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Empirical analysis of free-floating carsharing usage: The Munich and Berlin case

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ABSTRACT

Carsharing has become an important addition to existing mobility services over the last years. Today, several different systems are operating in many big cities. For an efficient and economic operation of any carsharing system, the identification of customer demand is essential. This demand is investigated within the presented research by analyzing booking data of a German free-floating carsharing system.

The objectives of this paper are to describe carsharing usage and to identify factors that have an influence on the demand for carsharing. Therefore, the booking data are analyzed for temporal aspects, showing recurring patterns of varying lengths. The spatial distribution of bookings is investigated using a geographic information system and indicates a relationship between city structure and areas with high demand for carsharing. The temporal and spatial facets are then combined by applying a cluster analysis to identify groups of days with similar spatial booking patterns and show asymmetries in the spatiotemporal distribution of vehicle supply and demand.

Influences on demand can be either short-term or long-term. The paper shows that changes in the weather conditions are a short-term influence as users of free-floating carsharing react to those. Furthermore, the application of a linear regression analysis reveals that socio-demographic data are suitable for making long-term demand predictions since booking numbers show quite a strong correlation with socio-demography, even in a simple model.

1. Introduction

For decades, the privately owned car carried very high importance as a status symbol. Moreover, it was promoted as the most important mode of transportation by many city planners and an adequate infrastructure was provided for it. Rethinking this viewpoint is a global trend today. Especially for young adults, owning a private car seems to be less important when compared to the past whereas modern technologies like mobile phones gain a higher importance (Zipcar, 2014). The assumption of private car ownership losing importance is also supported by the fact that car use – measured in vehicle miles traveled per capita – is decreasing (Davis et al., 2012; Kuhnimhof et al., 2012) and the percentage of persons holding a driver's license (Davis et al., 2012; Delbosc and Currie, 2013) has also dropped in many industrialized countries. In the past years, researchers identified several factors that could possibly explain this development (e.g. affordability or attitudes

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towards the car). Yet for most of these factors, it is still unclear how strong an influence they have (see (Delbosc and Currie, 2013) and references within for a summary).

Despite this development, many large cities have to deal with traffic problems today. These are mainly caused by continued urbanization (United Nations, 2014) and the corresponding population growth in cities. Since the negative impacts of vehicular traffic – such as noise or air pollution – are widely known today, policymakers address this topic with increasing sensitivity. The public sector in particular considers measures for counteracting environmental pollution and traffic in cities. Possible measures already in place are usually aimed at existing modes of transportation, and include the implementation of congestion charging (which has already proven to have positive effects in the charged areas (Beevers and Carslaw, 2005)), promoting public transport, or enhancing bicycle infrastructure.

However, some rethinking also takes place in the private sector. Sometimes this is driven by environmental awareness or idealism but sometimes also by seeing an opportunity to turn a profit out of a global trend. Either way more and more environmentally-friendly concepts are being offered now. One part of this trend is offering new mobility services which should be viewed as supplements to existing ones. Carsharing is one of these new services: it is becoming an integral part of the cityscape in many big cities today. In carsharing systems, vehicles are provided to registered customers for short-term rentals. Becoming a member of the carsharing organization is a mandatory step in order to get access to the cars and can usually be done by everyone with a valid driver's license. Fees to be paid are generally calculated per kilometer traveled, by duration, or a combination of both and cover both fuel and insurance. One indicator pointing to the importance of carsharing is the growth in membership numbers; this currently exceeds 10% per year in both North America and Germany (Shaheen and Cohen, 2014; Bundesverband CarSharing, 2014). At present, one can distinguish three main types of carsharing: station-based (with two subtypes), free-floating (which will be the focus of this paper) and peer-to-peer carsharing.

In a station-based system, the operator specifies positions for stations (usually parking spots reserved exclusively for this purpose) and parcels out vehicles among these stations. Depending on the operator, there are two different forms of station-based carsharing: in the first (operated e.g. by Zipcar in the US or Flinkster in Germany), only round trips are allowed, meaning that a trip has to end at the same station where it started. In the second form (run e.g. by Autolib' in Paris, France or tested by Zipcar in Boston, MA), mostly called one-way carsharing, cars can be returned to any of the designated stations, independent from where the trip started. This possibility increases flexibility for users but it also creates new problems for the operator. Since a return trip is not always made, it is very likely that at times there is a spatial imbalance over the stations. The operator still has to ensure that there are enough cars and enough parking spots at every station to cover demand most of the time. Consequently, there may be the necessity to relocate cars from one (overfilled) station to another (mostly unoccupied) station. However, any relocation causes an additional trip which results in additional costs for the operator and further pollution of the environment. The implementation of a "good" relocation method therefore is an important task and thus addressed by many researchers (Nair et al., 2011; Di Febbraro et al., 2012; Jorge et al., 2014). Other studies primarily concentrate on the customers and their use of carsharing as this knowledge could help spread carsharing further. Different surveys from around the world (see (Millard-Ball et al., 2005) and references within) show that most users of station-based carsharing are between 25 and 45 years old, live in a rather small household (one or two persons) and have an income and educational level above average. Studying the usage of station-based carsharing shows that the highest number of rentals occur on Fridays and Saturdays (Concas et al., 2013) and most trips are made for shopping, social-recreational purposes or personal business (Cervero, 2003; Cervero and Tsai, 2004; Cervero et al., 2007). When trying to increase the acceptance of carsharing one last point is very important to mention: one study shows that station-based carsharing reduces greenhouse gas emissions (Martin and Shaheen, 2011).

The type of system that will be the focus of this paper is free-floating carsharing (operated e.g. by DriveNow or car2go). Such a system often is operated by car manufacturers and also allows for one-way trips, but does not make use of stations. Instead, an operating area is defined and contracts with the municipalities ensure that cars can be parked at almost any free parking spot within this area. Assuming that each single station only attracts customers within a certain distance to the station (comparable to maximum acceptable walking distances to transit stations (O'Sullivan and Morrall, 1996)), using an operating area may attract more people because cars can be used even in areas where a station would not be profitable. The first systems of this type were implemented only few years ago; consequently, there is hardly any literature about free-floating carsharing. As with station-based carsharing, one study claims free-floating carsharing to have positive environmental effects because it reduces CO_2-emissions (Firnkorn and Müller, 2011). This result must be viewed with some criticism however, because of its very simplistic approach and, among others, the usage of total membership numbers (which are described as an unreliable variable later in the presented paper). Further studies attempt to describe the impact of carsharing on other modes (Firnkorn, 2012). To the authors' knowledge, only one study dealt with actual free-floating carsharing usage and the socio-demography of users (Kortum, 2012). Free-floating carsharing could also be referred to as a special case of one-way carsharing. Once again, this shows that there is a need to address the relocation problem, but the authors can infer from the lack of stations that there is an additional necessity for knowing exactly where cars are most likely to be rented again (Weikl and Bogenberger, 2012). Looking into the future, shared autonomous vehicles could be treated as a possible special case of free-floating carsharing. Those are assumed to have a great positive impact on the environment, even if the total amount of vehicle-miles traveled is expected to rise (Fagnant and Kockelman, 2014).

Another development on the market is peer-to-peer carsharing, in which private persons provide their own cars for renting. This way, private cars (most of which are unused 90% of the time (Shoup, 2005)) receive a higher average utilization and car owners are helped reducing the costs for maintaining their own cars. Operators of such a system usually do not offer own