Impacts of Carsharing on Passenger Vehicle Use and Greenhouse Gas Emissions

Policy Brief

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Policy Description

"Carsharing" refers to a specific type of service that offers members short-term vehicle access. Fees are based on an hourly or per-mile rate. Long popular in Europe, carsharing organizations were established in the U.S. starting in the 1990s. As of 2008, there were 279,174 carsharing members nationwide (Shaheen, Cohen, & Chung, 2009) and by 2012 there were 33 different carsharing organizations in North America (Shaheen et al., 2012). The largest network is Zipcar, which is in 17 cities and campuses in California.[1] Nonprofit City CarShare also has a sizable network, though is available only in the San Francisco Bay Area. Carsharing is growing by spreading to additional cities and by increasing the number of members and vehicles in existing service areas. For instance, in Zipcar's most established markets—Boston, New York, Washington, and San Francisco—membership increased 15% from 2011 to 2012 (Zipcar, 2012). In addition, new types of carsharing are expanding the types of services available.

There are currently several variations of carsharing (Table 1; see Shaheen, Mallery, & Kingsley, 2012 for an overview). In the conventional model, a carsharing organization (a non-profit, public sector, or private for-profit entity) provides and maintains the vehicles, which members can use through a pre-arranged reservation for a particular vehicle for a set period of time. The reservation, in some cases, can be made 15 minutes in advance, arranged online or by phone. Vehicles are located at unstaffed but fixed locations, distributed throughout a city or neighborhood, and the borrower must return a vehicle to the same pick-up spot, locking and unlocking the car with a cardkey. A new variation is the one-way or "*free-floating*" model, which allows members to borrow cars spontaneously without having to commit to a return time or location, and to search for the locations of available GPS-tracked cars using their smartphones (e.g. Car2go), DriveNow. Another variation on traditional carsharing is *peer-to-peer carsharing*, a service that offers car-owning members the opportunity to rent out their personal vehicle in exchange for payment, and in turn offers borrowing members short-term rental of these privately owned vehicles, with a process similar to that employed by traditional

[1] According to Zipcar's website, these include: San Francisco Bay Area, Santa Cruz, Los Angeles, San Diego, Santa Barbara, Stanford, Davis, Chico, San Luis Obispo, Santa Clara, Hayward, Point Loma, Sacramento, Camarillo, Atherton, Arcata, Stockton (www.zipcar.com, accessed 31 October 2012). Zipcar was purchased by Avis Budget Group in January 2013.

carsharing. Finally, some services focus on providing specific types of specialized vehicles, such as electric vehicles (e.g. Car2go), scooters (e.g. Scoot), high-end vehicles (e.g. DriveNow), or utility vans (e.g. Zipvan).

Many carsharing organizations received start-up grants from federal, state, and local sources (Shaheen, Schwartz, & Wipyewski, 2004). In addition, cities may provide free, discounted, or preferential parking for carsharing vehicles, and help publicize carsharing services (Shaheen, Schwartz, & Wipyewski, 2004; Shaheen, Cohen, & Martin, 2010). State legislation can play a role in removing regulatory barriers and clarifying the regulatory context for new services. For instance, a 2006 amendment to the California vehicle code allowed local governments to allocate exclusive-use on-street parking for carsharing vehicles. In 2011, Assembly Bill 1871 in California was the first in the country to clarify liability in the context of peer-to-peer carsharing, stipulating that car-owners could share their vehicles and make money on them without voiding their personal insurance policies.

Table 1. Types of Carsharing Programs

Type of Program		Examples	Locations
Conventional		Zipcar	Nationwide, including 17 cities and campuses in California
		City Carshare	Bay Area
Free-floating		Car2go	Austin, TX
		DriveNow	San Francisco, CA
Peer-to-peer		RelayRides	Select cities nationwide, including the Bay Area, Los Angeles, and San Diego
		Getaround	San Francisco, CA and Portland, OR
		Wheelz	Bay Area and Los Angeles, CA
Specialized vehicles	Electric vehicles	Car2go	Austin, TX
	Scooters	Scoot	San Francisco, CA
	High-end vehicles	DriveNow	San Francisco, CA
	Utility vans	Zipvan	Select cities nationwide, including the Bay Area

Impacts of Carsharing

Carsharing could increase vehicle-miles traveled (VMT) if it enables non-owners to drive more, utilizing carsharing, but it could decrease VMT if it enables people to forego buying their own cars and thereby drive less overall. In addition, carsharing vehicles are typically newer and more efficient than the average privately owned vehicle, and so use of carsharing vehicles can decrease emissions even if miles are not reduced.

The impact of carsharing has been measured in terms of the number of people who are members, car ownership changes among members, the number of private vehicles replaced by carshare vehicles, changes in the vehicle fleet mix, and change in members’ VMT. Some studies use these measures to estimate the impact of carsharing membership on gasoline consumption and GHG emissions.

Most studies have examined behavior change among carsharing members, rather than trying to estimate the impact of having a carsharing service available in a given region. The total impacts of carsharing in a region depend on both the change in VMT for carsharing users and on the number of car-sharing users.

Effect Size

Two studies found that the reductions in VMT among vehicle-owners (or previous owners) who joined carsharing outweighed increases in VMT among non-owners who had joined at the time of the study. As a result, carsharing appears to have reduced VMT overall by about a quarter to a third among those who have participated (Table 2). Cervero, Golub, and Nee's (2007) study in the San Francisco Bay area found greater effects after four years of participation versus two. In addition, while those who became carshare members drove less than non-members even prior to joining carsharing, the gap between members and non-members widened after the latter started using carsharing.

Table 2. Impact of Carshare Membership on Household VMT, Gasoline Consumption, and GHG Emissions

Study	Study Location	Study Year(s)	Difference in VMT	Difference in emissions	Difference in gasoline consumption
			After vs. before joining carsharing		
Martin & Shaheen, 2011a	Multiple cities	Varies-2008	-26.9%	-34.5%	NA
Cervero et al., 2007	San Francisco Bay area	2001-2003	Not significant	NA	-36.5%
		2001-2005	-32.9%	NA	-59.5%
			Carsharing members (or pre-members) vs. non-members		
Cervero et al., 2007	San Francisco Bay area	2001 (pre-launch)	-33.1%	NA	-65.1%
		2003	-66.4%	NA	-89.9%
		2005	-68.2%	NA	-90.3%

Evidence Quality

With so few rigorous studies, the size of the effect of carshare membership is uncertain. Martin and Shaheen's (2011a) study is sufficiently large for statistical reliability (n=6,281), but accuracy depends on respondents' own estimates of their annual mileage in the last year, as well as the year *prior* to joining carsharing, however long ago that may have been. Since they surveyed participants whose duration of membership varied and who were from a mix of carsharing organizations across North America, the timeframe of impact is also unknown. Cervero et al. (2007) examined carsharing in the Bay Area when it was two and four years old. The study used a travel diary as a basis for measuring VMT (with distances for each trip estimated using geographic information systems), producing a more accurate estimate than self-reports of total annual VMT. However, this study included a smaller sample size (n=143 before, and n=247 after 2 years, and n=363 after 4 years) than Martin and Shaheen's (2011a) study.

Caveats

Neither of the studies isolated the impact of carsharing from the impact of other factors on members' overall travel choices. Members may have changed their behavior over time (before versus after joining carsharing) for other reasons, such as a residential relocation. In addition, Cervero et al. (2007) found statistically significant differences in daily VMT among those who did not end up joining versus those who joined even before they began carsharing. To the extent that carsharing membership did result in reduced VMT among its early adopters, future members may not react in the same way. If the early adopters are more motivated to reduce their vehicle use, then initial estimates of the effects could be overly optimistic (Tal, 2009). On the other hand, early adopters of carsharing may have had especially limited access to vehicles prior to adopting carsharing, resulting in a greater increase in their annual VMT than later adopters and thus an underestimate of the impacts of carsharing as it matures. In general, VMT reductions are more likely if a greater share of future members consists of car-owners who get rid of a vehicle and/or reduce their vehicle travel after joining, versus non-owners who use carsharing to increase their vehicle use.

The empirical studies are also limited to the type of service offered at the time of study, when carsharing was relatively new, with low market penetration, in select cities, and with none of the flexibility of the free-floating models most recently introduced. The only multiyear study (Cervero et al., 2007) found that carsharing members' VMT reductions leveled off over time, with tapered effects four years versus just two years after the launch of carsharing in San Francisco. This trend could reflect maturation of the service provided or different types of people participating in carsharing.

All of the results are based on studies in major metro areas, where carsharing has been introduced. Outcomes are less certain in other types of communities, both in terms of the nature of the service provided as well as in how members would use it. To date, carsharing has been most successful in areas "where transit and walking are realistic alternatives and a car is not needed for everyday travel" (Celsor & Millard-Ball, 2007, p. 66; Stillwater, Mokhtarian, & Shaheen, 2009).

The overall effect of carsharing in a region depends on the percentage of the population that chooses to utilize it and on how that population utilizes it. Since current membership is such a small percentage of the population, the effect to date on regional

VMT may be negligible, but greater adoption would mean a greater effect. Potential synergistic effects of combining carsharing with other policies could influence overall outcomes. Carsharing is likely to be adopted by more people and more effective in reducing users' per-capita VMT if combined with complementary policies promoting alternative modes of transportation.

GHG Emissions

Martin and Shaheen (2011a) and Cervero et al. (2007) both estimated that the energy impact of carsharing (measured as GHG emissions and gasoline consumption, respectively) is even greater than the impact on VMT alone (see Table 1), mostly due to the use of more efficient vehicles for carsharing. In particular, Martin and Shaheen estimated that the 26.9% reduction in average VMT measured among carsharing members would correspond to a 34.5% reduction in GHG emissions, based on the average fuel economy of the vehicles used, resulting in a net reduction of 0.58 metric tons of GHGs per member annually. Cervero et al. (2007) estimated that the 32.9% reduction in average VMT measured among carsharing members would correspond to a 59.5% reduction in gasoline consumption, based on the fuel economy and occupancy of the vehicles used on the survey day, resulting in 0.044 fewer gallons consumed daily per member. However because of a large amount of variation among participants and a small sample size, none of these differences are statistically significantly different from zero.

Co-benefits

Carsharing offers many potential co-benefits for users, the environment, and the community. In particular, by providing vehicle access at a price that is less than the price of owning a vehicle, it provides more options to more people. In addition, because users pay for each use, it makes them think more consciously about driving, in contrast to vehicle owners who have paid a substantial cost at the outset (e.g. purchase price, insurance) and may use their vehicles more as a result. It enables more efficient use of parking spaces in urban areas where land is scarce, with more utilization per vehicle and parking space. More vehicle utilization also means faster carsharing fleet turnover, with more new and cleaner cars replacing older, more polluting cars. In general, carsharing is thought to complement transit and other investments in alternative forms of transportation, enhancing the likelihood of their success and adoption (Martin & Shaheen, 2011b).

Examples

City CarShare was the first major carsharing organization in California, launched in 2001 in the Bay Area where it continues to operate as a non-profit. Zipcar, which merged with Flexcar in 2007 and was purchased by Avis Budget Group in 2013, is a private, for-profit carsharing organization, operating in five countries, with about 11,000 vehicles and 730,000 members (as of September 2012), including service in the Bay Area and 16 other cities and campuses in California.

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