CASE STUDY 5

I. EXECUTIVE SUMMARY

The employer is a law firm in downtown Los Angeles. In 1990, the firm offered employees parking subsidies that ranged from $90 to $145 per space per month. The firm also offered such ridesharing benefits as guaranteed ride home, in-house carpool/vanpool matchlists, on-site bus pass sales, prize drawings, and promotional campaigns.

Since 1990, the firm's commuting policy has gradually changed every year. In 1993-1994, the firm offered all employees either a parking subsidy of $100 a month, or a cash transportation allowance of $150 per month. Except for minor changes, other ridesharing incentives remained the same. The following changes occurred after the firm began to offer employees the option to take cash in lieu of parking subsidies.

- The solo driver share fell from 75 to 53 percent.
- The carpool share rose from 10 to 23 percent.
- The transit share rose from 15 to 24 percent.
- The walking share remained the same at 1 percent.
- Vehicle round-trips to work fell from 0.70 to 0.53 per employee per day.

The shift from solo driving to ridesharing and transit reduced the number of vehicle trips and VMT for commuting to work by 24 percent. Table 1 summarizes the reductions (per employee and for the firm) in vehicle travel, pollution emissions, and gasoline consumption that occurred after cashing out.

II. BACKGROUND

The employer is a law firm in downtown Los Angeles. In 1990, the firm paid $145 per space per month to rent parking spaces for its employees; it offered free parking to attorneys, a parking subsidy of $90 a month for administrative employees with less than three years of service, and a parking subsidy of $120 a month to administrative employees with more than three years of service. The firm also offered other ridesharing benefits including guaranteed ride home, in-house carpool/vanpool matchlists, on-site bus pass sales, and promotional campaigns.

Table 2 shows the pattern of commuter subsidies in 1990 (Columns 2, 4, and 6). Column 2 shows that solo drivers received an average parking subsidy of $118 a month. Carpoolers split a parking subsidy, and received an average subsidy of $54 per carpooler per month. Transit riders received a subsidy of $15 a month, and others received nothing.

Column 4 shows the results found in a transportation survey required by the SCAQMD which was conducted in 1990. Seventy-five percent of employees drove solo, 10 percent carpooled, 15 percent rode transit, and 1 percent walked to work.

III. CASHING OUT REDUCED SOLO DRIVING

The firm gradually changed its commuter subsidy program starting in 1990. By 1993-1994, the firm paid $165 a month to rent parking spaces, and charged employees $65 a month for parking, so it offered a parking subsidy of $100 a month. The firm also offered a cash transportation allowance of $150 per month to employees who do not take a parking space. Thus it went beyond compliance with California's cash-out requirement. From 1990 to 1994, minor improvements were made in the quality of ridesharing services provided to employees, including preferential parking for carpools, a rideshare fair, promotional campaigns, partnership education program, and various award programs. The cash transportation allowance was the major policy change from 1990 to 1994.

Column 5 in Table 2 shows the results of the firm's employee transportation survey, conducted in February 1994. The solo driver share fell from 75 to 53 percent. The carpool share rose from 10 to 23 percent. The transit share increased from 15 to 24 percent. The share of employees who walked to work remained at 1 percent.

Figure 1 shows these mode shifts. The figures are taken from Columns 4 and 5 of Table 2, and show that the increase in transit and carpooling came at the expense of solo driving.

One may ask whether regional trends can explain part of the observed shift from driving to carpooling and transit. We can answer this question because Commuter Transportation Services conducts annual surveys of commuters in Southern California. Figure 2 shows the commute mode shares they found in 1990 and 1994. The share of commuters who drove to work alone in Southern California increased from 78 to 80 percent between 1990 and 1994, and the carpool share increased only slightly from 14.8 percent to 15.2 percent, while the transit share decreased from 5 to 2 percent.[1] Therefore, the shifts from solo driving to ridesharing and transit shown in Figure 1 for the firm are not explained by, and in fact run counter to, the results shown in Figure 2 for the region.

Columns 6 and 7 in Table 2 show how the firm's subsidy distribution among its employees changed between 1990 and 1994. In 1990, 75 percent of employees drove solo and received 92 percent of the total subsidy. In 1994, 53 percent of employees drove solo and received 43 percent of the total subsidy. The subsidy distribution in 1990 favored solo driving, while the subsidy distribution in 1994 favored ridesharing.

IV. CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE TRIPS AND VMT

Table 3 shows how the changes in mode shares reduced vehicle trips and VMT. Row 1 shows that there was an average of 0.88 commuters per employee. On an average day, 12 percent of employees did not commute to work because they were on vacation, sick, or for another reason; therefore, the firm's attendance rate was 88 percent.[2] Row 2 shows the number of vehicle round-trips per commuter per day, calculated from the data used to create Table 2. Each solo driver is counted as one vehicle trip, each person in a two-person carpool is counted

TABLE 5-2

COMMUTER MODE CHOICES BEFORE AND AFTER CASHING OUT

	Subsidy per Employee		Mode Share		Subsidy Distribution	
Commute Mode	**1990**	**1994**	**1990**	**1994**	**1990**	**1994**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Drive Alone	$118	$100	75%	53%	92%	43%
Carpool	$54	$150	10%	23%	5%	28%
Transit	$15	$150	15%	24%	2%	29%
Walk	$0	$150	1%	1%	0%	1%
Bicycle	$0	$150	0%	0%	0%	0%

Note: The survey response rate was 100% in 1990 and 100% in 1994. A Chi-Square test shows that the probability was less than 1 percent that the difference in commuter mode shares observed in Columns (4) and (5) occurred by chance.

FIGURE 5-2

Commuter Mode Choices

In Southern California

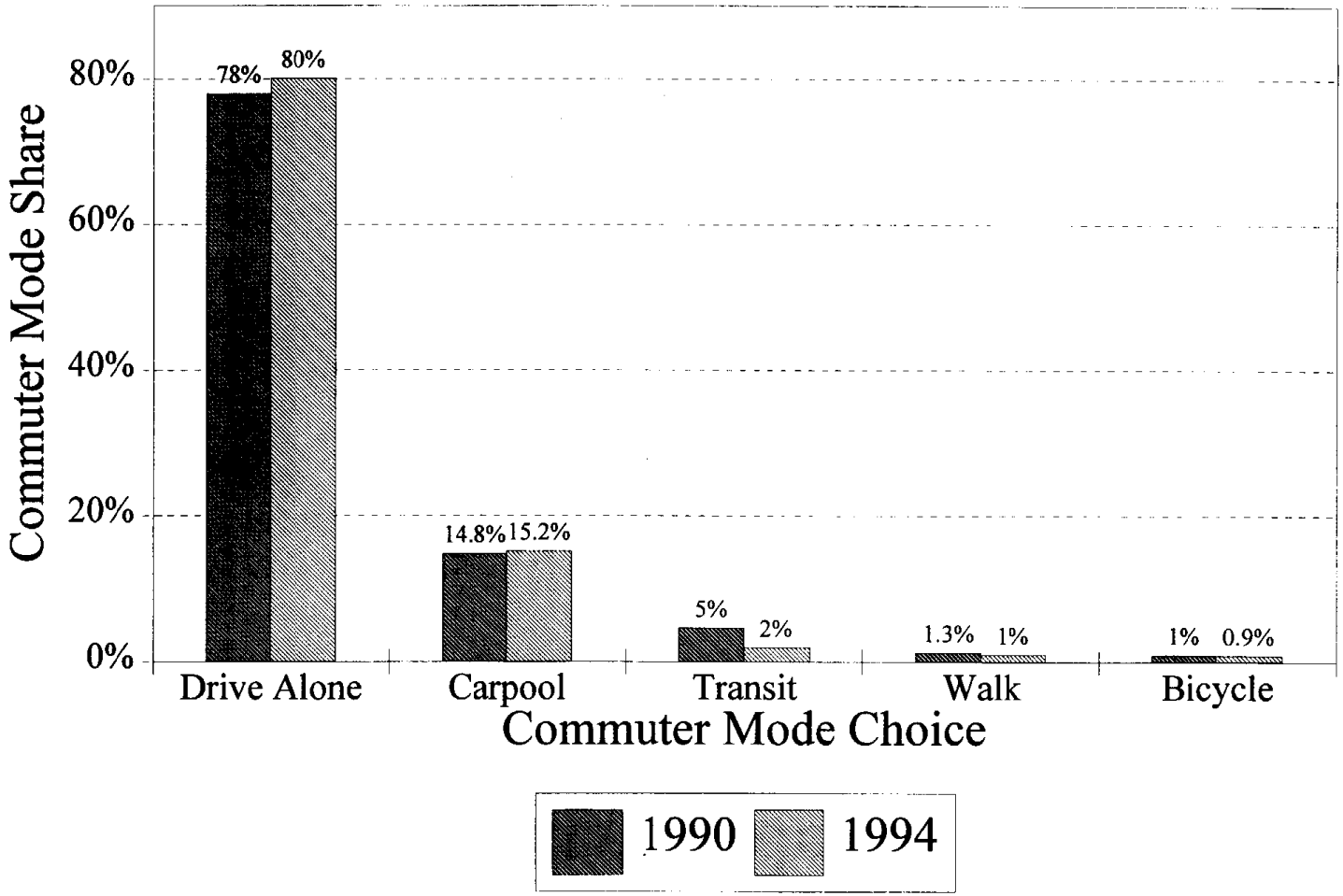
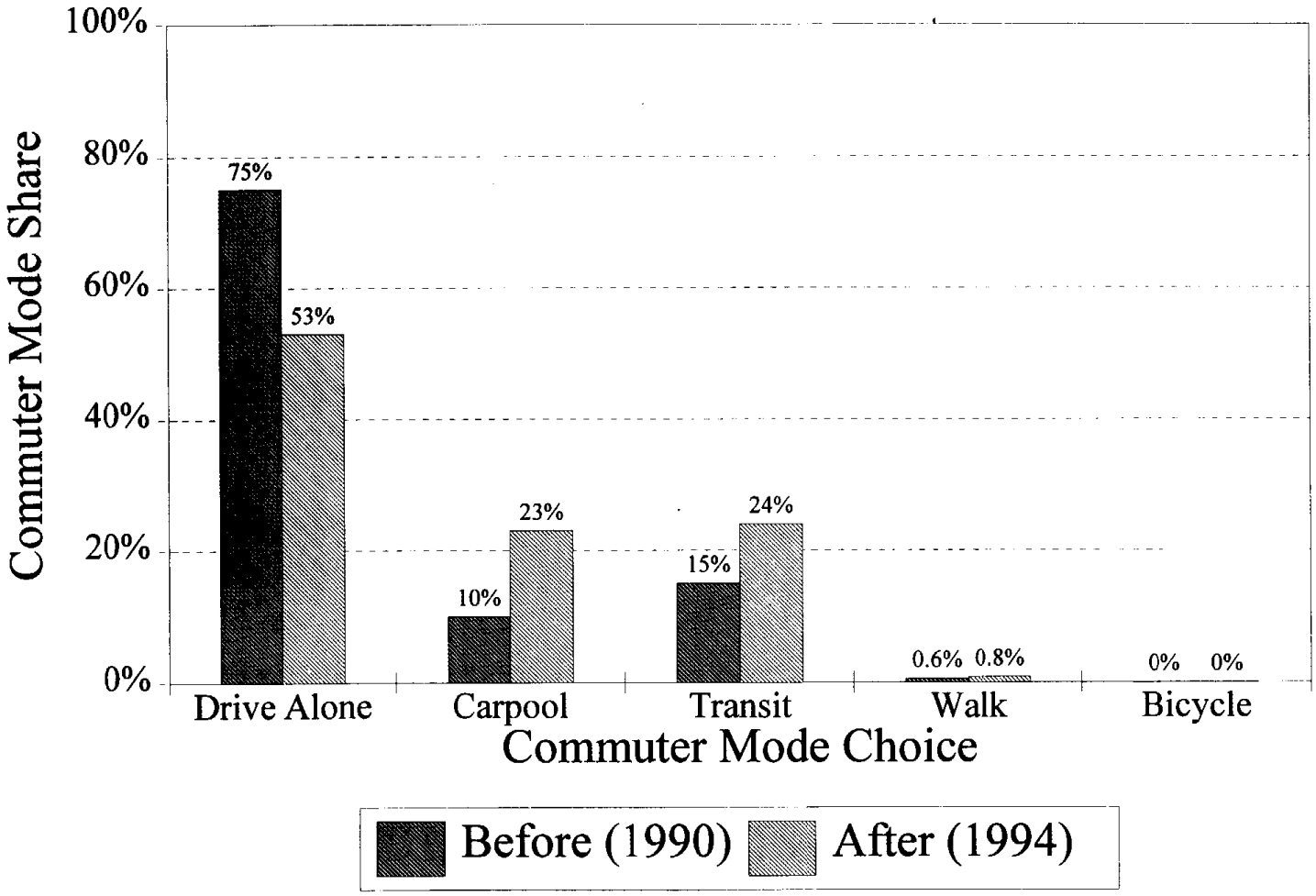


FIGURE 5-1

Commuter Mode Choices

Before and After Cashing Out



as one-half of a vehicle trip, each person in a three-person carpool is counted as one-third of a vehicle trip, and so on. No vehicle trips are attributed to transit riders, bicyclists, and pedestrians. The total number of vehicle trips is then divided by the total number of responding commuters to give the ratio of vehicle trips per commuter per day. Cashing out reduced the number of vehicle round-trips per commuter from 0.79 per day in 1990 to 0.60 per day in 1994, a 24 percent decrease.

Row 3 shows the number of vehicle round-trips per employee per day, obtained by multiplying the number of vehicle round-trips per commuter by the number of commuters per employee. Cashing out reduced the number of vehicle round-trips per employee by 24 percent, from 0.70 to 0.53 per day.

Row 4 shows the total number of one-way vehicle trips per employee per year. The number of one-way vehicle trips in 1990 is calculated by multiplying the 0.70 vehicle round-trips per employee per day found in 1990 by 252 work days per year, and doubling the result to obtain the number of one-way trips.[3] The number of one-way vehicle trips in 1994 is calculated by multiplying the 0.53 vehicle trips per employee per day found in 1994 by the same 252 working days per year, and doubling the result to obtain the number of one-way trips. The resulting change in the number of vehicle trips per employee per year therefore represents the change that occurred because mode shares changed.

Row 4 thus shows that were 353 vehicle trips per employee in 1990, and 268 vehicle trips per employee in 1994. Offering cash in lieu of parking subsidies eliminated 86 vehicle trips per employee per year for commuting (43 vehicle trips to work, and another 43 vehicle trips from work), a 24 percent decrease.

Vehicle trips for all automobile commuting to the firm were calculated by multiplying the trips per employee by the total of 281 employees of the firm. Row 5 shows that employees made 99,232 vehicle trips for commuting to the firm in 1990. Cashing out reduced the number of vehicle trips to 75,185 in 1994, or by 24,047 vehicle trips per year.

The SCAQMD survey reports do not include information on commuter trip distances. In calculating VMT reductions, the SCAQMD assumes that the average one-way distance for each avoided automobile trip is 15 miles.[4] If we follow this procedure, we can calculate how cashing out reduced VMT. Rows 6 and 7 show that cashing out eliminated 5.1 VMT per employee per day, and 1,284 VMT per employee per year. Row 8 shows that cashing out eliminated 360,709 VMT per year for commuting to the firm.

V. CASHING OUT REDUCED VEHICLE EMISSIONS

The emissions reductions are calculated by considering the reductions in both automobile *trips* and *VMT*. Pollution emissions are caused at the beginning and end of each automobile commute trip by the "cold start" as the engine warms up and the "hot soak" as the engine cools down; these "trip-end" emissions are independent of the total distance traveled for the commute.

TABLE 5-3

CASHING OUT REDUCED VEHICLE TRIPS AND VMT

		1990	1994	Change	Percent Change
		(1)	(2)	(3)	(4)
1	Commuters per Employee	0.88	0.88		
2	Vehicle Trips per Commuter per Day (Round-trip)	0.79	0.60	-0.19	-24%
3	Vehicle Trips per Employee per Day (Round-trip)	0.70	0.53	-0.17	-24%
4	Vehicle Trips per Employee per Year (One-way)	353	268	-86	-24%
5	Total Vehicle Trips per Year (One-way)	99,232	75,185	-24,047	-24%
6	VMT per Employee per Day	21.0	15.9	-5.1	-24%
7	VMT per Employee per Year	5,297	4,013	-1,284	-24%
8	Total VMT per Year	1,488,483	1,127,774	-360,709	-24%

There were 281 employees who reported to this work site during the 1994 survey period.

Row 3 = Row 2 x Row 1.

Row 4 = Row 3 x 252 x 2.

Row 5 = Row 4 x 281.

Row 6 = Row 3 x 30.

Row 7 = Row 6 x 252.

Row 8 = Row 7 x 281.

TABLE 5-4

CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE EMISSIONS

(Pounds Per Year)

	Change	Percent Change
ROG		
per Employee	-3.6	-24%
for Firm	-1,012	-24%
NOx		
per Employee	-3.0	-24%
for Firm	-852	-24%
CO		
per Employee	-32.3	-24%
for Firm	-9,071	-24%
PM		
per Employee	-2.1	-24%
for Firm	-596	-24%

The pollution emissions per trip-end and per VMT in 1994 are taken from the Air Resources Board's EMFAC7F1.1/B7F model.

These 1994 factors are:

	ROG	NOx	CO	PM
Trip end factor (grams/trip)	6.93	2.88	63.4	0
VMT factor (grams/mile)	0.81	0.88	7.18	0.75

These factors are multiplied by the reduction of 86 trips and 1,284 VMT per employee per year in Table 5-3 to give the reduction in emissions per employee in 1994.

The "running" emissions are a factor of total VMT for the trip. In Table 3 we have already estimated the reductions in automobile trips and VMT. Therefore, we can multiply these reductions in trips and VMT by the emissions created per trip-end and per VMT to obtain the reduction in total emissions caused by automobile commuting.

Cashing out reduced 86 trips and 1,284 VMT per employee per year. We multiply these reductions by the factors for ROG, NO_x, CO, and PM10 for both trip ends and VMT. We use the emission factors specific to 1994, the year in which the vehicle-trip and VMT reductions were estimated. We add the two sources of pollution, and then divide by 454 grams per pound to obtain the emissions reductions in pounds per employee per year. Table 4 shows that cashing out eliminated 3.6 pounds of ROG, 3.0 pounds of NO_x, 32.3 pounds of CO, and 2.1 pounds of PM per employee per year.

The emissions reduction for all employees of the firm is found by multiplying the emissions reduction per employee by the 281 employees of the firm in 1994. Cashing out eliminated a total of 1,012 pounds of ROG, 852 pounds of NO_x, 9,071 pounds of CO, and 596 pounds of PM per year for automobile commuting. The final column shows that cashing out reduced automobile emissions by 24 percent.

VI. CASHING OUT REDUCED GASOLINE CONSUMPTION AND CO_2 EMISSIONS

By reducing VMT, cashing out also reduced gasoline consumption and carbon dioxide emissions. Table 5 shows these results. The SCAQMD has estimated that the average fuel efficiency of light-duty passenger vehicles in Southern California is 25 miles per gallon in 1996. Therefore, the VMT figures estimated in Table 3 (Rows 7 and 8) are divided by 25 miles per gallon to estimate gasoline consumption for commuting.[5] Cashing out reduced gasoline consumption per employee by 51 gallons per year, and reduced total gasoline consumption for commuting to the firm by 14,428 gallons per year, a 24 percent decrease.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide. Therefore, the reduction in gasoline consumption reduced carbon dioxide emissions per employee by 1,012 pounds per year, and reduced total carbon dioxide emissions for commuting to the firm by 284,239 pounds per year, a 24 percent decrease.

VII. CASHING OUT INCREASED COMMUTING SUBSIDIES

In 1994, the firm went beyond compliance with California's cash out requirement; it offered a parking subsidy of $100 a month or a transportation allowance of $150 per month. Table 6 shows how this policy change increased the firm's spending for commuter subsidies.[6]

In 1990, the firm's commuter subsidy was $26,805 a month. In 1994 the firm's commuter subsidy was $36,007 a month, including $1,245 a month in payroll taxes on the cash benefits to ridesharers.[7] Total commuting subsidies, including payroll taxes, rose by $9,202 a month, or by 34 percent. The average subsidy per employee, including payroll taxes, increased

from $95 to $128 a month. This increase occurred largely because the commuting subsidy offered to ridesharers is 50 percent higher than is required for compliance with California's cash-out requirement.

VIII. SUMMARY

In 1990, the firm offered employees parking subsidies that ranged between $90 and $145 a month. Carpoolers split a parking subsidy, transit riders received $15 a month, and others received nothing. The firm gradually changed its commuter subsidy between 1990 and 1994; in 1994 it offered all employees the option of a parking subsidy of $100 a month or a cash subsidy of $150 a month.

In response to cashing out parking subsidies, the share of commuters who drive to work alone fell from 75 to 53 percent. The carpool share increased from 10 to 23 percent and the transit share increased from 15 to 24 percent. The walk share remained at 1 percent. These commuter changes from solo driving to carpooling and transit reduced the number of vehicle trips by 24 percent, eliminating a total of 24,047 vehicle trips and 360,709 VMT per year.

These reductions in automobile use reduced pollution emissions for automobile commuting by 24 percent. Cashing out eliminated 3.6 pounds of ROG, 3.0 pounds of NO_x, 32.3 pounds of CO, and 2.1 pounds of PM per employee per year. In total, cashing out eliminated 1,012 pounds of ROG, 852 pounds of NO_x, 9,071 pounds of CO, and 596 pounds of PM per year for commuting to the firm.

By reducing VMT, cashing out reduced gasoline consumption for commuting by 51 gallons per employee per year, and reduced gasoline consumption for commuting to the firm by 14,428 gallons per year. Finally, cashing out reduced carbon dioxide emissions by 1,012 pounds of CO_2 per employee per year, and reduced carbon dioxide emissions for commuting to the firm by 284,239 pounds of CO_2 per year.

The firm's spending for commuter subsidies increased by $33 per employee per month, or by 34 percent.

TABLE 5-5

CASHING OUT REDUCED GASOLINE CONSUMPTION AND CARBON DIOXIDE EMISSIONS

		1990	1994	Change	Percent Change
		(1)	(2)	(3)	(4)
1	Gasoline Consumption per Employee (gallons per year)	212	161	-51	-24%
2	Total Gasoline Consumption (gallons per year)	59,539	45,111	-14,428	-24%
3	Carbon Dioxide Emissions per Employee (pounds per year)	4,174	3,163	-1,012	-24%
4	Total Carbon Dioxide Emissions (pounds per year)	1,172,925	888,686	-284,239	-24%

There were 281 employees who reported to this work site during the 1994 survey period.

The average fuel efficiency is 25 miles per gallon.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide.

ENDNOTES

1. The sample size was 1,208 commuters in 1990 and 2,625 commuters in 1994. These results are presented in Table 2.1 of Commuter Transportation Services (1994).

2. To isolate any change in the number of trips caused solely by a change in the attendance rate, the attendance rate for 1994 is used for both years.

3. Vacations, sick days, and other absences are already accounted for in the calculation of the firm's average attendance rate, so the number of work days per year is five days per week for fifty-two weeks, minus the conventional eight national holidays per year.

4. This average trip distance was found in a 1991 travel survey for all commuters in the South Coast Air Basin. See Southern California Association of Governments (1993).

5. This estimated fuel efficiency of 25 miles per gallon was made using the Air Resources Board's EMFAC7F1.1/B7F model to represent conditions in Southern California on a workday in 1996. I am grateful to Waldo Lopez of the SCAQMD for this information. Average fuel efficiency of the fleet has been steadily increasing; it was only 22 miles per gallon in 1990. Because the estimates of VMT reductions refer to 1994, when average fuel efficiency was lower than in 1996, using a fuel efficiency of 25 miles per gallon produces a conservative estimate of how reducing VMT reduced fuel consumption.

6. To isolate the change in subsidy cost caused solely by the change in the number of employees, the number of employees reported in 1994 is used for both years.

7. The firm's payroll tax rate was 7.65 percent on cash payments to ridesharers.

REFERENCES

Commuter Transportation Services, *State of the Commute Report, 1994*, Los Angeles: Commuter Transportation Services, 1994.

Southern California Association of Governments, "1991 Southern California Origin-Destination Survey--Summary Findings," Los Angeles, 1993.

TABLE 5-6

COMMUTING SUBSIDIES BEFORE CASHING OUT (1990)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Firm
Drive Alone	$118	75%	92%	$24,686
2 Person Carpool	$59	8%	5%	$1,313
3 Person Carpool	$39	1%	0%	$131
4 Person Carpool	$29	1%	0.2%	$41
Vanpool	$17	0.2%	0.0%	$9
Mass Transit	$15	15%	2%	$626
Walk	$0	1%	0%	$0
Bicycle	$0	0%	0%	$0
Monthly Subsidies for 281 employees:				$26,805
Taxes on Cash Subsidies:				$0
Total Cost per Month:				$26,805
Cost per Employee per Month:				$95

COMMUTING SUBSIDIES AFTER CASHING OUT (1994)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Firm
Drive Alone	$100	53%	43%	$14,776
2 Person Carpool	$150	18%	22%	$7,490
3 Person Carpool	$150	5%	6%	$2,213
Mass Transit	$150	24%	29%	$9,908
Walk	$150	1%	1%	$340
Bicycle	$150	0.1%	0%	$34
Monthly Subsidies for 281 employees:				$34,762
Taxes on Cash Subsidies:				$1,245
Total Cost per Month:				$36,007
Cost per Employee per Month:				$128
Change in Total Cost per Month:				+$9,202
Change in Cost per Employee per Month:				+$33
Percent Change in Commuting Subsidy:				+34%

Case Study 5

Employer characteristics

Case study 5 provides legal services in the area of litigation. This firm had a total of 281 employees in 1994. All 281 employees reported to work between 6am and 10am, Monday through Friday.

Case study 5 is located at 333 South Hope Street in downtown Los Angeles. Three major freeways -- Harbor (110), Hollywood (101) and Century (105) -- provide nearby access to the firm. Major arterials serving this area include Grand Avenue, Flower Street and Figueroa Street. Fifteen bus routes serve this area.

Case study 5 provides many on-site services and amenities, including bank services, general store, restaurant, dry cleaners and barber / beauty stop. Moreover, the firm is conveniently accessible to nearby restaurants and retail establishments, and fitness centers.

Surrounding streets have wide sidewalks, pedestrian signals, crosswalks and good lighting.

The distribution of job categories is:

Professional	44.5%
Clerical	44.4%
Officials/Administrators	7.4%
Other	3.7%

Commuter Policies
Case Study 5

	1990		1994
1	Parking Subsidy	1	Parking Subsidy
2		2	**Commute Allowance**
3	Guaranteed Ride Home	3	Guaranteed Ride Home
4	In-House Carpool/Vanpool Matchlists	4	In-House Carpool/Vanpool Matchlists
5	Promotional Campaigns	5	Promotional Campaigns
6	Back-up Transportation Program	6	Back-up Transportation Program
7	On-Site Sale of Bus Passes	7	On-Site Sale of Bus Passes
8	Commuter Information Center	8	Commuter Information Center
9	*Prize Drawings*	9	**Public Transit/Vanpool Bonus**
10	*Telecommuting*	10	**Buy Back Rideshare Days Reward Program**
		11	**One Week Bus/Transit Subsidy**
		12	**Preferential Parking for Carpools**
		13	**Partnership Education Program**
		14	**Partner Rideshare Program**
		15	**Associate Education Program**
		16	**Partner Education Program**
		17	**Free DASH Coupons**
		18	**Flex Hour Scheduling**
		19	**Commuter Discount Cards**
		20	**Rideshare Fair**
		21	**Focus Group Meetings**
		22	**Reward Program**
		23	**Commuter of the Month**
		24	**Award Program**

Bold indicates an incentive present in 1994 but not in 1990
Italics indicates an incentive present in 1990 but not in 1994

TABLE 6-1

SUMMARY OF REDUCTIONS AFTER CASHING OUT

Variable Reduced	Reduction		
	Per Employee	For Firm	Percent Change
Vehicle Trips (per year)	38	4,582	9%
Vehicle Miles Traveled (per year)	568	68,730	9%
Reactive Organic Gas Emissions (pounds per year)	1.5	181	9%
Nitrogen Oxide Emissions (pounds per year)	1.3	154	9%
Carbon Monoxide Emissions (pounds per year)	13.2	1,600	9%
Particulate Matter Emissions (pounds per year)	0.9	114	9%
Gasoline Consumption (gallons per year)	23	2,749	9%
Carbon Dioxide Emissions (pounds per year)	448	54,160	9%

There were 121 employees who reported to this work site during the 1995 survey period.

CASE STUDY 6

I. EXECUTIVE SUMMARY

The employer does video and audio post-production for the entertainment industry. It offers all employees free parking in rented spaces that cost the firm $55 per space per month. In 1994, the firm began to offer employees the option to take cash in lieu of free parking. The following changes occurred after employees were offered the option to cash out parking subsidies.

- The solo driver share fell from 85 to 78 percent.
- The carpool share rose from 7 to 8 percent.
- The transit share doubled from 1 to 2 percent.
- The walking share doubled from 3 to 6 percent.
- The bicycle share rose from 4 to 6 percent.
- Vehicle round-trips to work fell from 0.86 to 0.78 per employee per day.
- Vehicle travel for commuting fell from 25.7 to 23.5 VMT per employee per day.

The shift from solo driving to ridesharing reduced the number of vehicle trips and VMT for commuting to work by 9 percent. Table 1 summarizes the reductions (per employee and for the firm) in vehicle travel, pollution emissions, and gasoline consumption after employees were offered to option to cash out parking subsidies.

II. BACKGROUND

The firm is located in Santa Monica, and employed 173 people in 1995. It specializes in video and audio post-production. The firm offers free parking to all employees; it has 19 parking spaces in its own building, and pays $55 per space per month to lease additional parking spaces off-site. The firm offers several other ridesharing benefits including guaranteed ride home, preferential parking for carpools, bicycle lockers, and a transit subsidy of $15 per month.

Table 2 shows the pattern of commuter subsidies in 1994 (Columns 2, 4, and 6 labeled "Before"). Column 2 shows that solo drivers received a parking subsidy of $55 a month, carpoolers split a parking subsidy of $55 a month, and other commuters received nothing.

Column 4 shows the results found in a transportation survey required by the South Coast Air Quality Management District (SCAQMD) which was conducted in February 1994, before the firm began to offer the cash option. Eighty-five percent of employees drove solo, 7 percent carpooled, 1 percent rode transit, 3 percent walked, and 4 percent bicycled to work.

III. CASHING OUT REDUCED SOLO DRIVING

In 1994 the firm began to offer a cash subsidy of $55 per month to employees who do not take a parking space. (This cash offer was introduced because Santa Monica required the firm to comply with California's cash-out requirement.) In addition, the firm offers an extra subsidy of $15 a month to transit riders. The firm thus complies with California's cash-out requirement, and goes beyond compliance because of the transit subsidy.

The firm also introduced guaranteed ride home, raffles, preferential parking spaces for carpools, and bicycle lockers in 1994. Although cashing out was not the only change between 1994 and 1995, it was the major change (see attached list of incentives offered in 1994 and 1995).

Column 5 (labeled "After") in Table 2 shows the results of the firm's 1995 employee transportation survey, conducted in June 1995, approximately 15 months after the firm began to offer employees the option of cash in lieu of parking. The solo driver share fell from 85 percent in 1994 to 78 percent in 1995. The carpool share rose from 7 to 8 percent, the transit share doubled from 1 to 2 percent, the walk share doubled from 3 to 6 percent, and the bicycle share increased from 4 to 6 percent.

Figure 1 shows these mode shifts. The data are taken from Columns 4 and 5 of Table 2, and they show that the increase in carpooling, transit, walking, and bicycling came at the expense of solo driving.

Columns 6 and 7 in Table 2 shows how the firm's subsidy distribution among its employees changed between 1994 and 1995. In 1994, 85 percent of employees drove solo and received 97 percent of the total subsidy. In 1995, 78 percent of employees drove solo and received 77 percent of the total subsidy. The subsidy distribution in 1994 favored solo drivers, while the subsidy distribution in 1995 was almost evenly distributed, with a slight preference for transit riders.

IV. CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE TRIPS AND VMT

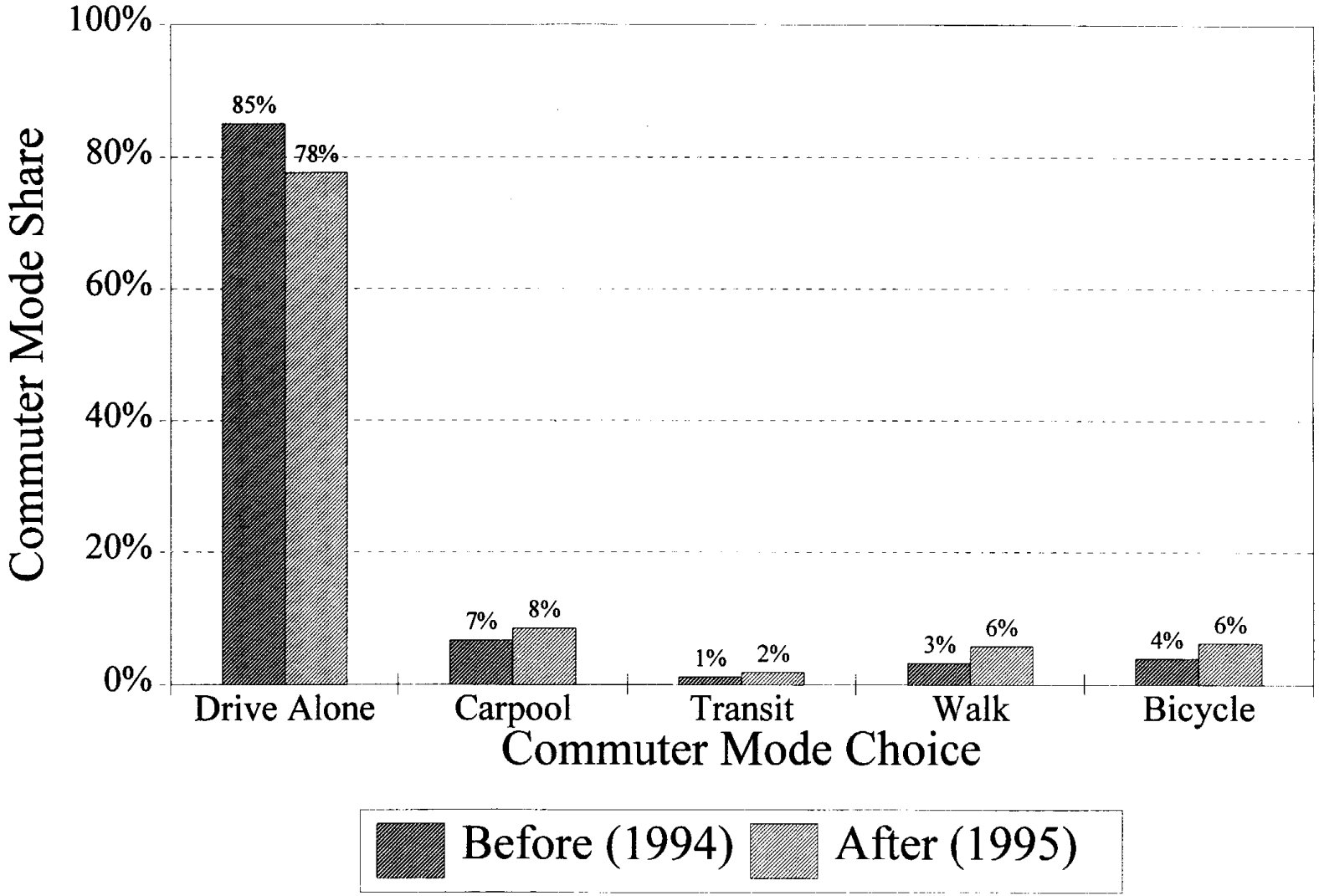
Table 3 shows how cashing out reduced vehicle trips and VMT. Row 1 shows that there was an average of 0.95 commuters per employee. On an average day, 5 percent of employees did not commute to work because they were on vacation, sick, or for another reason; therefore, the firm's attendance rate was 95 percent.[1]

Row 2 shows the number of vehicle round-trips per commuter per day, calculated from the data used to create Table 2. Each solo driver is counted as one vehicle trip, each person in a two-person carpool is counted as one-half of a vehicle trip, each person in a three-person carpool is counted as one-third of a vehicle trip, and so on. No vehicle trips are attributed to transit riders, bicyclists, and pedestrians. The total number of vehicle trips is then divided by the total number of responding commuters to give the ratio of vehicle trips per commuter per

FIGURE 6-1

Commuter Mode Choices

Before and After Cashing Out



day. Cashing out reduced the number of vehicle round-trips per commuter from 0.90 per day in 1994 to 0.82 per day in 1995, a 9 percent decrease.

Row 3 shows the number of vehicle round-trips per employee per day, obtained by multiplying the number of vehicle round-trips per commuter by 0.95 commuters per employee. Cashing out reduced the number of vehicle round-trips per employee per day from 0.86 in 1994 to 0.78 in 1995, a 9 percent decrease.[2]

Row 4 shows the total number of one-way vehicle trips per employee per year. The number of one-way vehicle trips in 1994 is calculated by multiplying the 0.86 vehicle round-trips per employee per day found in 1994 by 252 work days per year, and doubling the result to obtain the number of one-way trips.[3] The number of one-way vehicle trips in 1995 is calculated by multiplying the 0.78 vehicle trips per employee per day found in 1995 by the same 252 working days per year, and doubling the result to obtain the number of one-way trips. The resulting change in the number of vehicle trips per employee per year therefore represents the change that occurred because the commuter mode shares changed.

Row 4 thus shows that were 432 vehicle trips per employee in 1994, and 398 vehicle trips per employee in 1995. Cashing out therefore eliminated 38 vehicle trips per employee per year for commuting (19 vehicle trips to work, and another 19 vehicle trips from work), a 9 percent decrease.

Vehicle trips for all commuting to the firm were calculated by multiplying the trips per employee by the total of 121 employees who reported to this work site during the five-day survey period. Row 5 shows that employees made 52,255 vehicle trips for commuting to the firm in 1994, and 47,673 in 1995. Cashing out therefore eliminated 4,582 vehicle trips per year, a 9 percent decrease.

In calculating VMT reductions, the SCAQMD assumes that the average one-way distance for each avoided automobile trip is 15 miles, which is the average trip distance found in a 1991 travel survey for all commuters in the South Coast Air Basin.[4] If we follow this procedure, we can calculate how cashing out reduced VMT.

Row 6 shows that cashing out reduced VMT per employee per day from 25.7 in 1994 to 23.5 in 1995, or by 2.3 VMT per employee per day, a 9 percent decrease. Row 7 shows that cashing out reduced VMT per employee from 6,478 in 1994 to 5,910 in 1995, or by 568 VMT per employee per year, a 9 percent decrease. Row 8 shows that cashing out eliminated 68,730 VMT per year for all commuting to the firm.

V. CASHING OUT REDUCED VEHICLE EMISSIONS

The emissions reductions are calculated by considering the reductions in both automobile *trips* and *VMT*. Pollution emissions are caused at the beginning and end of each automobile commute trip by the "cold start" as the engine warms up and the "hot soak" as the engine cools

TABLE 6-2

COMMUTER MODE CHOICES BEFORE AND AFTER CASHING OUT

	Subsidy per Employee		Mode Share		Subsidy Distribution	
Commute Mode	**Before (1994)**	**After (1995)**	**Before (1994)**	**After (1995)**	**Before (1994)**	**After (1995)**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Drive Alone	$55	$55	85%	78%	97%	77%
Carpool	$23	$55	7%	8%	3%	8%
Transit	$0	$70	1%	2%	0%	2%
Walk	$0	$55	3%	6%	0%	6%
Bicycle	$0	$55	4%	6%	0%	6%

Note: The survey response rate was 83.8% in 1994 and 92% in 1995. A Chi-Square test shows that the probability was less than 1 percent that the difference in commuter mode shares observed in Columns (4) and (5) occurred by chance.

down; these "trip-end" emissions are independent of the total distance traveled for the commute. The "running" emissions are a factor of total VMT for the trip. In Table 3 we have already estimated the reductions in automobile trips and VMT. Therefore, we can multiply these reductions in trips and VMT by the emissions created per trip-end and per VMT to obtain the reduction in total emissions caused by automobile commuting.

Cashing out reduced 38 vehicle trips and 568 VMT per employee per year. We multiply these reductions by the factors for ROG, CO, NO_X, CO, and PM10 for both trip ends and VMT. We use the emission factors specific to 1995, the year in which the vehicle-trip and VMT reductions were estimated. We add the two sources of pollution (trip ends and VMT), and then divide by 454 grams per pound to obtain the emissions reductions in pounds per employee per year. Table 4 shows that cashing out eliminated 1.5 pounds of ROG, 1.3 pounds of NO_X, 13.2 pounds of CO, and 0.9 pounds of PM per employee per year.

The emissions reduction for all employees of the firm is found by multiplying the emissions reduction per employee by the 121 employees of the firm in 1995. Cashing out eliminated a total of 181 pounds of ROG, 154 pounds of NO_X, 1,600 pounds of CO, and 114 pounds of PM per year for automobile commuting. The final column shows that cashing out reduced automobile emissions by 9 percent.

VI. CASHING OUT REDUCED GASOLINE CONSUMPTION AND CO_2 EMISSIONS

By reducing VMT, cashing out also reduced gasoline consumption and carbon dioxide emissions. Table 5 shows these results. The SCAQMD has estimated that the average fuel efficiency of light-duty passenger vehicles in Southern California is 25 miles per gallon in 1996. Therefore, the VMT figures estimated in Table 3 (Rows 7 and 8) are divided by 25 miles per gallon to estimate gasoline consumption for commuting.[5] Cashing out reduced gasoline consumption per employee by 23 gallons per year, and reduced total gasoline consumption for commuting to the firm by 2,749 gallons per year, a 9 percent decrease.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide. Therefore, the reduction in gasoline consumption reduced carbon dioxide emissions per employee by 448 pounds per year, and reduced total carbon dioxide emissions for commuting to the firm by 54,160 pounds per year, a 9 percent decrease.

VII. CASHING OUT INCREASED COMMUTING SUBSIDIES

Table 6 shows how cashing out increased the firm's spending for commuter subsidies.[6] In 1994 the firm's commuter subsidy was $48 per employee per month.[7] In 1995 the firm's commuter subsidy was $56 per employee month, including payroll taxes on the cash benefits paid to ridesharers. Cashing out increased total commuting subsidies, including payroll taxes, by $948 a month, or by 16 percent. The average subsidy per employee, including payroll taxes, increased by $8 a month.

TABLE 6-3

CASHING OUT REDUCED VEHICLE TRIPS AND VMT

		Before (1994)	After (1995)	Change	Percent Change
		(1)	(2)	(3)	(4)
1	Commuters per Employee	0.95	0.95		
2	Vehicle Trips per Commuter per Day (Round-trip)	0.90	0.82	-0.08	-9%
3	Vehicle Trips per Employee per Day (Round-trip)	0.86	0.78	-0.08	-9%
4	Vehicle Trips per Employee per Year (One-way)	432	394	-38	-9%
5	Total Vehicle Trips per Year (One-way)	52,255	47,673	-4,582	-9%
6	VMT per Employee per Day	25.7	23.5	-2.3	-9%
7	VMT per Employee per Year	6,478	5,910	-568	-9%
8	Total VMT per Year	783,824	715,094	-68,730	-9%

There were 121 employees who reported to this work site during the 1995 survey period.

Row 3 = Row 2 x Row 1.

Row 4 = Row 3 x 252 x 2.

Row 5 = Row 4 x 121.

Row 6 = Row 3 x 30.

Row 7 = Row 6 x 252.

Row 8 = Row 7 x 121.

TABLE 6-5

CASHING OUT REDUCED GASOLINE CONSUMPTION AND CARBON DIOXIDE EMISSIONS

		Before (1994)	After (1995)	Change	Percent Change
		(1)	(2)	(3)	(4)
1	Gasoline Consumption per Employee (gallons per year)	259	236	-23	-9%
2	Total Gasoline Consumption (gallons per year)	31,353	28,604	-2,749	-9%
3	Carbon Dioxide Emissions per Employee (pounds per year)	5,105	4,657	-448	-9%
4	Total Carbon Dioxide Emissions (pounds per year)	617,654	563,494	-54,160	-9%

There were 121 employees who reported to this work site during the 1995 survey period.

The average fuel efficiency is 25 miles per gallon.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide.

TABLE 6-4

CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE EMISSIONS

(Pounds Per Year)

	Change	Percent Change
ROG		
per Employee	-1.5	-9%
for Firm	-181	-9%
NOx		
per Employee	-1.3	-9%
for Firm	-154	-9%
CO		
per Employee	-13.2	-9%
for Firm	-1,600	-9%
PM		
per Employee	-0.9	-9%
for Firm	-114	-9%

The pollution emissions per trip-end and per VMT in 1995 are taken from the Air Resources Board's EMFAC7F1.1/B7F model.

These 1995 factors are:

	ROG	NOx	CO	PM
Trip end factor (grams/trip)	6.54	2.78	58.74	0
VMT factor (grams/mile)	0.76	0.83	6.64	0.75

These factors are multiplied by the reduction of 38 trips and 568 VMT per employee per year in Table 6-3 to give the reduction in emissions per employee in 1995.

In addition to this cash outlay, the firm's facility manager estimates that she spends from three to five hours per month administering *all* of the firm's worksite transportation program (of which cashing out is one part), or less than two minutes per employee per month.

VIII. SUMMARY

The firm offers all employees free parking, at a cost to the firm of $55 per space per month. In 1994 the firm began to offer all employees the option to take $55 a month in lieu of taking the free parking. The firm's new commuter subsidy policy thus complies with California's cash-out requirement.

After cashing out, the share of commuters who drive to work alone fell from 85 to 78 percent. The carpool share increased from 7 to 8 percent, the transit share doubled from 1 to 2 percent, the walk share increased from 3 to 6 percent, and the bicycle share increased from 4 to 6 percent. These changes reduced the number of vehicle trips to work by 9 percent.

Cashing out eliminated a total of 38 vehicle trips per employee per year. Cashing out reduced vehicle travel for commuting by 2.3 VMT per employee per day, and by 568 VMT per employee per year. In total, cashing out eliminated 4,852 vehicle trips and 68,730 VMT per year for commuting to the firm.

These reductions in automobile use reduced pollution emissions for automobile commuting by 9 percent. Cashing out eliminated 1.5 pounds of ROG, 1.3 pounds of NO_X, 13.2 pounds of CO, and 0.9 pounds of PM per year. In total, cashing out eliminated 181 pounds of ROG, 154 pounds of NO_X, 1,600 pounds of CO, and 114 pounds of PM per year for commuting to the firm.

By reducing VMT, cashing out reduced gasoline consumption for commuting by 23 gallons per employee per year, and reduced gasoline consumption for commuting to the firm by 2,749 gallons per year. Finally, cashing out carbon dioxide emissions by 448 pounds of CO_2 per employee per year, and reduced carbon dioxide emissions for commuting to the firm by 54,160 pounds of CO_2 per year

The firm's spending for commuter subsidies increased by $8 per employee per month, or by 16 percent.

TABLE 6-6

COMMUTING SUBSIDIES BEFORE CASHING OUT (1994)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Firm
Drive Alone	$55	85%	97%	$5,661
2 Person Carpool	$28	4%	2%	$145
3 Person Carpool	$18	1%	0.4%	$25
6 Person Carpool	$9	1%	0.2%	$13
Mass Transit	$0	1%	0%	$0
Walk	$0	3%	0%	$0
Bicycle	$0	4%	0%	$0
Monthly Subsidies for 121 employees:				$5,844
Taxes on Cash Subsidies:				$0
Total Cost per Month:				$5,844
Cost per Employee per Month:				$48

COMMUTING SUBSIDIES AFTER CASHING OUT (1995)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Firm
Drive Alone	$55	78%	77%	$5,164
2 Person Carpool	$55	7%	7%	$452
3 Person Carpool	$55	2%	2%	$113
Mass Transit	$70	2%	2%	$158
Walk	$55	6%	6%	$384
Bicycle	$55	6%	6%	$418
Monthly Subsidies for 121 employees:				$6,689
Taxes on Cash Subsidies:				$105
Total Cost per Month:				$6,794
Cost per Employee per Month:				$56
Change in Total Cost per Month:				+$948
Change in Cost per Employee per Month:				+$8
Percent Change in Commuting Subsidy:				+16%

ENDNOTES

1. To isolate any change in the number of trips caused solely by a change in the attendance rate, the attendance rate for 1995 is used in the calculations for both years.

2. The mode shares of employees who did not respond to the survey are assumed to be the same as for employees who did respond to the survey.

3. Vacations, sick days, and other absences are already accounted for in the calculation of the firm's average attendance rate, so the number of work days per year is five days per week for fifty-two weeks, minus the conventional eight national holidays per year.

4. See Southern California Association of Governments (1993).

5. This estimated fuel efficiency of 25 miles per gallon was made using the Air Resources Board's EMFAC7F1.1/B7F model to represent conditions in Southern California on a workday in 1996. I am grateful to Waldo Lopez of the SCAQMD for this information. Average fuel efficiency of the fleet has been steadily increasing; it was only 22 miles per gallon in 1990. Because the estimates of VMT reductions refer to 1995, when average fuel efficiency was lower than in 1996, using a fuel efficiency of 25 miles per gallon produces a conservative estimate of how reducing VMT reduced fuel consumption.

6. To isolate the change in subsidy cost caused solely by the change in the number of employees, the number of employees reported in 1995 is used for both years.

7. The firm's payroll tax rate was 7.65 percent on cash benefits paid to ridesharers. The first $55 a month in transit benefits were tax exempt in 1995. See Table 1 in Appendix 2 for the payroll tax rates.

REFERENCES

Commuter Transportation Services, *State of the Commute Report, 1994*, Los Angeles: Commuter Transportation Services, 1994.

Southern California Association of Governments, "1991 Southern California Origin-Destination Survey--Summary Findings," Los Angeles, 1993.

Case Study 6

Employer characteristics

Case study 6 provides video and audio production and post production services. This firm had a total of 173 employees in 1995, with 121 employees reporting to work between 6am and 10am, Monday through Friday.

Case study 6 is located at 730 Arizona Avenue in Santa Monica. One freeway -- Santa Monica (10) -- provides nearby access to the firm. The major arterial serving this area is Lincoln Boulevard. Six bus routes serve this area.

Case study 6 is conveniently accessible to nearby restaurants, banks, medical services and retail establishments.

The neighborhood is flat and safe, with good sidewalks and lighting. Bike lanes connecting from the beach to Arizona Avenue to 20th Street provide easy access to the firm.

The distribution of job categories is:

Skilled Craft	60%
Professional	10%
Technical	9%
Clerical	6%
Sales & Associates	5%
Officials/Administrators	4%
Semi-skilled	4%

Commuter Policies
Case Study 6

	1994		1995
1	Free Parking	1	Free Parking
2		2	**Parking Cash-Out**
3		3	**Flexible Work Hours**
4		4	**Guaranteed Ride Home**
5		5	**Bicycle Locker**
6		6	**Preferential Parking Space**
7		7	**Raffles**
8		8	**Transit Subsidy**

Bold indicates an incentive present in 1995 but not in 1994

TABLE 7-1

SUMMARY OF REDUCTIONS AFTER CASHING OUT

Variable Reduced	Reduction		
	Per Employee	For Firm	Percent Change
Vehicle Trips (per year)	22	6,682	5%
Vehicle Miles Traveled (per year)	334	100,227	5%
Reactive Organic Gas Emissions (pounds per year)	0.9	264	5%
Nitrogen Oxide Emissions (pounds per year)	0.7	224	5%
Carbon Monoxide Emissions (pounds per year)	7.8	2,332	5%
Particulate Matter Emissions (pounds per year)	0.6	166	5%
Gasoline Consumption (gallons per year)	263	78,979	5%
Carbon Dioxide Emissions (pounds per year)	13	4,009	5%

There were 300 employees who reported to this work site during the 1995 survey period.

CASE STUDY 7

I. EXECUTIVE SUMMARY

The employer is a law firm in Santa Monica. It charges employees $15 a month for parking in rented spaces that cost the firm $77 per space per month. In 1994, the firm began to offer employees the option of cash in lieu of a parking subsidy. The following changes occurred after cashing out parking subsidies.

- The solo driver share fell from 83 to 75 percent.
- The carpool share rose from 13 to 20 percent.
- The transit share tripled from 1 to 3 percent.
- The walking share remained at 1 percent.
- The bicycle share fell from 1 to 0 percent.
- Vehicle round-trips to work fell from 0.83 to 0.79 per employee per day.
- Vehicle travel for commuting fell from 25 to 23.6 VMT per employee per day.

The shift from solo driving to ridesharing reduced the number of vehicle trips and VMT for commuting to work by 5 percent. Table 1 summarizes the reductions (per employee and for the firm) in vehicle travel, pollution emissions, and gasoline consumption that occurred after employees were offered to option to cash out parking subsidies.

II. BACKGROUND

The firm is located in Santa Monica, and employed 300 people at this worksite in 1995. The firm offers parking to all employees at $15 per month; it owns no parking, and pays $77 per space per month to lease its parking spaces. The firm offers several other ridesharing benefits including guaranteed ride home, preferential parking for carpools, and an introductory transit subsidy.

Table 2 shows the pattern of commuter subsidies in 1994 (Columns 2, 4, and 6 labeled "Before"). Column 2 shows that solo drivers received a parking subsidy of $62 a month; carpools received free parking, so they shared a single $77 subsidy among the carpool members. Vanpoolers received $175 a month, transit riders received $75 a month, and those who walked or bicycled received $25 a month.

Column 4 shows the results found in a transportation survey required by the South Coast Air Quality Management District (SCAQMD) which was conducted in October 1994, before the firm began to offer the cash option. Eighty-three percent of employees drove solo, 13 percent carpooled, 1 percent rode transit, 1 percent walked, and 1 percent bicycled to work.

III. CASHING OUT REDUCED SOLO DRIVING

In 1994 the firm began to offer a cash subsidy of $77 per month to employees who do not take a parking space. (This cash offer was introduced because Santa Monica required the firm to comply with California's cash-out requirement.) The firm thus goes beyond compliance with California's cash-out requirement because it offers $77 a month to ridesharers while subsidizing parking for solo drivers by only $62 a month. The firm reduced the vanpooler subsidy to $165 a month, and simultaneously eliminated several insignificant ridesharing subsidies, such as free breakfast for ridesharers in the parking lot, a walking and cycling club, and a monthly prize drawing of $50 for ridesharers. Cashing out was the only significant change between 1994 and 1995 (see attached list of incentives offered in 1994 and 1995).

Column 5 (labeled "After") in Table 2 shows the results of the firm's 1995 employee transportation survey, conducted in December 1995, one year after the firm began to offer employees the option of cash in lieu of a parking subsidy. The solo driver share fell from 83 percent in 1994 to 75 percent in 1995. The carpool share rose from 13 to 20 percent, the transit share tripled from 1 to 3 percent, the walk share remained at 1 percent, and the bicycle share fell from 1 to 0 percent. Figure 1 shows these mode shifts.

Columns 6 and 7 in Table 2 shows how the firm's subsidy distribution among its employees changed between 1994 and 1995. In 1994, 83 percent of employees drove solo and received 88 percent of the total subsidy. In 1995, 75 percent of employees drove solo and received 71 percent of the total subsidy. The subsidy distribution in 1994 favored solo driving, while the subsidy distribution in 1995 favored ridesharing.

IV. CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE TRIPS AND VMT

Table 3 shows how cashing out reduced vehicle trips and VMT. Row 1 shows that there was an average of 0.92 commuters per employee. On an average day, 8 percent of employees did not commute to work because they were on vacation, sick, or for some other reason; therefore, the firm's attendance rate was 92 percent.[1]

Row 2 shows the number of vehicle round-trips per commuter per day, calculated from the data used to create Table 2. Each solo driver is counted as one vehicle trip, each person in a two-person carpool is counted as one-half of a vehicle trip, each person in a three-person carpool is counted as one-third of a vehicle trip, and so on. No vehicle trips are attributed to transit riders, bicyclists, and pedestrians. The total number of vehicle trips is then divided by the total number of responding commuters to give the ratio of vehicle trips per commuter per day. Cashing out reduced the number of vehicle round-trips per commuter from 0.90 per day in 1994 to 0.85 per day in 1995, a 5 percent decrease.

Row 3 shows the number of vehicle round-trips per employee per day, obtained by multiplying the number of vehicle round-trips per commuter by 0.92 commuters per employee.

TABLE 7-2

COMMUTER MODE CHOICES BEFORE AND AFTER CASHING OUT

Commute Mode	Subsidy per Employee		Mode Share		Subsidy Distribution	
	Before (1994)	After (1995)	Before (1994)	After (1995)	Before (1994)	After (1995)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Drive Alone	$62	$62	83%	75%	88%	71%
Carpool	$37	$77	13%	20%	8%	23%
Vanpool	$175	$165	0.3%	0.3%	1%	1%
Transit	$75	$77	1%	3%	2%	3%
Walk	$25	$77	1%	1%	1%	1%
Bicycle	$25	$77	1%	0%	0%	0%

Note: The survey response rate was 94% in 1994 and 83% in 1995. A Chi-Square test shows that the probability was less than 1 percent that the difference in commuter mode shares observed in Columns (4) and (5) occurred by chance.

TABLE 7-3

CASHING OUT REDUCED VEHICLE TRIPS AND VMT

		Before (1994) (1)	After (1995) (2)	Change (3)	Percent Change (4)
1	Commuters per Employee	0.92	0.92		
2	Vehicle Trips per Commuter per Day (Round-trip)	0.90	0.85	-0.05	-5%
3	Vehicle Trips per Employee per Day (Round-trip)	0.83	0.79	-0.04	-5%
4	Vehicle Trips per Employee per Year (One-way)	420	397	-22	-5%
5	Total Vehicle Trips per Year (One-way)	125,872	119,190	-6,682	-5%
6	VMT per Employee per Day	25.0	23.6	-1.3	-5%
7	VMT per Employee per Year	6,294	5,960	-334	-5%
8	Total VMT per Year	1,888,080	1,787,853	-100,227	-5%

There were 300 employees who reported to this work site during the 1995 survey period.

Row 3 = Row 2 x Row 1.

Row 4 = Row 3 x 252 x 2.

Row 5 = Row 4 x 300.

Row 6 = Row 3 x 30.

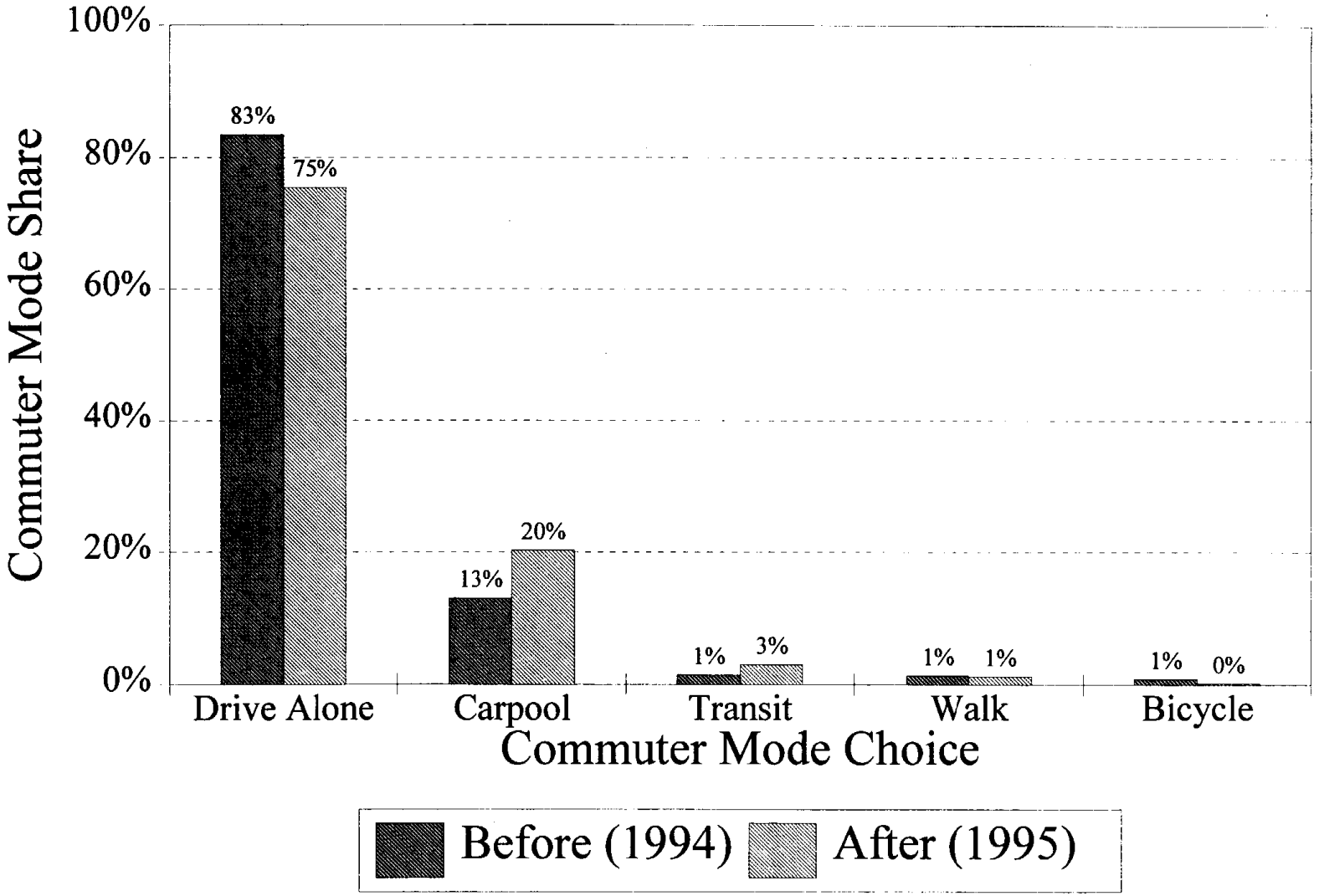
Row 7 = Row 6 x 252.

Row 8 = Row 7 x 300.

FIGURE 7-1

Commuter Mode Choices

Before and After Cashing Out



Cashing out reduced 22 trips and 334 VMT per employee per year. We multiply these reductions by the factors for ROG, NO_x, CO, and PM10 for both trip ends and VMT. We use the emission factors specific to 1995, the year in which the vehicle-trip and VMT reductions were estimated. We add the two sources of pollution, and then divide by 454 grams per pound to obtain the emissions reductions in pounds per employee per year. Table 4 shows that cashing out eliminated 0.9 pounds of ROG, 0.7 pounds of NO_x, 7.8 pounds of CO, and 0.6 pounds of PM per employee per year.

The emissions reduction for all employees of the firm is found by multiplying the emissions reduction per employee by the 300 employees of the firm in 1995. Cashing out eliminated a total of 264 pounds of ROG, 224 pounds of NO_x, 2,332 pounds of CO, and 166 pounds of PM per year for automobile commuting. The final column shows that cashing out reduced automobile emissions by 5 percent.

VI. CASHING OUT REDUCED GASOLINE CONSUMPTION AND CO_2 EMISSIONS

By reducing VMT, cashing out also reduced gasoline consumption and carbon dioxide emissions. Table 5 shows these results. The SCAQMD has estimated that the average fuel efficiency of light-duty passenger vehicles in Southern California is 25 miles per gallon in 1996. Therefore, the VMT figures estimated in Table 3 (Rows 7 and 8) are divided by 25 miles per gallon to estimate gasoline consumption for commuting.[5] Cashing out reduced gasoline consumption per employee by 13 gallons per year, and reduced total gasoline consumption for commuting to the firm by 4,009 gallons per year, a 5 percent decrease.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide. Therefore, the reduction in gasoline consumption reduced carbon dioxide emissions per employee by 263 pounds per year, and reduced total carbon dioxide emissions for commuting to the firm by 78,979 pounds per year, a 5 percent decrease.

VII. CASHING OUT INCREASED COMMUTING SUBSIDIES

Table 6 shows how cashing out increased the firm's spending for commuter subsidies.[6] In 1994 the firm's commuter subsidy was $59 per employee per month.[7] In 1995 the firm's commuter subsidy was $67 per employee month, including payroll taxes on the cash benefits paid to ridesharers. Cashing out increased total commuting subsidies, including payroll taxes, by $2,430 a month, or by 14 percent. The average subsidy per employee, including payroll taxes, increased by $8 a month.

VIII. SUMMARY

The firm offers parking to all employees at $15 a month, in spaces the firm rents for $77 per space per month. In 1994 the firm began to offer all employees the option to take $77 a month in lieu of taking the parking subsidy. The firm's new commuter subsidy policy thus

Cashing out reduced the number of vehicle round-trips per employee per day from 0.83 in 1994 to 0.79 in 1995, a 5 percent decrease.[2]

Row 4 shows the total number of one-way vehicle trips per employee per year. The number of one-way vehicle trips in 1994 is calculated by multiplying the 0.83 vehicle round-trips per employee per day found in 1994 by 252 work days per year, and doubling the result to obtain the number of one-way trips.[3] The number of one-way vehicle trips in 1995 is calculated by multiplying the 0.79 vehicle trips per employee per day found in 1995 by the same 252 working days per year, and doubling the result to obtain the number of one-way trips. The resulting change in the number of vehicle trips per employee per year therefore represents the change that occurred because the mode shares changed.

Row 4 thus shows that were 420 vehicle trips per employee in 1994, and 397 vehicle trips per employee in 1995. Cashing out therefore eliminated 22 vehicle trips per employee per year for commuting, a 5 percent decrease.

Vehicle trips for all automobile commuting to the firm were calculated by multiplying the trips per employee by the total of 300 employees who reported to this work site during the five-day survey period. Row 5 shows that employees made 125,872 vehicle trips for commuting to the firm in 1994, and 119,190 in 1995. Cashing out therefore eliminated 6,682 vehicle trips per year, a 5 percent decrease.

In calculating VMT reductions, the SCAQMD assumes that the average one-way distance for each avoided automobile trip is 15 miles, which is the average trip distance found in a 1991 travel survey for all commuters in the South Coast Air Basin.[4] If we follow this procedure, we can calculate how cashing out reduced VMT.

Row 6 shows that cashing out reduced VMT per employee per day from 25.0 in 1994 to 23.6 in 1995, or by 1.3 VMT per employee per day, a 5 percent decrease. Row 7 that cashing out reduced VMT per employee from 6,294 in 1994 to 5,960 in 1995, or by 334 VMT per employee per year, a 5 percent decrease. Row 8 shows that cashing out eliminated 100,227 VMT per year for all commuting to the firm.

V. CASHING OUT REDUCED VEHICLE EMISSIONS

The emissions reductions are calculated by considering the reductions in both automobile *trips* and *VMT*. The "cold start" as the engine warms up and the "hot soak" as the engine cools down cause pollution emissions at the beginning and end of each automobile trip; these "trip-end" emissions are independent of the total distance traveled for the commute. The "running" emissions are a factor of total VMT for the trip. In Table 3 we have already estimated the reductions in automobile trips and VMT. Therefore, we can multiply these reductions in trips and VMT by the emissions created per trip-end and per VMT to obtain the reduction in total emissions caused by automobile commuting.

TABLE 7-5

CASHING OUT REDUCED GASOLINE CONSUMPTION AND CARBON DIOXIDE EMISSIONS

		Before (1994)	After (1995)	Change	Percent Change
		(1)	(2)	(3)	(4)
1	Gasoline Consumption per Employee (gallons per year)	252	238	-13	-5%
2	Total Gasoline Consumption (gallons per year)	75,523	71,514	-4,009	-5%
3	Carbon Dioxide Emissions per Employee (pounds per year)	4,959	4,696	-263	-5%
4	Total Carbon Dioxide Emissions (pounds per year)	1,487,807	1,408,828	-78,979	-5%

There were 300 employees who reported to this work site during the 1995 survey period.

The average fuel efficiency is 25 miles per gallon.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide.

TABLE 7-4

CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE EMISSIONS

(Pounds Per Year)

	Change	Percent Change
ROG		
per Employee	-0.9	-5%
for Firm	-264	-5%
NOx		
per Employee	-0.7	-5%
for Firm	-224	-5%
CO		
per Employee	-7.8	-5%
for Firm	-2,332	-5%
PM		
per Employee	-0.6	-5%
for Firm	-166	-5%

The pollution emissions per trip-end and per VMT in 1995 are taken from the Air Resources Board's EMFAC7F.1/B7F model.

These 1995 factors are:

	ROG	NOx	CO	PM
Trip end factor (grams/trip)	6.54	2.78	58.74	0
VMT factor (grams/mile)	0.76	0.83	6.64	0.75

These factors are multiplied by the reduction of 22 trips and 334 VMT per employee per year in Table 7-3 to give the reduction in emissions per employee in 1995.

omplies with California's cash-out requirement, and goes beyond compliance because it offers a $77 cash subsidy for ridesharers that is greater than the $62 a month subsidy for solo drivers.

After cashing out parking subsidies, the share of commuters who drive to work alone fell from 83 to 75 percent. The carpool share increased from 13 to 20 percent, the transit share tripled from 1 to 3 percent, the walk share remained at 1 percent, and the bicycle share fell from 1 to 0 percent. These changes reduced the number of vehicle trips to work by 5 percent.

Cashing out eliminated a total of 22 vehicle trips per employee per year. Cashing out reduced vehicle travel for commuting by 1.3 VMT per employee per day, and by 334 VMT per employee per year. In total, cashing out eliminated 6,682 vehicle trips and 100,227 VMT per year for commuting to the firm.

These reductions in automobile use reduced pollution emissions for automobile commuting by 5 percent. Cashing out eliminated 0.9 pounds of ROG, 0.7 pounds of NO_x, 7.8 pounds of CO, and 0.6 pounds of PM per year. In total, cashing out eliminated 264 pounds of ROG, 224 pounds of NO_x, 2,332 pounds of CO, and 166 pounds of PM per year for commuting to the firm.

By reducing VMT, cashing out reduced gasoline consumption for commuting by 13 gallons per employee per year, and reduced gasoline consumption for commuting to the firm by 4,009 gallons per year. Finally, cashing out reduced carbon dioxide emissions by 263 pounds per employee per year, and reduced carbon dioxide emissions for commuting to the firm by 78,979 pounds per year.

The firm's spending for commuter subsidies increased by $8 per employee per month, or by 14 percent.

TABLE 7-6

COMMUTING SUBSIDIES BEFORE CASHING OUT (1994)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Firm
Drive Alone	$62	83%	88%	$15,528
2 Person Carpool	$39	11%	8%	$1,319
3 Person Carpool	$26	0.5%	0.2%	$38
4 Person Carpool	$19	0.3%	0.1%	$19
6 Person Carpool	$13	0.4%	0.1%	$16
Vanpool	$175	0.3%	1%	$173
Mass Transit	$75	1%	2%	$314
Walk	$25	1%	1%	$99
Bicycle	$25	1%	0%	$62
Monthly Subsidies for 300 employees:				$17,567
Taxes on Cash Subsidies:				$27
Total Cost per Month:				$17,594
Cost per Employee per Month:				$59

COMMUTING SUBSIDIES AFTER CASHING OUT (1995)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Firm
Drive Alone	$62	75%	71%	$14,035
2 Person Carpool	$77	19%	22%	$4,338
3 Person Carpool	$77	1%	1.1%	$222
4 Person Carpool	$77	0.2%	0.2%	$40
Vanpool	$165	0.3%	1%	$173
Mass Transit	$77	3%	3%	$686
Walk	$77	1%	1%	$262
Bicycle	$77	0%	0%	$40
Monthly Subsidies for 300 employees:				$19,797
Taxes on Cash Subsidies:				$227
Total Cost per Month:				$20,024
Cost per Employee per Month:				$67
Change in Total Cost per Month:				+$2,430
Change in Cost per Employee per Month:				+$8
Percent Change in Commuting Subsidy:				+14%

ENDNOTES

1. To isolate any change in the number of trips caused solely by a change in the attendance rate, the attendance rate for 1995 is used in the calculations for both years.

2. The mode shares of employees who did not respond to the survey are assumed to be the same as for employees who did respond to the survey.

3. Vacations, sick days, and other absences are already accounted for in the calculation of the firm's average attendance rate, so the number of work days per year is five days per week for fifty-two weeks, minus the conventional eight national holidays per year.

4. See Southern California Association of Governments (1993).

5. This estimated fuel efficiency of 25 miles per gallon was made using the Air Resources Board's EMFAC7F1.1/B7F model to represent conditions in Southern California on a workday in 1996. I am grateful to Waldo Lopez of the SCAQMD for this information. Average fuel efficiency of the fleet has been steadily increasing; it was only 22 miles per gallon in 1990. Because the estimates of VMT reductions refer to 1995, when average fuel efficiency was lower than in 1996, using a fuel efficiency of 25 miles per gallon produces a conservative estimate of how reducing VMT reduced fuel consumption.

6. To isolate the change in subsidy cost caused solely by the change in the number of employees, the number of employees reported in 1995 is used for both years.

7. The firm's payroll tax rate was 7.65 percent on cash benefits paid to ridesharers. The first $55 a month in transit benefits were tax exempt in 1995.

REFERENCES

Commuter Transportation Services, *State of the Commute Report, 1994*, Los Angeles: Commuter Transportation Services, 1994.

Southern California Association of Governments, "1991 Southern California Origin-Destination Survey--Summary Findings," Los Angeles, 1993.

Case Study 7

Employer characteristics

Case study 7 provides legal services in the area of insurance defense. With three offices in Santa Monica, Santa Ana and Riverside, this firm had a total of 332 employees in 1995. The largest of the three offices is situated in Santa Monica. All 300 employees reported to work between 6am and 10am, Monday through Friday.

Case study 7 is located at 1620 26th Street in Santa Monica. Two major freeways -- Santa Monica (10) and San Diego (405) -- provide nearby access to the firm. Major arterials serving this area include Cloverfield Avenue, 26th Street, Colorado Avenue and Olympic Boulevard. Three bus routes serve this area.

Case study 7 provides many on-site services and amenities, including child care, post office, food delivery / cafeteria, bank messenger and hair salon. Moreover, the firm is conveniently accessible to nearby restaurants, banks and health clubs.

The accessibility to the site by bicycle is limited to experienced bike riders. The lack of designated bike lanes discourages many commuters from riding their bikes to work. For those who live in Santa Monica, however, it is a good option.

Commuter Policies

Case Study 7

	1994		1995
1	Parking Subsidy	1	Parking Subsidy
2		2	**Parking Cash-Out/Transportation Allowance**
3	Preferred Parking	3	Preferential Parking for Ridesharers
4	Bus Subsidy	4	Introductory Transit Pass or Subsidy
5	Vanpool Subsidy	5	Direct Cash Subsidies for Vanpoolers
6	Emergency Ride Home	6	Guaranteed/Emergency Ride Home
7	Match List	7	Rideshare Matching Service
8	*Walk & Bike Club*	8	**Compressed Work Week**
9	*Breakfast*	9	**Telecommuting**
10	*Monthly Give Away*		

Bold indicates an incentive present in 1995 but not in 1994

Italics indicates an incentive present in 1994 but not in 1995

TABLE 8-1

SUMMARY OF REDUCTIONS AFTER CASHING OUT

Variable Reduced	Reduction		
	Per Employee	For Firm	Percent Change
Vehicle Commute Trips (per year)	58	16,414	16%
Vehicle Miles Traveled (per year)	864	246,215	16%
Reactive Organic Gas Emissions (pounds per year)	2.3	649	16%
Nitrogen Oxide Emissions (pounds per year)	1.9	551	16%
Carbon Monoxide Emissions (pounds per year)	20.1	5,730	16%
Particulate Matter Emissions (pounds per year)	1.4	407	16%
Carbon Dioxide Emissions (pounds per year)	681	194,017	16%
Gasoline Consumption (gallons per year)	35	9,849	16%

There were 285 employees who reported to this work site during the 1995 survey period.

CASE STUDY 8

I. EXECUTIVE SUMMARY

The employer is a managed care medical provider located on the edge of downtown Los Angeles. In 1990, the firm charged employees $10 a month to park in spaces the firm rented for $40 per space per month; the firm thus offered a parking subsidy of $30 a month. The firm offered no ridesharing benefits.

In 1991 the firm began to charge employees $25 a month to park, and to offer $50 a month to employees who did not take a parking space. In 1995, the firm paid $36 a month to rent parking spaces, so its parking subsidy was only $11 a month. The following changes occurred after the firm began to offer employees the option to take cash in lieu of parking subsidies.

- The solo driver share fell from 61 to 45 percent.
- The carpool share rose from 23 to 35 percent.
- The transit share rose from 12 to 15 percent.
- The walking and bicycling shares each rose from 0 to 1 percent.
- Vehicle round-trips to work fell from 0.70 to 0.58 per employee per day.

The shift from solo driving to ridesharing and transit reduced the number of vehicle trips and VMT for commuting to work by 16 percent. Table 1 summarizes the reductions (per employee and for the firm) in vehicle travel, pollution emissions, and gasoline consumption that occurred after cashing out.

II. BACKGROUND

The employer provides managed care medical services at a location on the edge of downtown Los Angeles. In 1990, the firm rented parking spaces at $40 a month, and offered them to employees at $10 a month. The firm offered no ridesharing benefits.

Table 2 shows the pattern of commuter subsidies in 1990 (Columns 2, 4, and 6). Column 2 shows that solo drivers received a parking subsidy of $30 a month. Carpoolers split a parking subsidy, with an average subsidy of $13 per carpooler. Others received nothing.

Column 4 shows the results found in a transportation survey required by the SCAQMD, which was conducted in 1990. Sixty-one percent of employees drove solo, 23 percent carpooled, and 12 percent rode transit.

TABLE 8-2

COMMUTER MODE CHOICES BEFORE AND AFTER CASHING OUT

Commute Mode	Subsidy per Employee		Mode Share		Subsidy Distribution	
	Before (1990)	After (1995)	Before (1990)	After (1995)	Before (1990)	After (1995)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Drive Alone	$30	$11	61%	45%	85%	15%
Carpool	$13	$50	23%	35%	15%	54%
Transit	$0	$50	12%	15%	0%	24%
Walk	$0	$50	0.4%	1%	0%	2%
Bicycle	$0	$50	0.4%	1%	0%	6%

Note: The survey response rate was 100% in 1990 and 76% in 1995. A Chi-Square test shows that the probability was less than 1 percent that the difference in commuter mode shares observed in Columns (4) and (5) occurred by chance.

III. CASHING OUT REDUCED SOLO DRIVING

In 1991 the firm began to offer a cash transportation allowance of $50 per month to employees who do not take a parking space. The firm also reduced its parking subsidies by raising its parking charge to employees to $25 a month. The firm introduced several other ridesharing benefits in 1991, such as guaranteed ride home, bicycle racks, and raffles, but reducing the parking subsidy and introducing the cash transportation allowance were the major policy changes from 1990 to 1995. In 1995 the firm's cost of renting parking spaces near its worksite had fallen to $36 a month, so its parking subsidy in 1995 was only $11 a month.

Column 5 in Table 2 shows the results of the firm's employee transportation survey, conducted in 1995. The solo driver share fell from 61 to 45 percent. The carpool share rose from 23 to 35 percent. The transit share increased from 12 to 15 percent. The share of employees who walked or bicycled to work each rose from 0 to 1 percent.

Figure 1 shows these mode shifts. The figures are taken from Columns 4 and 5 of Table 2, and show that the increase in carpooling, transit, walking, and bicycling all came at the expense of solo driving.

Columns 6 and 7 in Table 2 show how the firm's subsidy distribution among its employees changed between 1990 and 1995. In 1990, 61 percent of employees drove solo and received 85 percent of the total subsidy. In 1995, 45 percent of employees drove solo and received only 15 percent of the total subsidy. The subsidy distribution in 1990 favored solo driving, while the subsidy distribution in 1995 favored ridesharing.

IV. CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE TRIPS AND VMT

Table 3 shows how the changes in mode shares reduced vehicle trips and VMT. Row 1 shows that there was an average of 0.93 commuters per employee. On an average day, 7 percent of employees did not commute to work because they were on vacation, sick, or for another reason; therefore, the firm's attendance rate was 93 percent.[1] Row 2 shows the number of vehicle round-trips per commuter per day, calculated from the data used to create Table 2. Each solo driver is counted as one vehicle trip, each person in a two-person carpool is counted as one-half of a vehicle trip, each person in a three-person carpool is counted as one-third of a vehicle trip, and so on. No vehicle trips are attributed to transit riders, bicyclists, and pedestrians. The total number of vehicle trips is then divided by the total number of responding commuters to give the ratio of vehicle trips per commuter per day. Cashing out reduced the number of vehicle round-trips per commuter from 0.75 per day in 1990 to 0.63 per day in 1995, a 16 percent decrease.

Row 3 shows the number of vehicle round-trips per employee per day, obtained by multiplying the number of vehicle round-trips per commuter by the number of commuters per employee. Cashing out reduced the number of vehicle round-trips per employee by 16 percent, from 0.70 to 0.58 per day.

TABLE 8-3

CASHING OUT REDUCED VEHICLE TRIPS AND VMT

		Before (1990) (1)	After (1995) (2)	Change (3)	Percent Change (4)
1	Commuters per Employee	0.93	0.93		
2	Vehicle Trips per Commuter per Day (Round-trip)	0.75	0.63	-0.12	-16%
3	Vehicle Trips per Employee per Day (Round-trip)	0.70	0.58	-0.11	-16%
4	Vehicle Trips per Employee per Year (One-way)	352	295	-58	-16%
5	Total Vehicle Trips per Year (One-way)	100,348	83,934	-16,414	-16%
6	VMT per Employee per Day	21.0	17.5	-3.4	-16%
7	VMT per Employee per Year	5,281	4,418	-864	-16%
8	Total VMT per Year	1,505,220	1,259,005	-246,215	-16%

There were 285 employees who reported to this work site during the 1995 survey period.

Row 3 = Row 2 x Row 1.

Row 4 = Row 3 x 252 x 2.

Row 5 = Row 4 x 285.

Row 6 = Row 3 x 30.

Row 7 = Row 6 x 252.

Row 8 = Row 7 x 285.

Commuter Mode Choices

Before and After Cashing Out

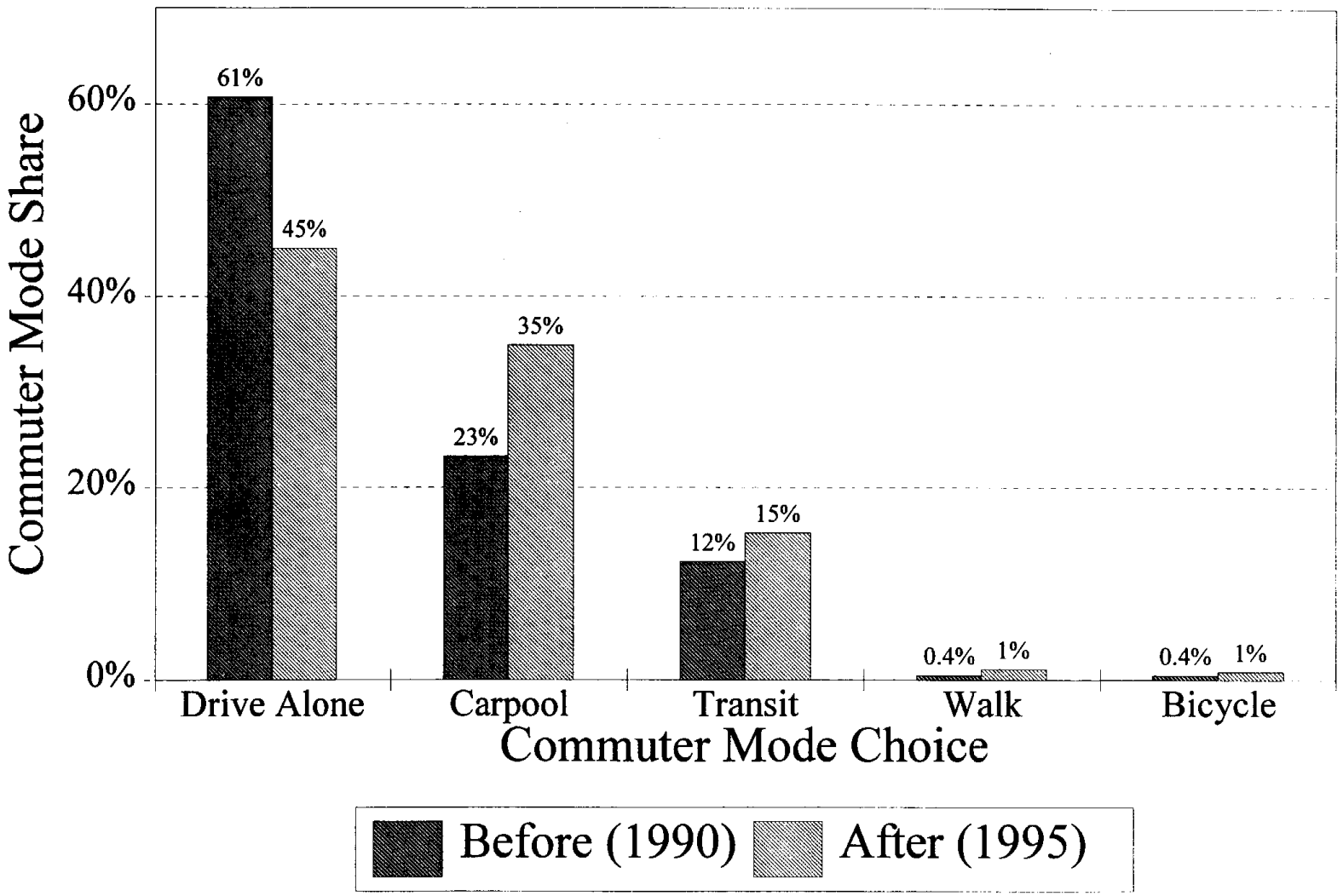


TABLE 8-4

CASHING OUT PARKING SUBSIDIES REDUCED VEHICLE EMISSIONS

(Pounds Per Year)

	Change	Percent Change
ROG		
per Employee	-2.3	-16%
for Firm	-649	-16%
NOx		
per Employee	-1.9	-16%
for Firm	-551	-16%
CO		
per Employee	-20.1	-16%
for Firm	-5,730	-16%
PM		
per Employee	-1.4	-16%
for Firm	-407	-16%

The pollution emissions per trip-end and per VMT in 1995 are taken from the Air Resources Board's EMFAC7F1.1/B7F model.

These 1995 factors are:

	ROG	NOx	CO	PM
Trip end factor (grams/trip)	6.54	2.78	58.74	0
VMT factor (grams/mile)	0.76	0.83	6.64	0.75

These factors are multiplied by the reduction of 58 trips and 864 VMT per employee per year in Table 8-3 to give the reduction in emissions per employee in 1995.

Row 4 shows the total number of one-way vehicle trips per employee per year. The number of one-way vehicle trips in 1990 is calculated by multiplying the 0.70 vehicle round-trips per employee per day found in 1990 by 252 work days per year, and doubling the result to obtain the number of one-way trips.[2] The number of one-way vehicle trips in 1995 is calculated by multiplying the 0.58 vehicle trips per employee per day found in 1995 by the same 252 working days per year, and doubling the result to obtain the number of one-way trips. The resulting change in the number of vehicle trips per employee per year therefore represents the change that occurred because the mode shares changed.

Row 4 thus shows that were 352 vehicle trips per employee in 1990, and 295 vehicle trips per employee in 1995. Offering cash in lieu of parking subsidies therefore eliminated 58 vehicle trips per employee per year for commuting (29 vehicle trips to work, and another 29 vehicle trips from work), a 16 percent decrease.

Vehicle trips for all automobile commuting to the firm were calculated by multiplying the trips per employee by the total of 285 employees of the firm. Row 5 shows that employees made 100,348 vehicle trips for commuting to the firm in 1990. Cashing out reduced the number of vehicle trips to 83,934 in 1995, or by 16,414 vehicle trips per year.

The SCAQMD survey reports do not include information on commuter trip distances. In calculating VMT reductions, the SCAQMD assumes that the average one-way distance for each avoided automobile trip is 15 miles.[3] If we follow this procedure, we can calculate how cashing out reduced VMT. Rows 6 and 7 show that cashing out eliminated 3.4 VMT per employee per day, and 864 VMT per employee per year. Row 8 shows that cashing out eliminated 246,215 VMT per year, or 16 percent of all VMT for commuting to the firm.

V. CASHING OUT REDUCED VEHICLE EMISSIONS

The emissions reductions are calculated by considering the reductions in both automobile *trips* and *VMT*. Pollution emissions are caused at the beginning and end of each automobile commute trip by the "cold start" as the engine warms up and the "hot soak" as the engine cools down; these "trip-end" emissions are independent of the total distance traveled for the commute. The "running" emissions are a factor of total VMT for the trip. In Table 3 we have already estimated the reductions in automobile trips and VMT. Therefore, we can multiply these reductions in trips and VMT by the emissions created per trip-end and per VMT to obtain the reduction in total emissions caused by automobile commuting.

Cashing out reduced 58 trips and 864 VMT per employee per year. We multiply these reductions by the factors for ROG, NO_x, CO, and PM10 for both trip ends and VMT. We use the emission factors specific to 1995, the year in which the vehicle-trip and VMT reductions were estimated. We add the two sources of pollution, and then divide by 454 grams per pound to obtain the emissions reductions in pounds per employee per year. Table 4 shows that cashing out eliminated 2.3 pounds of ROG, 1.9 pounds of NO_x, 20.1 pounds of CO, and 1.4 pounds of PM per employee per year.

TABLE 8-5

CASHING OUT REDUCED GASOLINE CONSUMPTION AND CARBON DIOXIDE EMISSIONS

		Before (1990)	After (1995)	Change	Percent Change
		(1)	(2)	(3)	(4)
1	Gasoline Consumption per Employee (gallons per year)	211	177	-35	-16%
2	Total Gasoline Consumption (gallons per year)	60,209	50,360	-9,849	-16%
3	Carbon Dioxide Emissions per Employee (pounds per year)	4,162	3,481	-681	-16%
4	Total Carbon Dioxide Emissions (pounds per year)	1,186,113	992,096	-194,017	-16%

There were 285 employees who reported to this work site during the 1995 survey period.

The average fuel efficiency is 25 miles per gallon.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide.

The emissions reduction for all employees of the firm is found by multiplying the emissions reduction per employee by the 285 employees of the firm in 1995. Cashing out eliminated a total of 649 pounds of ROG, 551 pounds of NO_x, 5,370 pounds of CO, and 407 pounds of PM per year for automobile commuting. The final column shows that cashing out reduced automobile emissions by 16 percent.

VI. CASHING OUT REDUCED GASOLINE CONSUMPTION AND CO_2 EMISSIONS

By reducing VMT, cashing out also reduced gasoline consumption and carbon dioxide emissions. Table 5 shows these results. The SCAQMD has estimated that the average fuel efficiency of light-duty passenger vehicles in Southern California is 25 miles per gallon in 1996. Therefore, the VMT figures estimated in Table 3 (Rows 7 and 8) are divided by 25 miles per gallon to estimate gasoline consumption for commuting.[4] Cashing out reduced gasoline consumption per employee by 35 gallons per year, and reduced total gasoline consumption for commuting to the firm by 9,849 gallons per year, or 16 percent of all gasoline consumption for automobile commuting to the firm.

Combustion of each gallon of gasoline produces 19.7 pounds of carbon dioxide. Therefore, the reduction in gasoline consumption reduced carbon dioxide emissions per employee by 681 pounds per year, and reduced total carbon dioxide emissions for commuting to the firm by 194,017 pounds per year, a 16 percent decrease.

VII. CASHING OUT INCREASED COMMUTING SUBSIDIES

In 1995, the firm went beyond compliance with California's cash out requirement; it offered a parking subsidy of $11 a month or a transportation allowance of $50 per month. Table 6 shows how this policy change increased the firm's spending for commuter subsidies.[5]

In 1990, the firm's commuter subsidy was $6,087 a month In 1995 the firm's commuter subsidy was $9,653 a month, including $431 in payroll taxes on the cash benefits to ridesharers.[6] Cashing out increased the average commuting subsidy per employee, including payroll taxes, by $13 a month.

The generous nature of the firm's cash offer caused part of this cost increase. Solo drivers receive a parking subsidy of $11 a month, while ridesharers receive a cash subsidy of $50 a month. The commuting subsidy offered to ridesharers is thus almost five times higher than is required for compliance with California's cash-out requirement.

VIII. SUMMARY

In 1990, the firm offered employees a parking subsidy $30 a month. Carpoolers split a parking subsidy, and others received nothing. The firm changed its commuter subsidy in 1991, and now offers employees the option of a parking subsidy of $11 a month or a cash subsidy of $50 a month.

In response to the change in commuting subsidies, the share of commuters who drive to work alone fell from 61 to 45 percent. The carpool share rose from 23 to 35 percent, and the transit share increased from 12 to 15 percent. The walk share increased from 0.4 to 1 percent. These commuter changes from solo driving to carpooling and transit reduced the number of vehicle trips by 16 percent, eliminating a total of 16,414 vehicle trips and 246,215 VMT per year.

These reductions in automobile use reduced pollution emissions for automobile commuting by 16 percent. Cashing out eliminated 2.3 pounds of ROG, 1.9 pounds of NO_x, 20.1 pounds of CO, and 1.4 pounds of PM per employee per year. In total, cashing out eliminated 649 pounds of ROG, 551 pounds of NO_x, 5,730 pounds of CO, and 407 pounds of PM per year for commuting to the firm.

By reducing VMT, cashing out reduced gasoline consumption for commuting by 35 gallons per employee per year, and reduced gasoline consumption for commuting to the firm by 9,849 gallons per year. Finally, cashing out reduced carbon dioxide emissions by 681 pounds per employee per year, and reduced carbon dioxide emissions for commuting to the firm by 194,017 pounds per year.

The firm's spending for commuter subsidies increased by approximately $13 per employee per month, or by 59 percent.

TABLE 8-6

COMMUTING SUBSIDIES BEFORE CASHING OUT (1990)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Agency
Drive Alone	$30	61%	85%	$5,196
2 Person Carpool	$15	17%	12%	$730
3 Person Carpool	$10	5%	2%	$138
4 Person Carpool	$8	1%	0.3%	$17
Buspool (7 Person)	$4	1%	0%	$7
Mass Transit	$0	12%	0%	$0
Walk	$0	0.4%	0%	$0
Bicycle	$0	0.4%	0%	$0
Monthly subsidies for 285 employees:				$6,087
Taxes on Cash Subsidies:				$0
Total Cost per Month:				$6,087
Cost per Employee per Month:				$21

COMMUTING SUBSIDIES AFTER CASHING OUT (1995)

(Per Month)

Travel Mode	Subsidy per Employee	Share of Employees	Share of Subsidy	Cost To Agency
Drive Alone	$11	45%	15%	$1,411
2 Person Carpool	$50	29%	45%	$4,124
3 Person Carpool	$50	2%	3%	$268
4 Person Carpool	$50	3%	5%	$438
5 Person Carpool	$50	1%	2%	$141
Mass Transit	$50	15%	24%	$2,175
Walk	$50	1%	2%	$155
Bicycle	$50	1%	6%	$509
Monthly subsidies for 285 employees:				$9,222
Taxes on Cash Subsidies:				$431
Total Cost per Month:				$9,653
Cost per Employee per Month:				$34
Change in Total Cost per Month:				+$3,566
Change in Cost per Employee per Month:				+$13
Percent Change in Commuting Subsidy:				+59%

Commuter Policies

Case Study 8

	1990		1995
1	Parking Subsidy	1	Parking Subsidy
2		2	**Non-Driver Subsidy**
3		3	**Flexible Work Hours**
4		4	**Guaranteed Ride Home**
5		5	**Bicycle Racks, Clothing Lockers and Showers**
6		6	**Preferential Parking Space**
7		7	**Raffles**

Bold indicates an incentive present in 1995 but not in 1990

Case Study 8

Employer characteristics

Case study 8 provides managed care medical services. In 1995, the firm had a total of 361 employees, with 285 employees reporting to work between 6am and 10am, Monday through Friday.

Case study 8 is located at 1025 W. Olympic Blvd. in the downtown Los Angeles area. Two major freeways -- Harbor (110) and Century (105) -- provide nearby access to the firm. Major arterials serving this area include Figueroa Street and Olympic Boulevard. Three bus routes and the Metro Rail Blue Line serve this area.

This area is noted for its heavy traffic and high crime.

The distribution of job categories is:

Clerical	48%
Professional	20%
Technical	17%
Officials/Administrators	11%
Service/Maintenance	4%

CASE STUDY 9

Two of the firms that cashed out their parking subsidies were in Santa Monica (Case Studies 6 and 7). We have also examined the commuter mode shares for a comparison case study in Santa Monica to show the experience of a firm that did not cash out its parking subsidies.

Because all firms of with more than 100 employees have been subject to Regulation XV during the period we have examined, we have been unable to find a comparison firm that has not been attempting to increase ridesharing among its employees. Case Study 9 is a suitable comparison firm, however, because the difference between its parking subsidy and its ridesharing subsidy remained almost unchanged between 1991 and 1995.

In 1991 the firm offered all employees free parking in spaces that it rented for $75 per space per month. Column 2 in Table 1 shows that solo drivers thus received a subsidy of $75 a month. Carpoolers also received free parking, and split the $75 per space subsidy; the larger the carpool, the smaller the subsidy per employee. Those who rode transit, walked, or bicycled to work received no subsidy.

Column 3 shows the subsidy arrangement in 1995. The firm continued to offer free parking, but the price it paid to rent spaces had risen to $114 per space per month. Therefore, solo drivers received a subsidy of $114 a month. Everyone who did not take a parking card received a subsidy of $40 per month--a partial cash out. A two-person carpool thus received one free parking space worth $114, plus $40 for the space not taken, for a total subsidy of $154 divided among two employees, or $77 each. Larger carpools received smaller subsidies per person, while those who rode transit, walked, or bicycled to work received $40 a month.

Although employees who did not take a parking card in 1995 received $40 a month, the parking subsidy itself had risen from $75 a month in 1991 to $114 a month in 1995, or by $39. Therefore, the *difference* in subsidy between solo drivers and those who rode transit, walked or bicycled remained almost constant between 1991 and 1995--it was $75 in 1991 and $74 (= $114 - $40) in 1995. The firm also adopted a number of typical ridesharing incentives, such as guaranteed ride home, prize drawings, and free meals for carpoolers once every three months.

Column 4 and 5 of Table 1 compare the mode shares in 1991 and 1995. The solo share was 83 percent in both years. The carpool share increased slightly, and the bicycle share decreased slightly. The changes are not statistically significant. Figure 1 displays these mode share data in both years.

The unchanged solo share at this comparison firm strengthens the conclusion that cashing out parking subsidies, and not some exogenous factor, caused the reductions in solo share observed at the two other firms in Santa Monica.

TABLE 9-1

SUBSIDIES AND MODE SHARES AT THE COMPARISON FIRM IN SANTA MONICA

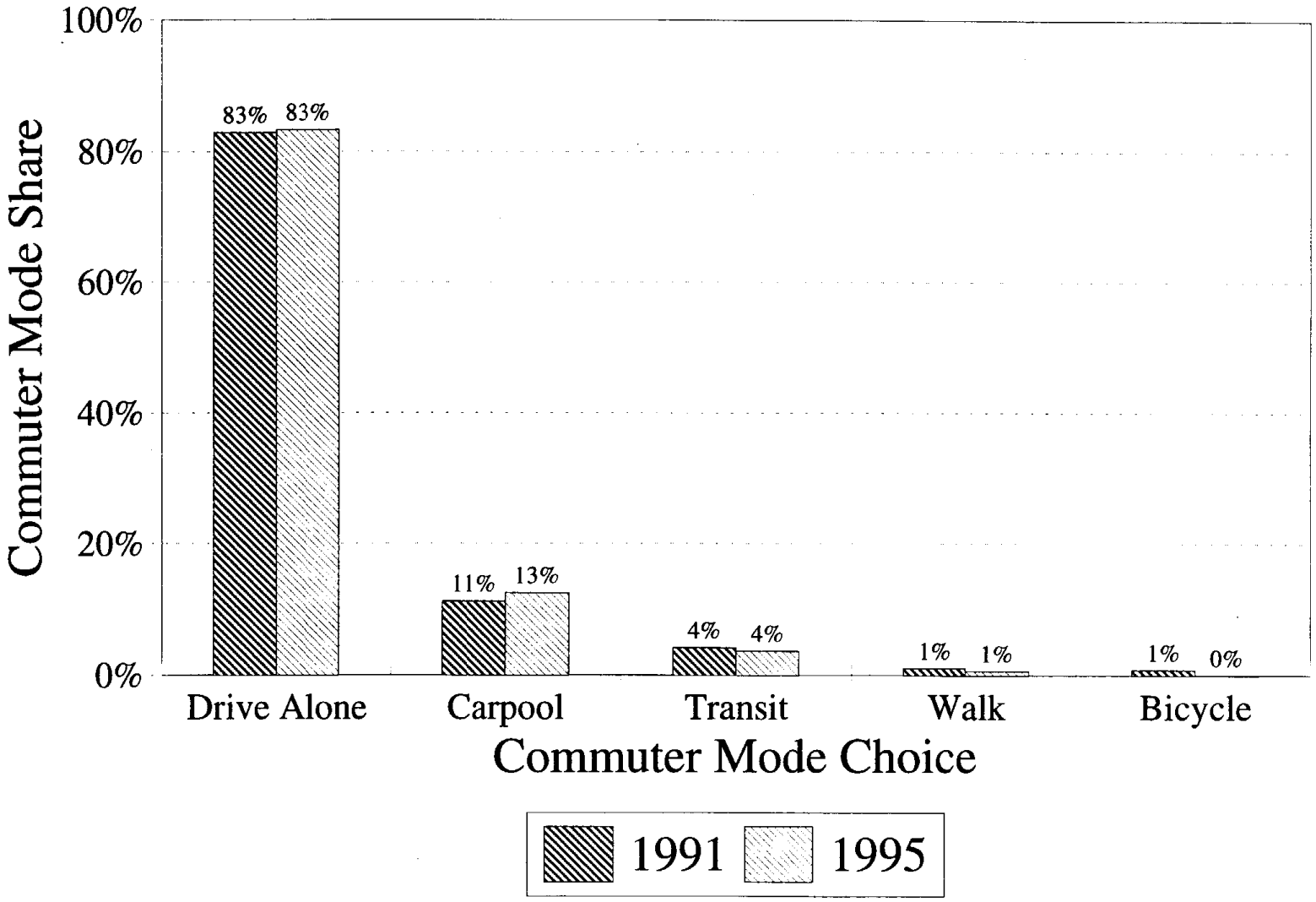
	Subsidy per Employee		Mode Share		Subsidy Distribution	
Commute Mode	**Before (1991)**	**After (1995)**	**Before (1991)**	**After (1995)**	**Before (1991)**	**After (1995)**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Drive Alone	$75	$114	83%	83%	94%	90%
Carpool	$35	$77	11%	13%	6%	9%
Transit	$0	$40	4%	4%	0%	1%
Walk	$0	$40	1%	1%	0%	0.2%
Bicycle	$0	$40	1%	0%	0%	0%

Note: The survey response rate was 100% in 1991 and 100% in 1995. A Chi-Square test shows that the difference in commuter mode shares observed in Columns (4) and (5) is not statistically significant at the .10 significance level.

FIGURE 9-1

Commuter Mode Choices

At the Comparison Firm in Santa Monica



Commuter Policies
Comparison Firm

	1991		1995
1	Free Parking	1	Free Parking
2		2	**Transportation Allowance**
3		3	**Direct Cash Subsidies**
4		4	**Guaranteed/Emergency Ride Home**
5		5	**Rideshare Matching Service**
6		6	**Flexible Hours**
7		7	**Prize Drawings**
8		8	**Free Meals**

Bold indicates an incentive present in 1995 but not in 1991

Case Study 9

Employer characteristics

Case study 9 is a perfume manufacturer. In 1996, the firm had a total of 113 employees, with all 113 employees reporting to work between 6am and 10am, Monday through Friday.

Case study 9 is located at 2400 Broadway in Santa Monica. Two major freeways -- Santa Monica (10) and San Diego (405) -- provide nearby access to the firm. Major arterials serving this area include Cloverdale and Broadway Avenues. Five bus routes serve this area. A bike path, lane or route exist within 1/2 mile of the worksite.

Case study 9 provides many on-site services and amenities, including fitness center, day care center, restaurants, and dry cleaning. Moreover, the firm is conveniently accessible to nearby restaurants, retail stores, and medical services.

Surrounding streets have wide sidewalks, pedestrian signals, crosswalks and good lighting.

Clerical	44%
Professional	34%
Officials/Administrators	17%
Technical	5%

APPENDIX 1: INTERVIEWS WITH TRANSPORTATION MANAGERS

INTERVIEW QUESTIONS REGARDING CASH-OUT PROGRAMS

I. How did your company come to have the cash-out program?
   A. Why did management decide to implement your cash-out program?

II. How would you describe your experience with the program?

III. Has the program had any financial effects on your company?
   A. When an employer cashes out parking subsidies, it must give cash to employees who already rideshare, without saving an equivalent amount by reducing parking expenditures.
      1. Did this create any problems for your firm?
      2. Do you think this is an objection to offering a cash-out program?
   B. Employers must pay payroll taxes on cash offered in lieu of a parking subsidy.
      1. Did this create any problems for your firm?
      2. Do you think this is an objection to offering a cash-out program?

IV. What is the administration of the parking cash-out program like?
   A. Did implementing the parking cash-out program cause any particular problems?
   B. Does continuing to offer the parking cash-out program cause any problems?
   C. Compared to other rideshare programs--carpool matching, guaranteed ride home, and so on--how difficult is administering the cash-out program?
   D. If you both own and rent parking spaces, has this caused any difficulty?

V. How would you describe your employees' experience with the cash-out program?
   A. Is the cash-out policy is fair to employees and to the company? Compared to what it replaced?
   B. Do employees feel the cash-out policy is fair?

VI. Could you list the benefits of the cash-out program?

VII. Could you list the disadvantages of the cash-out program?

VIII. If a transportation coordinator at another company asked you for advice in setting up a trip-reduction program, which policies would you recommend. Which would you warn against? Would you recommend a parking cash-out program to other employers? Why? What is most important?

INTERVIEW WITH TRANSPORTATION MANAGER (Case Study 2)

West Hollywood, CA
February 29, 1996

Shoup: How did the agency come to have the cash-out program?

JR: We started a cash-out program because we did not have enough parking spaces for employees. So in order to accommodate those employees who did not have a parking space and encourage them to not use parking spaces, we offered a cash out, offered them money, $45 a month to not drive.

Shoup: Why did the agency later increase the cash offer to $65 a month?

JR: We increased it to $65 because the rate that it cost to lease the spaces from one of the offsite locations, had increased to $65. So we thought we should offer $65 instead of $45, comparable to the value of the parking that we were leasing.

Shoup: How would you describe your experience with the cash-out program?

JR: I think it has been really positive with the employees. Employees see it as getting extra money, extra income. And also I think that it also encourages the opinion that it's important to walk, it's important to not drive. And if you're close, then you should not drive. And it seems to lead to a more conscious level of the involvement.

Shoup: Has the program had any financial effects on the agency? Did it create any problems?

JR: I don't think so. I think at the time when it was implemented, and even today, that the parking spaces are so limited for employees that I'm not aware that anyone looked at it that way. They weren't concerned about making the employees feel like they were going to get something if they didn't have to, in place of the parking spaces.

Shoup: In introducing a cash-out program, an employer would have to give cash to employees who already rideshare; do you think that's an objection to offering a cash-out program?

TM: No, I don't think it's a fair objection, because the people that are ridesharing anyway, I think it will encourage them to feel good about ridesharing. And feel like yes, I'm doing something and they appreciate me for doing something. My employer is compensating me fairly. They care about me and they care about the environment. You know?

Shoup: I see. Not just me, but the environment.

JR: Right.

Shoup: Another problem about financial effects is that the employers must pay payroll taxes on cash offered in lieu of a parking subsidy. Would you say this creates any problems for the agency?

JR: Again, I am not aware of any problems. I think that it is a separate line item on our checks. So I'm not really sure how it's perceived in the accounting department.

Shoup: So do you think this would be a general objection to offering a cash-out program?

TM: It could be for bigger employers. But I guess it depends. For us, if we didn't pay the $65, we'd have to pay a lot more money probably in parking or in parking structures. Or in parking spaces. We'd be spending the money somewhere else and having to provide parking for the employees who are using it.

Shoup: What is the administration of the parking cash-out program like?

JR: It's very simple. When an employee is a new hire during their first week when we fill out all the paperwork, Human Resources discusses the parking cash-out program and they can register then. Or if they decide later that they'd like to participate in it, then they can just go to Human Resources and register, sign a letter that they'll not be using a parking space. And then it is just automatically added to their paycheck every month.

Shoup: What about somebody who takes the cash out and wants to drive on a day when they don't feel well?

JR: That's not an option. The way our regulation is prepared, it is not an option.

Shoup: But can they pay to park in a commercial lot?

JR: There are no commercial lots around here. So, what may happen is that the employee may end up parking on the streets. We have watch-dog employees that if they see something like that, it's generally reported. They're not supposed to be receiving the money and they can be. The regulation is part of the general agency guidelines and that employee if discovered that they are breaking the rules so to speak, then they could be written up and go in their personnel file.

Shoup: Compared to other rideshare programs, like carpool matching and guaranteed rides home, how difficult is administering the cash-out program?

JR: It's not difficult at all. As I mentioned before, it's automatically added to the payroll check. The Human Resources fills out the paperwork. If someone wants to stop using the program

then they'll have to go to Human Resources and say I don't want to use it any more. I need a parking permit so I can have a parking space. And then I think it's a month later then they're out of the program.

Shoup: You are the first employer that we've run across that both owns and rents their parking spaces. Some employers have said that cashing out parking subsidies would be a real hassle if you both own and rent parking spaces because are you going to offer cash only to those who are in owned spaces and not in rented spaces? Has this caused any problem for you?

JR: No. The way our parking is assigned here, all the big shots get it first. The council people and the directors and then from there it's seniority and anyone who falls below their hire date after we've used up all the spaces in the lot we own then they're the ones who are shifted out to the off site parking. People who are higher up in the seniority level, they can still have the option to take the parking alternative if they want. If they find later that they need the space, they don't really lose their seniority.

Shoup: I see. How would you describe your employees' experience with the cash-out program? Is it fair to employees and to the agency?

JR: I think that in general the employees think it's fair. The problems that have arisen in the past were where do I park when I have a doctor's appointment, or where do I park when I have to leave early, that's been a general problem. And other problems have been like the seniority. I think previously if you were hired first, and you were taking a cash out and then you decided to change your mind, in the past you could have been bumped. You had to go to the bottom of the line.

Shoup: So that made you want to hold onto your parking space?

JR: Yes, but that was changed recently. And so now it doesn't matter where you're at.

Shoup: Do you think that change led anybody to consider cashing out? Because they knew they could cash back in if they wanted to?

JR: Yeah. I think there were a few people. I don't think very many. But I think there were a few people who that did happen with. But generally, the problem for employees has mostly been what do I do on the day that I need to drive?

Shoup: Some firms give you a couple of days of free parking if you take the cash. I don't know how you would do that in a place like West Hollywood where the parking is tight. I suppose on rainy days, everybody would want to park.

JR: Or there's always meetings going on that some people have to drive to. So that's why there isn't any room for that. For us to build that in. Because our parking lot is very small.

Shoup: Could you list the benefits of the cash-out program?

JR: I think as far, in relation to the Reg 15, I think it's made a big difference. The value, the extra money does mean a lot to some of the employees. It allows them to pay for their bus pass if they're farther away. And then for other people who are closer in, they can either use a bus pass if they want, or they can ride a bike or they can walk. And it's money in their pocket that they didn't have before. They don't have to worry about parking and they don't have to worry about gas and all those things that come with driving a car to work. And so I think that's one thing. I think it has improved the awareness about the environment here. Our employee base is a lot different than most other places. Most of the people here are not married. Most of the people do not have kids and while a lot of them may have outside commitments that they might need their car after hours, it's not the same as someone who might be in a family situation where they have to drive their kids to school. And they have to drive their, do whatever for the family.

Shoup: So that's why they can walk?

JR: And that's why they can ride their bike.

Shoup: Could you list any disadvantages of the cash-out program?

JR: There is the possibility that some employees will take the money and park on the street. Or take the money and park in the parking lot and it kind of creates a problem with other employees who are following the rules and you know obviously looking at what other people do and then being upset because no one does anything about it. I think that's a problem. But overall, no. I don't think there are any disadvantages. For us, I think it's been really a good thing. And it's good for making the employees aware that the agency is very interested in keeping cars away. Don't use it if you don't need it.

Shoup: If a transportation coordinator at another company asks you for advice in setting up a trip production program, which policies would you recommend? Would you recommend the parking cash-out program to other employers?

JR: Yes, I would. I think it makes people more aware about the importance of parking and just not take it for granted. And also what their options could be for walking. I would recommend that they consider some free days of use depending on their situation. For us, that is probably not a reality, but for other places who may have a lot more parking available to them, I think that's a really good idea.

Shoup: Well, thank you very much.

JR: Thank you.

INTERVIEW WITH FACILITIES MANAGER (Case Study 4)

Century City
Los Angeles, CA 90067
March 26, 1996

Shoup: How did your company come to have the cash-out program?

HD: Before the state law was passed, we had a rideshare program that gave people points they could use to buy items from a catalog. When I came on board in 1993, I polled all the rideshare participants in the program and asked them how they liked the points program. They were pretty much dissatisfied with it because they were forced to buy things out of a catalogue. We took a vote and I asked if they would rather have the cash to spend on whatever they wanted. Now we use a cash incentive program, which includes "cash out" for those who do not use a parking space.

Shoup: How much does it cost the firm to rent parking spaces?

HD: $130 a month.

Shoup: Why did you set the cash out at $150 a month, rather than $130?

HD: We wanted to give the employees an extra incentive to rideshare. Our rideshare participation increased due to this.

Shoup: What do the bus riders get? Do you pay for their bus pass?

HD: We pay for the bus pass.

Shoup: And anything else?

HD: A bus pass is typically $50 a month. In addition, we give them a cash incentive of $100.

Shoup: How would you describe your experience with the program?

HD: Since we moved to cash out, we've always received a good response. Especially when new employees come on board. When we orient new employees and explain cash out to them, they're very open to ridesharing. Especially in the legal industry, most of the people that we hire usually come from a prior law firm. If they come from downtown, most downtown firms don't pay for parking. So when they come here, if they're used to ridesharing, they are going to get a bonus, because the firm will cash them out. So in the orientation, this is a pleasant thing to be able to tell them.

Shoup: Has the program had any financial effects on your company? When an employer cashes out parking subsidies, it has to give cash to employees who already rideshare, without really saving on parking expense. Did this create any problem for your firm?

HD: No, it didn't.

Shoup: Do you think that this is an objection to offering a cash-out program, that you have to reward current ridesharers who are not getting anything?

HD: Not at all.

Shoup: A second question is that employers must pay payroll taxes on cash offered in lieu of a parking subsidy. Did this create any problems for your firm?

HD: No, it didn't create any problems.

Shoup: Do you think that this is an objection to a parking cash-out program?

HD: An objection?

Shoup: That you have to pay payroll taxes on the cash.

HD: No, I don't.

Shoup: What is the administration of the parking cash-out program like? Did the implementation cause any particular problems?

HD: Not really. We have a pretty sophisticated accounting and payroll department. The duties are split. I'm the ETC [employee transportation coordinator], and I handle all the paperwork as far as the ridesharing program goes.

Shoup: Compared to other rideshare programs like your previous points program, how difficult is administering the cash-out program?

HD: I think it's probably the easiest. The points program was very difficult to administer. There was a lot of paper work and you had to handle a lot of complaints from people who did not like the points program. The cash-out program is really simple.

Shoup: How would you describe your employees' experience with the cash-out program? Is the cash-out policy fair to employees and to the company?

HD: Yes. I definitely think it's fair. When new employees come on board, I think it's a great incentive to them. We're finding that most of the people who cash out are serious carpoolers. I think it's great to reward them that way.

Shoup: Compared to what it replaced, do you think the employees like the cash-out program?

HD: Yes they do. They voted for it.

Shoup: Do you think employees feel the cash-out policy is fair?

HD: Yes, I do.

Shoup: Could you list the benefits of the cash-out program?

HD: It's very easy to administer. It doesn't take up very much of my time, less paper work than previous programs that we've had before, and it's a good hiring incentive for us.

Shoup: How does that show up?

HD: We list the cash-out program as a benefit when recruiting new employees, and we receive positive feedback. Our employees are concerned about the pollution problems in Southern California, and what the AQMD is doing to improve air quality. They appreciate our efforts.

Shoup: That's fascinating. When you look at financial incentive schemes, you assume that they will work because of self-interest. But you often find there's a big response simply because people think this is the right thing to do.

HD: Exactly.

Shoup: Could you list the disadvantages of the parking cash-out program?

HD: I really don't see any. I remember when the cash-out law first came about, I talked to other companies. I don't know why, but people were kind of unsure about it. Because we were already offering something very similar, it really didn't have any effect on us.

Shoup: If a transportation coordinator at another company asked you for advice in setting up a trip reduction program, would you recommend a parking cash-out program to other employers?

HD: Yes, I would definitely recommend it. I would recommend staying away from things we've done before that haven't worked. Like a points program. Or trying to offer too many options for people to choose from. And to keep it simple. We've always found that cash works. Cash is always a good incentive.

Shoup: Thank you very much.

HD: You're welcome.

INTERVIEW WITH TRANSPORTATION COORDINATOR (Case Study 5)

Los Angeles, CA 90071
May 3, 1996

Shoup How did your firm come to have the cash-out program?

AG We were looking for something that would make ridesharing more appealing, and the only thing that seems to work is money. We became aware of parking cash out, so I presented it to management, and management felt that it was okay.

Shoup How would you describe your experience with the program?

AG It has been a really good experience. People really like it. People wanted that $150, so they looked for ways to rideshare and pocket some money. It is a good experience, and people are happy.

Shoup Has the program had any financial effects on your company? When you offer cash to your employees who already rideshare, you don't save money on parking. Did this create any problems for the firm?

AG Actually, no, because we lowered the parking subsidy when we began to offer cash to ridesharers. We were spending the money already, so the money just shifted to ridesharers.

Shoup When you offer cash to the ridesharers, you also have to pay payroll taxes. Has this caused a problem for the firm?

AG It caused a little bit of a problem at first, but it worked out okay. Sitting down with payroll and figuring it out did take a little bit of time. Once we figured out the right way to do it, it was fine. We have a very sophisticated accounting system and it didn't take them more than an hour or two, and now it is basically automatic. There's no problem at all.

Shoup What is the administration of the program like? Did implementing it cause any particular problem?

AG It caused a problem because we had to go through the budget line by line. We needed to explain to management how it was going to work . . but once we got it rolling it was fine.

Shoup Does operating the program cause any problems?

AG No. You have to keep up on it though. I get a report on a monthly basis on who gets what allowance and I do have to go through and check it, because once in awhile you have a human error and you put in the wrong amount. But, now that it's going, it's fine.

Shoup Compared to other rideshare programs, how difficult is cashing out?

AG People would rather see the cash than a lot of other little goodies. Many people have said, "Can't you just forget the drawings? Just give us some money." And, to tell you the truth, it would be easier if I just gave them money and didn't do all of the rest. But you have to keep ridesharing in their minds, so you have to keep those monthly drawings. Everybody who ride shares, their name goes into a huge basket, we have little drawings, and I give out 15 dozen donuts. They want those donuts -- oh, yes. For Valentines Day I get pink donuts. It's more trouble than the cash sure. But, you have to keep ridesharing in their heads constantly. I don't know if it encourages ride sharing . . . but I think they like to win something. It's just one little extra benefit.

Shoup Is the cash out policy fair to employees and to the company?

AG Compared to the previous policy, I think this is fairer.

Shoup Could you list any benefits of the cash out program?

AG I think it has benefits as a recruiting point. It is an excellent recruiting point because people count it as income. I think it makes the firm look like they want to help the environment. This is a way to encourage people to stop using their cars. It is a good benefit for the staff and it shows that we are trying to do something. Some of the recruits, fresh out of law school, are young and idealistic, and they think more of the firm because of its cash-out policy rather than just offering free parking. We get about 10 to 12 new attorneys every year, and they are more apt to ride share than the older attorneys. They are more environment conscious, and I'd say probably 90% of them make some effort to carpool on a regular basis. And, we have several attorneys, all in that younger group, who take the bus. The younger attorneys really like it. Why not sit on the bus and let the bus driver fight the traffic? A lot of people take the train or the bus so they can relax on their way home for a half an hour or 45 minutes. They are not behind the wheel, and some people do use that as a tool to relax.

Shoup Can you think of any disadvantages of the cash out program?

AG The expense is the only disadvantage. Other than that, I don't see any disadvantage. But we have to stay competitive in the market, so we have to give some kind of an allowance. So we are going to do this in order to stay competitive in the market.

Shoup If a transportation coordinator of another company asked you for advice, would you recommend a cash out program?

AG I would. I would because it is not a little drawing where they might win, or they might not win. This is a definite benefit that people are seriously going to look at. People like the idea, they like the cash in hand, and it does add to their pay check.

Shoup Thank you very much.

INTERVIEW WITH FACILITIES MANAGER (Case Study 6)

Santa Monica, CA
April 1, 1996

Shoup: How did your company come to have the cash-out program?

LL: I heard about it from the City. I think the cash-back program is required by state law.

Shoup: How would you describe your experience with the program?

LL: At first, I had a very difficult time interesting anyone in any type of participation in the program. But more and more people are getting interested. So I have more cooperation and participation than I did in the beginning. On the intake interview, I spend ten or fifteen minutes with each new person. And I tell them about cash back, and sometimes it does motivate them. The information does motivate them to seek another method. But just as often, they don't think about it at that time, but later they talk with other employees. Some even move closer and walk to work.

Shoup: Has your program had any financial effects on your company?

LL: I don't think it's significant.

Shoup: Do you think that the cost of offering cash to people who were already ridesharing is an objection to cash back?

LL: In our case, no. And management doesn't complain. Some of the employees really appreciate the benefits. The ones on the entry level really do. And the other ones really don't care.

Shoup: Employers must pay payroll taxes on the cash offered in lieu of a parking subsidy. Does this requirement to pay payroll taxes on the cash create any problem for your firm?

LL: I don't handle payroll, but I would say it's minor because it's just one small detail. Each employee has many details. And payroll is automated, so it's just a simple computer entry.

Shoup: Do you think that paying payroll taxes on the cash offered in lieu of a parking subsidy is an objection to offering a cash-out program?

LL: No, because you have to pay payroll taxes on their check anyway. Whether the number is up or down by $55, your work is the same.

Shoup: What is the administration of the parking cash-out program like? Did implementing it cause any particular problems?

LL: Cash back doesn't cause a problem, it helps you. It's the biggest single help. At first, I couldn't interest anyone in this. They just thought I was a big cornball to go around and try and push this rideshare thing when we had never had it before. No one was jumping. Later, people kind of warmed up. They would hear from so and so at the lunch table that you can get cash back. And now, I won't say they're beating my door down, but I've got a lot of people interested.

Shoup: Are there any operating problems with offering the cash back?

LL: The only problem that I've had from my own personal experience is if people don't understand very specifically what the rules are, and what the procedures are, then you can get some hard feelings. So I think administratively it has to be handled well.

Shoup: Compared to other rideshare programs like carpool matching and guaranteed ride home, is administering the cash-back program difficult?

LL: Not at all. I give it to payroll and they put it on a computer. It's automatic.

Shoup: You have your own parking spaces in the building, and you also rent additional parking spaces off site. Has this caused any difficulty with the cash-back program

LL: Not at all. Why would it?

Shoup: I don't think it does, but some people ask about it. How would you describe your employees' experience with the cash-out program? Do you think it's fair to employees and to the company?

LL: Yes. If an employee chooses to use an alternative form of transportation, it wouldn't be fair for the company to say oh, goody, we saved $55 this month. I think the benefit should go to the employee who makes a sacrifice. Maybe you want to go on an errand or go shopping and your car is at home and you are at work. So I think that the employee should be compensated and that the company shouldn't benefit.

Shoup: Do you think the employees feel the cash-back policy is fair?

LL: They love it. The ones that qualify love it. And the ones who drive alone don't care because they get free parking.

Shoup: Could you list the benefits of the cash-out program?

LL: Benefits for whom? The benefits for the City are that traffic congestion is reduced and air pollution is reduced. The employees have cash in their pockets. And if they're doing something like biking or walking or rollerskating, they have the opportunity to be out of doors for a longer period. Some people rollerskate to work and get the cash back. If they're in a van pool from a great distance, it would be very possible that they could have their car insurance reduced if they could register their car as being for pleasure only. This could represent more savings to the employee, more cash benefits in a year than the cash back itself. The amount of stress that the employee experiences could be reduced by an alternate form of transportation. No one likes gridlock. The company has employees who are grateful and thankful and more motivated. So, that's a plus for the company.

Shoup: Could you list any disadvantages of the program?

LL: Explaining it in a way that everyone understands. Sometimes you have to explain things again and again.

Shoup: If a transportation coordinator at another company asked you for advice in setting up a trip reduction program, would you recommend the parking cash-back program to other employers?

LL: You mean if it weren't mandatory already?

Shoup: Yes.

LL: I don't know how many employers would do it, if it wasn't mandatory. But it is a good way to get participation. And I would recommend it. And if you want to get participation, cash means something to most people.

Shoup: Thank you.

INTERVIEW WITH FACILITIES MANAGER (Case Study 8)

Los Angeles, CA 90015
May 3, 1996

Shoup How did your firm come to have the cash-out program?

MK When we initiated the program, our parking committee decided that $50 would be an appropriate cash offer. From no carpools at all, or relatively few, we jumped up to probably 80 carpools when we initiated this program. So that decreased at least 40 employee cars or so immediately, and freed up parking spaces for our patients. That helped us. We were doing our part in relieving congestion, but at the same time we were taking a big burden from ourselves, which was our parking problem.

Shoup How would you describe your experience with the cash-out program?

MK Oh, it made employees happy. It became a benefit that we were offering our employees. We emphasize it in our new employee orientation.

Shoup Has the program had any financial effect on your company?

MK The company is very much pro-staff. We do a lot of things to keep people happy. Cash was the easy way out of our parking problem.

Shoup When you start offering cash to people who don't take a parking subsidy, you have to begin offering cash to people who are already ridesharing. Do you think this is an objection to offering cash to ridesharers?

MK No.

Shoup You have to pay payroll taxes on the cash offered in lieu of a parking subsidy. Does this create any problems?

MK Not that I am aware of.

Shoup Do you think that paying payroll taxes on cash is an objection to a cash-out program?

MK No, I don't.

Shoup What is the administration of the cash program like? Does it cause any problems?
MK I am responsible for ridesharing, and I probably spend about 6 to 10 hours per month on it. The $50 cash is a only a part of this time.

Shoup Compared to other rideshare programs, how difficult is offering cash in lieu of free parking?

MK How difficult is offering cash rather than parking?

Shoup Yes. Has offering the $50 a month created much of a problem?

MK No. Basically, if you do not drive, you get the $50.

Shoup You own the parking spaces that are in the facility, and you also rent extra spaces offsite. Does that cause difficulty in offering cash?

MK No.

Shoup Is the cash-out policy fair to employees?

MK Oh, I believe so, definitely.

Shoup Could you list some of the benefits of offering cash if you don't take the parking subsidy?

MK Well, the benefits are relieving congestion on the freeways, and cleaning up the air, which I think everybody should play a part in one way or another. And the company doesn't have to do other things that we would have to do; like give free movie passes for ridesharing.

Shoup Do you think there are any disadvantages of offering cash to people who ride share?

MK Well, if we would decide to scratch the program, it would be a disadvantage to us and to our patients. If we decided to scratch the program, we would probably end up with at least 50 to 60 more employee cars, with no place to park.

Shoup If a transportation coordinator of another company asked you for advice in setting up a trip reduction program, what would you recommend?

MK Cash works very well for us. If I were going to assist somebody in setting up program or giving them advice I would want to see what type of operation they have, how many employees they have, and what their financial status is. I think we took the easy way out, but we were also fortunate that we have the financial capabilities to pay the $50 per month. If we took the cash away from our employees now, it would hit them very hard. And, if we offered movie passes or dinners in lieu of the $50, I don't think that would go over very well.

Shoup Thank you very much.

APPENDIX 2: METHODS FOR ESTIMATING CHANGES IN MODE SHARES, VEHICLE TRIPS, VMT, VEHICLE EMISSIONS, AND GASOLINE CONSUMPTION

SOURCES OF DATA

The mode share data in Case Studies 2 through 8 are derived from survey data reported in the employers' Trip Reduction Plans (TRP) submitted to the SCAQMD. The SCAQMD requires employers to conduct employee transportation surveys in a carefully prescribed manner, and to report the results in a uniform format. These surveys are conducted over a five-day period once a year, and the results are a rich source of information on travel behavior.

In Case Study 1, we were able to obtain all the individual responses for both the 1992 and 1994 surveys, not simply the summary reports submitted in the firm's TRP. We were thus able to recode all the responses to examine the results in detail. The SCAQMD's survey instrument asks each employee not only about mode choice, but also about the distance traveled to work. Although this additional information on distance traveled to work is not used to measure a firm's compliance with SCAQMD's Rule 1501 (which sets only mode-share goals), it is available in the individual survey responses. With the additional information on each employee's distance traveled to work, and with the employee's reported commute mode, we can estimate the employee's VMT) for commuting. The results obtained by the intensive data analysis in this case study are very similar to the results obtained in all the other case studies. This similarity of results increases our confidence in the results of all our other case studies.

METHOD OF DERIVING MODE SHARES FROM TRIP REDUCTION PLANS

We have devised two methods for using the data in TRPs submitted to the SCAQMD to estimate commuters' travel mode shares. To illustrate these two methods, we will use the data reported for West Hollywood on pp. IV-1 to IV-4 of its 1993 TRP (see attached). Both methods should give the same results, and we have used both to check the accuracy of the reported mode shares.

Method 1

Page IV-2B of the TRP shows the results of the "Weekly Employee Survey Form." Rows A through K report all the trips made to work in the week of February 1 to 5, 1993.

There were 352 drive-alone trips, 21 two-person carpool trips, 15 transit trips, 110 walk trips, and 8 bicycle trips, for a total of 506 trips (= 352 + 21 + 15 + 110 + 8). The drive-alone share is thus 70% (= 352/506), the carpool share is 4% (= 21/506), the transit share is 3% (= 15/506), the

walk share is 22% (= 110/506), and the bicycle share is 2% (= 8/506). These shares are shown in Column 5 of Table 2 of the West Hollywood study.

Method 2

Form A (attached) shows our second method of calculating mode shares. A version of Form A was prepared for every case study for every year of data reported.

Page IV-3 of West Hollywood's 1993 TRP shows a summary of the survey results. Box W shows a total of 643 employee trips, whereas the previous page IV-2B showed only 506 employee trips (as used in the paragraph describing Method 1 above). What accounts for this difference in the total number of trips?

To obtain the mode share data from page IV-3, we first calculate the total number of physical commute trips made to the worksite during the survey week (February 1 to February 5). Box W shows a total of 643 employee trips, as defined by the SCAQMD. From this total we must make several deductions to obtain a more conventional measure of commute trips.

First, we must deduct the 5 "trips" in Box M; the SCAQMD counts nonresponses to the survey as work trips, but this is a legal requirement, not conventional survey procedure. We want to measure the mode shares of those who did respond to the survey, without making assumptions about those who did not respond (the response rate was 99%).

Second, we must deduct the 5 "telecommute" trips in Box L; the SCAQMD counts telecommuters as making commute trips, but these trips should not be included in calculating the mode shares of those who physically commute to work.

Third, we must deduct the 127 "days off" for compressed work weeks in Boxes N, O, and P; the SCAQMD counts as work trips the trips that commuters would have made if they had not had days off because of compressed work weeks; again, in calculating the mode shares of those who did physically commute to work, these "days off" should not be included.

Therefore, the total number of work trips actually made during the survey week is 506 (= 643 - 5 - 5 - 127). The SCAQMD's unusual definition of a trip accounts for the difference between the 643 trips counted by the SCAQMD and the 506 trips found in Method 1.

To obtain the mode shares of those who did commute to work, we divide the number of reported trips using each mode by the total 506 work trips. For example, Box A shows 352 drive-alone trips; therefore, the drive-alone *share* is 70% (= 352/506). The two-person carpool share is 4% (= 21/506). And so on. The results are the same as shown for Method 1.

These two methodologies examine the travel behavior only of those who physically commute to work. Thus it abstracts from any changes that occurred because of changes in

compressed work weeks or telecommuting, or simply from changes in the survey response rate. Cashing out is expected to change mode shares of those who do commute to work, and those changes are the focus of our analysis. If cashing out also encourages workers to telecommute or shift to compressed work weeks, it will have an additional effect in reducing work trips, but we do not attempt to measure this additional effect.

METHOD OF ESTIMATING VEHICLE TRIP REDUCTIONS

Form B shows our method of calculating work trips. A version of Form B was prepared for every case study for every year of data reported.

The number of *work* trips by respondents to the survey is calculated by the two methods just described--506 commuter work trips during the survey week.

To obtain the number of *vehicle* trips per respondent, we follow the procedure required by the SCAQMD in calculating vehicle trips. Each solo driver is counted as one vehicle trip, each person in a two-person carpool is counted as one-half of a vehicle trip, each person in a three-person carpool is counted as one-third of a vehicle trip, and so on. No vehicle trips are attributed to transit riders, bicyclists, and pedestrians. Box V shows that 367.5 vehicle trips were reported to the SCAQMD for the survey week. From this we deduct the 5 trips in Box M, which are the nonrespondents to the survey. In calculating vehicle trips, the SCAQMD requires regulated employers to count all nonrespondents as solo drivers. This procedure obviously encourages employers to obtain the highest possible survey response rate, but it is not a standard research procedure when analyzing survey results. For our purposes, we want to estimate the vehicle trips made by respondents. There were 362.5 (= 367.5 - 5) vehicle trips made by the respondents.

We divide the 362.5 vehicle trips by the 506 commuter work trips to obtain the average of **0.72 vehicle trips per commuter.**

Next we calculate the number of employees who did not commute to work during the survey week. This is the sum of Box L (5 who telecommuted), Boxes O and P (127 who were off because of a compressed work week), Box Q (17 who were on vacation), Box R (15 who were sick), and Box S (20 who were off for other reasons). In total, there were 184 reported days off during the survey week. The survey response rate was 99 percent; to estimate the total days off, including nonrespondents, we divide 184 by 0.99 to give 185.9 employee-days-off during the survey week. Per day, the average number of employees off is 37.2 (= 185.9 ÷ 5).

To obtain the number of commuters per employee, we obtain the number of commuters who report to the work site. Box C on page IV-1 shows that 139 employees reported to the work site. We deduct the average 37.2 employees who did not come to work per day to give 101.8 employees who actually commuted to work per day (= 139 - 37.2). We then estimate that there are **0.73 commuters per employee** (= 101.8 ÷ 139) during the survey week.

Because there are 0.72 vehicle-trips per commuter, and 0.73 commuters per employee, there are **0.52 vehicle-trips per employee** (= 0.72 x 0.73).

This calculation refers to 1993. A similar calculation was carried out for the 1991 survey results. In that year there were 0.76 vehicle-trips per commuter. This is higher than the 0.72 vehicle-trips per commuter found in 1993 because there were a higher solo driver share and a lower walking share in 1991. To calculate the number of vehicle trips in 1991 we use the ratio of 0.73 commuters per employee found in 1993 (to eliminate any change due to changes in attendance rate. As a result, there were 0.55 vehicle-trips per employee in 1991 (= 0.73 x 0.76). Alternatively, we could say that there would have been 0.55 vehicle trips per employee in 1993 (rather than 0.52) if there had been the same mode shares in 1993 as in 1991.

To calculate the number of vehicle trips per employee in 1993, we multiply the 0.52 vehicle round-trips per employee by the 252 work days per year, and double that number to find a total of 265 one-way vehicle trips per employee per year. For 1991 we find 279 one-way vehicle trips per employee. Therefore, the change in mode shares reduced 15 one-way vehicle trips per year per employee.

Finally, we calculate the total number of vehicle trips per year for commuting to the firm by multiplying the number of trips per employee per year in 1991 and 1993 by the total of 139 employees who commuted to the firm in 1993. We use the 1993 employment for both years to estimate the change in trips caused by the change in mode shares between the two years, holding the number of employees constant. The 1991 vehicle-trip total is therefore the number of trips that would have occurred in 1991 with (1) the mode shares found in 1991, (2) the same 139 employees as in 1993, and (3) the same 73 percent attendance rate as in 1993. The difference between 1991 and 1993 therefore shows how the change in mode shares, by itself, changed the number of trips from 1991 to 1993.

We find 38,831 vehicle-trips in 1991, and 36,767 in 1993. Therefore, the shift from driving to walking in West Hollywood between 1991 and 1993 eliminated 2,064 vehicle trips. Another interpretation of this result is that if in 1993 there had been the same mode shares as in 1991, commuters would have made an extra 2,064 vehicle trips.

METHOD OF ESTIMATING VMT REDUCTIONS

The survey summaries reported to the SCAQMD do not include information on commuter trip distances. In calculating VMT reductions, the SCAQMD assumes that the average one-way distance for each avoided automobile trip is 15 miles. The Southern California Association of Governments (1993) found this average 15-mile commute distance in a 1991 travel survey for all commuters in the South Coast Air Basin. Other evidence also suggests that the average one-way trip distance is close to 15 miles. In its annual surveys conducted between 1989 and 1994, Commuter Transportation Services (1994) found average one-way trip distances that ranged from 14.8 and 16.5 miles.

We follow the SCAQMD's procedure to calculate how cashing out reduces VMT. In Case Study 4, for example, Row 6 of Table 3 shows that commuting created an average of 26.0 VMT per employee per day in 1992; this figure is derived by multiplying the 0.87 vehicle trips per employee per day in Row 3 by an average 30-mile round trip to work (26.1 = 0.87 x 30). Because the average number of vehicle trips per employee per day declined to 0.79 in 1994, the average VMT per employee per day declined to 23.7 in 1994. Cashing out thus reduced vehicle commuting by 2.3 VMT per employee per day.

To calculate VMT per employee per year, we multiply the VMT per employee per day by 252 work days per year. Vacations, sick days, and other absences are already accounted for in the calculation of the firm's average attendance rate, so the number of work days per year is five days per week for 52 weeks, minus the conventional eight national holidays. Row 7 of Table 3 in Case Study 4 shows that cashing out reduced 585 VMT per employee in 1994. When all 191 employees of the firm are considered, Row 8 shows that cashing out reduced 111,739 VMT for commuting to the firm in 1994.

The Circuity Factor

When commuters join carpools, they may have to drive a more circuitous route to work than if they drove solo. Fricker (1986, 34) defined circuity as "the extra distance that a member of a carpool travels, compared to that person's drive-alone distance between home and work." He defined the "circuity factor" as the "ratio of ridesharing distance to drive-alone distance."

If circuity is a serious problem with carpooling, the method we have used to calculate VMT will underestimate the VMT by carpoolers, and will therefore overestimate the VMT reduced when commuters shift from solo driving to carpooling. We have investigated this issue, and find that it is inconsequential.

Fricker estimated an average circuity factor of 1.071 for carpooling. That is, a commuter would drive 7.1 percent farther to work if carpooling than if solo driving. Because we have the trip distances for both solo drivers and carpoolers for Case Study 1, we can estimate the circuity factor for commuters who travel from the same zip code. The estimated circuity factor is 1.035, which is less than the 1.071 estimated by Fricker. One reason for this difference is that Fricker estimated circuity for carpoolers traveling to multiple work sites, so there was circuity possible on both the home-end and work-end of the commute trip. In contrast, the Case Study data were gathered at a single work site, so there would be no circuity on the work-end of the commute trip.

If we assume that half of the trip circuity occurs at the work end and the other half occurs at the home end, we can divide Fricker's circuity factor (1.071) in half, attributing half of the circuity to the home end and half to the work end. This leaves a circuity factor of 1.035; since the Case Study employees all work at the same site, the circuity factor of 1.035 is in line with the previously published data.

Our methodology of estimating VMT, which is the same as that used by the SCAQMD, implicitly assumes that the circuity factor is zero. The VMT for each person in a two-person carpool is one-half the distance to work for the carpool; the VMT for a three-person carpool is one-third the distance to work for the carpool; and so on. We have tested the outcomes of this method to examine their sensitivity to the circuity factor. Table A-1 shows a test of the data in Case Study 4 to test the outcomes for their sensitivity to assumed circuity in carpooling.

Column 1 shows assumed circuity factors from 1.00 to 1.12. Columns 2 and 3 show the VMT per employee per day for Case Study 4 in 1992 and 1994, given the assumed circuity factor; a higher circuity factor increases VMT per employee per day in both years. Because there was more carpooling in 1994, the VMT per employee is more sensitive to the circuity factor in 1994 than in 1992.

Column 4 shows the change in VMT per employee per day between 1992 and 1994, given the assumed circuity factor. The change in VMT is only slightly affected by the circuity factor. Column 5 shows the percent change in VMT between 1992 and 1994; again the percent change is only slightly affected by the circuity factor. For this reason, we have not used circuity factors in estimating the effects of cashing out.

METHOD OF ESTIMATING VEHICLE EMISSION REDUCTIONS

The emissions reductions are calculated by considering the reductions in both automobile *trips* and *VMT*. Pollution emissions are caused at the beginning and end of each automobile commute trip by the "cold start" as the engine warms up and the "hot soak" as the engine cools down; these "trip-end" emissions are independent of the total distance traveled for the commute. The "running" emissions are a factor of total VMT for the trip.

We have already estimated the reductions in vehicle trips and VMT. We multiply these reductions in trips and VMT by the emissions created per trip-end and per VMT to obtain the reduction in total emissions caused by automobile commuting. We use emission factors specific to the year in which the reductions were estimated. For example, in Case Study 4, Table 3 shows the estimated reductions in trips and VMT achieved in 1994. Therefore, we use the emission factors for 1994. The emissions per trip-end and per VMT in 1994 were taken from the ARB's EMFAC7F1.1/B7F model (see attached table of emission factors).

Cashing out reduced 40 trips and 585 VMT per employee per year. Multiplying these reductions by the factors for ROG, CO, NO_x, and PM10 for both trip ends and VMT, adding the two sources of pollution, and dividing by 454 grams per pound gives the emissions reductions in pounds per employee per year. Multiplying the emissions reduction per employee by the 191 employees of the firm in 1994 gives the emissions reduction for all the firm's employees.

Reactive organic gases (ROG) and nitrogen oxides (NO_x) react in the presence of sunlight to form ozone, the chief component of urban smog. Over 70 percent of ROG and NO_x

TABLE A-1

CIRCUITY SENSITIVITY ANALYSIS

	VMT per Employee per Day			
Circuity Factor	Before (1992)	After (1994)	Change	Percent Change
(1)	(2)	(3)	(4)	(5)
1.00	26.04	23.71	-2.32	-8.92%
1.01	26.05	23.74	-2.31	-8.87%
1.02	26.06	23.76	-2.30	-8.83%
1.03	26.08	23.79	-2.29	-8.78%
1.04	26.09	23.81	-2.28	-8.74%
1.05	26.10	23.83	-2.27	-8.69%
1.06	26.12	23.86	-2.26	-8.65%
1.07	26.13	23.88	-2.25	-8.61%
1.08	26.14	23.91	-2.24	-8.56%
1.09	26.16	23.93	-2.23	-8.52%
1.10	26.17	23.95	-2.22	-8.47%
1.11	26.18	23.98	-2.21	-8.43%
1.12	26.20	24.00	-2.20	-8.39%

emissions in California are caused by motor vehicles. Ozone has been linked to lung tissue damage, breathing difficulties, and vegetation damage.

Carbon monoxide (CO) is formed by incomplete fuel combustion, and motor vehicles are its largest source. Exposure to excessive CO can cause headaches, fatigue, slow reflexes, and dizziness, as well as chest pains in heart patients.

Particles small enough to be inhaled deep into the lungs are called inhalable particulate matter (PM10). Particulate matter from motor vehicles includes road dust, particles due to brake and tire wear, and exhaust emission particles. The adverse health effects linked to particulate matter include increased respiratory disease, lung damage, and cancer.

METHOD OF ESTIMATING GASOLINE CONSUMPTION REDUCTIONS

By reducing VMT, cashing out also reduces gasoline consumption for commuting. To estimate the gallons of gasoline consumed for commuting, we divide the average VMT per employee per year by the average number of miles per gallon for light-duty passenger vehicles.

The SCAQMD has estimated that the average fuel efficiency of light-duty passenger vehicles in Southern California is 25 miles per gallon in 1996. This estimate was made using the Air Resources Board's EMFAC7F1.1/B7F model to represent conditions in Southern California on an average workday in 1996. Average fuel efficiency of the fleet has been steadily increasing in recent years; it was only 22 miles per gallon in 1990. The estimates of VMT reductions in the case studies refer to the years 1993, 1994, and 1995, when average fuel efficiency was lower than in 1996. Therefore, using a 1996 fuel efficiency of 25 miles per gallon produces a conservative estimate of how cashing out reduced fuel consumption in these earlier years, and a realistic estimate of how cashing out can reduce fuel consumption in 1996.

METHOD OF ESTIMATING CARBON DIOXIDE EMISSION REDUCTIONS

Combustion of each gallon of gasoline produces 19.4 pounds of tailpipe emissions of carbon dioxide (Energy Information Administration 1994, 79). Therefore, multiplying the reduction in gasoline consumption by 19.4 pounds per gallon gives the reduction in tailpipe carbon dioxide emissions produced by commuting. This estimate is conservative because the full-fuel-cycle emissions (counting emissions from extraction, transport, refining, and so forth) are 30.5 pounds of carbon dioxide per gallon of gasoline consumed for commuting. When these additional non-tailpipe emissions are included, cashing out reduces total carbon dioxide emissions by 57 percent more than the reduction in tailpipe emissions alone.

METHOD OF ESTIMATING EMPLOYERS' COMMUTING SUBSIDIES

A firm's total subsidies for parking and for cash in lieu of parking are derived from data reported in the firm's Trip Reduction Report. For solo drivers, the firm's parking subsidy is the price

the firm pays of parking, less what the firm charges solo drivers for parking. For carpools, the subsidy per carpooler is the parking subsidy per carpool divided by the number of commuters in the carpool, plus any additional cash paid to carpoolers.

For example, see Table 7-6 for Case Study 7. In 1994, the firm paid $77 a month to rent parking spaces, and charged solo drivers $15 a month to park, so each solo driver received a parking subsidy of $62 a month. Carpools parked free, so they split a subsidy of $77 a month. A two-person carpool received a subsidy of $38.50 per employee; a three-person carpool received a subsidy of $25.66; and so on. Vanpoolers received a subsidy of $175 a month, transit riders received $75 a month, and others received $25 a month.

The total cost to the firm in 1994 was the subsidy per employee in each mode, multiplied by the number of employees who chose that mode. For example, solo drivers received $15,528 a month (= $62 x 0.83 x 300). The monthly subsidy for all 300 commuters was $17,567, of which solo drivers received 88 percent (= $15,528 ÷ $17,567).

The parking subsidies were tax exempt, but the cash paid to commuters who walked or bicycled were fully taxable. The first $55 a month of a vanpool or transit subsidy was exempt from income taxes in 1994, but the subsidy in excess of $55 a month was taxable. Thus, of the one vanpool subsidy, $118 was taxable, and of the four transit subsidies, $80 was taxable. The total taxable subsidy was therefore $359 (= $118 + $80 + $99 + $62).

In addition to income taxes, there are also payroll taxes. The firm's combined Social Security and Medicare tax rate was 7.65 percent. There was also payroll taxes for State Unemployment Insurance (SUI), Federal Unemployment Tax (FUTA), and Employment Training Tax (ETT). These taxes rates are neglected because they are calculated on only the first $7,000 of an employee's income. The firm's payroll tax rate was 7.65 percent of taxable cash. The payroll tax on the taxable cash paid to ridesharers was thus $27 a month (= $359 x 0.765).

In 1995, cashing out changed the subsidy pattern for everyone except solo drivers. Those who didn't take a parking card received a cash subsidy of $77 a month, and the vanpool subsidy was reduced to $165 a month. The total subsidy for solo drivers fell to $14,035 a month because the solo driver share fell from 83 to 75 percent. The cash subsidies paid to others was taxable, except for the first $60 a month paid to vanpoolers and bus riders.

Of the subsidy for two-person carpools, we assume that one carpooler took a tax-exempt parking space, and the other took $77 in cash. Therefore, one-half of the $4,388 subsidy for two-person carpools ($2,169) was taxable. Of the total subsidy to three-person carpools, two-thirds was taxable. In 1995, the first $60 of subsidy to vanpoolers and transit riders was taxable. All the cash to commuters who walked or bicycled was taxable. The total taxable cash in 1995 was therefore $2,969, and the payroll tax was $227.

These estimates refer only to the employers' spending for parking subsidies and for cash payments in lieu of parking subsidies. Five of the eight employers eliminated other ridesharing subsidies when they began to cash out, however, so this would reduce their cost of cashing out. Table 8 showed that, on average, the employers' spending for parking subsidies and for cash payments in lieu of parking subsidies increased by 3 percent, or by $2 per employee per month, after complying with the cash-out requirement. Because we have not estimated the firms' savings from eliminating other ridesharing subsides after cashing out, the firms' net cost of cashing out should be less than $2 per employee per month.

In the broader context of cost-benefit analysis (rather than the narrower context of cost-effectiveness analysis) most of the employer's spending increase is a transfer to previously undersubsidized ridesharers, not a use of resources. In cashing out, employers began to offer cash to commuters who were already ridesharing, so the cash was a pure transfer--employees gained what the employers spent, so there was no net cost to society. And the employers' payroll taxes are a transfer to the government, not a use of resources. Even the employers gained as a result of cashing out, because the cash became a fringe benefit to their employees, and served as a recruiting tool. Therefore, the employers' estimated spending of $2 per employee per month clearly overestimates the cost of cashing out employer-paid parking.

Year: 199 3
Site ID#: 077117

Section IV: Employee Survey Process

Section IV must be completed by employers filing both initial and update plans. Use AQMD approved survey forms only. Attach a blank survey form including employee involvement questions.

A. Survey Methodology

Describe the survey methodology used to obtain the data to calculate your Average Vehicle Ridership (AVR).

The same survey used for the 1st update plan was used for the 2nd update. Minor revisions were made to reflect changes in the incentives which were implemented after the first survey. The CTS AVR was used to calculate AVR. Management was notified of surveys and employees were noticed at union meetings and electronic mail.

B. Which group of employees did you survey? Check one only. **Employees reporting to work 6:00am to 10:00am?** ☐
All employees? ☒

C.

138	divided by	139	x 100 =	99	%
Number of Surveys Received from 6:00am - 10:00am employees		Number of 6:00am - 10:00am employees Box 1 on form III -1		Survey Response Rate	

D. Name of person responsible for survey administration:

Joyce	Rooney	Associate Transportation Planner
First	Last	Title

E. Survey Date Start: 93/2/1 (YY / MM / DD) **Survey Date End:** 93/2/5 (YY / MM / DD)

F. Specific Location Where Surveys are Stored

Main Transportation files in City Hall

Year: 199 3
Site ID#: 077117

Weekly Employee Survey Summary Form

Section IV-2B must be completed and submitted only by employers filing both initial and update plans. This form is for employees reporting to work between 6:00am and 10:00am. Please read instructions before completing this Form.

Mode	Mon	Tue	Wed	Thu	Fri	Total
	1	2	3	4	5	6
A. Drive Alone	83	86	88	87	8	352
B. Motorcycle						
C. 2 person carpool	5	6	4	5	1	21
D. 3 person carpool						
E. 4 person carpool						
F. 5 person carpool						
G. 6 person carpool						
H. Vanpool						
I. Transit (bus/rail)	3	5	4	3		15
J. Walk	27	30	27	26		110
K. Bicycle	2	2	2	2		8
L. Telecommute*	1		2	1	1	5
M. No Survey Response	1	1	1	1	1	5
Compressed Work Week						
N. 3/36 work week						
O. 4/40 work week					4	4
P. 9/80 work week	4				119	123
Days Off						
Q. Vacation	5	4	4	4	0	17
R. Sick	3	2	4	5	1	15
S. Other	5	3	3	5	4	20

Note: If the total number of employees at this site includes employees who did work one or more days during the survey week (such as part-time, on call or weekend workers) mark this number in the other (S) category and attach an explanation.
**Attach a copy of company's formal telecommuting policy.*

Year: 199 3
Site ID#: 077117

Weekly Employee / Vehicle Calculation

Section IV-3 must be completed by employers filing both initial and update plans.

Mode	Column 1		Column 2	Column 3
A. Drive Alone	352	A.	divided by 1 =	352
B. Motorcycle		B.	divided by 1 =	-
C. 2 person carpool	21	C.	divided by 2 =	10.5
D. 3 person carpool		D.	divided by 3 =	-
E. 4 person carpool		E.	divided by 4 =	-
F. 5 person carpool		F.	divided by 5 =	-
G. 6 person carpool		G.	divided by 6 =	-
H. Vanpool (7 or more)		H.	Weekly van trips**	-
I. Transit (bus/rail)	15		** Value from Appendix E	
J. Walk	110			
K. Bicycle	8			
L. Telecommute	5			
M. No Survey Response	5	M.	divided by 1 =	5
		V.	**Subtotal (A thru M)**	367.5

Compressed Work Week Credit (days off)

N. 3/36 work week	
O. 4/40 work week	4
P. 9/80 work week	123

Clean Fuel Vehicle Credit (See Page 50) U: -

W. Employee Trips (Total A thru P): 643

T. Total Vehicles (V-U): 367.5

Days Off

Q. Vacation	17
R. Sick	15
S. Other	20
X. Total (W + Q + R + S)	695
Y. Enter Number- from Box 1 on Page 16.	139
Z. Multiply box Y by 5	695

Note: The numbers in box X and box Z should be the same.

Year: 199 3
Site ID#: 077117

AVR Planning Form

Section IV must be completed by employers filing both new and update plans

Section A

1.	Total employee trips generated Monday through Friday between 6:00am - 10:00am inclusive (Column 1 (W) Form IV-3).	1. 643
2.	Total vehicles arriving at the worksite Monday through Friday between 6:00am - 10:00am. (Column 3 use (T) if claiming clean fuel vehicle credit, otherwise use (V) form IV-3).	2. 367.5
3.	Divide line #1 by line #2 for current AVR.	3. 1.75
4.	Enter AVR target here.	4. 1.50
5.	Prior year AVR (leave blank if filing for first year).	5. 1.34
6.	Divide line #1 by line #4. This is the maximum weekly number of vehicles at which you reach the target AVR.	6. 428.6
7.	Subtract line #6 from line #2. This is your weekly necessary vehicle reduction to reach your target AVR.	7. N/A
8.	Divide line #7 by 5 to calculate the necessary daily vehicle reduction to reach your target AVR.	8. N/A

Weekly Employee Survey Form

Instructions: Print or type the Employee Information requested. Print or type an (X) to identify your survey responses.

Employee Information

Name: _____
First Last

Employee I.D.#: _____ **Dept./Section:** _____

Phone Ext.: _____ **Home Zip Code:** **Miles to Worksite (one way):** _____

Signature: _____ **Date:** _____

Mode / Report Time	Mon	Tue	Wed	Thu	Fri
	a.m. p.m.	a.m. p.m.	a.m. p.m.	a.m. p.m.	a.m. p.m.
A. Drive Alone					
B. Motorcycle					
C. 2 person carpool					
D. 3 person carpool					
E. 4 person carpool					
F. 5 person carpool					
G. 6 person carpool					
H. Vanpool H1. [ ] Capacity					
I. Buspool					
J. Transit (bus/rail/plane)					
K. Walk					
L. Bicycle					
M. Zero Emission Vehicles					
N. Telecommute (reduction of more than 50% of trip)					
O. Noncommuting					

(circle AM or PM as applicable)

Compressed Work Week Day(s) Off

P. 3/36 work week					
Q. 4/40 work week					
R. 9/80 work week					

Other Days Off

S. Vacation					
T. Sick					
U. Other					

(Jury duty, Leave of Absence, Home Dispatched, etc.)

Alternative Fuel Vehicles*

If alternative fuel vehicles were used for commuting during the survey period, please indicate by using the appropriate type in each box as shown below:					

Type: P=Propane LPG=Liquified Petroleum Gas M=Methanol NG=Natural Gas

Note: Alternative fuels do not include reformulated gasoline.

FORM A

Methods of Calculating Reported Mode Shares for City of West Hollywood for 1993
(from the data reported on page IV-3 of City of West Hollywood's 1993 Trip Reduction Plan)

Work trips reported by respondents to the survey:

643 =	Box W, employee work trips counted, including nonresponses and noncommuters
5 =	Box M, vehicle trips attributed to nonresponders (No survey response)
5 =	Box L, Telecommute
127 =	Boxes N, O, P, compressed work week credits
506 =	W-M-L-N-O-P work trips reported by respondents in survey (This number includes the phantom work trips "saved" by the compressed work weeks, reported in Boxes N,O, and P)
352 =	Box A, drive alone trips
352/506 =	Drive alone mode share
69.6% =	Drive alone mode share
21 =	Boxes C, D, E, F, G, H, carpool trips
21/506 =	Carpool mode share
4.2% =	Carpool mode share
15 =	Box I, transit trips
15/506 =	Transit mode share
3.0% =	Transit mode share
110 =	Box J, walk trips
110/506 =	Walk mode share
21.7% =	Walk mode share
8 =	Boxes B, K, bicycle/motorcycle trips
8/506 =	Bicycle/motorcycle mode share
1.6% =	Bicycle/motorcycle mode share
127 =	Boxes N, O, P, phantom work trips saved by compressed work weeks
127/506 =	Phantom work trip mode share
25% =	Phantom work trip mode share

Revised 3/10/1996

FORM B

Methods of Calculating Work Trips and Vehicle Trips for City of West Hollywood for 1993
(from the data reported on page IV-3 of City of West Hollywood's 1993 Trip Reduction Plan)

Work trips reported by respondents to the survey:

643 =	Box W, employee work trips counted, including nonresponses and noncommuters
5 =	Box M, vehicle trips attributed to nonresponders (No survey response)
5 =	Box L, Telecommute
127 =	Boxes N, O, P, Compressed work week credits
506 =	W-M-N-O-P work trips reported by respondents in survey (This number includes the phantom work trips "saved" by the compressed work weeks, reported in Boxes N,O, and P)

All non-responses were counted as solo drivers, and therefore as worktrips, so

367.5 =	Box V, vehicle trips counted
5 =	Box M, vehicle trips attributed to nonresponders (No survey response)
362.5 =	Box V-M, vehicle trips reported by respondents in survey
362.5/506 =	Box V-M/W-M-L-N-O-P, vehicle-trips/work-trip reported by respondents in survey
0.72 =	**vehicle-trips/work-trips reported by respondents in survey**

The number of employees who do not travel to work:

4 =	Box O, 4/40 work week
123 =	Box P, 9/80 work week
17 =	Box Q, Vacation days
15 =	Box R, Sick days
20 =	Box S, other days
5 =	Box L, Telecommute
184 =	Boxes O+P+Q+R+S+L, reported employee-days off.
0.99 =	Response rate to survey (Box C, Pg. IV-1)

So if all those with days off had the same response rate as for all employees, the number of employee-days off were:

184/0.99 =	Boxes Q+R+S+L/Response rate, employee-days off
185.9 =	Employee days-off during survey week
185.9/5 =	Employees off per day
37.2 =	Employees off per day (including nonrespondents to the survey)
139 =	Number of employees (Box C, Pg. IV-1)
139-37.2 =	Number of Commuters
101.8 =	Number of Commuters
101.8/139 =	Commuters/employee
0.73 =	**Commuters/employee**

commuters/employee	**x**	**vehicle-trips/commuter**	**=**	**vehicle-trips/employee**
0.73	**x**	**0.72**	**=**	**0.52**

Revised 3/10/1996

Emission Factors 1992 - 2020

Average Light Duty Fleet with Cold Starts

Methodology: Multiply miles traveled for each year by the VMT factor to get emissions in grams
Multiply number of trips by the trips factor (trip ends) for each year.
Add VMT emissions to trip end emissions.

	1992	1993	1994	1995
ROG				
VMT (g/mi)	0.92	0.86	0.81	0.76
trips (g/trip)	7.63	7.30	6.93	6.54
NOx				
vmt	1.00	0.94	0.88	0.83
trips	3.14	3.00	2.88	2.78
CO				
vmt	8.27	7.72	7.18	6.64
trips	70.54	67.58	63.40	58.74

	1996	1997	1998	1999	2000
ROG					
VMT (g/mi)	0.58	0.55	0.51	0.47	0.44
trips (g/trip)	5.7	5.39	5.04	4.65	4.23
NOx					
vmt	0.71	0.67	0.64	0.6	0.57
trips	2.28	2.23	2.17	2.09	2
CO					
vmt	4.56	4.19	3.86	3.56	3.29
trips	62.47	58.18	53.76	49.19	44.53

Source: EMFAC7F1.1/B7F. Includes annual average statewide emissions for light duty cars and trucks plus motorcycles.
VMT factor equals running exhaust plus running losses divided by daily VMT.
Trips factor equals (cold starts divided by cold trips) plus (hot soaks divided by daily trips).

PM10

0.75 grams per mile*

* There is no year-specific or trip end emission factor for PM10.
Includes 0.66 g/mi from entrained road dust (dust from roads that becomes airborne because of traffic) and 0.09 g/mi from tire wear and exhaust.

APPENDIX 3: TEXT OF CALIFORNIA'S CASH-OUT LEGISLATION

Text of Parking Cash-Out Law

§ 43845. Parking cash-out program. California Health and Safety Code.
(a) In any air basin designated as a nonattainment area pursuant to Section 39608, each employer of 50 persons or more who provides a parking subsidy to employees, shall offer a parking cash-out program. "Parking cash-out program" means an employer-funded program under which an employer offers to provide a cash allowance to an employee equivalent to the parking subsidy that the employer would otherwise pay to provide the employee with a parking space.
(b) A parking cash-out program may include a requirement that employee participants certify that they will comply with guidelines established by the employer designed to avoid neighborhood parking problems, with a provision that employees not complying with the guidelines will no longer be eligible for the parking cash-out program.
(c) As used in this section, the following terms have the following meanings:
(1) "Employee" means an employee of an employer subject to this section.
(2) "Parking subsidy" means the difference between the out-of-pocket amount paid by an employer on a regular basis in order to secure the availability of an employee parking space not owned by the employer and the price, if any, charged to an employee for use of that space.
(d) Subdivision (a) does not apply to any employer who, on or before January 1, 1993, has leased employee parking, until the expiration of that lease or unless the lease permits the employer to reduce, without penalty, the number of parking spaces subject to the lease.
(e) It is the intent of the Legislature, in enacting this section, that the cash-out requirements apply only to employers who can reduce, without penalty, the number of paid parking spaces they maintain for the use of their employees and instead provide their employees the cash-out option described in this section.

Related Provisions

Sections 17202 and 24343.5, California Revenue & Taxation Code. Specifies that costs related to a parking cash-out program may be deducted as business expenses for employers.

Section 17090, California Revenue & Taxation Code. States that the cash allowance given to employees must be included in gross income subject to state income and payroll taxes (except any portion used for ridesharing purposes).

Sections 65088.1, 65089, and 65089.3, California Government Code. Requires (1) congestion management agencies to consider parking cash-out when developing and updating the trip reduction and travel demand elements of their congestion management plans, and (2) requires cities or counties to grant appropriate reductions in parking requirements to new and existing commercial developments if they offer parking cash-out programs.

Uncodified language:

The Legislature hereby finds and declares all of the following:
(a) Existing local, state, and federal policies tend to encourage the provision of subsidized parking by employers.
(b) Subsidized parking creates a strong incentive for employees to commute to work in a single occupancy vehicle.
(c) Commuting in a single occupancy vehicle contributes to traffic congestion and air pollution.
(d) In Los Angeles and Orange Counties, more than 90 percent of the commuters receive free worksite parking, but less than 10 percent of employers provide an employee ridesharing or transit benefit.

APPENDIX 4: PARKING SUBSIDIES AND TRAVEL CHOICES: ASSESSING THE EVIDENCE

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Parking subsidies and travel choices: Assessing the evidence

RICHARD W. WILLSON[1] & DONALD C. SHOUP[2]

[1] *Department of Urban and Regional Planning California State Polytechnic University, Pomona 3801 West Temple Avenue Pomona, CA 91768-4048, USA*

[2] *Graduate School of Architecture and Urban Planning University of California, Los Angeles, CA 90024-1467, USA*

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Key words: mode choice, parking, transportation demand management, travel behavior

Abstract. This article reviews empirical studies of how employer-paid parking affects employees' travel choices. A strong effect is found: parking subsidies greatly increase solo driving. When employers reduce or remove parking subsidies, a significant number of solo drivers shift to carpools and/or transit. This conclusion is based on studies of parking subsidies in a variety of circumstances, including central city and suburban areas, private and public employers, and clerical and professional employees. Three measures are developed to compare changes in commute patterns: changes in the share of solo drivers, changes in the number of autos driven to work per 100 employees, and the parking price elasticity of demand for solo driving. The studies reviewed here show that 19 to 81 percent fewer employees drive to work alone when they pay for their own parking. Because 90 percent of American commuters who drive to work receive employer-paid parking, these findings are significant for designing transportation policies to reduce air pollution, traffic congestion, and energy consumption.

Introduction

Nine out of every ten American commuters who drive to work park free at work.[1] Although employer-paid parking may appear to be a generous, enlightened, and popular employment policy, it is also a strong incentive to drive to work alone, and it strongly works at cross purposes with public policies designed to reduce traffic congestion, energy consumption, and air pollution.

To illustrate how strongly employer-paid parking can sway a commuter's decision toward driving to work alone, consider how much a parking subsidy can reduce the cost of driving to work. Using the 172,000 office workers in the Central Business District (CBD) of Los Angeles as an example, we find that 105,000 of them drive to work alone, and approximately 54,000 of them park free in employer-provided spaces. The cost of

the gasoline for the average commute trip is approximately $1.75 per day, and the average daily equivalent market cost of monthly parking in the Los Angeles CBD is $4.32 per day, so if an auto commuter pays for parking the sum of the gasoline and parking cost for the round trip is $6.07 per day.[2] Thus, employer-paid parking reduces the cost of driving alone to work from $6.07 to $1.75 per day, when compared to the out-of-pocket cost for gasoline and parking faced by a commuter who has to pay to park at work. The federal tax on gasoline would have to rise from the present 9 cents per gallon to $2.56 per gallon merely to counteract the parking subsidy now given to the approximately 54,000 solo drivers in the Los Angeles CBD who park free at their employers' expense.

As the price of travel by any one mode (as measured by monetary costs and time) rises, demand decreases. Demand decreases because of reduced trips or shifts in travel mode or travel time. The objective of this study is to assemble, summarize, and compare previous research showing how employer-paid parking subsidies affect the price of travel and thus commuter mode choice. We review case studies covering a wide range of locations, employers and employees. The assembled studies clearly demonstrate that employer-paid parking greatly increases solo driving, in some cases more than doubling the share who drive to work alone. Further, employers who remove or reduce parking subsidies find that many solo drivers shift to carpools or transit.

Techniques for summarizing the results of the case studies

We use three techniques to summarize and compare the results found in each of the case studies. The first and most direct way to measure the effect of employer-paid parking on commuter travel choices is to compare the *share of commuters who drive to work alone* between conditions where

— the employer pays for employees' parking, and
— employees pay for their own parking.

For example, in one study of commuters to the Civic Center of Los Angeles, 72 percent of employees who received employer-paid parking drove to work alone, while only 40 percent of otherwise similar employees who paid for their own parking drove to work alone (Francis & Groninga 1969).

The second way to measure the effect of employer-paid parking on commuter travel choices is to compare the *number of autos driven to work per 100 employees* between conditions where the employer or the driver

pays for parking.[3] The advantage of this "autos/100 employees" technique is it expresses the effects of employer parking subsidies in a way that reveals the implications for vehicular trip generation rates and parking requirements. For example, when an employer in the mid-Wilshire district of Los Angeles ended parking subsidies for solo drivers, the number of autos driven to work per 100 employees fell from 48 to 30 (Surber et al. 1984).

The third way to measure the effect of employer-paid parking on travel choices is to calculate the *parking price elasticity of demand* for solo driving. The advantage of a price elasticity is that it standardizes the parking price changes in each of cases studies. Elasticities estimate the percentage change in the proportion of solo drivers that results from a one percent change in parking price.[4] Accordingly, we expect to find negative price elasticities, meaning that solo commuting decreases as parking price increases. For example, when an employer at the Warner Center in suburban Los Angeles reduced its parking subsidy for solo drivers from $45 to $15 per month, and thus increased the price of solo driver parking from $0 to $30, the share of solo drivers decreased from 90 percent to 46 percent (Soper 1989). The mid-point parking price elasticity of demand for solo driving for this example is estimated to be −0.32.

How do parking subsidies change mode choice?

The key question in examining parking subsidies is whether there is a clearly established relationship between levels of parking subsidies and commuter behavior. The studies reviewed generally examine the effects of *changes or differences* in the amount of subsidy employers offer.

The strongest evidence demonstrating that employer-paid parking encourages commuters to drive to work alone largely comes from case studies that have either

- examined the commuting behavior of employees *before* and *after* employer-paid parking was eliminated; or
- compared the commuting behavior of matched samples of employees *with* and *without* employer-paid parking.

Both types of studies are of interest. The "before/after" studies show short-term adjustments to changes in parking subsidy. This technique helps to ensure the comparability of the cases. These "before/after" studies are most useful when other employer policies and external conditions are held constant during the comparison period. The "with/without" studies show the long-term adjustment that commuters make to varying

levels of transportation subsidy. Again, the results of these studies are most useful when the effects of other factors affecting mode choice, such as the employer's characteristics, location, and support for ridesharing, are controlled.

Many of the available case studies are from Southern California, but the reader should note that this does not preclude circumstances where substantial transit service is available — three of the case studies are in or near downtown Los Angeles, where bus transit is a reasonable option for many commuters.

This article also reviews studies of parking pricing which either did not provide a basis for "before/after" or "with/without" comparisons, or did not directly concern employee parking subsidies. Finally, commuter surveys that provide insights to the effect of parking subsidies are reviewed.

All the studies reviewed show that ending employer-paid parking greatly reduces solo driving. The degree of influence varies with local conditions, as expected. However, the reduction in solo driving achieved by ending parking subsidies is usually greater than that achieved by providing subsidies to mass transit and ridesharing when parking continues to be subsidized. Table 1 shows how ending employer-paid parking reduces the solo driver share. The smallest reduction in the number of solo drivers was 19 percent and the largest reduction was an impressive 81 percent (in this case the employer eliminated free parking only for solo drivers).

Table 1. How employer parking subsidies affect solo driving.

Case study and type	Solo driver mode share		Decrease in solo drivers
	Employer pays for parking	Driver pays for parking	
Mid Wilshire, Los Angeles (before/after)	42%	8%	−81%
Warner Center, Los Angeles (before/after)	90%	46%	−49%
Century City, Los Angeles (with/without)	92%	75%	−19%
Civic Center, Los Angeles (with/without)	72%	40%	−44%
Downtown Ottawa, Canada (before/after)	35%	28%	−20%
Average of case studies	66%	39%	−41%

Table 2 shows how ending employer-paid parking reduces the number of automobile trips to the site. Because many solo drivers shift to carpools when employers eliminate parking subsidies, the number of autos driven to work does not decline by as much as the number of solo drivers, but

Table 2. How employer parking subsidies affect automobile trips.

Case study and type	Autos driven per 100 employees		Decrease in auto trips
	Employer pays for parking	Driver pays for parking	
Mid Wilshire, Los Angeles (before/after)	48	30	−38%
Warner Center, Los Angeles (before/after)	92	64	−30%
Century City, Los Angeles (with/without)	94	80	−15%
Civic Center, Los Angeles (with/without)	78	50	−36%
Downtown Ottawa, Canada (before/after)	39	32	−18%
Average of case studies	70	51	−27%

the decline is still very impressive, ranging from 15 to 38 percent. *Thus, all the cases show that ending employer-paid parking reduces, and in some cases greatly reduces, both solo driving and automobile trips.*

Overviews

A comprehensive examination of employer parking subsidies is found in *Free Parking as a Transportation Problem* (Shoup & Pickrell 1980), which examined the effect of employer parking subsidies. Using five case studies and six alternative travel models, they show that free parking causes more solo driving. The case studies include three examples in "auto-dependent" Los Angeles — Civic Center employees, Century City employees and UCLA students. All the case studies show that employer-paid parking increases solo driving. The strength of the effect depended on transportation conditions (e.g., parking price, transit service) in the area studied. The study also tested the response of existing mode split models to increases in parking cost. The models all predict decreases in drive-alone commuting. The best model produced results close to the generalized results of the case studies. Based on the models and case studies, the authors conclude that 20 percent fewer employees drive alone to work when they pay to park than when the employer provides free parking.

The study also examined the prevalence of free parking in U.S. cities. Using national data, the authors show that for 93 percent of all auto work trips the driver did not pay for parking. Comparing components of travel cost, Shoup & Pickrell conclude that free parking is a greater incentive to drive alone than an offer of free gasoline. They also find that parking subsidies tend to benefit higher income groups, because of the distribution of subsidies and the effects of tax law.

Before / after studies

Four strong before/after case studies are reviewed in this section. In each case, the employer reduced parking subsidies for commuters who drive alone, and realized dramatic changes in mode split. Table 3 summarizes the mode choice and parking price data assembled, and is followed by a discussion of each case study.

In the first "before / after" case study, Commuter Computer, the non-profit ridesharing agency for Southern California, ended employer-paid parking for its employees who drive to work alone (Surber et al. 1984). The employment site is the mid-Wilshire area near downtown Los Angeles, and has good transit service. Although its employees clearly understood all the arguments in favor of ridesharing and had complete access to all conceivable ridesharing matching facilities, when parking was free to all employees only 17 percent carpooled to work, and 42 percent drove to work alone.

After parking for solo drivers was desubsidized in 1983, the carpool share rose from 17 percent to 58 percent, and the solo driver share fell from 42 percent to 8 percent. This study included a mode survey at a nearby control site, to determine if external factors contributed to the change. There was no change in the mode split at the control site, where the employer continued to offer free parking. Thus, this dramatic change

Table 3. Parking price and mode share data for "before/after" case studies.

Location/organization	Variable	Before (full subsidy)	After (subsidies reduced)	Change
Mid-Wilshire Area (near CBD)	Parking Cost/Mo.	$0	$58	+$58
Los Angeles, CA	Solo Driver	42%	8%	−81%
Mid-sized non-profit	Carpool/Vanpool	17%	58%	+241%
	Transit	38%	28%	−26%
Warner Center (suburban)	Parking Cost/Mo.	$0	$30	+$30
Los Angeles, CA	Solo Driver	90%	46%	−49%
Large private firm	Carpool/Vanpool	6%	48%	+700%
	Transit	0%	0%	0%
Central Business District	Parking Cost/Mo.	$0	$23	+$23
Ottawa, Canada	Solo Driver	35%	28%	−20%
Federal Government	Carpool/Vanpool	11%	11%	0%
	Transit	42%	49%	+17%

in commuting behavior (more than tripling the number of carpoolers and cutting the number of solo drivers to less than one-fifth of the previous figure) can be attributed solely to the desubsidization of parking for solo drivers. The "autos/100 employees" measure dropped from 48 to 30, a 38 percent decrease, and the price elasticity of demand for solo driving is estimated to be −0.68.

It appears that many solo drivers at Commuter Computer responded to the increase in parking cost by recruiting bus riders into carpools. Bus ridership actually fell by 26 percent after solo drivers were charged for parking. This case also confirms growing evidence that employers who provide rideshare incentives while continuing to subsidize solo drivers rarely achieve significant increases in ridesharing.

In the second "before/after" case study, the 20th Century Insurance Company eliminated free parking for solo drivers (Soper 1989). The firm is located in Warner Center, a suburban community in Los Angeles' San Fernando Valley, where transit service is not extensive. This office has a high percentage of female employees and a high percentage of clerical positions. The firm first tried offering traditional rideshare incentives, such as transit and vanpool subsidies, preferential carpool parking spaces and a transportation coordinator, but these programs had almost no effect on mode choice.

In 1989, the firm raised the price of solo driver parking from no charge to two thirds of the market rate ($30 per month) and continued to offer rideshare incentives. A dramatic 49 percent decrease in solo driving was achieved, mostly as the result of increased ridesharing. The "autos/100 employees" measure dropped from 92 to 64, and the price elasticity of demand for solo driving demand is estimated to be −0.32.

A lack of transit service is often cited as a reason why employers subsidize employees' parking at suburban employment locations. The argument is made that sufficient alternatives to solo driving do not exist. However, the 20th Century case study demonstrates that significant changes in mode split can be achieved at suburban locations that lack transit service — carpooling is the underutilized option. After solo driver parking was desubsidized, carpooling was broadly distributed throughout the firm's departments, with the exception of non-participation by the actuary and executive mangement departments. This study did not include a control group at a similar site, but it is highly unlikely that such large mode split changes occurred at employment sites where the parking subsidy policy did not change. A key research question is whether these kinds of improvements can be achieved by smaller suburban employers, and by different types of businesses.

A third "before/after" study in Canada provides further evidence that reducing parking subsidies reduces solo driving (Transport Canada 1978). This study examined the results when the Canadian government stopped providing free parking to its employees in Ottawa in 1974. Ottawa has an all-bus transit system with high ridership levels. Employees were asked to report their travel mode choice before and after the date of the policy change. Although the parking subsidy was not entirely eliminated, the subsidy was reduced from 100 percent to 30 percent of the cost of parking. Based on 3,500+ survey responses and corroborating cordon counts, the study found that 20 percent fewer employees drove to work alone, and 17 percent more were riding transit within a year. Two employees began ice skating to work. The "autos/100 employees" measure fell from 39 to 32, and the price elasticity of demand for solo driving is estimated to be −0.11. Unlike the suburban case studies, the increase in ridesharing was in the form of higher bus patronage, reflecting the good CBD bus service and a trend of improved bus service and patronage in the Ottawa area. No special subsidies to carpools were provided.

Most of the Canadian Federal Government employees who shifted modes did so because of the change in parking subsidies. Contrary to expectations, the shift away from solo driving was greater among higher income male employees. Many of these higher income drivers switched to transit. In addition, the number of women who drove alone *increased* after parking was desubsidized. Both of these unexpected results probably occurred because when parking was free there were not enough spaces for everyone who wanted one, and the available spaces were allocated according to job title or seniority, which meant that the free parking spaces were more likely to go to higher income males. This finding undercuts the claim that it is "unfair" to charge for parking; rather, after parking charges were instituted, men and women were able to compete on a more equal basis for the available spaces, and women took advantage of the new opportunity to bid spaces away from men who had previously parked free.

A fourth before/after study examined the results when the U.S. Federal government raised solo driver parking prices in fifteen central city and suburban facilities in Washington D.C. in 1979 (Miller & Everett 1982). The parking charges were raised from mostly free to one-half the market parking rate. Before the program, parking charges varied from $0 to $15.10 per month; after the prices were raised charges varied from $14.50 to $32.50 per month. Solo driving decreased, but not uniformly. The solo driver share decreased between one and six percent at 11 sites and increased between one and five percent at four sites. The mode shift away from solo driving was measured with before and after surveys, and com-

parisons with control groups. Overall, the effect of the reduced parking subsidy was less than in the other case studies. This case is not summarized in the Tables 1 or 2 because the varied mode shifts and parking prices preclude the usefulness of a single quantitative expression of the results.

The researchers analyzed responses to follow-up surveys to determine the reasons for differences in mode choice among the various sites. They found the following important: locational characteristics (e.g., transit accessibility, on-street parking), existing mode split characteristics, the socioeconomic characteristics of the workforce, and employer-controlled aspects (e.g., number of employer-provided spaces). For example, some locations already had high levels of carpooling, due to a parking permit allocation process that favored carpools. These locations did not experience large mode shifts. In the central city area, price increases had the effect of shifting carpool participants to transit. The single case where solo drivers increased by a significant amount occurred when existing carpoolers shifted to available free on-street parking to avoid the increased parking charge, thereby making available on-site spaces for those who wished to drive alone.

Although the greatest rate of mode change occurred in the lower income categories, the study found cases of large shifts among high income groups. Therefore, higher parking prices are not necessarily a policy change which stratifies high and low income groups into particular modes. Another finding of significance is that workforce size did *not* have much impact on mode shift — for instance, smaller workforces were not at any disadvantage in forming carpools. Finally, the study points to the importance of evaluating unintended effects of parking policy changes, such as creating spill-over parking around the employment site.

With / without comparisons

Comparing mode choice among employers having different parking subsidy policies can also reveal the reaction of commuters to parking costs. The key issue is ensuring the comparability of the comparison groups. Three "with/without" studies are reviewed here; the data are summarized in Table 4.

The first research on the effects of employer-paid parking was done in the Los Angeles Civic Center (Francis & Groninga 1969). This area has relatively good bus transit and moderately high parking prices. In 1969, researchers surveyed a sample of employees of the County of Los Angeles (who received employer-paid parking if they drove to work) and an

Table 4. Parking price and mode share data for "with/without" case studies.

Location/organization	Variable	Full subsidy	No subsidy	Difference
Civic Center (in CBD)	Parking Cost/Mo.	$0	$30	+$30
Los Angeles, CA	Solo Driver	72%	40%	−44%
Federal and county Gov't.	Carpool/Vanpool	16%	27%	+69%
	Transit	12%	33%	+175%
Century City	Parking Cost/Mo.	$0	$30	+$30
Los Angeles, CA	Solo Driver	92%	75%	−19%
Private employers	Carpool/Vanpool	4%	12%	+200%
	Transit	4%	13%	+225%
		Company B	Company A	Difference
Central Business District	Parking Cost/Mo.	$50	$60	+$10
Los Angeles, CA	Solo Driver	48%	49%	+2%
Private employers	Carpool/Vanpool	34%	20%	−41%
(see text for explanation)	Transit	18%	31%	+72%

otherwise similar sample of employees of the Federal government (who paid for their parking if they drove to work). Of the County employees *with* employer-paid parking, 72 percent drove to work alone, while of the Federal employees *without* employer-paid parking, only 40 percent drove to work alone. Thus, the County's offer of employer-paid parking almost doubled the share of its employees who drove to work alone. The "autos/100 employees" measure is 78 for County employees and 50 for Federal employees. The price elasticity of demand for solo driving is estimated to be −0.29.

Francis and Groninga examined the differences in mode share among subgroups of the sample representing income and gender, and found statistically significant differences in each group. Although the groupings do not completely control for factors other than parking price, the consistent differences in commuting behavior in each group show clearly that parking subsidy policy exerts a strong influence.

A 1976 survey of 3,500 employees working in Century City reinforced the importance of parking subsidies on commuter travel choices (Shoup & Pickrell 1980). Century City is a relatively high density, but highly automobile oriented employment center in West Los Angeles. Among employees receiving free parking, 92 percent drove to work alone, compared to a 75 percent solo driver share for those who paid to park. Carpooling and transit ridership increased from four percent for each among those

with employer-paid parking to 12 and 13 percent, respectively, among those who paid to park. The "autos/100 employees" measure dropped from 94 at the firms subsidizing parking, to 80 at firms where the driver paid for parking. The estimated price elasticity of demand for solo driving is −0.10. Controls for the effects of variables other than parking are absent, so the data must be interpreted cautiously.

A more recent study comparing the parking subsidies of two downtown Los Angeles companies also shows the strong impact of offering parking subsidies to solo drivers (Mehranian et al. 1987). The first company, nationally known for its aggressive promotion of ridesharing, subsidizes half the parking cost for solo drivers, three-quarters of the parking cost for two-person carpools, and all the parking cost of carpools of three or more (Company "B"). (Although this subsidy structure is intended to encourage carpooling by increasing the parking subsidy *per auto* as vehicle occupancy increases, it should be noted that the parking subsidy *per employee* decreases as the vehicle occupancy rate increases). The second company has no ridesharing program, but does not provide a parking subsidy to three-quarters of its employees. A partial subsidy is provided to the remaining employees, with no preference to carpoolers (Company "A"). When the mode split of the two companies is compared, the share of solo drivers is almost identical for the two companies.

Because the company with the elaborate plan to subsidize carpooling also continued to subsidize half the cost of parking for all who drove alone, its parking subsidy program primarily shifted commuters from mass transit to carpooling and vanpooling, and thus actually *increased* the number of vehicles driven to work. While the workers of the company with extensive ridesharing and parking benefits no doubt appreciated the commute choices they had, the implication of this finding is that it is difficult or impossible to significantly reduce solo driving by subsidizing carpooling if solo driving also remains subsidized.

The companies were located in the same development, and their employees faced similar transit access and market parking prices. Crosstabulations and chi square tests were conducted to identify possible associations between the characteristics of the companies' workforces and the distribution of their mode choices. No significant differences between the companies were found in travel distances, need for an auto at work, job classifications, and the availability of market rate parking.

Other studies

The studies summarized in this section report on other interesting parking

pricing experiments, but do not provide data on employee parking in a form that permits the comparisons made in the previous sections.

In Seattle, Washington, a major employer moved from downtown Seattle to Bellevue, (a suburban employment center) and maintained low levels of solo driving (Kenyon 1984). Only 19 percent of the employees in the new location were solo drivers, the result of parking supply and pricing limitations ($60 month for parking; limited number of spaces available) and a strong rideshare program. Most workers (51 percent) commuted in carpools of three or more persons.

In downtown Seattle, the city lowered parking charges for carpools of 3+ persons at two city facilities, to encourage mode shifts (Olsson & Miller 1978). Given that many commuters already paid low prices for parking, the lowered price encouraged relatively few solo drivers to form carpools — about one quarter of the users of the discounted carpool spaces were former solo drivers. The study cites a City of Toronto, Canada experiment showing similar results (23 percent of discounted carpool spaces users were former solo drivers). The shift did encourage transit riders to form carpools, and also encouraged shifts from other less convenient but low cost parking locations.

In Madison, Wisconsin a peak period surcharge of $1.00 was instituted in four public parking facilities (Charles River Associates, Inc. 1984). Shifts in travel patterns were studied using a panel of commuters who were surveyed before and after the city imposed the surcharge. Although the surcharge did change the temporal characteristics of parking use, it did not result in substantial carpool formation. The surcharge did result in a five to eight percent switch to transit among a panel of commuters who used that same facility before the surcharge. Commuters frequently shifted parking locations or arrived after the peak period to avoid the surcharge. Morning peak period occupancy in the parking facilities decreased by 40 percent. Although shifts in mode split were not great, the location and temporal shift could be of assistance in congestion reduction efforts. The experiment points out the importance of considering the boundaries and extent of parking pricing efforts (the "surcharge" spaces represented only six percent of total downtown parking spaces).

Higgins & Miller (1981) summarize additional experiments. For example, San Francisco instituted a 25 percent off-street parking tax in the CBD in 1970. It generated substantial funds for the city, mostly coming from parking operator profits rather than increased parking charges. The number of autos parked declined slightly, with substantial variation between facilities. Long-term parkers were more sensitive to the price increase than short-term parkers. Chicago raised parking charges in municipal lots from below market rates to about equal to long-term

market rates. Parking revenues went up, and the number of all-day parkers arriving before 9:30 am dropped by 72 percent. Although mode shifts were not documented, officials believe significant shifts to transit and carpooling occurred. In 1980, Eugene, Oregon raised parking prices at downtown lots by about 100 percent. Monthly permit sales decreased, as some commuters shifted to carpools and a shuttle system. Most others parked in other locations.

Surveys

Most travel surveys do not provide a matched sample of employee and employer responses, which is needed to provide evidence on the relationship between an organization's parking policies and its mode split. However, a few sources do provide the needed information.

A 1985 mail survey of Commuter Transportation Services, Inc. clients probed *employers* on their rideshare policies and their attitudes concerning the same. Most of these firms had collected information on their employees' mode split, so it is possible to relate parking subsidies to mode split. Although the survey was not representative of all firms in Southern California, it demonstrates that parking subsidies lead to more solo driving. Those firms charging no parking fee to solo drivers reported that 77 percent of their employees drove to work alone; employers charging solo drivers $40 or more per month to park reported 52 percent drive-alone commuting. The difference was made up in transit patronage. It is not possible to determine from the report the proportion of the difference attributable to the employer's location (e.g., CBD versus suburban).

A 1986 workplace commute mode survey in downtown Los Angeles provides a matched sample of 118 employers and 5,060 office worker employees (Barton Aschman Associates, Inc. 1986). Willson & Shoup (1990) reanalyzed this data, investigating the effect and prevalence of subsidized parking. When they compared the mode choice of employees who get free parking to the mode choice of those who pay to park, they found that 24 percent fewer commuters drive to work alone if they pay for their own parking. This finding is significant because almost half of the drivers in downtown Los Angeles receive free parking at work. Currently, sixty percent of downtown office commuters are solo drivers; 80 percent of the solo drivers do *not* need their auto at work for work travel purposes.

Another survey collected information on the level of parking subsidies received by auto drivers crossing bridges and tunnels into New York City (Port Authority of New York and New Jersey, 1984). The study confirmed that most auto drivers receive parking subsidies: between 54 and 64 percent of the auto commuters surveyed received parking subsidies.

The survey also collected attitudinal information indicating auto commuters' willingness to shift to transit if public transit fares were subsidized.

Conclusion

This literature review provides strong evidence that employer-paid parking greatly increases solo driving to work, and that ending employer-paid parking significantly decreases solo driving. One might argue that each of the case studies is unique and that findings will not be replicated in other situations. Yet the case studies cover a variety of locations (both downtown and suburban), employer types (public and private) and employee categories (professional and clerical), and the case study results are reinforced by the survey findings. The consistency of the studies is striking. Free parking at work does have an important effect on commuter mode choice — it invites commuters to drive to work alone.

The evidence from the case studies shows that ending employer-paid parking reduces the number of solo drivers by between 19 and 81 percent, and reduces the number of autos driven to work by between 15 and 38 percent. Estimates of the price elasticity of demand for solo driving range between −0.10 and −0.68, meaning that as the after-subsidy price of parking is doubled, solo driving is likely to decrease by between 10 and 68 percent. Such changes can have a major impact on regional mobility.

A critical perception that future research should address is whether employees would really prefer to drive alone if those who do not drive alone were offered a cash travel allowance as an option to employer-paid parking. It is important to note that an employer can offer a cash travel allowance to those who do not drive to work *without* eliminating the offer of employer-paid parking, and yet the offer of cash in lieu of free parking in effect raises the price of parking for all employees from zero to the level of the cash alternative. In this way, the effective price of employee parking can be raised by offering a new fringe benefit (the cash allowance in lieu of free parking) and without reducing any existing fringe benefit.

Another important topic for future research is the connection between parking subsidies and minimum parking requirements in local zoning ordinances. Employer-paid parking increases the amount of parking "demanded," leading jurisdictions to require more parking than a market would support. If local requirements force over-building of parking, they will depress the market price for parking and further increase solo driving. A coordinated approach to reduce both employer-paid parking *and* local parking requirements is needed.

Because employer-paid parking encourages solo driving and discourages carpool and transit use, it increases air pollution, traffic congestion, and energy consumption, and undermines the effectiveness of public investments in transit. Further, ending parking subsidies does not mean a loss in employee benefits if commute allowances are provided. We believe that the harmful consequences of free parking's current status as a "take it or leave it" benefit can no longer be ignored.

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Notes

1. A national survey conducted in 1989 found that 90% of those who drive to work park free (Center for Urban Transportation Research 1989). Commuter Transportation Services Inc. (1988) found that 91% of employees in Los Angeles, Riverside, San Bernardino, and Ventura Counties receive employer-paid parking.
2. The average round trip to work for those who drive to work alone is 35 miles, so at an average fuel efficiency of 20 miles per gallon, the round trip to work requires 1.75 gallons of gasoline: at $1 per gallon, the cost of gasoline for the average round trip to work is $1.75. The number of workers and drive-alone commuters, parking subsidies, and average trip length were calculated from data collected in 1986 for the *Los Angeles Central Business District Employee Travel Baseline Survey* (Barton Aschman Associates, Inc. 1986). The average daily cost of parking was calculated by dividing the weighted average of the CBD monthly parking rate by 21.75 working days per month. The average CBD monthly parking rate was derived from the *Downtown Los Angeles Parking Price Survey* (Anil Verma Associates 1986).
3. The number of automobiles driven to work per 100 commuters incorporates the effect of employer-paid parking subsidies not only on the number of employees who drive to work solo, but also on the number who carpool, ride public transit, walk and bike to work. Most of the case studies surveyed include information on the share of employees who carpool, but not on the average carpool size. In order to estimate the number of cars driven to work by carpoolers, we used the figure of one vehicle per 2.62 carpool/vanpool commuters, which was found in the 1988 *Commuter Survey* of Southern California commuters conducted by Commuter Transportation Services, Inc. We also tested the sensitivity of the measure to larger and smaller carpool sizes, and found that the results generally varied no more than 5 percent.
4. This measure estimates elasticity of demand for single occupancy commuting with respect to parking price. The elasticity is calculated as follows. The numerator is the difference in percentage of solo drivers between when the employer pays and when the driver pays for parking, divided by average percentage of solo drivers in the two instances. The denominator is the difference in price paid by the commuter between

when the employer pays and when the driver pays for parking, divided by the average price to commuters in both instances. The outcome of this calculation indicates the percentage change in solo driving expected given a one percent increase in parking cost. This "midpoint" estimate approximates the average elasticity along a demand curve.

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