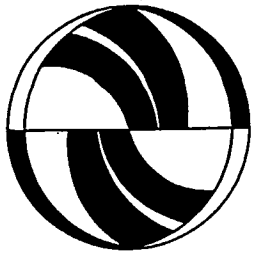

Parking Subsidies and Travel Choices: Assessing the Evidence

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Parking subsidies and travel choices: Assessing the evidence

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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		
	Employer pays for parking	Driver pays for parking	Decrease in auto trips
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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