transportation more sustainable. Yet, their diffusion is slow and the general public is skeptical of their potential to replace conventional combustion vehicles (CVs). We investigate differences in driver behavior between the two types, showing how sharing economy approaches can help people overcome concerns related to electric mobility. We analyze a dataset of carsharing rentals of a provider who offers EVs and CVs under the same conditions, within the same city, comprising over 230,000 rentals of approximately 750 cars over a period of 3.5 months. Our preliminary results suggest that in fact, once people get acquainted with EVs – at least in an urban carsharing context – they use them in a very similar manner as they use CVs. This suggests that the sharing economy supports the adoption of electric mobility and fosters more sustainable transportation.

Keywords: Sustainable Mobility, Carsharing, Sharing Economy, Electric Vehicles, Range Anxiety

Introduction

Technological innovations do not only change the way we interact with technology, they also advance the way we interact with the subject which was enhanced by technology. The success of Google's AlphaGo, for example, has shown how world-class Go players adapt their game when they play AlphaGo. But also when playing each other, players have adapted their traditional behavior to include new strategies and moves as a result of the introduction of AlphaGo (Zastrow 2016).

In the urban mobility sector, innovations in information technology (IT) have fundamentally changed the way we move about the city, for example through interacting with app-enabled navigation or cab-hiring services. More recently, IT advancements have also enabled shared mobility services on a larger scale, most prominently ride-, bike- and carsharing (Puschmann and Alt 2016). Following the analogy of AlphaGo, IT-enabled carsharing potentially also changes how we interact with the subject, the car. Carsharing providers are increasingly introducing electric vehicles (EVs) into their fleets. For instance, Autolib in Paris and car2go Amsterdam have all EV-fleets. While drivers are still hesitant with respect to all-electric vehicles, carsharing provides the means for users to assess and potentially refute their objections. Thus, the overall question motivating the research in this paper is "Can sharing economy approaches help to guide people towards a more sustainable mobility behavior by increasing the acceptance of EVs?"

Researchers largely agree that EVs are a substantial factor towards sustainability and a reduction in harmful emissions. Yet, among motorists, many reservations remain, which have slowed the rate of adoption. For instance, the German government has abandoned the unrealistic target of 1 million EVs in Germany by 2020, and has just recently decided on a subsidized rebate for EVs to reach 0.5 million by 2020. Experts have identified multiple factors to explain the hesitant adoption of electric mobility. First, the high costs of EV-batteries require significantly higher initial investments into electric vehicles (Brandt et al. 2013). Second, cognitive biases may still steer people towards conventional fuel-powered combustion vehicles (CVs), which are often perceived as more appealing and sporty – aside from high-end EVs like Tesla's Model S or BMW's i8. Finally, most people are genuinely concerned that the maximum range on a full charge is insufficient. This *range anxiety*, while generally exaggerated (Franke and Krems 2013), is often fueled by actual challenges EV owners face, such as long charging times or the absence of public charge points.

At the same time, there have also been several studies suggesting that, with regard to usability, EVs are not significantly inferior and that drivers' concerns are unsubstantiated (Franke et al. 2012). Thus, the **sharing economy**, could serve as a **crucial channel** to push the EV technology into the market and facilitate a faster rate of adoption. Due to the absences of large capital expenditures for carsharing users, the sharing mechanism makes it easier for people to **get acquainted with the technology** and **overcome biases**. Ultimately, people who are less inclined to buy an EV, but who are curious to test it in a shared setting, can assess more quickly whether their reservations are justified.

Not only does the sharing economy provide access to capital intensive innovations and allows individual users to asses them, it also provides the means to collect data and analyze the innovation on a larger scale. In July 2015, one of the leading free-floating carsharing providers has introduced EVs in select cities in Germany, in addition to their CV fleet. Since both types of vehicles are offered at the same time in the same context, rental data after the introduction presents us with the unique opportunity to compare the user behavior for the two different engine types. Specifically, we will determine if EVs are used any differently compared to CVs in a carsharing context. In this respect, we also examine whether the aforementioned driver hesitations about usability are substantiated. Previous analyses on EV-consumer behavior have been mostly tested in stated preference surveys or staged experiments. Our dataset allows us to analyze the revealed preferences of consumers in what is essentially a natural experiment. Therefore, it can shed more light on actual consumer interactions with EVs (neither assumed nor stated). The results can provide valuable insights on how to accelerate the rollout of EVs.

The remainder of the paper is structured as follows: in the next section we review the current state of research on differences in driver behavior, the sharing economy in general and carsharing in particular. In section three we describe our approach and dataset. The findings from our preliminary analyses are presented in section four. In section five we discuss the implications of our results and provide an outlook on further developments of the research project.

Literature Review

EVs and sustainable mobility: EVs, because they are tail-pipe emission free, can play a major role in reducing CO_2 and other emissions, making transportation overall more sustainable (Ehsani et al. 2010). Relative and absolute numbers of EVs are still low, which is why many researchers have turned to analyzing the causes for faltering adoption rates. General reasons for slow diffusion of cost-effective energy conservation technologies have been described as lacking knowledge by consumers, low consumer risk tolerance and high initial production costs (Jaffe and Stavins 1994), which all apply to EVs as well. More specifically, the factors influencing the purchase decision of an EV have been summarized as purchase price, operating costs, driving range, recharging times, and the charging network (Carley et al. 2013; Daziano and Chiew 2012; Pierre et al. 2011). Of these, range anxiety has been deemed the largest obstacle to broader adoption (cf. Dimitropoulos et al. (2013), for an overview of studies on EV driving range).

The limited range of electric vehicles per se, however, does not necessarily explain the slow adoption rate of EVs. In fact, several studies have shown that a range capacity of 100 miles, common for many of today's EVs, is sufficient for a large number of drivers in their everyday routine (see Franke and Krems (2013) for an overview of these studies). Instead range anxiety as a psychological barrier is the more pressing problem (Franke et al. 2012) and first-hand usage of EVs has been shown to positively affect range anxiety or even overcome it (Franke and Krems 2013). On the other hand, Jensen et al. (2013) have found that drivers' preference for driving range increased after testing EVs for a three-month period.

The sharing economy and carsharing: The sharing economy and collaborative consumption are rapidly growing, fueled by innovation in IT and a societal shift where people are less status symbol oriented and instead increasingly value the access to a good or service over its ownership (Belk 2014). Various new business models have been enabled by the intermediary role of information systems (IS), connecting the different services and disciplines (Puschmann and Alt 2016). Among them, carsharing is one of the sharing economy's most prominent examples (Bardhi and Eckhardt 2012). In general, sharing economy approaches are said to have a positive sustainable impact, due to their more resource-efficient nature and the way they change consumer patterns (Leismann et al. 2013). The sustainability aspect is also a key motivator for people to participate in collaborative consumption (Hamari et al. 2015).

Carsharing, even for conventional vehicles, has already been attested with a reduction of many of today's urban transportation problems, including emissions, traffic congestion, and a shortage in parking spaces (Baptista et al. 2014; Firnkorn and Müller 2011). More recently, also researchers in the IS domain have taken interest in the topic and have investigated how IS can support to increase the positive environmental impact of carsharing: Bui and Veit (2015) show how a gamified information system can change customers' behavior towards an improved level of personal environmental sustainability; In the related domain of ridesharing, information systems can leverage the sustainability potential by enabling multi-hop ridesharing (Teubner and Flath 2015); And for the case of station-based EV carsharing systems, Sonneberg et al. (2015) develop a decision support system to anticipate the optimal locations for the carsharing stations. Beyond the sustainability aspect, carsharing data has previously been employed to explain people's urban mobility behavior (Wagner et al. 2016).

Research Gap: In the past, researchers have turned to stated preferences surveys to determine users' attitudes towards EVs and their respective driving behavior (Carley et al. 2013; Jensen et al. 2013; Pierre et al. 2011; Ziegler 2012) or conducted staged experiments (Franke et al. 2012; Franke and Krems 2013). There has been no medium-term observation of the differences in driver behavior in a natural or non-experimental setting. As Kurani et al. (1994) point out, it is essential to study drivers with EV experience to overcome the disparity between revealed preference driving range needs and stated preference needs which tend to be much higher. IS-enabled sharing economy businesses generate vast amounts of data. Since in the case of carsharing, the data is in part openly accessible, we are able to study EV experience on a larger scale by analyzing the revealed preferences and actual driver behavior of EVs in direct comparison to CVs.

Data Sources and Approach

As mentioned above, in 2015 a major free-floating carsharing provider has introduced EVs in addition to their already operating CVs in several German cities. Out of these cities we chose to investigate the rental behavior in Hamburg first, as in this city the relative number of EV rentals was largest at a little more than 5 percent of all rentals (Berlin had slightly more EV rides in absolute terms but only around 3 percent in relative terms).

In a free-floating carsharing system, customers can start and end their rentals anywhere within a pre-defined operating area, which is mostly smaller but similar to the city boundaries. For Hamburg this area consists of a main zone, as indicated by the black line in Figure 1, and a parking area at the airport. About 77 square kilometers are covered with a maximum east-west distance of 15 kilometers and 8.6 kilometers from north to south. In order to rent a car, customers generally use a smartphone app to locate, reserve and open the vehicle. The rental itself is a one-way trip and users are billed on a per minute basis. At the end of a trip the carsharing vehicle stands idle at the destination until it is rented again by the next customer. EVs can be used in the same way as conventional carsharing vehicles, which includes that customers are not required to park their EV at a charge point. The pricing for EVs is also in line with the remaining fleet, they cost 34 EUR cents per minute, the same as convertible CVs or small SUVs. Compact CVs are slightly less expensive at 31 EUR cents per minute.

For the purpose of our analysis, each rental can thus be associated with start- and end-point coordinates, as well as the time and date at beginning and end of the rental. We assign the idle time after a rental to the subsequent rental, as it is indicative of the demand at its time and place (Wagner et al. 2016). As customers can see the fuel-level (or battery charge) and engine type (EV or CV) when choosing a car, this information is also added to the rental data. A single rental can therefore be expressed as the following 10-tuple:

$$r_i = (lat_{start}, lon_{start}, lat_{end}, lon_{end}, timestamp_{start}, timestamp_{end}, idle, fuel, engine, vehicleID) \qquad (1)$$

The information within each r_i is based on the provider's publicly available data. Due to privacy reasons, information on the exact driven route is not available. For this preliminary analysis, we rely on the rental duration (Table 1), implicitly assuming a high correlation between rental duration, trip duration, and trip distance. We will further refine this approach in the course of this research project by using a routing API to generate precise distance measurements for each trip.

Our observation period spans from the point in time when EVs were introduced into the fleet in mid-July until the end of October 2015, a period of 3.5 months or 108 days. Within this timeframe we recorded a total of over 230,000 rentals by 748 unique vehicles (712 CVs and 36 EVs). Additional summary statistics as shown in Table 1 already indicate that there are significant variations in demand (idle time) and rental duration. In the next sections we investigate these metrics in greater detail.

Table 1. Dataset characteristics

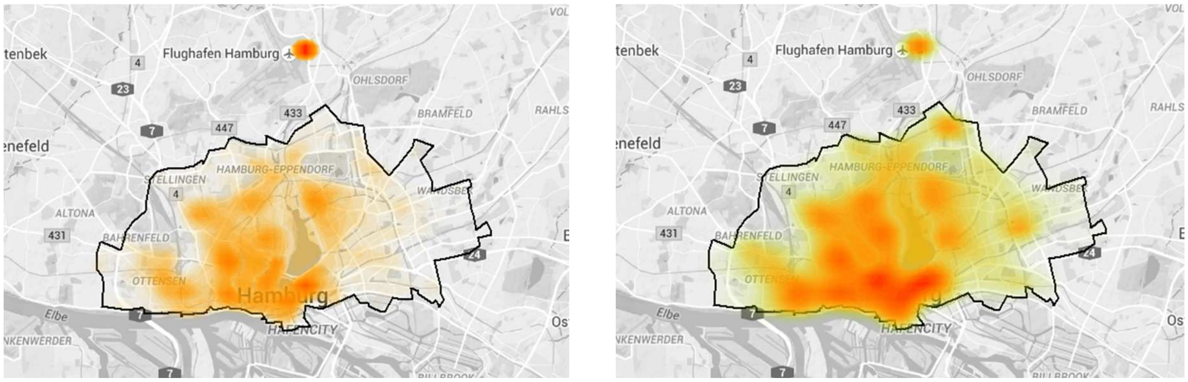
	Mean	SD	Min	Max
Rentals/day	2,242	348	1,259	2,953
Rental duration	41 min	33 min	5 min	180 min
Idle time	184 min	280 min	1 min	7,063 min
Fuel level	61 %	24%	0%	100%

Comparison of EV and CV rentals

Demand estimation

Spatial distribution of demand: As a starting point to determine differences in user behavior, it can be useful to visualize the trip data. However, plotting and comparing individual rentals for EVs and CVs is usually insufficient to provide meaningful insights. Instead, a larger aggregation level is necessary to reveal spatial demand patterns. We therefore calculate the relative densities of start and end points within the operating area and translate them into heatmaps as shown in Figure 1. Overall, the patterns seem quite similar with the same areas exhibiting either high or low demand. For both vehicle types, demand is particularly high in the city center, located at the middle of the business area's southern border. Only the relative importance of the airport, the bright spot in the north seemingly outside of the business area, seems to differ. The much darker color for it in the CV heatmap suggests that there are relatively more rentals to and from the airport with CVs. Since the airport is outside of the main business area, this could be seen as an indication for range anxiety of EV users.

When looking closer, other small differences also become apparent. One would expect that EV rentals would only be highly concentrated within the city center due to range anxiety and the concern of a missing charge point at the final destination. Surprisingly, comparison of the heatmaps suggests that EV rentals are actually more dispersed over the entire business area. Further differences include two hot spots which show up in the EV map but not in the CV map, one at the northern border of the main business area located in a business district, and one in the east in a densely populated area. There is nothing particular about these areas except that at both locations there are charging stations of the carsharing provider, indicating that start and end locations for EV rentals do in fact concentrate around charge-points, which is understandable since customers are incentivized with free rental minutes if they refuel or recharge the car.



(a) CV rentals **(b) EV rentals**

Figure 1. Density of start- and end-points of rentals

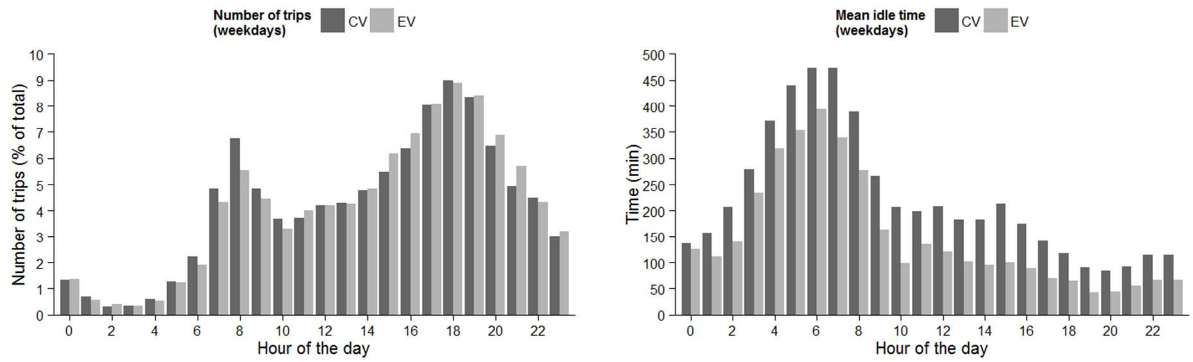
Difference in total demand: Evidence from the literature and public conjecture suggest that demand for CVs overall is still higher than for EVs. To test whether this proposition also holds in the carsharing context we look at the utilization of vehicles as an indicator of absolute demand. Utilization can be measured by both, number of trips per vehicle and average idle time. The latter has, for instance, been employed by Wagner et al. (2015) to estimate carsharing demand and optimize relocation strategies.

Previous studies on general carsharing dynamics have found that user behavior on weekdays and weekends differs substantially (Wagner et al. 2016). Similar differences could also be expected when considering EVs. For instance, on weekends people are usually more flexible with regard to time and could therefore be more inclined to try something new, which would increase the demand for EVs. Consequentially, we compare demand for the two groups of days separately. Table 2 displays the statistical comparison of the two mean demand indicators. The results from two-tailed t tests suggest that in terms of number of trips, EVs have slightly more rentals per car, but the difference is not statistically significant. With regard to the second indicator, however, the idle time between trips is on average ~80 minutes lower for EVs, statistically significant at the 1 percent level. The proposition that the demand for CVs is higher than for EVs thus cannot be supported, in fact our results suggest that it is the other way around.

Table 2. Differences in demand

	Number of trips per car			**Idle time** (in minutes)		
	CVs Mean (SD)	**EVs** Mean (SD)	**Diff**	**CVs** Mean (SD)	**EVs** Mean (SD)	**Diff**
Overall	315 (176)	349 (143)	-34	188 (284)	109 (182)	79***
Weekday	221 (121)	251 (103)	-30	196 (294)	116 (190)	80***
Weekend	100 (52)	101 (38)	-1	169 (256)	91 (156)	78***
N	*712 cars*	*36 cars*		*224,341 rentals*	*12,573 rentals*	
*Statistical significance at the 10%, 5% and 1% level are indicated by *, ** and *** respectively.*						

Temporal differences in demand: Since we do not only want to compare overall demand but also investigate differences in user behavior we next look at how demand changes over the course of the day for the two types of vehicles, for weekdays only due to the reasons mentioned above. Plotting the number of trips and mean idle times for each hour of the day, as shown in Figure 2, supports the conclusions from our previous analysis: with regard to number of rentals there are only minor differences, but idle times are longer for CVs during every hour of the day – suggesting a comparatively higher demand for EVs. Overall, demand patterns are very similar for EVs and CVs. Again, looking closer at the data reveals some interesting nuances. There appears to be a slight preference for CVs during morning hours (6-10 am) and slight preference towards EVs during evening hours (7-11 pm). A possible explanation could be that people experience a higher need for punctuality in the morning and therefore prefer the habitual and seemingly more reliable CVs.



(a) Number of trips in % of all weekday rides **(b) Mean idle time between rentals**

Figure 2. Temporal demand variations – by hour of the day on weekdays

Combining the insight from the number of trips comparison (no significant difference) and the idle time comparison (longer idle times for CVs) leaves as the only logical conclusion that average rental times have to be longer for EVs than for CVs. If the assumption that rental duration and trip distance are correlated holds, this would contradict the presence of a prevailing range anxiety.

Range anxiety

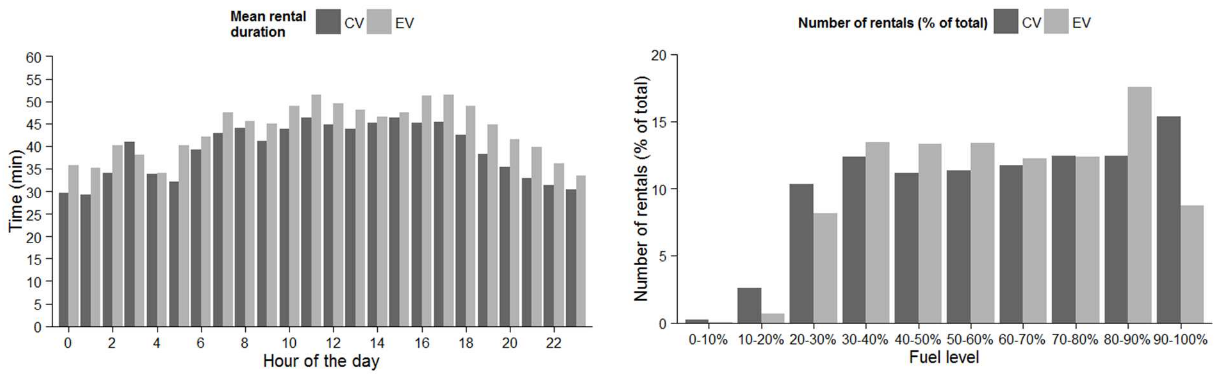
Due to the widely documented range anxiety it would be intuitive to assume that, overall, customers use EVs for shorter routes and turn to CVs for longer journeys. Furthermore, if range anxiety is persistent, we expect that it will have an influence on customers' choice of vehicles with regard to fuel level. Customers with a pronounced range anxiety will likely only rent EVs which are well-charged to be on the safe side. To test these conjectures we compare total rental times, which will be extended to an analysis of trip distances and driving times in the further course of this research project.

Differences in rental duration: As the data for demand comparison already suggested, surprisingly EVs exhibit longer total rental durations. The results in Table 3 show an average difference of 12 percent on weekdays and 18 percent on weekends, significant at the 1 percent level. Over the course of the day on weekdays this holds true for all but one time-slots and the difference is most pronounced from 4 pm to 2 am, as can be seen in Figure 3a. The intuitive hypothesis of shorter rentals for EVs thus has to be rejected, and again the data supports the counterfactual.

Table 3. Differences in demand

	Rental duration (in min)			**Fuel-/Battery level** (1 = full)		
	CVs Mean (SD)	**EVs** Mean (SD)	**Diff**	**CVs** Mean (SD)	**EVs** Mean (SD)	**Diff**
Overall	40.7 (33.0)	46.2 (33.9)	-5.5***	0.61 (0.24)	0.61 (0.22)	0.0
Weekday	40.9 (33.0)	45.7 (33.6)	-4.8***	0.62 (0.24)	0.62 (0.22)	0.0
Weekend	40.2 (32.9)	47.6 (34.7)	-7.4***	0.61 (0.24)	0.60 (0.22)	0.0
N	*224,341 rentals*	*12,573 rentals*		*224,341 rentals*	*12,573 rentals*	
*Statistical significance at the 10%, 5% and 1% level are indicated by *, ** and *** respectively.*						

Differences in fuel level: The average fuel levels and battery charge can be observed by users before a rental and are therefore assumed to have an effect on rental behavior. Specifically, we expect people to favor EVs with a well-charged battery due to the fear of not reaching one's destination or having to recharge during the rental, which could be perceived as slow and as undesirable simply because people are not familiar with the process. This should result in comparatively higher average fuel levels for EVs. However, the data in Figure 3b, again shows a similar pattern for both vehicle types. While there have been relatively more CV rentals with fuel levels of 30 percent and less, the differences are not as pronounced as expected and on average the differences are not statistically significant (Table 3). Hence, without a substantial difference in fuel levels and longer rental duration for EVs we cannot observe the range anxiety effect in our dataset.



(a) Rental duration on (in min) **(b) Fuel-/Battery-level at time of rental**

Figure 3. Range anxiety estimation

Experience effect: Franke and Krems (2013) suggested that when people get acquainted with EVs, their initial range anxiety dissolves. Although the mentioned concerns have not been visible in our data, they could have been present at the beginning of our dataset, right after the introduction of EVs. We therefore look at the evolution of idle time within our observation period to see whether demand for EVs has increased over time. The data in Figure 4 again shows the opposite of what one would expect, idle times for EVs are in fact increasing over the first 6 weeks, meaning demand for EVs has decreased during this period. The effect could represent a growing dissatisfaction with EVs. A much more likely explanation, however, is that right after the introduction of EVs, customers were curious and rented them simply for testing purposes, which is supported by the fact that even in the last week, EVs still exhibit shorter idle times than CVs. A longer-term observation could prove valuable to isolate this "excitement effect" from the experience effect.

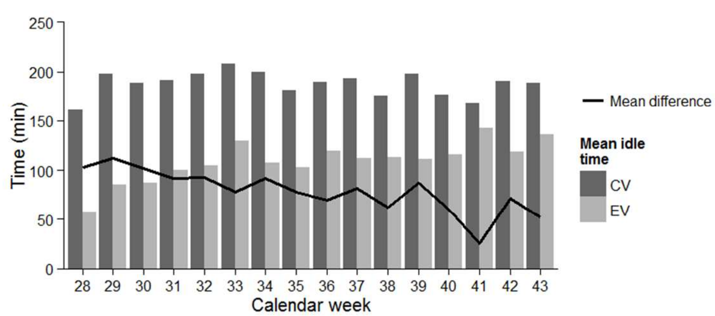


Figure 4. Idle time development

Discussion and Implications

In addition to the limited observation period, we are aware of several biases in our data. Our results are subject to a selection bias since carsharing users tend to be already more open to innovative mobility concepts than the public average. Our results are also not necessarily fully applicable to personal EVs. An EV owner, for instance, might worry more about a charge point at work while carsharing users do not need to worry about a sufficient charge for the subsequent trip (Sun et al. 2015). Moreover, the location of charge points most likely influences demand and driver behavior. This could positively affect EV demand if charge points are disproportionately located in areas of high demand and low expected idle times. A visual assessment of the respective charge point map, however, shows that their distribution seems very similar to the CV demand heatmap in Figure 1a. Nevertheless, we plan to investigate the influence of charge points further by comparing charge point densities and how well they are placed, with the data of a second city (Munich). As mentioned before, we will also include a more thorough investigation of range anxiety by including real trip data, i.e. driven distances and driven duration, which we were not able to do until now due to a limits with routing services APIs. Moreover, we plan to derive hypotheses from our results and verify them by conducting interviews with carsharing users in the respective cities. This will enhance our analysis by combining a stated preference approach with the analyses of revealed preferences, enriching the results from the spatial data analysis.

In this paper we have analyzed the revealed preferences of EV users to determine if EVs are used differently compared to CVs in a carsharing context, in a setting which resembles a natural experiment. We have found that in terms of spatial differences in demand, start and end point patterns are generally similarly distributed for CVs and EVs, though EV trips are slightly more dispersed and tend to concentrate around charging stations. Total demand seems also similar when comparing the number of rides per car. Yet, significantly lower idle times for EVs suggests that demand for them is in fact larger than for CVs. While this advantage decreases over the course of our observation period, it is still substantial at the end. Usage patterns during the day are also fairly similar between the two vehicle types, although there seems to be a slight preference for CVs in morning hours (6-10 am) and a preference towards EVs during evening hours (7-11 pm). We hypothesize that this can be attributed to the time pressure of commuters in the morning, which requires the higher perceived reliability of CVs. Furthermore, range anxiety in a carsharing context, approximated by the differences in total rental time and by the fuel level at the start of a rental, cannot be observed for our data. The preliminary analysis in this paper therefore does not support popular conjectures. In fact, it appears that once people get acquainted with EVs – at least in a carsharing context – they use them in a very similar way as they use CVs. Hence, we believe that a more thorough reevaluation of the extensively reported skepticism towards the usability of EVs is needed.

In addition to usability concerns, the comparatively higher acquisition costs for EVs prevent many from purchasing but also experiencing an all-electric car. We show how the IS-enabled sharing economy allows people to circumvent this obstacle and experience and use EVs first-hand in real life, thereby reducing the lack of knowledge about EVs (Krause et al. 2013). This may help to dissolve worries about electric mobility and, as a consequence, could lead to a swifter adoption of electric vehicles – both privately owned and in carsharing fleets. In any case, EV-carsharing increases the share of electric mobility and thereby has the potential to contribute to lower emissions and more sustainable mobility in general. The sharing economy approach seems a promising route to advance the acceptance and roll-out of EVs. It should be leveraged and encouraged as such, not only by carsharing providers but also by public policy makers and charging infrastructure providers. OEMs should also be encouraged by our results, as we have provided another example where all-EVs have been well-received.

References

Baptista, P., Melo, S., and Rolim, C. 2014. "Energy, Environmental and Mobility Impacts of Car-sharing Systems. Empirical Results from Lisbon, Portugal," *Procedia - Social and Behavioral Sciences* (111), pp. 28–37.

Bardhi, F., and Eckhardt, G. M. 2012. "Access-Based Consumption: The Case of Car Sharing," *Journal of Consumer Research* (39:4), pp. 881–898.

Belk, R. 2014. "You are what you can access: Sharing and collaborative consumption online," *Journal of Business Research* (67:8), pp. 1595–1600.

Brandt, T., Feuerriegel, S., and Neumann, D. 2013. "Shaping a Sustainable Society: How Information Systems Utilize Hidden Synergies between Green Technologies," in *Proceedings of the 34th International Conference on Information Systems,* Milan, Italy.

Bui, A., and Veit, D. 2015. "The Effects of Gamification on Driver Behavior: An Example from a Free Float Carsharing Service," in *Proceedings of the 23rd European Conference on Information Systems (ECIS),* Münster, Germany.

Carley, S., Krause, R. M., Lane, B. W., and Graham, J. D. 2013. "Intent to purchase a plug-in electric vehicle: A survey of early impressions in large US cites," *Transportation Research Part D: Transport and Environment* (18), pp. 39–45.

Daziano, R. A., and Chiew, E. 2012. "Electric vehicles rising from the dead: Data needs for forecasting consumer response toward sustainable energy sources in personal transportation," *Energy Policy* (51), pp. 876–894.

Dimitropoulos, A., Rietveld, P., and van Ommeren, J. N. 2013. "Consumer valuation of changes in driving range: A meta-analysis," *Transportation Research Part A: Policy and Practice* (55), pp. 27–45.

Ehsani, M., Gao, Y., and Emadi, A. 2010. *Modern electric, hybrid electric, and fuel cell vehicles*: *Fundamentals, theory, and design*, Boca Raton: CRC Press.

Firnkorn, J., and Müller, M. 2011. "What will be the environmental effects of new free-floating car-sharing systems?: The case of car2go in Ulm," *Ecological Economics* (70:8), pp. 1519–1528.

Franke, T., and Krems, J. F. 2013. "What drives range preferences in electric vehicle users?" *Transport Policy* (30), pp. 56–62.

Franke, T., Neumann, I., Bühler, F., Cocron, P., and Krems, J. F. 2012. "Experiencing Range in an Electric Vehicle: Understanding Psychological Barriers," *Applied Psychology* (61:3), pp. 368–391.

Hamari, J., Sjöklint, M., and Ukkonen, A. 2015. "The sharing economy: Why people participate in collaborative consumption," *Journal of the Association for Information Science and Technology* (In print, article first published online: 2 Jun 2015).

Jaffe, A. B., and Stavins, R. N. 1994. "The energy paradox and the diffusion of conservation technology," *Resource and Energy Economics* (16:2), pp. 91–122.

Jensen, A. F., Cherchi, E., and Mabit, S. L. 2013. "On the stability of preferences and attitudes before and after experiencing an electric vehicle," *Transportation Research Part D: Transport and Environment* (25), pp. 24–32.

Krause, R. M., Carley, S. R., Lane, B. W., and Graham, J. D. 2013. "Perception and reality: Public knowledge of plug-in electric vehicles in 21 U.S. cities," *Energy Policy* (63), pp. 433–440.

Kurani, K. S., Turrentine, T., and Sperling, D. 1994. "Demand for electric vehicles in hybrid households: An exploratory analysis," *Transport Policy* (1:4), pp. 244–256.

Leismann, K., Schmitt, M., Rohn, H., and Baedeker, C. 2013. "Collaborative Consumption: Towards a Resource-Saving Consumption Culture," *Resources* (2:3), pp. 184–203.

Pierre, M., Jemelin, C., and Louvet, N. 2011. "Driving an electric vehicle. A sociological analysis on pioneer users," *Energy Efficiency* (4:4), pp. 511–522.

Puschmann, T., and Alt, R. 2016. "Sharing Economy," *Business & Information Systems Engineering* (58:1), pp. 93–99.

Sonneberg, M., Kuehne, K., and Breitner, M. 2015. "A Decision Support System for the Optimization of Electric Car Sharing Stations," in *Proceedings of the 36th International Conference on Information Systems,* Fort Worth, TX.

Sun, X.-H., Yamamoto, T., and Morikawa, T. 2015. "Charge timing choice behavior of battery electric vehicle users," *Transportation Research Part D: Transport and Environment* (37), pp. 97–107.

Teubner, T., and Flath, C. 2015. "The Economics of Multi-Hop Ride Sharing - Creating New Mobility Networks Through IS," *Business & Information Systems Engineering* (57:5), pp. 311–324.

Wagner, S., Brandt, T., and Neumann, D. 2016. "In free float: Developing Business Analytics support for carsharing providers," *Omega* (59), pp. 4–14.

Wagner, S., Willing, C., Brandt, T., and Neumann, D. 2015. "Data Analytics for Location-Based Services: Enabling User-Based Relocation of Carsharing Vehicles," in *Proceedings of the 36th International Conference on Information Systems,* Fort Worth, TX.

Zastrow, M. 2016. "Machine outsmarts man in battle of the decade," *New Scientist* (229:3065), p. 21.

Ziegler, A. 2012. "Individual characteristics and stated preferences for alternative energy sources and propulsion technologies in vehicles: A discrete choice analysis for Germany," *Transportation Research Part A: Policy and Practice* (46:8), pp. 1372–1385.