Travel Effects of a Suburban Commuter Carsharing Service

CarLink Case Study

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Since 1998, carsharing organizations in the United States have experienced exponential membership growth, but to date there have been only a few evaluations of their effects on travel. Using the results of focus groups, interviews, and surveys, this paper examines the change in travel among members of CarLink—a carsharing model in the San Francisco Bay Area, California, with explicit links to transit and suburban employment—after approximately 1 year of participation. The demographic and attitudinal analyses of CarLink members indicated that the typical member (*a*) was more likely than an average Bay Area resident to be highly educated, in an upper income bracket, and professionally employed and (*b*) displayed sensitivity to congestion, willingness to try new experiences, and environmental concern. Some of the more important commuter travel effects of the CarLink programs included an increase in rail transit use by 23 percentage points in CarLink I and II; a reduction in driving without passengers by 44 and 23 percentage points in CarLink I and II, respectively; a reduction in average vehicle miles traveled by 23 mi in CarLink II and by 18 mi in CarLink I; an increase in travel time and a reduction in travel stress; a reduction in vehicle ownership by almost 6% in CarLink II; and reduced parking demand at participating train stations and among member businesses. The CarLink travel results are compared with those of neighborhood carsharing models in the United States and Europe.

Automobiles have profoundly influenced travel and land use in the United States by providing unprecedented flexibility, convenience, and speed. Despite the myriad benefits offered by private vehicles, there is a recognition of the negative social and environmental effects of auto dependence (*1, 2*), for example, traffic-related deaths, congestion, air and water pollution, and suburban sprawl. To date, implemented strategies to reduce auto use and dependency have focused largely on public transit. Carsharing programs (or short-term auto rentals) represent an intermediate strategy—between public transit and private vehicle ownership—for addressing several auto-related concerns. Carsharing vehicles also may have the potential to enhance the existing transportation infrastructure, improving transit access and reducing parking demand at a lower cost than traditional capacity-expansion projects.

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Carsharing was conceived in Europe but has gained popularity in the United States over the past 7 years. Generally, members subscribe to a carsharing organization and pay a fee, which covers the cost of vehicle use, insurance, maintenance, and fuel, each time they use the vehicle. As a result, members incur variable costs of auto use, rather than the largely fixed costs of auto ownership, a factor that may lead to lower auto ownership, increased transit use, and reduced auto travel.

In Europe and the United States, the most common carsharing model is neighborhood carsharing. In this model, the carsharing organization maintains a fleet of cars distributed among a network of neighborhood locations for convenient member access. This form of carsharing typically is located in urban areas with high-quality transit. Ideally, members use transit for most of their trips and carshare only when traveling outside the transit network, when travel times do not coincide with transit schedules, or for transporting heavy or bulky items. CarLink, the carsharing model evaluated in this study, differs from neighborhood carsharing by providing a formal link to transit and employers in a suburban location.

Despite the recent increase in demand for carsharing services, not much evidence exists of their potential travel benefits. Most research has focused on the European neighborhood carsharing experience and shows large reductions in auto travel (30% to 70%) and auto ownership (10% to 60%) (*3–6*). The methods used in these studies are limited, however, and results may not be able to be generalized to the United States. Only a few studies have been conducted on neighborhood carsharing in the United States, and these suggest more modest travel benefits (*7–9*). However, evaluations of U.S. carsharing programs with explicit transit links (also known as station cars) consistently suggest larger reductions in auto travel (*10–12*).

Using the results of focus groups, interviews, and surveys, this paper examines the change in travel among members of CarLink I and II pilot programs after approximately 1 year of participation. The CarLink results are also compared to those of neighborhood carsharing models in the United States and Europe to gain insight into user attributes and the influence of program elements (e.g., location and design) on travel effects.

OVERVIEW OF CARLINK I AND II

The CarLink I field test launched on January 20, 1999, and ended on November 15, 1999. Enrollment was 54 people; they shared 12 natural gas–powered Honda Civics. The participants were from San Francisco, Oakland, and East Bay, California, communities. The cars were based in conveniently located parking spaces at the Dublin–Pleasanton Bay Area Rapid Transit (BART) station. The CarLink I

TABLE 1 Key Differences Between CarLink I and CarLink II

Character	CarLink I	CarLink II
Community access	Limited primarily to employees of a national laboratory and 10 households 54 users	Increased network of users, with several businesses 107 users
Time frame	10-month field test	12-month pilot project, before transitioning to third-party operator (Flexcar)
Vehicles	12 Honda Civics fueled with compressed natural gas	19 internal combustion engine Honda vehicles
Technology	Smart key manager Manual key boxes Onboard vehicle computers Vehicle tracking units Manual reservation system (facilitated through web page)	Smart key fob remote access system (i.e., no key boxes) Onboard vehicle computers Global Positioning System (GPS) vehicle tracking units In-vehicle navigation system Computerized reservation system for day use
Transit partner	BART District	Caltrain
Location	Dublin–Pleasanton and Livermore (east of San Francisco)	Palo Alto and Silicon Valley (south of San Francisco)

model accommodated traditional and reverse commute travel patterns as well as the daytime travel needs of employees at the Lawrence Livermore National Laboratory (LLNL).

The CarLink II pilot program launched on July 1, 2001, and ended on June 30, 2002. Enrollment was 107 individuals, and the fleet consisted of 19 ultra–low-emission vehicle Honda Civics of model year 2001. CarLink II was located in the Palo Alto region, south of San Francisco, and its chief transit partner was Caltrain, a commuter rail system that runs for approximately 75 mi between Gilroy and San Francisco. This program facilitated access to rail transit for commuter travel and provided day-use services to many companies. The participation of multiple employers and employees required the development of integrated carsharing technologies, which coordinated vehicle tracking, data collection, and reservations. Smart key fobs allowed for instant vehicle access and eliminated the need for multiple key boxes at transit stations and work locations. The major differences between CarLink I and CarLink II are summarized in Table 1.

The six employer participants in CarLink II were located in and around the Stanford Research Park, which has more than 700 acres and 10 million square feet of developed facilities, 162 buildings, 150 companies, and 23,000 employees. The Stanford Research Park primarily houses research companies whose type and size varies widely, including high-tech law firms, software companies, pharmaceutical research companies, and several dot-coms. The participating companies tended to have employees with regular work schedules (in contrast to dot-coms) and ranged in size from 100 to 600 employees.

CarLink II (like CarLink I) included three distinct categories of shared vehicle users. Home-based users had access to vehicles on evenings and weekends and paid $300 per month. These members lived in or near Palo Alto and drove a CarLink vehicle to the Caltrain California Avenue station each weekday morning, before taking a train to work, and then home again at night. Work-based commuters were employees of participant companies and used the CarLink vehicles that home-based users parked at Caltrain in the morning, to commute from the California Avenue station to their work sites and back. Employers paid approximately $50 per month per vehicle for their employees to access these vehicles and were encouraged to promote carpooling among work-based commuters. Work-based day users were also employees of participant companies and used the vehicles for personal and business trips throughout the day. Day use was provided as a subscription package to employers for $300 per vehicle per month. Employers paid a total of $350 per month per car for the day-use and work-based commuter components. All user fees included maintenance, insurance, fuel costs, roadside assistance, and emergency taxi services.

RESEARCH AND DATA COLLECTION METHODOLOGY

The CarLink II evaluation was built on the CarLink I longitudinal survey and field test research (*12, 13*). As in the CarLink I field test, the CarLink II research investigated the use attributes and changes in travel patterns through focus groups, questionnaires, household interviews, 3-day travel diaries, and automatically collected vehicle data.

The response rates for the before-and-after questionnaires and diaries by gender and user groups are presented in Table 2. The total response rate for the CarLink II questionnaires and diaries was 59.8%. Some surveys were returned 2 to 6 months after the end of the program and after Flexcar—the third-party operator—took over the program. Participants were contacted by telephone to remind them

TABLE 2 CarLink II Response Rates by Gender and User Group

User Group	Male	Female	Average
Home-based users (*N*=9)	62.5%	50.0%	56.3%
Work-based commuters (*N*=21)	64.3%	85.7%	75.0%
Work-based day users (*N*=34)	50.0%	57.1%	54.0%
Total average (*N*=64)	56.0%	63.2%	59.8%

to complete the surveys. The total female response rate was seven percentage points higher than the male response rate.

The distribution of program members and survey respondents by user group are presented in Table 3. The distribution of home-based users is close to equal. However, it appears that work-based commuter respondents are somewhat underrepresented and work-based day user respondents are somewhat overrepresented relative to total user group proportions.

The CarLink in-vehicle technology provided car usage data, including user identification, start and end time, and location by trip. These data could be viewed in real time by fleet managers and were archived to provide usage histories.

USER PROFILES

In this section, demographic and attitudinal characteristics of CarLink members are identified to gain insight into its potential market. The demand for carsharing services may depend not only on the population density and quality of transit in a region, but also on the attributes of its population.

Demographic Attributes

Men and women were equally represented in CarLink II, but in CarLink I, twice as many participants were male than female. Studies of European carsharing organizations have also found that men tend to participate more frequently than women (*13*). The difference in gender distribution between CarLink I and CarLink II may be explained by differences in employees at the respective worksites. The worksite in CarLink I (LLNL) may employ more men than women or the female employees may have been less likely to possess attitudes common to members, as discussed later.

CarLink II participants tended to be younger than the general Bay Area population as reported in the 2000 U.S. census (by approximately 15 percentage points), as were CarLink I participants (by approximately 38 percentage points). The location of CarLink II in the Silicon Valley, which tends to have a relatively young employee base, may explain the lower relative age of participants in CarLink II. Similarly, the LLNL worksite in CarLink I may explain the higher relative age of participants (e.g., employment at LLNL may require more advanced degrees).

Participants in both CarLink I and II possessed higher levels of education than the general Bay Area population as reported in the 2000 U.S. census. A bachelor's degree or higher was held by 57% of CarLink I users, 48% of CarLink II users, and 14% of Bay Area residents.

The household income levels of CarLink participants were also relatively high. Of CarLink I members, 30% had household incomes ranging from $80,000 to $99,999, and 16% had a household income greater than $100,000. CarLink II members had fewer participants in the $80,000 to $99,999 range (19%), but more participants earning over $100,000 (47%). In CarLink II, the greatest portion of all user groups was in the $100,000+ income category. Home-based users tended to have a relatively large percentage of members in lower income groups; the reverse was true for work-based commuters; and work-based day users tended to have a relatively even distribution across the income categories.

CarLink members were also primarily employed in the professional and technical fields (68.2% in CarLink I and 64.7% in CarLink II). This is high relative to Bay Area residents (approximately 18%). The distribution of occupation types did not vary substantially among user groups in CarLink II relative to CarLink I.

CarLink II members owned or leased an average of 1.75 vehicles per household at the start of the program. Overall, the number of vehicles per CarLink II member household was similar to the Bay Area population. Figure 1 presents a comparison of the household vehicle distribution of CarLink II members and the Bay Area population.

Figure 2 shows the number of vehicles per household by CarLink II user groups. Members who belonged to a household without access to a vehicle should have been able to improve their mobility significantly. More than one-fourth of home-based users and one-tenth of work-based commuters had no vehicle in their household. One-third of home-based users had household incomes of less than $50,000 (compared to 11% of work-based commuters). The lower relative incomes of home-based members help explain their lower car ownership levels and their participation in CarLink II.

Attitudinal Characteristics

In this section, attitudinal characteristics of CarLink II users are identified based on the results of questionnaires completed by people before joining the program. Respondents were first asked to rate, on a five-point scale, how much they agreed or disagreed with 10 statements describing attitudes about their primary transportation mode. As a group, home-based users expressed neutral attitudes and work-based commuters and day users expressed somewhat more satisfied attitudes. Similarly, the CarLink I study found that 77% were satisfied with their current mode. These results suggest that members were not likely to join CarLink because of a general dissatisfaction with their current mode.

Respondents next were asked to rank a list of negative attributes for their current primary transportation mode. The top four choices for all participants were "spend too much time in traffic," "it takes too long to get places," "it is not flexible enough," and "it is too expensive."

TABLE 3 Distribution of CarLink II Participants and Survey Respondents by User Group

User Group	Participants (*N*=107)	Respondents (*N*=64)
Home-based users	15.0%	14.1%
Work-based commuters	26.2%	32.8%
Work-based day users	58.9%	53.1%

All participants completed the initial surveys, but respondents completed both the initial and final surveys.

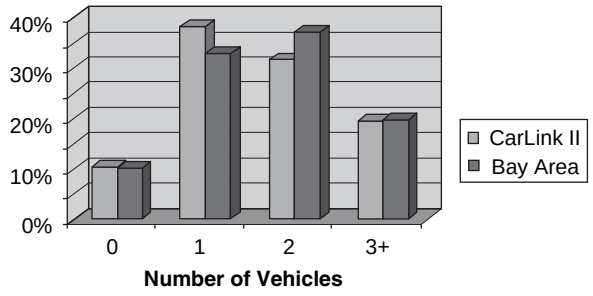

FIGURE 1 Percentage of households by number of vehicles available for CarLink II participants and Bay Area residents.

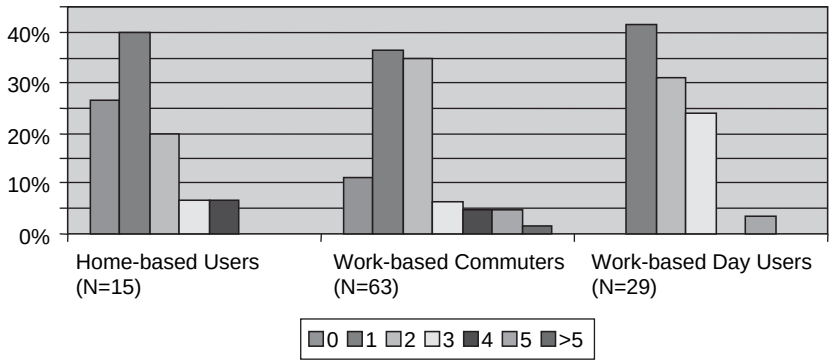

FIGURE 2 Percentage of CarLink II user group participants by number of vehicles available to their household.

Participants' least favorite attribute was "spend too much time in traffic." CarLink I results also suggested that participants may be sensitive to congestion. Thus, traffic congestion may be an important factor in joining the CarLink carsharing model. Interestingly, however, commute time (or "it takes too long to get places") was not improved through CarLink II participation—additional time was required to link to transit with a CarLink vehicle. Average CarLink commute times were longer than non-CarLink I and II commutes. However, there is evidence that CarLink I and II travel times were higher in quality, less stressful, or both, than non-CarLink travel times.

A set of psychographic questions was also included in the questionnaire. Responses to these questions were pooled to three scales—experimental, vehicle hassle, and environment—which were found to be significant (Cronbach's alpha score) in Shaheen's (*13*) analysis of a larger longitudinal carsharing survey (207 respondents). The experimental scale indicates willingness to try new experiences. The vehicle hassle scale suggests the degree of difficulty experienced by respondents in maintaining their private vehicle. The environmental scale indicates how strongly respondents believe that it is important to change behavior to help the environment. Responses were evaluated on a five-point scale (ranging from "Strongly Disagree" to "Strongly Agree"), which were assigned a point value (–2 to +2, with 0 being neutral) and averaged over related questions.

The psychographic results are presented in Table 4. A tendency to experiment was exhibited by CarLink II participants (the average score was 0.68) and was most pronounced among home-based users. A similar inclination toward experimentation was found among CarLink I users. All user groups in CarLink II tended to disagree that "vehicles are a hassle." The average total score was –0.43 in CarLink II and +0.40 for CarLink I. Thus, CarLink II participants may have been motivated less by vehicle hassle and more by a desire to get out of traffic, relative to CarLink I participants. Concern for the environment yielded the highest average score, 1.04 for CarLink II and 1.35 for CarLink I, making reducing automobile effects on the environment an important motivating factor in both CarLink programs.

TABLE 4 Psychographic Scale Scores from CarLink II and I

	Experimental	Vehicle Hassle	Environment
CarLink II			
Home-based users (*N*=15)	0.94	–0.38	0.98
Work-based commuters (*N*=63)	0.64	–0.40	1.03
Work-based day users (*N*=29)	0.62	–0.50	1.01
Total users (*N*=107)	0.68	–0.43	1.10
CarLink I			
Total users (*N*=44)	0.51	0.40	1.04

TRAVEL EFFECTS

Commute Travel

The commute travel results from CarLink II are presented in Table 5. The comparison of the mode use before and after joining the program indicates that Caltrain use increased by 23.1 percentage points and driving alone decreased by 22.9 percentage points, despite the fact that over one-third of participants (39.6%) used Caltrain prior to joining the program. Similar mode shifts were obtained for CarLink I, with a 23.2-percentage-point increase in BART use and a 43.5-percentage-point reduction in driving alone for the commute travel.

The shift from driving alone to transit reduced average commute vehicle travel distance by 23 mi among all users. An average 18.5-mi reduction was found in CarLink I. Among home-based users, however, average commute vehicle travel distance increased by 1.2 mi. The results of interviews and focus groups indicated that this increase in VMT typically occurred when an individual joined the program and switched from walk, bike, or shuttle modes to a CarLink vehicle to access Caltrain. More than half of home-based users used Caltrain regularly to commute prior to joining CarLink II. Work-based commuters and day users reported a 27.2-mi decrease in average commute vehicle travel, even though some CarLink II employers had previously operated a shuttle service, and one was within walking distance of the station (less than 1 mi). In interviews, participants stated that the hassle of getting from the station to the worksite (especially by shuttles) caused them to drive to work more frequently than they would have liked.

After joining the program, participants typically experienced an increase in commute travel time by more than 30 min. Most participants did not previously use Caltrain, and waiting for transit can increase total commute time relative to traveling by auto. On the other hand, commute stress among participants generally decreased, as indicated in Table 6. Some members, however, did mention some

TABLE 5 Change in Commute Travel for CarLink II

	Before			After			Change		
Mode[a]	HB[b] (*N*=15)	WB[c] (*N*=92)	All (*N*=107)	HB (*N*=8)	WB (*N*=51)	All (*N*=59)	HB	WB	All
Drive alone	37.5%	64.1%	60.2%	12.5%	41.2%	37.3%	–25.0%[d]	–22.9%	–22.9%
Carpool	12.5%	10.9%	11.1%	0.0%	11.8%	10.2%	–12.5%	0.9%	–0.9%
Bus, shuttle	25.1%	22.8%	23.2%	37.5%	13.7%	15.3%	12.4%	–9.1%	–7.9%
Caltrain	56.3%	35.9%	39.6%	100.0%	56.9%	62.7%	43.7%	21.0%	23.1%
Bike	12.5%	5.4%	6.5%	0.0%	3.9%	3.4%	–12.5%	–1.5%	–3.1%
Walk	43.8%	22.8%	25.9%	50.0%	52.9%	52.5%	6.2%	30.1%	26.6%
Other	6.3%	2.2%	3.7%	12.5%	11.8%	11.9%	6.2%	9.6%	8.2%
CarLink	0.0%	0.0%	0.0%	100.0%	56.9%	62.7%	100.0%	56.9%	62.7%
	HB (*N*=15)	WB (*N*=92)	All (*N*=107)	HB (*N*=9)	WB (*N*=55)	All (*N*=64)	HB	WB	All
VMT[e]	10.4	34.4	30.8	11.6	7.2	7.8	1.2	–27.2	–23
Travel time (minutes)	71.8	90.2	87.4	108.3	120.8	118.9	36.5	30.6	31.5

[a]Total percentages sum to over 100% because many participants took more than one mode to commute.
[b]HB is home-based user.
[c]WB is work-based commuter and day user.
[d]Figures are percentage point change.
[e]VMT includes all miles traveled in a private automobile or in a CarLink II vehicle. Carpool travel was adjusted to avoid double counting.

difficulty in arranging their schedules with other carpool members in the final CarLink II interviews and focus groups. The results of focus groups and in-person interviews with participants in CarLink I also indicated an increase in average commute travel times and a reduction in average commute stress. Work-based users stated that relaxing during their BART commute was a significant program benefit.

All Travel

This section explores the effect of CarLink II on noncommute and commute travel for participants and their households. For example, it is possible that exposure to transit in CarLink II may have encouraged its greater use for noncommute travel. In addition, the availability of an extra car in a participant household may have increased overall auto use.

The issue of total auto and transit use was explored by asking participants to assess how their personal and household travel behavior changed after joining CarLink II. The results are presented in Table 7. More than half of the total participants stated that their drive-alone travel decreased or greatly decreased, most likely because of increased commuting by Caltrain. Not surprisingly, one-fourth of the home-based users indicated that their drive-alone travel greatly increased, most likely because of increased access to the CarLink vehicles on evenings and weekends. At the household level, 6.3% of all participants indicated that vehicle use increased, 64.6% stated that it remained the same, and 27.1% said that it decreased. Total participant transit use tended to increase (36.1% increased and 11.5% greatly increased) or stay the same (42.6%). Most of the participants indicated that their transit use for noncommute trips did not change (71.2%), whereas 15.3% indicated that it increased or greatly increased, and 13.6% indicated that it decreased. The auto use for all travel was also reduced in CarLink I, but unlike CarLink II, bus use decreased while walk and bike use increased.

In sum, these results suggest that the CarLink II program had a positive overall effect on participant transit use including noncommute travel, and tended to reduce drive-alone and vehicle travel by both the participants and their households.

TABLE 6 Participation and Commute Stress for CarLink II

	Home-Based Users (*N*=9)	Work-Based Users[a] (*N*=55)	All (*N*=64)
Greatly increased	0.0%	1.8%	1.6%
Increased	12.5%	7.1%	7.8%
No change	25.0%	44.6%	42.2%
Decreased	62.5%	39.3%	42.2%
Greatly decreased	0.0%	7.1%	6.3%

[a]Work-based includes both work-based commuters and day users.

Household Personal Vehicle Use

The final CarLink II questionnaire asked participants about the status of their personal vehicles after joining the program. As shown in Table 8, more than half (52.2%) of the respondents reported no change in personal vehicle use, and 11% of home-based users and 5% of work-based commuters and day users sold a personal vehicle or put it in storage. No one purchased or leased a personal vehicle. The low rate of new car purchases may have resulted from program participation or from the economic downturn during this period. In the final CarLink II questionnaire, 44.4% of home-based users and 11.7% of work-based commuters and day users reported that postponing or avoiding the purchase of a car was a major benefit of joining the program. These findings may have no direct environmental or vehicle miles traveled (VMT) benefits, since households may keep their cars longer, but postponing or eliminating the costly purchase of a new car may have significant financial benefits to households.

Carpooling and Parking

The design of CarLink programs encouraged (CarLink II) or required (CarLink I) carpooling. Carpooling can be an effective strategy to

TABLE 7 Change in Noncommute and Commute Travel for CarLink II

	Drive Alone			Total Transit			Noncommute Transit			Total Household Vehicle Use		
Change	HB (*N*=8)	WB[a] (*N*=48)	All (*N*=56)	HB (*N*=8)	WB (*N*=53)	All (*N*=61)	HB (*N*=8)	WB (*N*=51)	All (*N*=59)	HB (*N*=6)	WB (*N*=42)	All (*N*=48)
Greatly increased	25.0%	2.1%	5.4%	25.0%	9.4%	11.5%	12.5%	0.0%	1.7%	0.0%	0.0%	0.0%
Increased	12.5%	2.1%	3.6%	25.0%	37.7%	36.1%	12.5%	13.7%	13.6%	16.7%	4.8%	6.3%
Same	25.0%	39.6%	37.5%	25.0%	45.3%	42.6%	37.5%	76.5%	71.2%	33.3%	69.0%	64.6%
Decreased	25.0%	50.0%	46.4%	12.5%	7.5%	8.2%	37.5%	9.8%	13.6%	33.3%	26.2%	27.1%
Greatly decreased	12.5%	6.3%	7.1%	12.5%	0.0%	1.6%	0.0%	0.0%	0.0%	16.7%	0.0%	2.1%

[a]Work-based includes both work-based commuters and day users.

TABLE 8 Change in Use of Household Personal Vehicles for CarLink II

	HB (*N*=9)	WB[a] (*N*=55)	All (*N*=64)
No change in use of household personal vehicles	22.2%	56.7%	52.2%
Family member drives a car more frequently	11.1%	6.7%	7.3%
Loaned a vehicle to someone outside immediate family	0.0%	3.3%	2.9%
Sold or stored one or more of our personal vehicles	11.1%	5.0%	5.8%
Purchased or leased a personal vehicle	0.0%	0.0%	0.0%
Did not have a vehicle when I joined CarLink	44.4%	8.3%	13.0%
Other	11.1%	15.0%	14.5%
No response	0.0%	5.0%	4.4%

[a]Work-based includes both work-based commuters and day users.

reduce the demand for and costs of employee parking. Preferential carpool parking can also help reduce employee frustration when on-site parking is limited. For some CarLink II employer subscribers, encouraging CarLink carpooling to reduce parking demand was a stated goal. CarLink II program did not require members to carpool, leaving this decision to the businesses. Including drivers, the overall average number of work-based commuters in a CarLink II vehicle during commutes between the train station and the work sites was 1.48 in both mornings and evenings. During the final CarLink II interviews and focus groups, researchers learned that the composition of individual carpools (i.e., specific persons in each car) varied between morning and evening. Overall the parking benefit to employers resulted in approximately one parking space serving two CarLink II vehicles on average. The impact on individual businesses varied. In focus groups with employees of businesses with more restricted parking, respondents said that they tended to carpool every day, meaning each CarLink II vehicle freed up at least one space.

SUMMARY AND CONCLUSIONS

This paper examined the user characteristics and the travel effects of the CarLink I and II programs, a carsharing model with explicit links to transit and suburban employment. What follows is a summary of key study conclusions with a discussion of relevant findings from carsharing studies in the United States and Europe.

Demographic Attributes

The typical CarLink II member was similar to the average San Francisco Bay Area resident with respect to gender and household vehicle ownership distribution. On the other hand, CarLink II participants were more likely to be highly educated, in a higher income bracket, professionally employed, and younger than the average Bay Area resident. Demographic attributes of CarLink I participants varied similarly from the Bay Area average with respect to education, income, and employment. However, men and older individuals were represented more frequently in CarLink I relative to CarLink II and the Bay Area population. The program location and type of participating company may explain the variation in age and gender distribution between CarLink I and II. However, studies in Europe have found that men were more likely to participate in carsharing programs (*13*). Studies of neighborhood carsharing in Portland and San Francisco have also found that members tended to be highly educated and professionally employed (*8, 9*).

Attitudinal Characteristics

Similar attitudes were shared by members of CarLink I and II, including sensitivity to congestion, willingness to experiment, and concern for the environment. However, CarLink II members did not typically view vehicle maintenance as a "hassle," whereas CarLink I members did.

Mode Choice

The change in mode choice for all travel among CarLink II members indicated relatively large reductions in driving alone and increases in

transit use. This change was most pronounced for commute travel, however, in which driving alone was reduced by 22.9 percentage points and use of the transit (Caltrain) increased by 23.1 percentage points. Similar mode shifts were obtained for CarLink I, with a 23.2-percentage-point increase in BART use and a 43.5-percentage-point reduction in driving alone for the commute travel. In contrast, results of neighborhood carsharing studies indicate small but conflicting results with respect to mode shifts. The CarSharing Portland study (*8*) showed a small shift from the auto mode to transit, walking, and cycling modes, while the City CarShare study (*9*) indicated a small decline in transit, walking, and cycling.

Vehicle Travel

Commute vehicle travel distance was reduced by an average of 23 mi per day in CarLink II and by 18.5 mi in Carlink I (*11*). In CarLink I and II, reductions in commute VMT were not offset by increases in non-commute travel. For example, more than 50% of CarLink II members stated that their vehicle use decreased or greatly decreased, while almost half indicated that their transit use increased. Across their entire households, nearly 30% of member households reported an overall decrease in vehicle use. During interviews, participants said that CarLink led to more trip-chaining during their commutes and the elimination of some unnecessary trips, and thus it appears that the CarLink model encouraged members to plan trips more carefully. Reductions in VMT for CarLink I and II are comparable to the low end of the VMT reductions found in European neighborhood carsharing studies, which ranged from 30% to 70% (*3–6*).

Household Vehicle Availability

CarLink II results indicate that a relatively modest number of members (5.8%) sold or stored their vehicle after joining the program. Some CarLink I members also indicated that they sold a vehicle after joining CarLink. The Portland and San Francisco neighborhood carsharing studies (*7–9*) suggest that 12% to 30% of members sold a vehicle after joining the organization. In Europe, neighborhood carsharing studies indicate that 10% to 60% of members sold a vehicle after joining a service (*3–6*).

Early U.S. results indicate that neighborhood carsharing in urban environments tends to increase auto travel among members without prior access to a household vehicle and reduce auto travel among those with prior access to a household vehicle. The changes in vehicle availability in the CarLink programs are at least half of those found in the neighborhood carsharing organizations in Portland and San Francisco. The higher-quality transit and pedestrian environment in the urban locations of neighborhood carsharing services may facilitate reductions in the number of available household vehicles. However, the reduction in auto travel among members of the CarLink and station car programs were larger than those found in U.S. neighborhood carsharing studies. Together, these results suggest that changes in household vehicle availability may be the key variable affecting reduction in auto travel in neighborhood carsharing programs, and the strong transit link may be the variable affecting auto travel reduction in the CarLink programs. It is unclear, however, whether the market potential for the suburban commuter carsharing model could be as extensive as that of neighborhood carsharing. Thus, total systemwide travel effects are unclear and require future research.

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