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Carsharing

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Equity review by Ruben Abrica, City of East Palo Alto

Project Description

This project reviews and summarizes empirical evidence for a selection of transportation and land use policies, infrastructure investments, demand management programs, and pricing policies for reducing vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions. The project explicitly considers social equity (fairness that accounts for differences in opportunity) and justice (equity of social systems) for the strategies and their outcomes. Each brief identifies the best available evidence in the peer-reviewed academic literature and has detailed discussions of study selection and methodological issues.

VMT and GHG emissions reduction is shown by effect size, defined as the amount of change in VMT (or other measures of travel behavior) per unit of the strategy, e.g., a unit increase in density. Effect sizes can be used to predict the outcome of a proposed policy or strategy. They can be in absolute terms (e.g., VMT reduced), but are more commonly in relative terms (e.g., percent VMT reduced). Relative effect sizes are often reported as the percent change in the outcome divided by the percent change in the strategy, also called an elasticity.

Summary

Strategy Description

Carsharing services rent cars to their members for short periods of time, billing by the minute, hour, or day. The process of renting a car through a carsharing service is easier than for conventional car rental services, and the pick-up locations may be dispersed throughout the community. Some services enable one-way trips, while others require cars to be returned to the pick-up location. “Free-floating” systems operate without fixed stations for the cars.

Behavioral Effect Size

Carsharing can increase driving for households with limited car access, resulting in an increase in vehicle miles traveled (VMT). Carsharing also provides an alternative to car ownership, enabling households to forego the purchase of a vehicle or make it possible for households

with cars to give up one or more vehicles. Lowering car ownership tends to reduce VMT. The available evidence suggests that the net effect of carsharing is a reduction in car ownership and VMT, but the magnitude of the effect cannot be easily quantified based on the available evidence.

Strategy Extent

Carsharing services are found in at least 384 cities across the U.S. These services can be implemented in urban, suburban, and rural areas.

Strategy Synergy

Carsharing is likely to be most effective in reducing car ownership in areas where transit, walking, bicycling, and other non-driving modes are good options. Higher population and employment densities facilitate higher densities of carshare vehicles. Carsharing can be included in mobility hubs and mobility wallets.

Equity Effects

Carsharing services can provide access to cars for households that cannot afford to own a car. Having access to a car when needed can make it

easier to reach health care and other critical services. Public subsidies may be needed to ensure that the services are affordable and usable for low-income households and those without credit cards or smart phones.

Strategy Description

Carsharing services rent cars to their members for short periods of time, billing by the minute, hour, or day. The process of renting a car through a carsharing service is generally easier than for conventional car rental services, the service may be open to younger renters, and the pick-up locations may be dispersed throughout the community. Some services enable one-way trips, while others require return trips to the pick-up location. “Free-floating” systems operate without fixed stations for the cars, do not require reservations, and do not require return trips. Some services provide electric or hybrid-electric vehicles. Another model is peer-to-peer carsharing services, which enable private car owners to rent out their vehicles to others.

Although the concept of carsharing dates back to Switzerland in the late 1940s, current services derive from successful car-sharing programs that started in the 1980s and consolidated in the 1990s (Ferrero et al., 2018). The carshare market continues to evolve. Some large for-profit companies provide car-sharing services across the U.S. and internationally, while other companies operate within selected countries. Smaller non-profit carshare providers tend to serve markets over-looked by the for-profit operators. Peer-to-peer carsharing services, which enable car owners to recoup some of their costs, have grown in popularity especially in the U.S.

It appears that while the use of carsharing services grew through 2015, services after that point were generally stable or declining (Giordano et al., 2021), likely due in part to increasing use of ride-hailing services such as Uber and Lyft. Even so, one industry observer

estimated the global car-sharing market at \$8 billion in 2023 (IMARC Group, 2023). The share of Americans who have used carsharing services may be as high as 30% (Autoinsurance.com, 2023). Zipcar, the largest provider in the U.S., reportedly has 16,000 vehicles in 384 cities and over 1 million members (Parsear, 2024).

Strategy Effects

Behavioral Effect Size

Carsharing can increase driving for households with limited car access, resulting in an increase in VMT. But these services also provide an alternative to car ownership, potentially enabling households to forgo the purchase of a vehicle or making it possible for households with multiple cars to give up one or more of them. Lowering car ownership has the potential reduce household VMT. While car owners have an incentive to drive more as a way to justify their sunk cost, carsharing users have an incentive to drive only as much as needed since they are paying by the mile or the minute and have less ready access to the vehicle.

The available evidence suggests that the net effect of carsharing is a reduction in car ownership and VMT. The magnitude of the effect cannot be easily quantified based on the available evidence and likely varies based on the characteristics of the service and the context in which it is implemented. Evidence for the U.S. is limited but points to possible reductions in VMT. One study of members of a peer-to-peer carsharing service in North America estimated that each carsharing vehicle resulted in as many as 7 to 11 fewer private vehicles on the road, and that as a result member households reduced their VMT by 6 to 16% on average (Martin et al., 2016).

Extent

Scale of Application: Carsharing services are found in at least 384 cities across the U.S. and are common at university campuses. Carsharing can be implemented in urban, suburban, and rural areas.

Efficiency or Cost: The establishment of a carsharing service requires an initial public or private investment. Once established, the fees charged to members can support the operations of the system. Services targeting low-income members may require on-going subsidies to ensure affordability.

Time / Speed of Change: Carsharing services can be implemented relatively quickly, given support by local government and adequate public or private financing.

Geographic variation: Car-sharing services have been implemented in urban, suburban, and rural settings. The impacts on VMT are likely to vary by setting.

Equity

Carsharing services can provide access to cars when needed for households that cannot afford to own their own car. Having occasional access to a car can improve access to health care and other critical services, particularly in areas where transit service and other options are limited. For example, Miocar, a non-profit electric vehicle carsharing service launched in California's Central Valley in 2019, has increased mobility for its members: according to surveys, 63% of trips taken with Miocar would not have been made without the service and were often used for trips that could not have been made by transit (Rodier et al., 2022). Such services may enable carpooling and shared rides for community members, thereby extending the benefits beyond service members and their households.

Public subsidies may be needed to ensure that the services are affordable for low-income households, and policies may be needed to ensure that individuals without bank accounts, credit cards, or smart phones have access to these services.

Synergy

Carsharing is likely to be most effective in reducing car ownership in areas where transit, walking, bicycling, and other non-driving modes are good options. Higher population and employment densities facilitate higher densities of carshare vehicles, which puts vehicles in closer proximity to potential users and their destinations. Carsharing services are often incorporated into mobility hubs and transit-oriented development to expand mode options and discourage car ownership. They can also be included in "mobility wallet" programs as one of a number of mode options. Some evidence suggests that experience with carsharing can increase the likelihood of choosing electric vehicles when purchasing a private vehicle (Hoerler et al., 2021).

Confidence

Evidence Quality

Evidence from the U.S. of the impacts of carsharing on VMT is limited. No available studies employ a quasi-experimental design with before-and-after measurements and control groups to evaluate the impacts of the service.

Caveats

Much of the limited evidence available on the potential impacts of carsharing is from Europe or other parts of the world and may not be applicable to the U.S.

Technical & Background Information

Study Selection

Studies of the effect of carsharing on travel behavior in the U.S. context are limited, and many date from the early 2000s. Concerns about these studies include the likelihood that they only captured early adopters and that the impacts might vary significantly by context. A 2016 review of the evidence as of that time concluded that carsharing reduces VMT by 27% to 67% upon joining a carshare program for “candidate household members,” defined as individuals who travel shorter total distances and reside in higher-density urban neighborhoods, with good walking, cycling, and transit services (Chen and Kockelman, 2016). Methods used in the available U.S. studies are discussed in the following section.

Many of the studies of the effect of car-sharing on travel behavior come from Europe and other places, where carsharing is more widely available than in the U.S. Because auto ownership is lower in Europe and transit service is generally superior, the effects reported in European studies may not be generalizable to the U.S. These studies generally find that car sharing reduces driving and/or car ownership, as in these examples:

- A study from Germany found that 6% of customers of a free-floating carsharing service reduced their private vehicle ownership (Becker et al., 2018).
- Another study from Germany examined the relationship between the number of carshare vehicles and auto ownership at the city level, finding that one additional car is associated with a reduction of about nine cars owned by private individuals (Kolleck, 2021).
- In a study in the U.K., 37% of the users of a free-floating carshare program said that the program impacted their car ownership, with 83% of those users saying that they decided not to buy a car they otherwise would have purchased, and 11% reporting that they disposed of a car after joining the program (Le Vine and Polak, 2019).
- A study in Italy found that carsharing can substitute for car driving trips but found no evidence that they substitute for walking and bicycling trips; carsharing had complementary relationships with both transit and bike sharing (Ceccato and Diana, 2021).
- A study from the Netherlands found that car ownership declined 30% in response to joining a car-share program, with shared cars mostly replacing second or third cars; members drove 15% to 20% fewer kilometers than before joining (Nijland and van Meerkerk, 2017).
- A study from Korea found that 4.3% of carshare members had disposed of at least one vehicle after four years of the program, while over one quarter chose to forgo a car purchase (Kim, Park, and Ko, 2019).

The impact of carsharing depends on the extent to which it is adopted. A 2020 study of 1,500 households in Australia, a small share of whom were car-share users, found limited impact of the availability of carsharing on vehicle ownership across the population as a whole, pointing to the importance of increasing awareness of carsharing services and encouraging their use (Zhou, Zheng, et al., 2020). Indeed, many studies of carsharing focus on its adoption rather than its use (e.g., Dias et al., 2017). Several studies examine the connection between individual characteristics and their awareness and acceptance of carsharing services (e.g., Shaheen & Cohen, 2007; Zheng et al., 2009). Some studies examine the correlation between neighborhood characteristics and carshare rentals (e.g., Stillwater, Mokhtarian, & Shaheen, 2009; Kim, 2015). Several other studies examine factors influencing the

willingness to adopt carsharing, specifically electric-vehicle carsharing (e.g., Kim, Ko, and Park, 2015; Zoepf and Keith, 2016).

Much of the research on carsharing focuses on operational aspects of these systems, including business and service optimization, rather than their effect on travel behavior (Ferrero et al., 2018). Such studies are not relevant to this brief but can be helpful in efforts to develop new carshare programs.

Methodological Considerations

Cross-sectional studies comparing VMT for carshare users versus car owners are not adequate for assessing the impacts of carsharing. Such studies establish correlation but not necessarily causation between carshare membership and either car ownership or car use. For example, studies showing that carshare members own fewer vehicles than non-members do not establish whether carshare caused lower car ownership or whether lower car ownership motivated membership in the carshare program. Studies from outside the U.S. provide evidence that the direction of causality is often the latter. A qualitative study of carsharing users in Australia concluded that carsharing enabled and facilitated but did not generally cause changes in car ownership, which was often triggered by life events such as residential relocation (Jain et al., 2020). Initial analysis in a Copenhagen study found that membership in a free-floating carshare program led to a decrease in car ownership, but after controlling for the intention to reduce car ownership at the time of joining the program, the effect on car ownership was no longer significant (Haustein, 2021). The available evidence thus suggests that while carsharing services can play an important role in enabling a reduction in car ownership for individuals or households motivated to reduce their car ownership, they are unlikely to reduce car ownership in the absence of such motivations.

Stronger evidence on the causal effects of carsharing would come from quasi-experimental studies in which car ownership and VMT are measured before and after individuals join a carshare program coupled with similar measurements for a control group of non-members who are otherwise similar to the members. A difference-in-differences analysis can then be used to assess whether the change in travel behavior for the “treatment” group (i.e., those becoming members of the program) exceeds the change in travel behavior for the “control” group (i.e., those who did not join). Such studies should include both car owners and non-car owners who join the program to separately test its effect on getting rid of a car versus foregoing the purchase of a car. No U.S. studies meet all these criteria, though one early study of carsharing (Cervero, et al., 2007) used repeat cross-sectional surveys of members and non-members to assess the program’s effects.

Data collection for such studies generally requires a survey of residents to measure travel behavior before and after joining the program. The survey should measure the frequency of use of all relevant modes as well as car ownership and (weekly, monthly, or annual) VMT to assess changes in travel behavior more broadly. Data on travel behavior can also be collected with a smartphone app that tracks movements and uses a survey to collect additional information. The control group of non-members should be as similar as possible to the treatment group with the exception of their membership in the service.

Studies providing evidence of the effects of carshare programs on car ownership and VMT in the U.S. are as follows:

- Martin, Shaheen, and Lidicker, 2010: This cross-sectional study analyzed data from a 2008 survey of 6,281 car-share members from 11 programs across North America. The survey relied

on recall of travel behavior before car sharing and self-reporting of current car ownership to assess the impacts of the program. Vehicle ownership dropped from 0.47 to 0.24 vehicles per household, primarily as a result of many one-car households becoming carless households. Approximately 9 to 13 vehicles were taken off the road (shed autos plus postponed car purchases) per each carsharing vehicle. This study does not establish whether carshare caused the differences in car ownership and VMT.

- Martin and Shaheen, 2011: This cross-sectional study analyzed data from a 2008 survey of 6,281 car-share members from 11 programs across North America. The survey relied on recall of travel behavior before car sharing and self-reporting of current travel behavior to assess changes in travel behavior. Respondents were almost equally split between using transit (bus and rail) more and using transit less after joining the carshare program, but the majority reported increasing their walking, bicycling, and carpooling. Over 80% of members reported that they reduced their car commuting. This study does not establish whether carshare caused the differences in car ownership and VMT.
- Mishra et al., 2015: This cross-sectional study compared carshare members to non-members in the San Francisco Bay Area using data from 2010-12 California Household Travel Survey. The study used propensity-score matching to control for socio-demographic differences between members and non-members. The analysis showed that members owned significantly fewer vehicles than non-members with similar characteristics. Members were more likely to walk, bike, and use transit more frequently than non-members, but these differences were minor and mostly not significant. Although the use of propensity-score matching helps to address the question of causality, this study still leaves open the possibility that carshare did not cause the differences in car ownership and VMT.
- Clewlow, 2016: This cross-sectional study compares car-share members in the San Francisco Bay Area in to non-members in the same areas using data from the 2010-12 California Household Travel Survey. Car ownership was lower for members only in urban areas: members owned 0.58 vehicles per household compared to 0.96 vehicles per household for the control group. In suburban areas, carshare members drove less than non-members. Carshare members were more likely to own electric vehicles. This study does not establish whether carshare caused the differences in car ownership and VMT.
- Namazu and Dowlatabadi, 2018: This cross-sectional study used data from a survey of 3,405 carsharing users in Vancouver, drawing from members of two programs: Car2go offering one-way, free-floating, 2-seater cars; and Modo offering two-way service with variety of vehicles. Users of both systems reported that they reduced car ownership after joining the carshare program. The effects differed by program, however. Rates of ownership before joining were higher for Car2go than for Modo, and the drop in ownership was larger for Modo. Implications for driving also differed: Car2go was more likely to be used as complement to other modes, while Modo more likely to be used as a substitute for private car ownership. This study demonstrates that the characteristics of the service may have an important influence on its effects. This study does not establish whether carshare caused the differences in car ownership and VMT.
- Dill, McNeil, and Howland, 2019: This longitudinal study used data from a survey of 235 car owners who enrolled in a peer-to-peer carsharing program in Portland, Oregon. The analysis showed that the majority of members made few changes to their driving behavior, though

nearly 4 in 10 owners decreased their driving by 10% or more one year after joining. Some owners seemed to use the program as a catalyst for changing their travel behavior, including increasing their use of other modes. This study does not establish whether carshare caused the differences in car ownership and VMT.

- Martin and Shaheen, 2016: This study used data from a 2014 survey of members of the peer-to-peer carsharing service car2go in five North American cities. The study found that for every car2go vehicle, between 1 to 3 personal vehicles were sold and between 4 to 9 vehicles were not purchased. Based on the reduction in vehicles and the average annual VMT per vehicle as reported by the survey respondents, the study estimated that member households reduced their VMT from 6 to 16% on average because of the carsharing service.
- Shaheen, Martin, and Hoffman-Stapleton, 2021: This study used data from a 2014 survey of peer-to-peer carsharing members from three different services across the U.S. In the survey, 19% of respondents reported that they avoided a vehicle purchase due to the availability of the service and 44% said they would likely purchase a vehicle if car-sharing services were not available.

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