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Measuring the car ownership impact of free-floating car-sharing – A case study in Basel, Switzerland

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ABSTRACT

Free-floating car-sharing schemes operate without fixed car-sharing stations, ahead reservations or return-trip requirements. Providing fast and convenient motorization, they attract both public transport users and (former) car-owners. Thus, their impact on individual travel behavior depends on the user type. Estimating the travel behavior impact of these systems therefore requires quantitative data. Using a two-wave survey approach (shortly after launch of the scheme plus one year later) including travel diaries, this research indicates that (due to their membership) 6% of the free-floating car-sharing customers reduce their private vehicle ownership. Moreover, the results suggest that free-floating car-sharing both complements and competes with station-based car-sharing.

1. Introduction

Since its first implementation in Ulm, Germany, in 2009, free-floating car-sharing has expanded rapidly around the globe (Shaheen et al., 2015). Instead of relying on fixed car-sharing stations, free-floating car-sharing schemes usually make use of public parking spaces within a designated, citywide service area. Customers can locate and book the closest available vehicle using a smartphone app. At the end of their trip, they can leave the vehicle on any public parking space. Free-floating car-sharing thus offers flexible one-way trips, overcoming key limitations of traditional, station-based car-sharing schemes.

Because free-floating car-sharing schemes require access to public parking spaces, they are more dependent on the support of local authorities. However, concerned about a deteriorating traffic situation, many authorities limit the number of parking permits for free-floating vehicles. Before relaxing such restrictions, they ask for more detailed knowledge about the travel behavior impact of free-floating car-sharing.

Addressing this issue requires new research, because insights from previous studies on station-based car-sharing are in general not transferable to free-floating car-sharing, given their structural differences (Becker et al., 2017a). Moreover, first attempts to determine the net impact on travel behaviour have failed due to a lack of quantitative data (Seattle Department of Transportation, 2014).

This paper reports on an approach, which was designed to allow quantification of the travel behaviour impact of free-floating car-sharing. The method is applied to a new free-floating car-sharing scheme launched in Basel, Switzerland, in August 2014.

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2. Background

2.1. Free-floating car-sharing

Modern car-sharing dates back to the early 1990s and has seen exponential growth in both customers and fleet size since then (Shaheen and Cohen, 2013). The schemes offer their customers access to cars on an as-needed basis, representing a cheap alternative to a private vehicle - especially for households with relatively low annual mileage (Litman, 2000). Originally, car-sharing operations were exclusively station-based; cars were available at predefined parking spaces (stations) and had to be returned to one of those stations at the end of the trip. While most schemes required the vehicles to be brought back to the start station (round-trip requirement), some of the schemes also permitted one-way trips. Le Vine et al. (2014) suggest that such one-way car-sharing schemes are more attractive to customers, but less of a complement to public transport than round-trip car-sharing.

By lifting the restriction of fixed car-sharing stations as well as allowing one-way trips, free-floating car-sharing is an even more flexible form of car-sharing. First launched in 2009, the number of customers and schemes has skyrocketed in recent years (Shaheen et al., 2015).

2.2. Measuring car-sharing impact

The environmental and travel behaviour impact of (station-based) car-sharing has been the subject of various studies around the world. Despite different methodological setups, previous studies have consistently found that while a small group of car-sharing members increase their car use, their additional vehicle mileage is more than offset by previous car-owners, who have substantially reduced their car ownership and travel in the course of their car-sharing membership (Martin and Shaheen, 2011). Moreover, it has been pointed out that the environmental impact exceeds the savings in vehicle miles, because - on average - car-sharing vehicles consume significantly less energy than the private vehicles they replace (Steer Davies Gleave, 2017).

One of the first comprehensive explorations of car-sharing travel behaviour impacts was conducted in Switzerland (Muheim and Reinhardt, 1999). In a survey, respondents were asked to report their travel behaviour both currently and retrospectively, prior to their car-sharing membership. Lacking any travel survey data, the study relied solely on respondents' estimates for their current and past vehicle miles travelled, without any knowledge about the accuracy of such estimates. Moreover, neglecting unobserved heterogeneity, changes in car-ownership and vehicle miles travelled were attributed to car-sharing membership, which probably inflated the actual effect (Mishra et al., 2016). Furthermore, it must be assumed that a retrospective survey approach like this prompts recall bias (Kopec and Esdaile, 1990; Mokhtarian and Cao, 2008), particularly affecting estimates of vehicle miles travelled. Yet, because they impose a low response burden and require minimal administrative effort, similar methodologies have been adopted by many later studies (Martin and Shaheen, 2011; Lane, 2005; Rydén and Morin, 2005; Martin et al., 2010).

Cervero and Tsai (2004) and Cervero et al. (2007) were the first to address these limitations using a major methodological innovation; in a longitudinal setting, they administered their survey to a panel in multiple waves to overcome recall bias. Moreover, the survey was augmented by a two-day travel diary to strengthen travel behaviour data validity. Finally, a control group was supposed to allow isolation of the actual impact of car-sharing membership from external effects. However, the control group suffered from self-selection issues, probably biasing the results.

Given the later appearance of free-floating car-sharing, there is not yet a great volume of scientific literature dealing with its environmental impact. While early studies predicted a significant reduction in car ownership and CO_2 emissions (Firnkorn and Müller, 2011) from free-floating car-sharing, the actual impact seems to be more complex, as non-car-owners reduce bike, walk and public transit trips, but start to use a (shared) car instead (Firnkorn, 2012).

Some of the early empirical data on the impact of free-floating car-sharing was published by the (Seattle Department of Transportation, 2014), citing results of a Car2go member survey. The results indicate a rather small reduction in household vehicle holdings. The impact on mode choice remains unclear, given that 40% of the customers claimed to use private cars less often, but 50% of the respondents also stated that they used public transportation less frequently. A related approach conducted in Switzerland yielded similar results (Becker et al., 2017a).

Using a survey approach, as in Muheim and Reinhardt (1999), a recent study by Martin and Shaheen (2016) aimed to define the net impact of free-floating car-sharing. The study indicated a clear trend towards less car ownership and less vehicle miles travelled due to free-floating car-sharing. However, the impacts were calculated based on a non-representative sample. The approach was further enhanced by Giesel and Nobis (2016) and Le Vine and Polak (2017). Again using a retrospective survey approach, they differentiated the impact of free-floating car-sharing on the level of car-ownership by frequency of use, as well as selected socio-demographic variables. However, also in these cases, validity of the resulting car-ownership impacts may be limited due to response bias. An overview of the results of the discussed studies is given in Table A.4. In this research, the net impact of free-floating car-sharing is studied further using quantitative data on individual travel behaviour.

2.3. Survey method

A common way to collect quantitative data on individual travel behaviour are travel diaries, which capture all activities and trips during a pre-defined survey period. As individual travel behaviour varies over the course of a week, the travel diary should ideally cover multiple days to account for such variation. However, collecting manual (paper-based or CATI[1]) trip diaries was found to yield imprecise and missing data (Bricka and Bhat, 1972; Stopher et al., 2007). GPS-loggers would allow improvement of data quality, but

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