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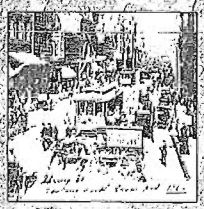

C O N T E N T S

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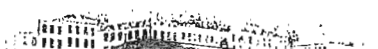
Front cover (background): Florence, Italy.



PREFACE

The first issue of ACCESS seems to have been well received, so we're pleased to continue these summaries of our research. Paralleling the spurt of work on new transportation technology, there's been renewed attention to institutional means for improving the nation's transport system. We focus here on several such fiscal and organizational tools for decreasing solo driving, increasing transit riding, and thereby reducing highway congestion, air pollution, and energy consumption.

Don Shoup has been resolutely examining the effects of employer-paid parking and finds it a major cause of solo commuting. The California Legislature has now adopted his ingenious scheme for discouraging drive-alone commuting through cash payments in lieu of free parking. Here he's proposing a revision in the U.S. Internal Revenue Code with a similar scheme that promises large benefits, presumably without opening new tax loopholes.

His article is followed by three that explore various road-pricing schemes. Ken Small explores the idea of congestion pricing—its theoretic rationale and its likely economic, political, and social outcomes. Dan Klein summarizes the history of the old toll roads in America, suggesting it offers lessons for the impending development of new roads. In turn, Pete Fielding invites colleagues elsewhere to join in monitoring the effects of new highways in Orange County that will employ both tolls and congestion prices as traffic-mitigation and revenue-raising measures.

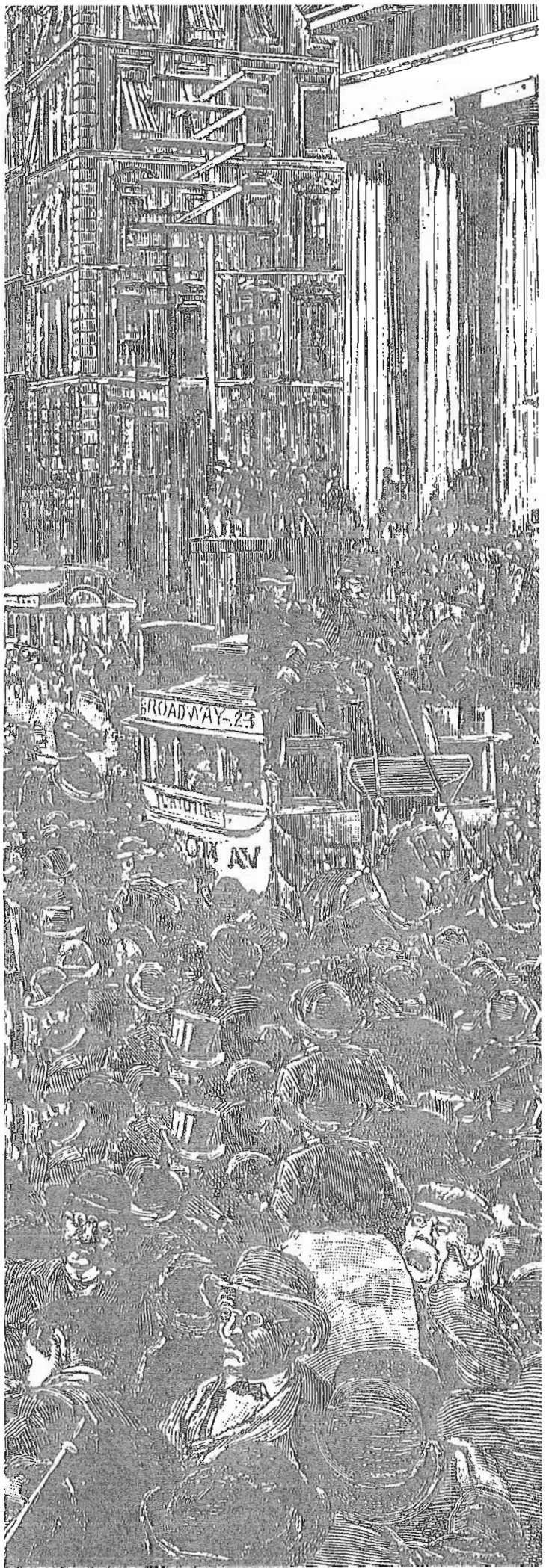
Robert Cervero's search for inducements to transit riding necessarily focuses on the suburbs where growth is most rapid. Suburban commuters' origins, destinations, and schedules don't match the operating characteristics of large-vehicle transit systems. So he explores some promising prospects for transit systems that operate more nearly like automobiles. In turn, Patricia Mokhtarian examines the travel and living patterns of those who are giving up on full-time commuting and have taken to working some days at home.

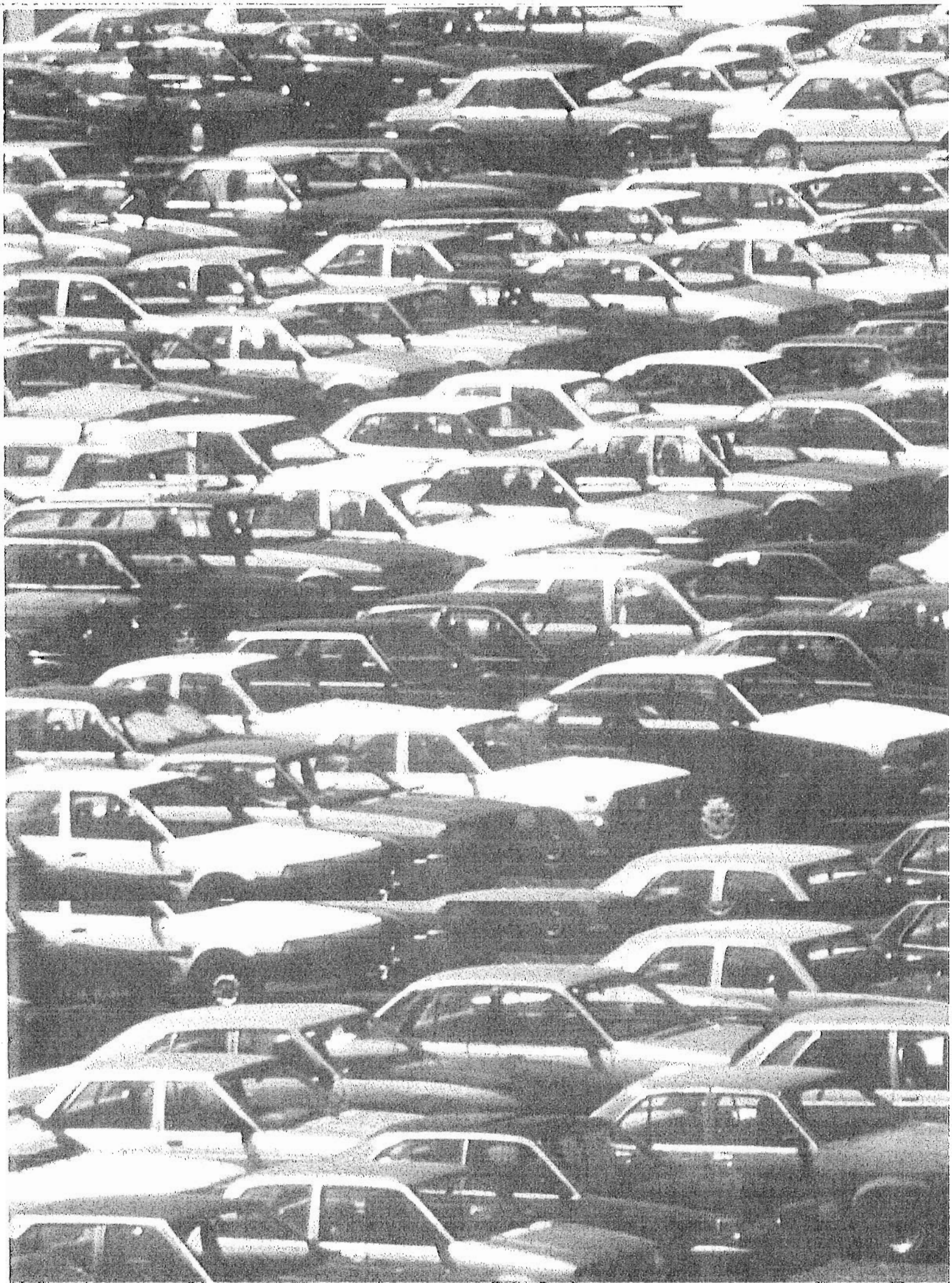
Although these approaches are basically institutional in character, some nevertheless rely on new technologies as well. Congestion pricing and toll collections now employ roadside electronic sensors reading charge cards in moving vehicles. In turn, the systems rely on sensors and computers that can monitor traffic volumes and modulate prices to accord. Cervero's fancy demand-responsive transit vehicles rely on satellites to sense their locations and help dispatch them efficiently. And, of course, many of Mokhtarian's

in moving vehicles. In turn, the systems rely on sensors and computers that can monitor traffic volumes and modulate prices to accord. Cervero's fancy demand-responsive transit vehicles rely on satellites to sense their locations and help dispatch them efficiently. And, of course, many of Mokhtarian's telecommuters are using computers, phones, and faxes in their daily work.

It's evident that there's a place for all sorts of researchers and designers in this enterprise. With the encouragement of the U.S. Department of Transportation and the California Department of Transportation (Caltrans), we here look forward to working with more and more of our colleagues in diverse disciplines and professions. And then, we plan to report on more of their research in future issues of ACCESS.

Melvin M. Webber
Center Director





Cashing Out Employer-Paid Parking

BY DONALD C. SHOUP

Employer-paid parking is an invitation to drive to work alone. Thus, it increases traffic congestion, air pollution, and energy consumption. To deal with problems created by employer-paid parking, I propose a minor technical change in the Internal Revenue Code. The proposal is that employers who subsidize employee parking should be required to offer employees the *option* to take a taxable cash travel allowance equal to the fair market value of the parking subsidy. Case studies and a statistical model suggest that offering employees the *option* to cash out their parking subsidies could reduce solo driving to work by 20 percent, reduce automobile travel to work by 76 billion
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miles per year, save 4.5 billion gallons of gasoline per year, eliminate 40 million metric tons of CO_2 emissions per year, and increase tax revenues by $1.2 billion per year. These objectives would be accomplished by offering commuters the *option* to take taxable cash in lieu of a free parking space. ➢

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Employer-Paid Parking Encourages Solo Driving

Employer-paid parking is a matching grant: employers offer to pay the cost of parking if employees are willing to pay all the other costs of driving to work. Evidence from a variety of sources, including the 1990 Nationwide Personal Transportation Survey, shows that at least ninety percent of American commuters who drive to work pay nothing to park.

How strongly does employer-paid parking encourage solo driving to work? For the 50,000 solo drivers who receive employer-paid parking in downtown Los Angeles, the average parking subsidy is equivalent to 11 cents per mile driven. Their average parking subsidy is 16 times greater than the federal gasoline tax they pay for their commute trip. Thus, even an improbably huge increase in the gasoline tax would discourage fewer solo commute trips than free parking now encourages. Finally the average subsidy for commuter parking in downtown Los Angeles is almost 50 percent greater than the total cost of gasoline for the average commute trip. An employer's offer of free gasoline for all employees who drive to work would be recognized as an environmental outrage, yet employer-paid parking is a much stronger financial incentive to drive to work.

Table 1 summarizes the results of well-documented case studies of how employer-paid parking stimulates solo driving to work. On average, employer-paid parking shifts 27 percent of all commuters into solo driving from other modes and stimulates 19 more cars to be driven to work for every 100 employees. Among solo drivers whose employers offer free parking, 41 percent drive solo *only* because their employers pay for the parking.

A survey of 5,000 commuters and their employers in downtown Los Angeles shows that employers spend $4.10 on parking subsidies for every $1 employees save on the total cost of parking *and* driving. This surprising disproportion between the large amount that employers pay for parking and the small amount that employees save on the total cost of parking *and* driving occurs because employer-paid parking so strongly stimulates spending on both parking *and* driving: the stimulus to parking demand inflates what employers must pay for parking, and the stimulus to solo driving diminishes what employees save on their total cost of parking *and* driving. On average, employer-paid parking stimulates a 33 percent increase in vehicle miles traveled to work per employee per year.

TABLE 1

Employer-Paid Parking Stimulates Solo Driving to Work

	SOLO DRIVER MODE SHARE			CARS DRIVEN TO WORK PER 100 EMPLOYEES			
CASE STUDY LOCATION	*DRIVER* Pays for Parking	*EMPLOYER* Pays for Parking	Stimulated Increase In Solo Share	*DRIVER* Pays for Parking	*EMPLOYER* Pays for Parking	Stimulated Increase In Auto Trips	Price Elasticity of Demand
Mid-Wilshire, Los Angeles	8%	42%	+34%	30	48	+18	-0.23
Warner Center, Los Angeles	46%	90%	+44%	64	92	+28	-0.18
Century City, Los Angeles	75%	92%	+17%	80	94	+14	-0.08
Civic Center, Los Angeles	40%	72%	+32%	50	78	+28	-0.22
Downtown Ottawa, Canada	28%	35%	+7%	32	39	+7	-0.10

The Internal Revenue Code Encourages Employer-Paid Parking

The Internal Revenue Code classifies an employer's payment for an employee's parking as a tax-exempt fringe benefit for the employee. But if the employee pays for parking at work, the Code does not allow the employee to deduct the parking charge as a work-related expense. Therefore, to take advantage of the tax-exemption for commuter parking, the employer must pay for the employee's parking. The Code exempts employer-paid parking from more than just the Federal income tax. The exemption is automatically extended to Social Security taxes, state income taxes, unemployment insurance taxes, and all other payroll taxes. When these related exemptions are taken into account, $1 of employer-paid parking is worth more than $2 in taxable cash wage income for many employees. Therefore, the Code's peculiar asymmetrical tax exemption for *employer*-paid (but not for *employee*-paid) parking is a clear and strong financial incentive that has inadvertently shifted the responsibility for paying for almost all commuter parking entirely from the employee to the employer, and has thus reduced the employee's parking cost to zero.

No other fringe benefit is tax-exempt when paid for by the employer but taxable when paid for by the employee. Thus, the tax exemption for *employer*-paid parking subsidies is a unique, deliberate, and specially targeted tax subsidy that has the unfortunate, unintended, and largely unnoticed effect of stimulating a huge increase in the number of commuters who drive to work alone.

Cashing Out Employer-Paid Parking

Ridesharing and mass transit advocates have argued for years to end this tax bias because it aggravates traffic congestion and air pollution, and stimulates gasoline consumption. But eliminating a tax exemption that benefits so many workers—at all income levels—is politically difficult. Thus, it seems quixotic to try to eliminate the special tax exemption for employer-paid parking, no matter how much harm it does.

Given the general popularity of employer-paid parking subsidies, a long step in the right direction would be to amend the Internal Revenue Code's definition of tax-exempt "qualified parking," as follows:

QUALIFIED PARKING— The term "qualified parking" means parking provided to an employee on or near the business premises of the employer ... *if the employer offers the employee the option to receive, in lieu of the parking, the fair market value of the parking, either as a taxable cash commute allowance or as a mass transit or ridesharing subsidy.*

The text in roman type is the existing definition of tax-exempt "qualified parking" in Paragraph (5) of Section 132(f) of the Internal Revenue Code, and the italic text is the proposed amendment.

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This amendment retains the popular tax exemption for employer-paid parking but would require that employers offer their employees the option of cash or a mass transit or ridesharing subsidy in lieu of the tax-exempt parking. The proposal has several important advantages:

1. Free Parking Will Have an Opportunity Cost. When commuters are offered the choice between free parking or nothing, the parking has no opportunity cost and is therefore over-used. But asking commuters to choose between a free parking space *or its cash value* makes it clear that parking has a cost, which is the cash not taken. The new ➢

"price" for taking the "free" parking would increase the perceived cost of solo driving to work.

2. Cashing Out Will Benefit Employees. Offering employees the option to cash out employer-paid parking subsidies avoids the seemingly intractable problem that voters don't like new taxes and motorists don't like to pay for parking they used to get free. Employers could continue to offer tax-exempt parking subsidies, so long as they broadened the offer. Cashing out *adds* a new alternative to the typical take-it-or-leave-it choice between a parking subsidy or nothing.

3. Cashing Out Will Cost Employers Little or Nothing. Compared to other solutions to the employer-paid parking problem, the cash-option requirement is least intrusive in the employer's decisions about employee compensation. The requirement is only that if an employer offers to subsidize commuting expenses, use of the subsidy cannot be confined to parking (and thus driving to work). The only added cost for an employer would occur in the unusual case of current ridesharers who are now offered the choice between free parking or nothing and yet do not take the parking. These current ridesharers would have to be offered the cash value of the parking subsidies they have not taken. But there can be only a very small percentage of employees who are now offered a parking subsidy but do not take it. The 1990 Nationwide Personal Transportation Survey found that 91 percent of the American work force commutes to work by car. And one reason that many of the remaining 9 percent do not commute by car is probably that they are among the few employees who are not offered employer-paid parking (and who therefore would not have to be offered the in-lieu cash). Of those very few who are now offered free parking but do not take it, some are already offered an alternative ridesharing subsidy (such as a bus pass), and for these employees the employer's cost of the cash option would be the only difference (if any) between the cash option and the cost of the existing rideshare subsidy. Thus, the employers' added cost of offering cash in lieu of parking subsidies would have to be inconsequential.

4. Cashing Out Will Especially Benefit Low-Income and Disabled Employees. Because they are in the lowest tax brackets, the lowest paid workers would gain the most after-tax cash from a taxable tax allowance. Also, the cash allowance would be larger in proportion to a lower income, so the cash option would clearly improve the relative well-being of the lowest paid workers. Disabled employees and others who cannot drive a car will also benefit from the option to choose cash in lieu of a parking subsidy.

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5. Cashing Out Will Strengthen Central Business Districts. Employer-paid parking simply equalizes the cost of parking between downtown and suburban work sites (by making it free in both places) and does nothing to make downtown superior to a suburban location. Because downtown employers must pay more than suburban employers to provide employee parking, however, downtown employers could offer more cash in lieu of a parking space without any increase in their cost. This higher cash option for downtown employees would make downtown work sites relatively more attractive than suburban work sites, at least for those who rideshare. Downtown employees could more easily take advantage of the cash option by shifting to mass transit. Also, because a high den-

sity of employment implies a high density of potential fellow carpoolers, downtown employees could more easily shift to carpools. Finally, parking spaces vacated by new carpoolers would be a boon to visitors, including shoppers, business clients, and tourists.

6. Cashing Out Will Yield a Tax Revenue Windfall. In making the choice between a parking subsidy or its cash value, commuters would have to consider that the cash is taxable, while the parking subsidy is not. When a commuter does voluntarily choose taxable cash rather than a tax-exempt parking subsidy, federal and state income tax revenues increase. With very conservative assumptions, I have estimated that offering employees the *option* to cash out employer-paid parking subsidies would increase federal and state tax revenues by at least $1.2 billion a year. This increase in tax payments does not result from an increase in tax rates, or from taxation of previously tax-exempt parking subsidies. Rather, it results from voluntary action: cashing out an inefficient in-kind parking subsidy that costs the employer more to provide than the employee thinks it is worth. Put most simply, cashing out an inefficient parking subsidy converts economic waste into increased tax revenue and increased employee welfare, at no extra cost to the employer. This tax revenue windfall is an additional benefit above and beyond the reductions in air pollution, traffic congestion, and energy use.

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The Results of Cashing Out Employer-Paid Parking

Table 2 shows estimates of how offering the option to cash out parking subsidies would affect commuters' travel behavior. A mode-choice model was estimated with data from a survey of 5,000 commuters and their employers in downtown Los Angeles. The model suggests that offering the option of a taxable cash travel allowance to employees who now park free in downtown Los Angeles would reduce their solo share from the current 69 percent to 55 percent. This mode shift would reduce automobile commuting by 847 VMT per commuter per year and would reduce gas consumption for automobile commuting by 50 gallons per commuter per year.

TRAVEL BEHAVIOR	Driver Pays for Parking	Employer Pays for Parking WITH Cash Option	Employer Pays for Parking WITHOUT Cash Option	Effect of Cash Option
Solo Driver Share	48%	55%	69%	-14%
Vehicle Miles Traveled (per Employee per Day)	18.1	20.2	24.1	-3.9
Vehicle Miles Traveled (per Employee per Year)	3,919	4,383	5,230	-847
Gasoline Consumed (Gallons per Employee per Year)	231	258	308	-50

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TABLE 2

Commuters' Responses to the Cash Option for Travel to the Los Angeles Central Business District

Although it's risky to extrapolate from one city to the rest of the country, we can illustrate the implications of what has been found in Los Angeles. Approximately 90 million commuters park free at work in the United States. If all these commuters respond to the cash option as has been estimated for Los Angeles, automobile use for commuting would decrease by 76 billion VMT a year, and gasoline consumption would decrease by 4.5 billion gallons a year. Obviously, these estimates can suggest only general magnitudes and must be viewed cautiously.

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Experience of Firms That Offer Their Employees the Cash Option

A survey of the few firms that already offer employees the cash option shows that it is simple and cheap to administer, ➢

particularly in comparison with other ridesharing incentives employers offer. A detailed case study shows how one firm was able to offer all its employees the option to cash out their parking subsidies without increasing the firm's total cost of subsidizing.

California's New Parking Cash-Out Legislation

The Federal Internal Revenue Code creates a strong incentive for employers to pay for their employees' parking and thus a strong incentive for commuters to drive to work alone. States and localities are then left with the enormous problem of devising policies to deal with the resulting traffic congestion and air pollution. The State of California has recently enacted legislation (AB 2109) that directly addresses the problems caused by employer-paid parking and that serves as a model of how the Federal government could address the same problems. Briefly, the new California cash-out legislation requires employers of 50 or more persons who provide a parking subsidy to employees 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. "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 the use of that space.*

Note that the employer must offer an employee the option to take cash in lieu of a parking subsidy *only* if the employer makes an explicit cash payment to a third party to subsidize the employee's parking. Therefore the employer clearly saves the cash paid for the parking subsidy if the employee takes the cash allowance instead. The employer's avoided parking subsidy directly funds, dollar for dollar, the employee's cash allowance, so there is *no net cost* for the employer when an employee forgoes the parking and takes the cash. The employer must offer the cash allowance *only* to each employee who is offered a parking subsidy. And each employee's cash allowance is equal to the parking subsidy offered to *that* employee, so if some employees are offered smaller parking subsidies than other employees, their required cash allowance would also be smaller. Thus, the law is tightly written to avoid imposing a net cost on employers.

The California cash-out legislation also reduces the burden of parking requirements on new development by mandating that:

> *The city or county in which a commercial development will implement a parking cash-out program...shall grant to that development an appropriate reduction in the parking requirements otherwise in effect for new commercial development.*

Data derived from case studies and from a statistical model were used to estimate that cashing out employer-paid parking would reduce parking requirements for new develop-

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Data derived from case studies and from a statistical model were used to estimate that cashing out employer-paid parking would reduce parking requirements for new development by at least 17 percent.

Implications for Federal Action

California's cash-out legislation shows that it is feasible to require that employers who pay for parking if an employee drives to work must offer to pay the same amount if the employee rideshares to work. Some employers will undoubtedly encounter problems in adjusting to the cash-out requirement, but the new legislation will merely expose, not create, most of these problems. The real challenge for many employers will be to abandon the outdated notion that the best way to help employees get to work is to pay for their parking.

California's experience suggests that, at the Federal level, it is sensible to proceed cautiously, beginning first with the requirement to offer cash in lieu of a parking subsidy only in the clearest "win-win" case where the employer pays out-of-pocket cash to a third party to subsidize employee parking. Later, after employers have been given sufficient advance notice to adjust to the emergence of a parking market where spaces are allocated by prices rather than by subsidies, the cash-out requirement could be extended to all employer-paid parking. To repeat, however, the proposed cash-out requirement does not prohibit, tax, or discourage any employer-paid parking subsidy. Rather, the proposal is simply that an employer who offers to pay for an employee's parking *if the employee drives to work* must also offer to pay the same amount *if the employee rideshares to work.*

Because cash is taxable and a parking subsidy is tax-exempt, offering employees the option to cash out parking subsidies will reduce solo driving to work by less than would ending parking subsidies altogether. However, the research on commuters in Los Angeles suggests that the taxable nature of cash does not seriously diminish its attractiveness. Requiring employers to offer employees the *option* to cash out their parking subsidies will reduce traffic congestion, improve air quality, conserve gasoline, enhance employee welfare without adding to employers' costs, and increase tax revenue without increasing tax rates. All these benefits will derive simply from subsidizing *people*, not *parking.* ♦

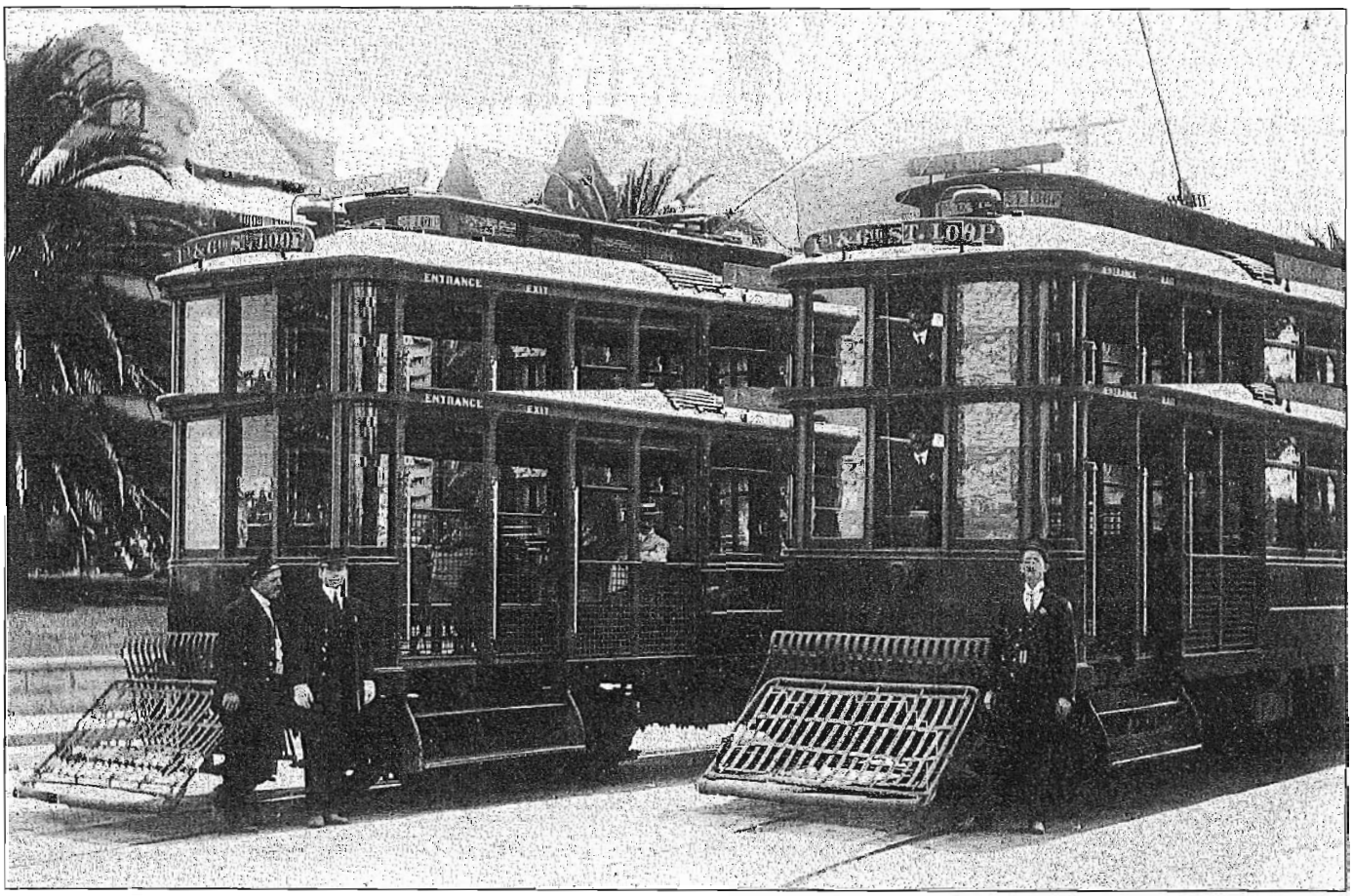
REFERENCES

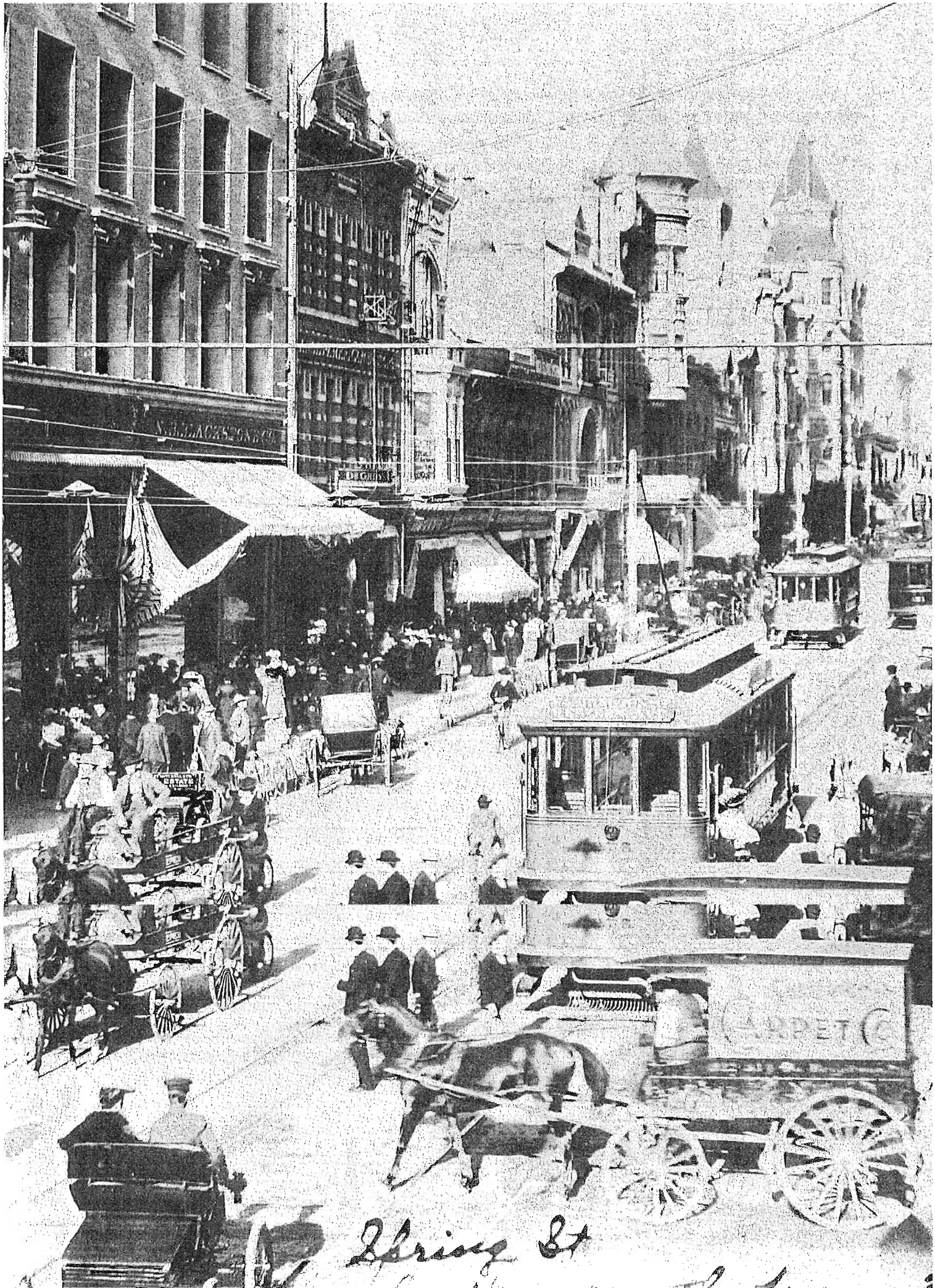
Donald Shoup, *Cashing Out Employer-Paid Parking*, Publication No. FTA-CA-11-0035-92-1, Washington, D.C.: U.S. Department of Transportation, 1992. (This is the full 155-page report of the material summarized in this article. To request a free copy, write to Office of Technical Assistance and Safety, Federal Transit Administration, U.S. Department of Transportation, 400 Seventh St., S.W., Washington, D.C. 20590.) UCTC No. 140

Donald Shoup and Don Pickrell, *Free Parking as a Transportation Problem*, Washington D.C.: U.S. Department of Transportation, 1980.

Donald Shoup and Richard Willson, "Employer-Paid Parking: the Problem and Proposed Solutions," *Transportation Quarterly*, Vol.46, No.2, April 1992, pp. 169-192. UCTC No. 119.

Richard Willson and Donald Shoup, "Parking Subsidies and Travel Choices: Assessing the Evidence," *Transportation*, Vol. 17,1990, pp.141-157. UCTC No. 34.

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CONGESTION PRICING: NEW LIFE FOR AN OLD IDEA?

BY KENNETH A. SMALL

Driven by problems of traffic congestion, U.S. policy toward urban highways has lurched over several decades from highway building to high-occupancy-vehicle lanes to travel demand management. Yet congestion has worsened, and there is scant evidence that these policies have had any appreciable effect on it. As financial straits tighten, policy analysts are looking for new solutions.

Meanwhile, economists have been polishing up a long-standing proposal known as congestion pricing. Under this policy, drivers would have to pay a very high fee for driving on the most popular roads during peak hours. We already expect to pay top price for long-distance phone calls during business hours, and many of us wait for discounts at night. But can the same concept work for highways?

Economists, policy analysts, transportation planners, and politicians in Europe and Asia, as well as in the United States, are warming up to the idea. Singapore's remains the outstanding peak-hour pricing scheme, in effect since 1975. On a smaller scale, France began last year to apply congestion pricing to Sunday traffic on the A1 motorway into Paris. Britain has embarked on a third and massive study for London. In Hong Kong, Norway, Sweden, the Netherlands, and Cambridge, England, politicians have nearly (but not quite) signed off on trials. In South America, the government of Chile is seriously considering it.

In the United States, the 1991 highway reauthorization bill provided $150 million for up to five demonstration projects of congestion pricing; applications for projects in sixteen different locations have been received by the Federal Highway Administration. Separately, two private consortia are planning to use congestion pricing on California highway projects recently approved under Assembly Bill 680. One of these, scheduled for construction this year, is a four-lane road in the median of the existing Riverside Freeway southeast of Los Angeles (see Fielding's article on p.22). This highway will be open only to cars with electronic tags that permit nonstop payment. The charge for the entire 10-mile stretch is likely to vary in fine increments from an off-peak rate of 50 cents to a peak rate of $2.50, with free or discounted passage for carpools.

Why the sudden interest? Are the formidable barriers to public acceptance about to be overcome? What would congestion pricing accomplish, and how would various segments of the urban population be affected? Answering these questions points to the causes of congestion and to the reasons various other policies cannot succeed.

THE FAILURES OF CONGESTION POLICY

Congestion occurs when there is an imbalance between the supply of highway capacity and the demand for highway travel. Most suggested remedies attempt to reduce this imbalance by either increasing supply or reducing demand. Among those aimed at sup-

Congestion occurs when there is an imbalance between the supply of highway capacity and the demand for highway travel. Most suggested remedies attempt to reduce this imbalance by either increasing supply or reducing demand. Among those aimed at supply are the construction or widening of highways, improved signal timing, and (in the future) electronic sensors to allow closer vehicle spacings. These policies are costly in public outlays. Among policies aimed at demand are parking controls, ridesharing promotion, mass transit, employer-based commuting requirements, staggered work hours, telecommuting, and measures to reduce jobs-housing imbalance. These tend to be costly in behavioral compliance.

Even when such policies successfully add to capacity or change behavior, they do not necessarily eliminate severe congestion. That's because the newly uncongested highways inspire people to use them even more. Respectable people who used to shun anti-social activities like driving to work alone find reasons to join the immoral majority. ➢

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New workers, people who just moved, yuppies with new families—all sorts of people in changed circumstances—find, in greater numbers than before, that solo driving during peak hours is just what they need to juggle their complex lives.

This perverse reaction is not accidental. It arises because the current equilibrium in any large congested city is maintained by an unholy but remarkably stable balance. Congestion itself deters many people from traveling when and where they would otherwise prefer—on busy streets and highways during peak hours. This reservoir of potential peak-period drivers is a sort of reserve army of the unfulfilled, more prosaically known as *latent demand.* As soon as additional road space appears because of a policy "success," it is appropriated by someone who previously was part of that latent demand.

This is not to say that conventional congestion policy has no value. On the contrary, fulfilling the desires of latent demanders for more convenient travel is a genuine and important benefit. But the policy does *not* eliminate congestion, or even reduce it much, in those situations where substantial latent demand has built up. At best it may reduce the duration of congestion, since one component of latent demand is people traveling just outside the peak period who would rather travel during it.

THE ROLE OF CONGESTION PRICING

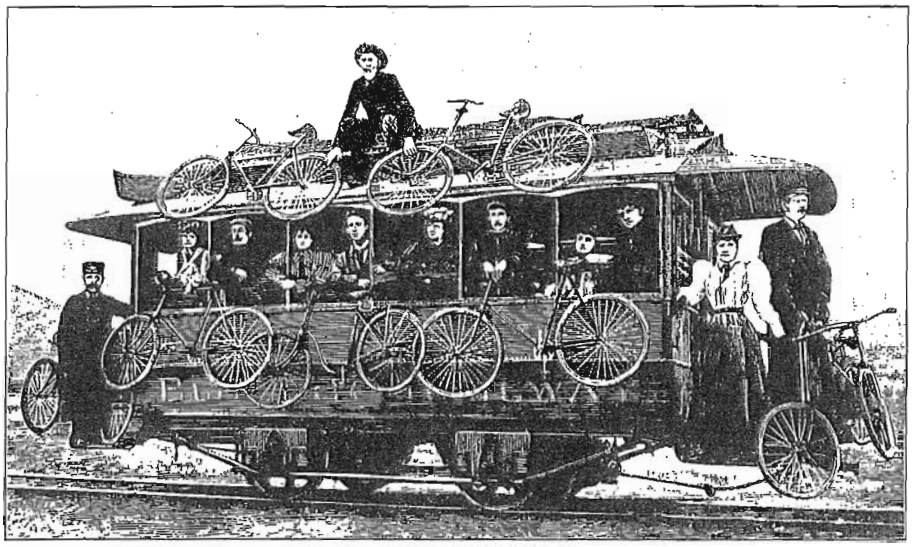
Congestion pricing is an alternative policy which breaks this cycle by using money—instead of congestion delay—to ration scarce capacity. Not only does this continue to deter the latent demanders, but it also allows the cost of the deterrence—tolls paid—to be resurrected in other, socially useful, forms. Time spent in congestion delay is lost forever. But tolls paid by travelers are revenue to some public or private organization: revenue that can be spent on something useful, or just substituted for some other revenue source. The real resources expended in a congestion-pricing scheme are limited to toll-collection costs and with today's technology, these are minimal.

Congestion pricing differs from other demand-side policies by addressing its incentives to *all* highway users, not just a fraction of them. For example, parking charges deter trips destined to an area but do not affect through trips; mass transit entices those well served by it but not those who could more easily carpool or travel off peak.

For a policy properly to be called congestion pricing, it must be carefully targeted at congestion. Two characteristics are therefore necessary. First, the toll charged must vary significantly by time of day, so that off-peak travel is not discouraged. Second, the rush hour toll must be high enough to make serious inroads into peak demand, enough to reduce congestion significantly. This is not as hard as it might seem because people may consider a number of alternatives to peak-hour driving, as illustrated by the variety of

significantly by time of day, so that off-peak travel is not discouraged. Second, the rush hour toll must be high enough to make serious inroads into peak demand, enough to reduce congestion significantly. This is not as hard as it might seem because people may consider a number of alternatives to peak-hour driving, as illustrated by the variety of demand-side policies attempting to get people to change their commuting patterns. Congestion pricing promotes all alternatives to peak-hour driving, but leaves it to the user to decide which is best (assuming, of course, that suppliers are allowed to add or expand the necessary services).

Congestion pricing is therefore just one of a broader array of policies, known as *road pricing*, which use fees to influence travel behavior. Examples are conventional road tolls, fuel taxes, and parking fees. Indeed, congestion pricing can be viewed as a variant of conventional road tolls, but its purpose is fundamentally different: it is aimed primarily



at peak-hour congestion relief, not infrastructure finance or environmental protection. It is important to keep these goals distinct because, even though certain policies may work in the same direction for all three goals, a single policy cannot be expected to achieve all of them satisfactorily.

POLITICAL FEASIBILITY: THE INFRASTRUCTURE CONNECTION

Congestion pricing is a politician's nightmare. Charging people for what was free is no more popular in the United States than in Russia, and the efficiency rationale for congestion pricing in Los Angeles is no more obvious than that for raising the price of sugar in St. Petersburg. So why does congestion pricing seem to have new life as a policy option?

Several factors combine to give currency to the unthinkable. Technology now enables toll collection to be non-intrusive and easy for the traveler. With toll roads already seen as needed for financial viability, this technology invites taking the next step and fine-tuning the tolls for purposes of demand management and revenue enhancement. Perhaps most important, the failure of current policies to relieve congestion gives new allure to more drastic options.

However, the current interest in congestion pricing emerged in the market-oriented Bush administration. After all, the concept's greatest appeal is to high-income people who greatly value their time. How should it be viewed in the context of a more populist economic agenda?

However, the current interest in congestion pricing emerged in the market-oriented Bush administration. After all, the concept's greatest appeal is to high-income people who greatly value their time. How should it be viewed in the context of a more populist economic agenda?

The answer may be found in one of the few areas of consensus across the political spectrum: the need for infrastructure improvements. At present, this need seems in direct conflict with budgetary imperatives. Congestion pricing offers a surprising resolution to this dilemma. Not only does it raise revenue, it also reduces one of the most expensive infrastructure needs: expanded highway capacity. By reducing peak demand, it would enable highway planners to scale back their proposals, creating financial, land-use, and environmental benefits in the process. ➢

A PACKAGE OF REVENUE USES FOR THE LOS ANGELES REGION

PROGRAM	ANNUAL AMOUNT ($ MILLIONS)
REIMBURSEMENTS TO TRAVELERS	
1- Employee Commuting Allowance ($10/mo.)	695
2- Fuel Tax Reduction (5 cents/gal.)	350
GENERAL TAX REDUCTIONS	
3- Sales Tax Reduction (1/2 of Transportation Surcharge)	525
4- Property Tax Rebate (Eliminate Local Highway Subsidy)	465
NEW TRANSPORTATION SERVICES	
5- Highway Improvements	315
6- Transit Improvements	310
7- Transportation Services in Business Centers	320
TOTAL (Net Revenue)	2,980
Collection Costs	140
TOTAL (Gross Revenue)	3,120

A

TABLE 1

Source:
Author's estimates, based in part on data from the U.S. Federal Highway Administration, California Department of Transportation, and California State Board of Equalization.
For details see Small, 1993.

Board of Equalization.
For details see Small, 1993.

For example, an eight-lane freeway proposed to relieve suburban congestion might be found to require only six lanes if it were priced at peak hours. If other highways were priced also, thereby cutting peak traffic throughout the region, perhaps four new lanes would do. In this way, each dollar spent on infrastructure accomplishes more in terms of providing accessibility. Meanwhile the revenues can be funneled back to citizens in the form of tax relief or publicly supported expenditures.

No one should underestimate the political difficulties in accomplishing such a transformation of transportation policy. For the immediate future, the most we can hope for is aggressive pursuit of demonstration projects that provide lessons on both implementation and on public acceptance.

In the longer run, however, technology will drive policy and make some form of congestion pricing almost a certainty. Electronic road pricing has been thoroughly tested in Hong Kong and is now used on many toll roads in the United States and elsewhere. Toll authorities in New York, New Jersey, and Pennsylvania have agreed to develop common technology for electronic toll collection, which will result in millions of cars being equipped with devices that simplify toll payments. From there, it's an easy technical step to collect tolls differentiated by time of day.

Inevitably, the potential of time-varying tolls to increase revenues and reduce infrastructure requirements will lead to experimentation. Consider just the revenue potential. Suppose a toll road is proposed parallel to a congested free road, but construction financing is questionable. With a constant all-day toll rate, setting the rate too high could cause most off-peak traffic to use the parallel road, making it impossible to raise enough revenue. But if the toll can be differentiated, the rate during peak hours can be adjusted so as to limit traffic just enough to maintain a time advantage over the congested free road, while still bringing in plenty of revenue. At the same time, off-peak tolls can be kept lower so that patronage is maintained and some supplementary revenue brought in.

DISTRIBUTIONAL EFFECTS: IS IT FAIR?

Congestion pricing could have significant effects on the distribution of real incomes. The complexity of the induced shifts in labor, housing, and land markets makes them difficult to predict. Nevertheless, the direct effects would be relatively unfavorable to low income people. Low-income people use roads almost as much as wealthier people, but they cannot as readily spare the money to save time. This anticipated result is a significant political barrier to enactment as well as a problem to be addressed in designing a policy.

The full distributional effects, however, can be judged only by looking at outcomes of the entire program, including how revenues are spent. If revenues are spent mainly on

they cannot as readily spare the money to save time. This anticipated result is a significant political barrier to enactment as well as a problem to be addressed in designing a policy.

The full distributional effects, however, can be judged only by looking at outcomes of the entire program, including how revenues are spent. If revenues are spent mainly on services for affluent suburbs, the net result would surely be regressive; but if they are redirected so as to help lower-income people, for example by fuel-tax relief or improving inner cities, the package could well be neutral or even slightly progressive in its impact. More generally, revenues can be used to offset the adverse effects on a number of groups such as commuters or inner-city business owners.

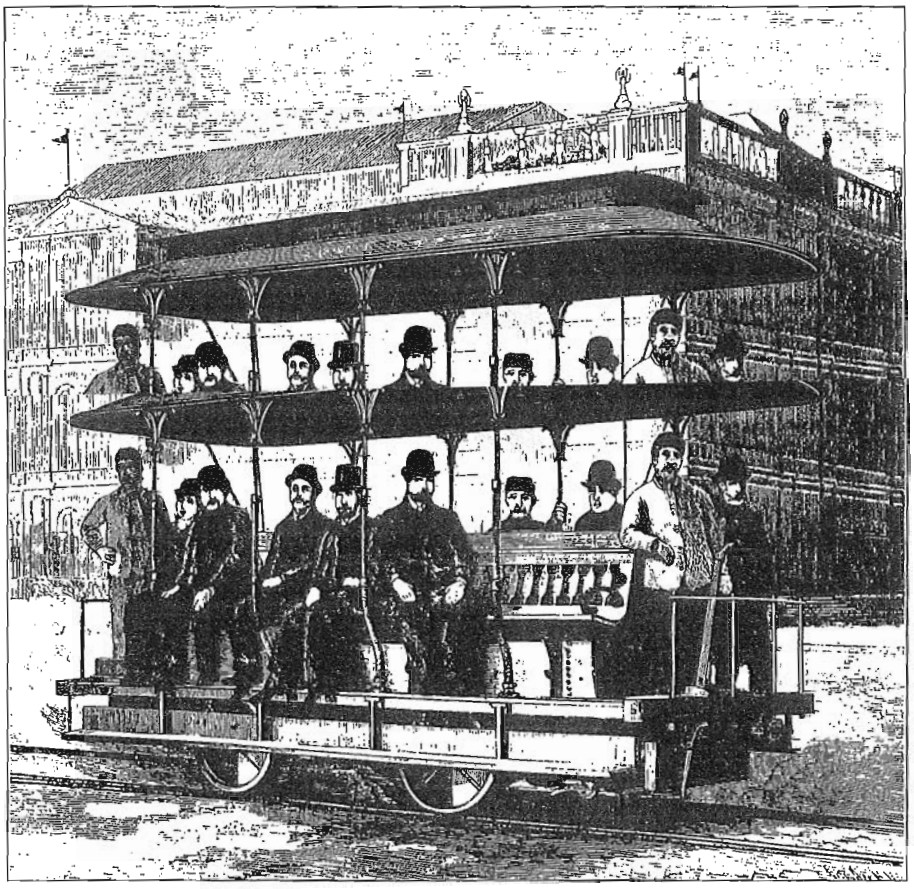
A plan for using the revenues, then, is an integral and critical component of any congestion pricing proposal. Designing such a plan to meet distributional goals, either across or within income groups, presents political and analytical challenges, but these are amenable to analysis. Elsewhere I have suggested a seven-part allocation scheme for the revenues projected from a hypothetical region-wide policy of congestion pricing for the

greater Los Angeles area. The policy is that proposed jointly by the Environmental Defense Fund and the Regional Institute of Southern California, and it could raise an astounding $3 billion per year by charging an average of 15 cents per mile at the busiest times and places. Under my proposal, two-thirds of this revenue would be returned in direct monetary payments (commuting allowances and property-tax rebates) or tax reductions (fuel and sales tax). The rest would be used to improve mass transit and build infrastructure. Specific numbers are provided in Table 1. It seems possible to target the revenues at various classes of people in such a way that the majority of those disadvantaged by the fees end up receiving equal or greater benefits in return.

CONCLUSION

What, then, is the role of congestion pricing in our future? Coupled with intelligent and understandable programs for using revenues, congestion pricing shows great promise as part of a comprehensive strategy toward urban transportation. Alone among proposed policies, it can bring about dramatic reductions in the severity of congestion while leaving individuals great flexibility in responding to its incentives. At the same time, it raises money instead of spending it. This creates the opportunity to ease fiscal constraints on federal, state, and local governments while providing significant benefits through commuting allowances, tax reductions, highway and other infrastructure investments, and improvements to mass transit services.

It is encouraging that various levels of government are taking the first tentative steps toward giving the concept a trial. If carried out in good faith, the resulting demonstrations should point the way toward genuine alleviation of some urban transportation problems. ◆



REFERENCES

Bay Area Economic Forum, *Market Based Solutions to the Transportation Crisis*, San Francisco: Bay Area Economic Forum, 1990.

Michael Cameron, *Transportation Efficiency: Tackling Southern California's Air Pollution and Congestion*, Oakland, California: Environmental Defense Fund, 1991.

U.S. Federal Highway Administration and U.S. Federal Transit Administration, *Exploring the Role of Pricing as a Congestion Management Tool: Summary of Proceedings of the Seminar on the Application of Pricing Principles to Congestion Management*, Publication No. FHWA-PL-92 012, Washington, D.C.: U.S. Federal Highway Administration, 1992.

Timothy D. Hau, "Congestion Charging Mechanisms for Roads: An Evaluation of Current Practice," Policy Research Working Paper No. WPS 1071, Transport Division, The World Bank, 1992.

Reason Foundation, *Congestion Pricing for Southern California: Using Market Pricing to Reduce Congestion and Emissions*, Los Angeles: The Reason Foundation, 1992.

Kenneth A. Small, Clifford Winston, and Carol A. Evans, *Road Work: A New Highway Pricing and Investment Policy*, Washington, D.C.: Brookings Institution, 1989.

Kenneth A. Small, "Using the Revenues from Congestion Pricing," forthcoming in *Transportation*, 1993.

Private Toll Roads in America— The First Time Around

BY DANIEL B. KLEIN

The notion of private highways, which must have seemed fantastic to Americans just a few years ago, was commonplace to our great-great-grandparents. Built in the 1790s in the growing Republic, the first toll roads stimulated commerce, settlement, and population. Fiscal constraints and insufficient administrative manpower led communities to search outside the public sector for help. During the 19th century more than 2,000 private companies financed, built, and operated toll roads. A glimpse at our history may provide a useful perspective on today's budding toll-road movement.

Private road companies in the 19th century answered an urgent community need, where the government couldn't, and they did it with creativity and motivation. The investment impetus and indirect benefits animated merchants, farmers, and landowners to support toll roads. At times when government regulations limited the roads' profitability, local boosterism and the participatory ethic

and indirect benefits animated merchants, farmers, and landowners to support toll roads. At times when government regulations limited the roads' profitability, local boosterism and the participatory ethic encouraged community members to keep investing. The acuity of private initiative established toll roads from the Atlantic to the Pacific Ocean. ➢

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TABLE 1

Turnpike Incorporation, 1792-1845

Source:
Klein and Fielding, "Private Toll Roads: Learning from the 19th Century."

STATE	1792-1800	1801-10	1811-20	1821-30	1831-40	1841-45	TOTAL
NH	4	45	5	1	4	0	59
VT	9	19	15	7	4	3	57
MA	9	80	8	16	1	1	115
RI	3	13	8	13	3	1	41
CT	23	37	16	24	13	0	113
NY	13	126	133	75	83	27	457
❖ PA	5	39	101	59	101	37	342
NJ	0	22	22	3	3	0	50
❖ VA	0	6	7	8	25	0	46
MD	3	9	33	12	14	7	78
❖ OH	0	2	14	12	114	62	204
TOTAL	69	398	362	230	365	138	1562

❖ These states subsidized the turnpike companies.

The Turnpike Heyday, 1800-1825

Once the Commonwealth of Pennsylvania chartered a private company in 1792 t build a road connecting Philadelphia and Lancaster, rival states were stimulated to try sin ilar projects. Private initiative was then the only effective means of providing new higl ways because state and county resources were scarce, and town resources were meage In an age before the canal and railroad, legislators were willing to try anything to get som means of transport constructed.

The turnpikes were financed by private stock subscription and set up to pay dividends With a surface of gravel and earth, the roads were usually 15 to 40 miles long, costin $2,000 per mile to build. Such massive undertakings relied on widespread investment sup port from each community. Some travelers objected to the idea of paying tolls, particularly to a corporate monopoly. Legislators, often suspicious of corporate motives, wrote exten sive restrictions into company charters, which specified conditions for construction, main tenance, toll rates, and toll collection. But despite the restraints many roads got built and rapidly. (See Table 1.)

However, the turnpike movement had its problems. About a third of the chartered companies failed to construct any roads, and many turnpikes that were completed paid

rapidly. (See Table 1.)

However, the turnpike movement had its problems. About a third of the chartered companies failed to construct any roads, and many turnpikes that were completed paid very small dividends or none at all. Toll evasion was rampant, as people learned to go around the tollgates, a practice known as "shunpiking." In many cases, roads were built in advance of settlement, where travel demand was low. Furthermore, legal restrictions hampered the turnpikes' abilities to turn a profit. Toll rates were set by law; generous toll exemptions were granted to local travelers; tollgates were separated by great distances and countermeasures to shunpiking were denied legislative approval.

But unprofitability did not necessarily mean unfruitfulness. Even an unprofitable turnpike improved transportation for the community, stimulating commerce, raising land values, and aiding in the race for expansion. So community leaders sought ways to secure subscription to turnpike stock despite the sad prospects for dividends. They resorted to a

fascinating array of tactics to boost the turnpike cause. They applied social pressure through newspaper appeals, town meetings, door-to-door solicitations, and correspondence. In the early Republic, American communities had to rely on volunteers for a great many services; and, as Alexis de Tocqueville so elegantly described it, they were effective in using local participation, rather than government power, to provide many essential services. The resulting turnpike construction in New York is shown in Figure 1.

Canals, Railroads, and Spur Turnpikes, 1826-1845

In the late 1820s, canals began taking business away from the major turnpikes. Railroads joined in a bit later. Between 1825 and 1845 existing turnpike mileage dropped considerably. However, the canals and railroads changed the patterns of trade and development, and they stimulated new demands for shorter toll roads that would serve as feeders. Table 1 shows that turnpike activity by no means ceased with the advent of canals and rails.

Plank Road Fever, 1847-1853

High hopes for a new kind of short feeder road attached to the idea of plank roads. Organized like turnpikes, the new roads were surfaced with wooden planks, which promised a smooth, inexpensive alternative to the rivers of mud that turnpikes sometimes resembled. In the late 1840s and early 1850s, more than one thousand plank roads were constructed nationwide. (See Table 2.)

For this new burst of toll-road chartering, a high percentage were successfully constructed (perhaps 80 percent) and always strictly with private funds. Figure 2 shows the plank road system in New York in mid-century. Compared to the turnpike system of the previous generation, the plank road system shows a nodal structure. ➢

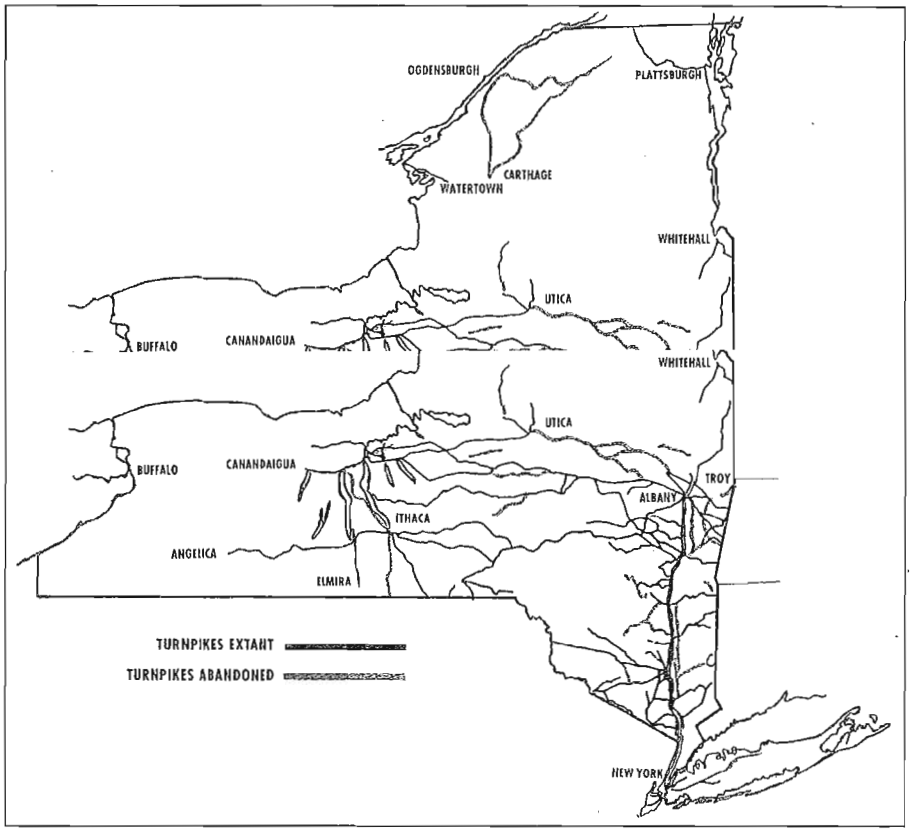
STATE	NUMBER
NEW YORK	335
PENNSYLVANIA	315
OHIO	205
MICHIGAN	122
ILLINOIS	88
NORTH CAROLINA	54
MISSOURI	49
NEW JERSEY	25
GEORGIA	16
IOWA	14
VERMONT	14
MARYLAND	13
CONNECTICUT	7
MASSACHUSETTS	1
RHODE ISLAND, MAINE	0

TABLE 2

Plank Road Incorporation by State (almost entirely between 1847-1852)

Notes: The figure for Ohio is through 1851; Pennsylvania, New Jersey, and Maryland are through 1857. Few plank roads were incorporated after 1857.

Source: Klein and Majewski, "Promoters and Investors in Antebellum America: The Spread of Plank Road Fever."



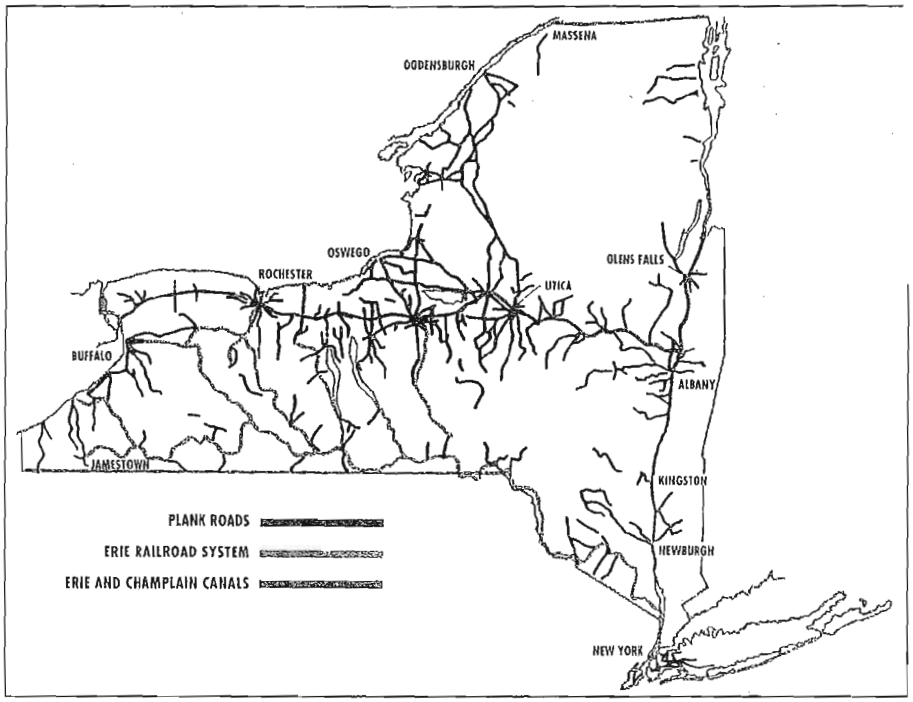
Compiled and drawn by C.T. Baer, 1991

FIGURE 1

Turnpikes of New York (as of 1830)

FIGURE 2

Plank Roads of New York
1845-1860



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Civil engineers and enthusiasts predicted that plank roads would last eight years before needing to be resurfaced. But, to the chagrin of everyone, the planks wore out twice as fast as the experts had predicted—usually within four years. The movement ended as suddenly as it began. Most plank road companies folded, while many converted their operations to turnpikes surfaced with gravel.

Toll Roads in the Far West, 1850-1890

The toll-road idea endured to the end of the century, and it traversed the country. When miners struck gold, silver, copper, and other minerals in the West, hordes of newcomers rushed there, and with them came the means for their survival. Entrepreneurs organized toll-road enterprises to serve the mining communities, and some got rich in the process. More than 150 toll roads were constructed in California, more than 200 in areas that would later become Colorado and Nevada.

This experience in the Far West casts doubt on the notion that government must pro-

organized toll road enterprises to serve the mining communities, and some got rich in the process. More than 150 toll roads were constructed in California, more than 200 in areas that would later become Colorado and Nevada.

This experience in the Far West casts doubt on the notion that government must provide infrastructure as a precondition to economic development. Given favorable circumstances, it seems that private developers can generate infrastructure on their own, especially when they can prevent toll evasion, as they can today.

The Good Roads Movement and the End of the Toll Road, 1890-1916

By the end of the 19th century, state and county governments had grown in resources and capabilities. New governmental highway agencies began setting goals for centralized highway management. It was the Progressive Era of administrative expertise and service. The independent private toll road did not fit into the plan, and the hundreds that remained, from Maine to California, were bought out or shut down. The words of a county board in New York in 1906 are particularly telling:

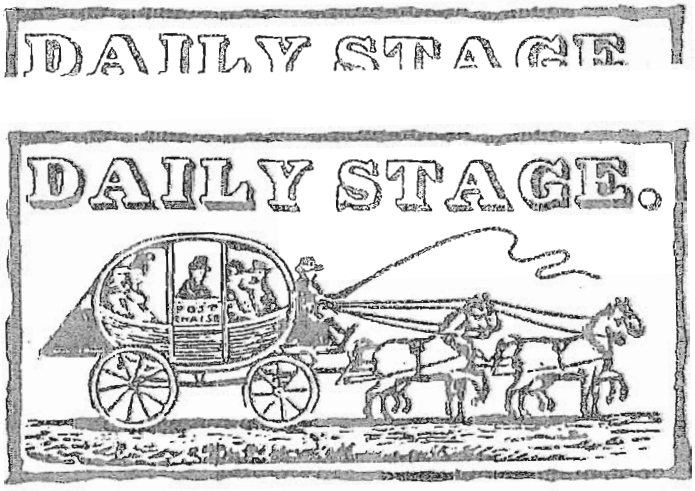
> *the ownership and operation of this road by a private corporation is contrary to public sentiment in this county, and [the] cause of good roads, which has received so much attention in this state in recent years, requires that this antiquated system should be abolished....That public opinion throughout the state is strongly in favor of the abolition of toll roads is indicated by the fact that since the passage of the act of 1899, which permits counties to acquire these roads, the boards of supervisors of most of the counties where such roads have existed have availed themselves of its provisions and have practically abolished the toll road.*

At this time the federal government itself became interested in highway development, while showing low regard for the private toll road. Although private toll roads proliferated in the 19th century, the Federal Aid Highway Act of 1916 barred the use of tolls on any highways receiving federal money. Thus, anti-toll-road sentiment became national policy.

Toll Roads Rehabilitated

Privatization has come into increased favor, and many states have embarked on franchising new highway facilities to private consortia. In 1992 Congress passed the Intermodal Surface Transportation Efficiency Act (ISTEA), which, according to Robert Poole of the Reason Foundation "contains the most sweeping privatization provisions ever enacted by Congress." ISTEA reverses the 76-year policy against toll roads. Under this act, federal funds can now go toward toll roads, including private toll roads, and states no longer have to repay federal funds if a facility is privatized. America can again test the effectiveness of private management of highways and the economic value of user charges.

With new electronic technologies of toll collection, toll roads may be more feasible than before. And, with knowledge of our past, perhaps we can be encouraged to plan them more effectively and thus to avoid old pitfalls. ◆



REFERENCES

Joseph A. Durrenberger, *Turnpikes: A Study of the Toll Road Movement in the Middle Atlantic States and Maryland*, Vandosta, Georgia: 1931.

Gerald Gunderson, "Privatization and the 19th-Century Turnpike," *Cato Journal*, Vol. 9, Spring/Summer 1989.

Gordon J. Fielding and Daniel B. Klein, "How to Franchise Highways," 1992, UCTC No. 134.

Daniel B. Klein, "The Voluntary Provision of Public Goods? The Turnpike Companies of Early America," *Economic Inquiry*, Vol. 28, Oct. 1990. UCTC No. 18.

Daniel B. Klein and Gordon J. Fielding, "Private Toll Roads: Learning from the 19th Century," *Transportation Quarterly*, Vol. 46, July 1992. UCTC No. 118.

Daniel B. Klein and John Majewski, "Economy, Community and Law: The Turnpike Movement in New York, 1797-1845," *Law and Society Review*, Vol. 26, 1992, pp. 469-512. UCTC No. 76.

Daniel B. Klein and John Majewski, "Promoters and Investors in America: The Spread of Plank Road Fever," UC-Irvine ITS WP 91-1.

John Majewski, Christopher T. Baer, and Daniel B. Klein, "Responding to Relative Decline: The Plank Road Boom of Antebellum New York," *Journal of Economic History*, Vol. 53, March 1993, pp.106-122.

Philip E. Taylor, "The Turnpike Era in New England," Ph.D. dissertation, Yale University, 1934.

INVESTIGATING TOLL ROADS IN CALIFORNIA

BY GORDON J. FIELDING

Californians are used to driving on highways for free, but today free driving also means slow driving. Highway congestion is increasing in urbanized areas, and there's not enough money to both maintain and expand existing roads. To raise funds, as well as discourage drive-alone travel, California legislators are now rediscovering the once-dreaded toll road.

In 1987 the California legislature permitted a joint-powers authority to construct toll roads in Orange County and connect them to the state highway system. Three years later, the legislature passed the AB680 bill, authorizing California State Department of Transportation (Caltrans) to test the feasibility of building four privately funded transportation facilities. More recent encouragement has come from the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), which abolished restraints against tolls on interstate facilities and allowed federal agencies to support toll roads and to participate in their financing.

Orange County, just south of Los Angeles, was ready for these changes. With population increasing by 25 percent, employment by 58 percent, number of autos by 30 percent, and vehicle miles traveled by 50 percent between 1975 and 1985, roads were congested during peak periods. However, county representatives were unable to convince the State Highway Commission of its need for additional capacity, and only four miles of

cent, and vehicle miles traveled by 50 percent between 1975 and 1985, roads were congested during peak periods. However, county representatives were unable to convince the State Highway Commission of its need for additional capacity, and only four miles of new state highway were constructed between 1975 and 1985—an increase of only 2 percent. Needless to say, traffic became a nightmare, and toll roads were reluctantly proposed in 1986 as a solution. Now, five toll roads–three public and two private –are under construction or being planned. (See Figure 1.)

The Transportation Corridor Agencies, three joint-powers authorities administered as one unit, control the public projects: San Joaquin Hills Corridor, a 17.5-mile road from Irvine to San Juan Capistrano; Foothill Corridor, a 30-mile freeway from San Clemente to

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Tustin; and Eastern Corridor, a 23-mile road linking the Foothill with Route 91 in the Santa Ana Canyon. The total estimated cost of these three roads is $2.4 billion. The Transportation Corridor Agencies are intent on building the maximum number of lanes to encourage development of surrounding lands, regardless of the environmental effects or their ability to repay construction loans. As a result, the three public roads have become highly politicized and are now mired in squabbles that jeopardize construction.

The two roads proposed by private firms are: Route 57 Extension, an 11-mile road that will be constructed as an elevated (viaduct) highway down the middle of the seasonal Santa Ana River, and State Route 91, a 10-mile road using the median of an existing freeway along the Santa Ana Canyon. Together, these two projects are expected to cost $735 million. The two private proposals will apply congestion pricing both to reduce peak-period demand and to increase revenue.

THE EXPERIMENT AS OPPORTUNITY

All five toll roads in Orange County will use automatic vehicle-identification technology, automatic toll-collection equipment, and changeable message signs to guide traffic. They thus comprise a rare, quasi-experimental setting in which transportation researchers can test some new technologies and some currently popular ideas.

transportation researchers can test some new technologies and some currently popular ideas.

In response, a group of us at UC-Irvine intends to conduct a five-year study, monitoring the actions of participating public and private organizations, the behaviors of travelers, and the workings of the highway network. Among the topics we plan to investigate are:

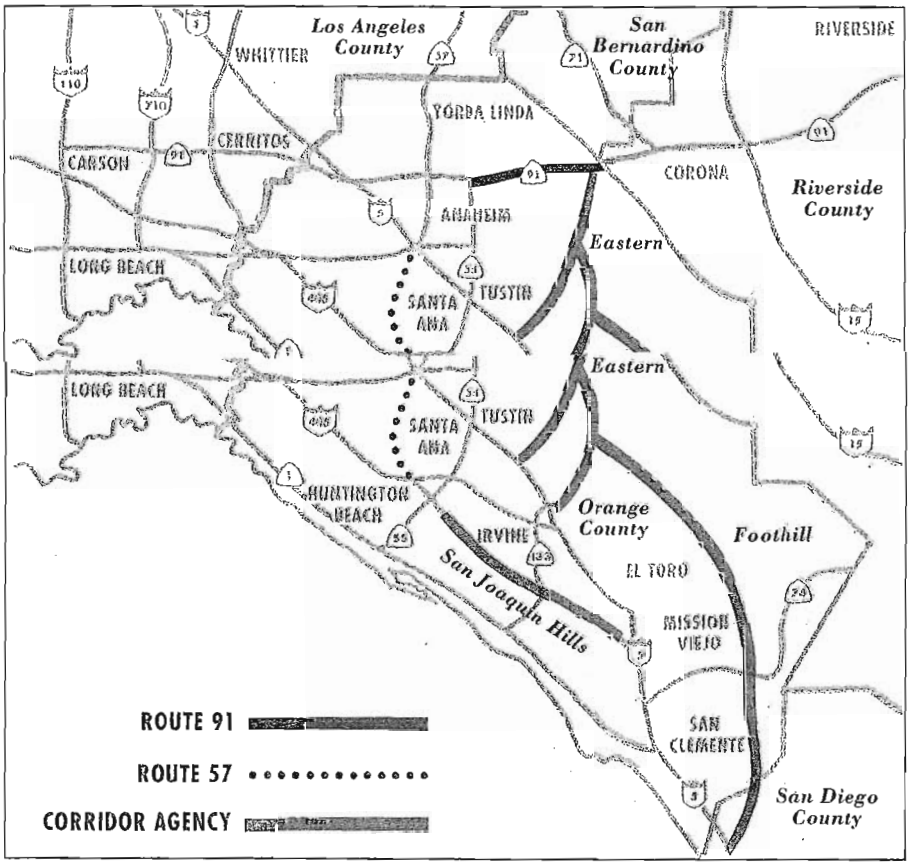
- travelers' responses to pricing
- price-elasticities of demand
- values of time for various groups
- effectiveness of traffic management strategies for encouraging ridesharing
- degrees to which tolls are regressive
- capacity of private toll roads to compete with free public roads
- users' and nonusers' opinions of highways' environmental consequences
- state procedures for awarding franchises for private toll roads
- potential roles of toll roads in Intelligent Vehicle Highway Systems (IVHS).

CASE IN POINT

Because the Route 91 toll road is scheduled to open in 1996, we must begin data gathering and behavioral analysis in 1993.

State Route 91 is the major link between Orange and Riverside Counties. California Private Transportation Corporation (CPTC) is now authorized to plan, construct, and operate for 35 years, four lanes within the freeway median. ➢

Orange County Toll Roads



The four median lanes will operate like high-occupancy-vehicle (HOV) lanes. But unlike the usual HOV facility, vehicles with one or two occupants can enter only by paying tolls. Vehicles with three persons or more will travel free at first and at a discount later.

Route 91 now carries an average of 203,000 vehicles per day at the county boundary. The forecast for 2010 is 370,000. Drivers already battle severe congestion five hours each day, and the "rush hour" is expanding, as travelers shift to both sides of the peak to avoid congestion.

Caltrans had planned HOV lanes for the median. They had cleared the project with environmental protection groups but had insufficient money for construction. Now, by using private funds, construction can begin sooner. Meanwhile, the state funds can be shifted to higher priority construction along the I-5 corridor.

By making excess HOV lane capacity available to toll-paying single- or double-occupancy vehicles, CPTC estimates it will recoup operating and maintenance costs, as well as earn a 17 percent rate of return on investment. An additional 6 percent incentive return can be earned by increasing vehicle occupancy during peak demand periods by encouraging ridesharing and transit riding. Revenue in excess of the base and incentive return will be paid to the state as the owner of the facility.

Preliminary estimates indicate that travelers would be willing to pay a $2.50

the state as the owner of the facility.

Preliminary estimates indicate that travelers would be willing to pay a $2.50 toll during peak hours for the time saved traveling 10 miles. To encourage use of the road during non-peak hours, discounts will be offered then.

As demand increases, tolls will be increased to prevent congestion in the restricted lanes. The aim is to maintain speed so that patrons save time compared to users of the unrestricted lanes. Toll charges are based on a value of the time saved, estimated at $0.20 per minute for peak-period commuters in single-occupant vehicles.

Transportation economists have long believed that higher toll rates for peak period travel could influence travel behavior. Route 91 offers an ideal opportunity to test the validity of congestion pricing as the unpriced alternative is only four feet away!

AN INVITATION

At this stage, we are eager to receive research design suggestions and supplements from colleagues in other places who wish to take advantage of this unusual research opportunity now emerging in Orange County.

We believe it's crucial to find out how consumers respond to variable congestion prices; who uses tolled lanes, when, why, and for which trip purposes; what effects tolls have on individuals' accessibility; how redistributive effects fall out on different population groups; and what political repercussions are generated and how they play out in the long run.

Apart from the contributions these studies might make to theory, we expect the findings will prove immediately applicable. If these toll roads prove both profitable and beneficial, they may spur other transportation agencies to sell the right to use HOV facilities. We're therefore eager to share our locational advantage, confident that those of you in other states can both contribute to and learn from the studies here.

Accordingly, we invite interested readers to contact us with their questions, suggestions, and requests for specific data and analysis. ♦

REFERENCES

California Legislature, Senate Bill 1413, Act to Amend Section 66484.3 of the *Government Code* relating to subdivisions, Chapter 1402, State of California, 1987.

California Legislature, Assembly Bill 680, Statutes of 1989, adding section 143 to the *California Streets and Highway Code*, Chapter 107.

California State Transportation Plan Task Force, *Recommended Statewide Transportation Goals, Policies, and Objectives*, Sacramento: State Transportation Board, 1978.

Ward Elliot, "Fumbling Toward the Edge of History: California's Quest for a Road-Pricing Experiment," *Transportation Research* 20A, pp. 151-156, 1986.

Gordon J. Fielding and Daniel B. Klein, "How to Franchise Highways," 1992. UCTC No. 134.

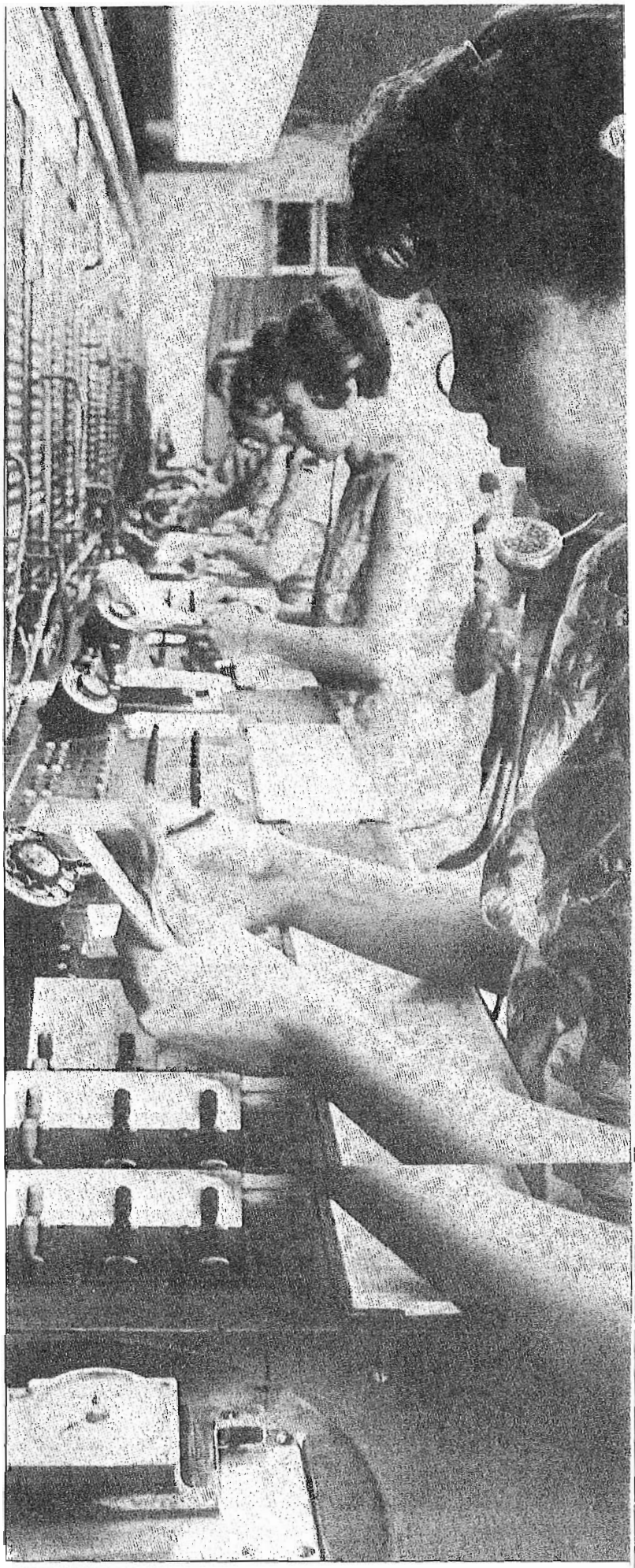
Gordon J. Fielding and Daniel B. Klein, "Private Toll Roads: Learning from the 19th Century," *Transportation Quarterly* 46: 3, pp. 321-341, 1992. UCTC No. 118.

Jose A. Gomez-Ibanez and John R. Meyer, "Private Toll Roads in the United States: The Early Experience of Virginia and California," Taubman Center, John F. Kennedy School of Government, Harvard University, 1991.

State of California, Department of Transportation, *Development Franchise Agreement: State Route 91 Median Improvements*, Sacramento, 1991.

Telecommuting: What's the Payoff?

BY PATRICIA L. MOKHTARIAN



Science fiction writers and high-tech enthusiasts may envision a world without commuting. Already, modern telecommunications technology allows people separated by hundreds of miles to work together as if they had adjacent desks. By simply lifting a phone, or switching on a computer modem, we can do our office work from anywhere—even from home. But the convenience telecommuting offers is not problem free. ➢

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There's been so much loose talk about "telecommuting" recently that it's best we agree on what it means. In this discussion I will refer to telecommuting as working from home, or a location close to home, instead of travelling to a conventional work location. I do not include either after-hours work at home or home-based businesses. Telecommuting might be full time, but it's more often part time (one or two days a week is typical), and it need not require computers or sophisticated technology. The terms "telework" and "telecommuting"are often used interchangeably, especially outside the United States, but I make a distinction between them: application of *telework* technologies (such as teleconferencing, fax, cellular phone, and laptop computers) that involve use of telecommunications but do not replace or modify commute travel does not count as *telecommuting*.

Telecommuting supporters point to the many potential benefits of their favored work mode:

- reduced travel
- reduced energy consumption
- improved air quality
- better balanced demands of job and family
- reduced costs of health care, reflecting lessened stress and sick leave
- more employment opportunity for mobility-limited and disabled persons
- recruitment and retention of the best workers, regardless of location
- improved availability of services, leading to higher productivity and happier customers
- improved balance between locations of jobs and housing
- increased work brought to underdeveloped regions, boosting their economies
- speedier resumption of business operations, at least partially, after disasters.

While obviously no single publi icy can offer a panacea for attaining one of these ends, telecommuting indisputably earned a place on the p policy agenda as a potential contribu

Governmental support for tele muting has been growing and has t several forms. The states of California Washington have formally author telecommuting for government emp ees, as has the federal government (s on a pilot basis). The California Dep ment of Transportation and Washington State Energy Office, amc others, have prepared guidebooks a other implementation materials. T California South Coast Air Qual Management District's Regulation XV a the State of Washington Commute T Reduction Ordinance both explicitly re ognize telecommuting as a transportati demand-management strategy, the latt assigning a 20 percent "bonus" to trip eliminated through home-based telecon muting.

A synergistic relationship has arise between policy support for telecommutin and its acceptance by employers and work ers. Positive evaluations of early demon stration programs lent muscle to the claim that support for telecommuting was desirable public policy. In turn, the increasing body of public policy promoting telecommuting has naturally increased the willingness and ability of executives in both the private and public sectors to adopt it.

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Link Resources, a marketing research firm, estimates there were approximately 3.9 million telecommuting salaried employees in the United States in 1992, about 3.5 percent of the workforce. (See chart.) Extrapolating from its Annual Work-at-Home Survey, Link Resources believes the number of telecommuters to be increasing at about 20 percent a year.

	NUMBER (millions)	PERCENT OF TOTAL
TOTAL TELECOMMUTERS	6.6	100
Households	4.9	
BY EMPLOYEE TYPE		
Conventional Employees	3.9	59
Contract-Based	2.7	41
BY TIME WORKED AT HOME		
Full-Time	1.2	19
Part-Time	5.4	81
BY SIZE OF EMPLOYER		
<100 Employees	5.3	81
100-999 Employees	0.7	9
1000 or More Employees	0.6	10

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1992 U.S. Telecommuting Universe

Source: Thomas E. Miller, Link Resources

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Although current adoption levels are low, the levels seem to be briskly moving upward.

Transportation Effects

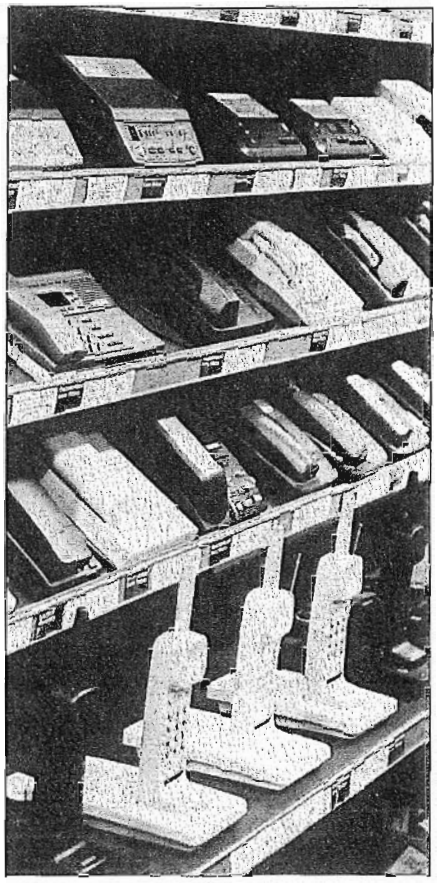
At first glance, it seems that telecommuting must certainly reduce travel. However, it's not necessarily so. We can imagine a number of ways in which telecommuting might *increase* travel. For example the telecommuter might get "cabin fever" from sitting at home all day and begin to go out on extra "errands," or another household member might use the telecommuter's vehicle throughout the day, or telecommuting might create new trips (to the post office, or office supply store, or public fax machine).

Further, *vehicle*-miles of travel could end up increasing, even while *person*-miles and numbers of trips decrease. Consider this scenario: a person who used to carpool five days a week now telecommutes three days a week. The carpool breaks up because he and his carpool friends now telecommute, but on different schedules. So, on their non-telecommute days, he and the others drive alone. Fewer person-trips are made, but more vehicle-miles are traveled.

Another possibility: a person who used to live 10 miles from work and drove alone five days a week—traveling 100 miles per week—begins to telecommute. Because she goes to the office only twice a week now, she moves to that cabin in the mountains, 50 miles from work. She now makes sixty percent fewer trips than before, but her weekly commute distance has doubled, to 200 miles.

Well, it's easy to come up with hypothetical or isolated examples of counterproductive results. The real question is what happens in practice? Are the cases that result in negative outcomes in the majority? Or are these more than compensated for by cases with beneficial effects? The good news is that a number of empirical studies (notably by the State of California and Puget Sound Demonstration Projects) confirm that the bottom-line effects on transportation, energy, and air quality are positive. Specific findings include these:

- Total vehicle-miles of work and nonwork travel by telecommuters decline approximately 75 percent on telecommuting days.
- There's no aggregate increase in noncommute travel.
- Telecommuters make fewer peak-hour trips, having eliminated the work trip (but, interestingly, they continue their peak-hour nonwork trips).
- Destinations concentrate closer to home after telecommuting begins—on both telecommuting days and regular commuting days.
- Reductions in emissions and fuel use are nearly proportional to reductions in vehicle-miles traveled.



Why Do People Do It, and How Many Will Eventually Do It?

It seems reasonable to believe, then, that telecommuting has positive travel-related effects *in those specific, small-scale settings in which it is implemented.* But recognizing these benefits is only half the battle in determining whether telecommuting is a useful transportation improvement measure. We also must know whether enough people will eventually opt to telecommute to make a significant difference in travel patterns. If telecommuting is unlikely ever to become a mainstream work alternative, then perhaps it is not cost-effective for governments to promote it.

We are now directing our research toward a causal forecast that reflects motivation and payoffs for telecommuting. Our aim is to learn more about why individuals decide whether to telecommute or not, thus to give us an empirical basis for predicting the future scale of telecommuting practice. This knowledge can then be used to investigate the potential consequences for transportation, air quality, and energy consumption.

Currently, most people don't even have the choice to telecommute. The constraints include lack of awareness, unsuitability of the job, unwillingness of management, technology limitations, and cost. Any long-range, aggregate forecast of the adoption of telecommuting must address the degree to which those constraints are likely to be binding.

On the other hand, there are many people without these constraints, and yet they have not switched to telecommuting. We intend to find out what proportions ➢

of people are actively choosing not to telecommute, and why they are making that choice. Learning more about why people do or don't choose to telecommute will allow us to design policy supporting telecommuting more intelligently.

We are currently analyzing data from about 800 survey respondents (including telecommuters, telecommuter "wanna-bes," and those with no desire or ability to telecommute). We seek to identify different market segments among the set of potential telecommuters and to describe those segments with demographic and lifestyle variables. Once we find out who are likely to become future telecommuters, the aggregate effect on travel behavior can be estimated more accurately.

Unanswered Questions

So far, telecommuting seems to offer great promise as a transportation improvement strategy. However, many questions remain. Skeptics say we may not even know what we think we know, because findings to date have been based on small, nonrepresentative samples. For example, telecommuters studied so far tend to live two or three times farther from work than do the region's average employees. Forecasts of transportation savings based on these early adopters are likely to be overstated.

Another limitation is that currently available findings deal with short-term effects. Long-term outcomes, such as the effects of telecommuting on residential and job locations and on the rates of employment-turnover among telecommuters, have yet to be determined. Further, we don't yet know enough about why one-time telecommuters return to regular commuting.

Other concerns surround potential effects of telecommuting on the worker and on family dynamics. What happens to workaholics when their work is always in sight at home? What happens to women trying to do it all when business and home life are combined? What happens when father is at home much of the time, while mother is away at work? What shifts in habits and roles are likely, and what are the potential consequences of those shifts? Telecommuting clearly bears important consequences for more than the conduct of business and the behavior of traffic.

Finally, forecasting the aggregate effects of telecommuting, even just on travel, is complicated by our ignorance of the interactions between telecommunications and transportation. It is possible to have *relative substitution* of telecommunications for travel, simultaneously with *absolute expansions* in the volume of both telecommunications and travel. Thus, travel volume might be 5 percent less with telecommuting than it would be without telecommuting (which I think is plausible), but the absolute numbers might continue to increase.

Is a potential "five-percenter" solution worth pursuing? In my opinion it is, for both the travel and the other benefits that telecommuting brings. Many transportation demand-management strategies do yield small impacts when taken alone, but a combination of tactics can have an important effect.

For telecommuting, it seems that we need to act on what we know today about its positive effects, while continuing to seek answers to the important unknowns, thus improving our capacity to adjust as we learn more. As the revolution in telecommunications runs its course, it seems certain that travel behavior will change as well, and we need to keep ahead of the revolution lest we be overwhelmed by it. ◆

REFERENCE

Patricia L. Mokhtarian, "Telecommuting a Travel: State of the Practice, State of the Art," *Transportation*, Vol. 18 (4), 1991, pp. 319-342. UCTC No. 79.

Patricia L. Mokhtarian, "A Typology of Relationships Between Telecommunicatio and Transportation," *Transportation Research* 24A, No. 3, 1990, pp. 231-242. UCTC No. 82.

Patricia L. Mokhtarian and Ilan Salomon, "Modeling the Choice of Telecommuting: Setting the Context," Research Report UCI ITS-RR-92-12, March 1993. UCTC No. 147.

Ram M. Pendyala, Konstadinos G. Goulias, and Ryuichi Kitamura, "Impact of Telecommuting on Spatial and Temporal Patterns of Household Travel," *Transportation*, Vol. 18, No.4, 1991, pp. 383-409. UCTC No. 111.

Maureen Quaid and Brian Lagerberg, *Puget Sound Telecommuting Demonstration Executive Summary*, Washington State Energy Office, November 1992.

Ilan Salomon, "Telecommunications and Travel Relationships: A Review," *Transportation Research* 20A , 1986, pp. 223-38.

E. Shirazi, J. Fink, J. Pratt, P. Mokhtarian, G. Gordon, P. Conroy, C. McKeever, D. Carter and E. Schreffler, *Telecommuting: A Handbook to Help You Set Up a Program at Your Company*, Sacramento: California Department of Transportation, Office of Traffic Improvement, September 1991.

Surviving in the Suburbs: Transit's Untapped Frontier

BY ROBERT CERVERO

Potomac, Maryland

Living in suburbia, owning a house, and watching the kids play on a green lawn was the American dream as early as the 1800s. At first, mass transit was crucial to suburban life, with streetcars and rail lines providing access to lawn was the American dream as early as the 1800s. At first, mass transit was crucial to suburban life, with streetcars and rail lines providing access to new residential areas outside of cities. After World War II, as automobiles became even more popular and the pace of suburbanization accelerated, the American dream expanded to include two cars in every garage. For the mass transportation industry, this spelled disaster. ➢

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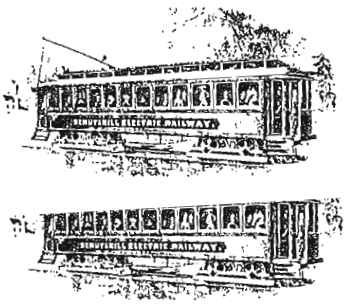
From a height of 26 billion passengers in 1946, U.S. transit patronage fell st for thirty years, reaching 8.8 billion in 1980. Through the 1980s, the total number o sit riders remained the same, but those numbers represented a smaller and smaller of commute trips, from 6.4 percent in 1980 to 5.3 percent in 1990. Most suburban muters do not use mass transit. In 1980, only 1.6 percent of suburban workers used sit to go to work, and that percentage, analysts agree, has likely fallen.

Deterrents and Opportunities

Transit's falling fortunes in suburbia are an outcome of many factors. Traditional f route services radially linked to central business districts (CBD) are ill-suited for lat suburb-to-suburb journeys, the most rapidly growing travel market. Also, most built ronments in the suburbs are not conducive to transit riding. Low employment dens and the prevalence of abundant, free parking at most suburban workplaces induce m to solo-commute. A recent survey of over 300 office workers whose jobs were reloc from downtown San Francisco to the Bishop Ranch Office Park found that transit's m split plummeted from 58 percent prior to the move to only 3 percent after the move.

Demographics and institutions also work against transit in suburbia. Suburban r dents and workers tend to be more affluent and own more cars than their central city co terparts. Suburbs also produce high rates of off-peak and weekend travel, periods wh bus headways tend to be longest. Service coordination is also sometimes hampered b multitude of competing suburban jurisdictions. In the San Francisco area, for instanc some two dozen separate transit agencies operate bus services outside of central cities

Against these deterrents several trends could work in transit's favor over time. A they mature, many suburban centers are evolving into relatively dense, mixed-use co centrations, varyingly referred to as transit-oriented developments (TOD), neo-traditio al developments, and, at a larger scale, edge cities. Such hubs could form the buildin blocks for truly integrated regional transit networks. Increasingly, moreover, suburb become home to the elderly, ethnic minorities, and new immigrants to the U.S.—group that have historically been transit dependent. Tight and expensive housing markets ar also creating a demand for condominiums and apartments near rail stations in some sub urban areas of the country. And clean air requirements are forcing some non-attainment areas, like greater Los Angeles, to actively promote transit-oriented and infill development.



At the simplest level, two possible policy sets might respond to decentralized growth: (1) adapt land uses to make them more serviceable by transit—e.g., greater densities and mixtures of uses; and (2) adapt transit services, making them more flexible, demand-responsive, and suitable to serving dispersed origins and [illegible]

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Land Use Initiatives

Transit works best when it connects relatively dense nodes along radial axes. Having mixtures of apartments/condos, office towers, and other mixed uses is also needed for balanced, two-way flows. Greater Stockholm and Toronto have such built environments, and operate world-class rail systems that handle upwards of three-quarters of all suburban work-trip origins and destinations.

Currently Bay Area Rapid Transit (BART) planners are working with local officials and developers to create transit-based communities near several suburban BART ➢

	DAILY TRANSIT COMMUTE TRIPS BY SUBURBAN RESIDENTS			TRANSIT SHARE OF ALL COMMUTE TRIPS BY SUBURBAN RESIDENTS		
	1980	1990	% Change	1980	1990	% Pt. Change
Houston-Galveston	4,726	15,500	227.97	0.75	1.70	0.95
Orlando	2,836	5,006	76.52	1.01	1.12	0.11
Dallas-Fort Worth	6,088	10,611	74.29	0.76	0.87	0.11
San Diego	9,957	16,831	69.04	2.54	2.77	0.23
Washington, D.C.	128,974	191,943	48.82	10.81	10.62	-0.19
Miami-Fort Lauderdale	31,779	41,269	29.86	3.77	3.57	-0.20
Seattle-Everett	27,864	33,994	22.00	4.55	3.91	-0.64
Atlanta	30,021	35,303	17.59	3.97	2.79	-1.18
Boston-Lawrence	120,368	134,543	11.78	11.67	8.06	-3.61
Los Angeles-Anaheim	97,410	106,405	9.23	3.23	2.62	-0.61
San Francisco-Oakland-San Jose	112,669	121,616	7.94	7.23	6.31	-0.92
Sacramento	9,443	10,084	6.79	3.07	2.03	-1.04

TABLE 1

Changes in Transit Commuting Among Suburban Residents of Those Large MSAs Experiencing Absolute Growth in Suburban Transit Trips

Among the 50 largest MSAs studied, only the 12 shown here registered absolute increases in transit work trips by suburban residents during the 1980s. Except for greater Boston, all of the MSAs are in the sunbelt or on the West Coast.

Houston's suburban transit ridership increased the most in relative terms, perhaps due in part to the phase-in of the nation's most extensive HOV/busway facility during the 1980s. Still, transit made up less than two percent of all work trips made by Houston suburbanites in 1990, and Houston's total number of suburban transit trips was similar to Portland, Oregon's (whose suburbs have only one-half the population of Houston's).

Greater Washington, D.C. witnessed the largest gain in the absolute number of suburban commuter trips made by transit, largely due to healthy ridership gains in suburban Maryland, notably around suburbs near the Metrorail's Red Line.

Two-thirds of the cities with absolute increases in transit work trips by suburban residents nonetheless saw transit's market share slide during the 1980s.

FIGURE 1

Percentage Changes in Suburban Population, Employment, and Modal Shares, Large MSAs From 1980-1990

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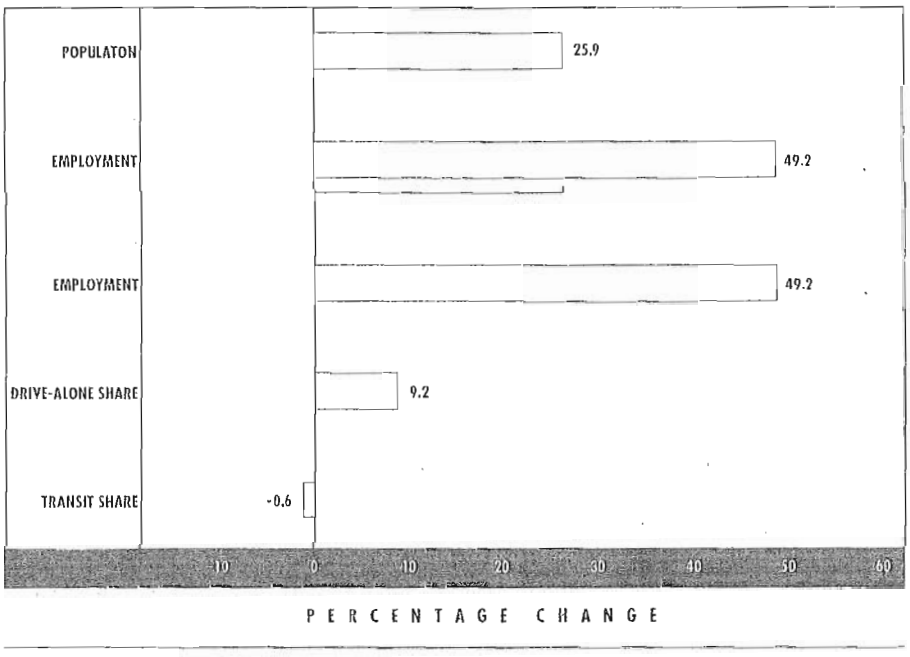
For 50 of the 75 largest Metropolitan Statistical Areas (MSA) for which statistics were available, transit's share of commuter trips among suburban residents fell by more than one-half percent between 1980 and 1990.

Drive-alone commuting, by contrast, rose nearly 10 percent over the same period. This represented, on average, around 60 percent of all work trips originating in the suburbs in 1990.

Transit's overall market share of 1990 commute trips originating in the suburbs of these 50 large MSAs was only 1.8 percent. In greater Detroit, San Antonio, Austin, Memphis, and El Paso, buses carried less than one-half percent of all suburban workers heading to their jobs.



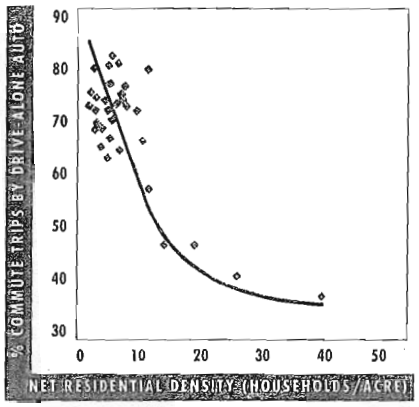


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FIGURE 2

Influence of Residential Densities on Drive-Alone Commuting, San Francisco Bay Area, 1990

This graph plots 1990 drive-alone commuting shares versus residential density of 33 superdistricts in the nine-county Bay Area. (The downtown San Francisco superdistrict was omitted. At 130 dwellings per acre, it had the lowest share of work trips by solo-commuters in 1990—only 20 percent.)

The negative exponential function implied by the graph confirms what others have found—every doubling of density is associated with a 25-30 percent decline in drive-alone commuting.

stations. Several plans call for converting portions of park-and-ride lots to housing p jects, using lease revenues to help finance replacement parking structures. Besides bo ing ridership, planners hope the new communities will allow riders to walk or bike to station, yielding important air-quality benefits. Short auto trips to rail stations emit h levels of pollutants because of cold start impacts. For those who live farther than one-qu ter mile away, electric vehicles might be promoted for accessing transit stations. Suc scenario is not far-fetched in California given that state law mandates that at least 10 p cent of new car sales ten years from now be zero-emission vehicles.

Several recent studies found a strong association between transit use and such f tors as density, physical design, and proximity to transit stops in suburban settings. In t Bay Area, residents of traditional, pre-World War II neighborhoods (with mixed us moderate-to-high residential densities, and grid streets) traveled by transit 22 percent the time, compared to only 3 percent for those residing in 1960s style suburban tract dev opments. Similar differences were found in the share of walking trips.

The Washington, D.C. region provides the best evidence in the U.S. of how trans oriented development and high-quality mass transit services can shape travel choices. Montgomery County, Maryland study found that workers from "transit and pedestria friendly neighborhoods" use transit 8 percent to 45 percent more often than workers fro neighborhoods conducive to automobile use (e.g., with curvilinear roads and no reta shops). All neighborhoods in the study were about the same distance away from transi facilities.

Another comparison showed that workers in heavy business districts are more like ly to use mass transit than those who work in smaller business areas. Among worker with similar incomes, 55 percent of those working in downtown Washington commute by mass transit, compared to 15 percent of those working in a suburban downtow (Bethesda) and only 2 percent of those working in a suburban office campus (Rock Springs Park). In suburban Virginia, between 50 percent and 70 percent of residents living within one-quarter mile of Metrorail stations ride transit to work, reflecting high shares of government workers heading into the nation's capital each morning. For those who live near rail stations but work outside the District, transit modal splits are under 10 percent.

Redesigning Mass Transit Services

Although land-use strategies might encourage some transit-oriented development, for the most part American suburbs will continue to be spread out and auto-oriented. Thus another strategy is to adapt transit to this landscape by making it more flexible, interconnected, and ubiquitous—in short, more auto-like. Similar to telephone networks, for transit to survive in suburbia, it must cast a larger net to allow more patrons to get from anywhere to everywhere.

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One option is to reconfigure routes from radial (downtown-oriented) to grid (multi-destinational) structures. AC Transit serving the Oakland–East Bay area has begun phasing in such a system with good results to date. AC Transit's ridership began falling in the mid-eighties as more and more jobs were locating in suburban areas away from its traditional routes. AC planners began phasing in the multi-destinational network in early 1989. Table 2 shows that ridership has risen noticeably in the two subdistricts where grid-like, interconnected services have been introduced. On the other hand, patronage in the rest of AC's service area where traditional radial services remain has continued to fall off.

Timed-transfer networks, wherein buses operate in sync to allow easy transfers at suburban transit centers, were first introduced in Edmonton and Calgary in the 1970s and have since caught on in a number of U.S. cities. With multi-centered transit networks, buses can better serve suburb-to-suburb trips. Tidewater, Virginia converted over to a timed-transfer network in 1991. Although ridership has fallen some because of the local recession, patronage has increased at the four largest employment centers in Virginia Beach. A recent survey revealed that three-quarters of Tidewater Transit's customers prefer timed-transfers to previous services.

Bellevue is the major suburban hub on Seattle Metro's regional timed-transfer network. With seventeen Metro routes converging on Bellevue's transit center on regular 15 to 30 minute intervals, transit has attracted about 10 percent of work trips to central Bellevue, a share unmatched in U.S. suburbs not served by rail transit. Bellevue's parking supply caps have also had a hand in transit's success.

Dedicated busways and high-occupancy-vehicle (HOV) facilities improve suburban services because, unlike rail systems, vehicles can leave guideways and filter into low-density neighborhoods, reducing the need for the dreaded transfer. Ottawa's 30-kilometer busway captures as many as one-third of all trips to several large shopping plazas and work centers outside the core. Houston is building what is being touted as the world's largest transitway system (95 miles in length by 1995), a seemingly perfect technology for a region that is spread out but features two dozen or more large-scale activity centers. Despite strong economic growth over the past few years, Houston's average freeway speeds and transit patronage have increased faster, and arterial congestion levels have fallen more than any large U.S. city over the past five years.

A variation of transitways is tracked-guided buses, or O-Bahns, introduced with some success in Essen, Germany and Adelaide, Australia. In these places, buses operate like electrified trains on the line-haul segments of trips and like diesel coaches on the feeder ends. Such technologies provide obvious flexibility advantages for intrasuburban trip-making.

Paratransit services, like jitneys, shared-ride taxis, and minibuses, are well suited to suburbia because of their curb-to-curb features. One promising marriage is paratransit and AVL (automated vehicle location) technologies. Satellite vehicle tracking systems enable vehicles equipped with sensors to be located and promptly dispatched to customers so as to minimize waits, detours, and deadheading. In Germany, AVL-aided paratransit services flourish in many suburban areas. There, an assortment of microbuses, minibuses, and maxibuses with sensors mounted on engine blocks are in continual contact with central computers that optimize dispatching and routing of vehicles to handle

transit services flourish in many suburban areas. There, an assortment of microbuses, minibuses, and maxibuses with sensors mounted on engine blocks are in continual contact with central computers that optimize dispatching and routing of vehicles to handle ride requests. Average passenger waiting times of seven minutes have been reported, and most paratransit operators are recovering 80 percent of full costs through the farebox, two to three times more than most U.S. suburban transit services.

Back to the Future

Fixed-route, fixed-schedule transit services can no longer effectively compete with the private auto in suburbia. Recent census statistics reveal that transit's market shares are rapidly eroding nearly everywhere. Major policy reforms are needed. We are well advised to borrow from yesteryear as we plan for the future. Early streetcar suburbs were successful in part because private entrepreneurs were allowed to link transit ➢

	AVERAGE WEEKDAY RIDERSHIP		
SUBDISTRICT	DECEMBER 1989	DECEMBER 1991	% CHANGE
West Contra Costo County*	12,488	28,329	+32
Oakland-Berkeley Alameda**	146,386	156,987	+7
Remainder of AC Transit Service Area	58,671	49,357	-16
SYSTEM TOTAL	226,545	234,673	+4

* Grid and Timed-Transfer System Introduced in September 1990

** Grid and Timed-Transfer System Introduced in April 1991

TABLE 2

Ridership Trends Associated with the Phase-In by AC Transit of a Grid Network and Timed-Transfer System

Source:
AC Transit, Short Range Transit Plan: 1993-2001
Oakland, CA, 1992

investments and land development, producing moderately dense, mixed-use land u terns. Well over half of suburban rail services in greater Tokyo are privately buil cally by large consortiums that link transit investments to new town development. F jitneys and other forms of paratransit also thrived throughout U.S. cities in the earl of this century but were later regulated out of existence at the urging of taxi operato bus companies. Given the freedom to operate, door-to-door van and jitney services, lar to regional airport shuttles, would likely emerge in many suburban settings, ta new market niches like suburban mall and office complexes, regional sports stadia recreational theme parks.

We have tried the model of publicly led transit and privately led land develop over the past 50 years with disappointing results. We should encourage developers tc transit and real estate projects just as they are currently doing through tollway fran es throughout California and other states—hopefully creating more transit-oriented c munities in the process.

While the private sector is probably best suited to responding to the needs of su ban travelers, there will always be an important role for the public sector as well—s as assembling rights-of-way for dedicated busways, providing startup funds for im menting satellite-based vehicle tracking and dispatching systems, and zoning for mo ate-to-high density housing around major transit stops. In combination, profit-seek entrepreneurs and community-minded governments are in a position to create the ki of transit services and built environments that within a decade could allow transit to cc pete successfully in suburbia with the automobile. ◆

REFERENCES

Robert Benke and P. Woodworth, *Integrating Transit, Paratransit and Ridesharing Via IVHA/FOCCS Technologies*, Honolulu: Aegis Transportation Information Systems, 1991.

Robert Cervero, *Suburban Gridlock*, New Brunswick, New Jersey: Center for Urban Policy Research, 1986.

Robert Cervero and John Landis, "Suburbanization of Jobs and the Journey to Work," *Journal of Advanced Transportation* 26, 3: 275-298, 1991. UCTC No. 83.

Fehr & Peers [illegible] John Landis, "Suburbanization of Jobs and the Journey to Work," *Journal of Advanced Transportation* 26, 3: 275-298, 1991. UCTC No. 83.

Fehr & Peers Associates, *Metropolitan Transportation Commission Bay Area Trip Rate Survey Analysis*, Oakland, California, 1992.

J. Hanks and T. Lomax, "Roadway Congestion in Major Urban Areas: 1982 to 1988," *Transportation Research Record* 1305: 177 189, 1991.

JHK & Associates, *Development Related Ridership Survey II: Washington Metropolitan Area Transit Authority*, Washington, D.C.: WMATA, 1989.

David Jones, *Urban Transit Policy: An Economic and Political History*, Englewood Cliffs, New Jersey: Prentice Hall, 1985.

Maryland-National Capital Park & Planning Commission, *Transit and Pedestrian Oriented Neighborhoods*, Silver Spring, Maryland, 1992.

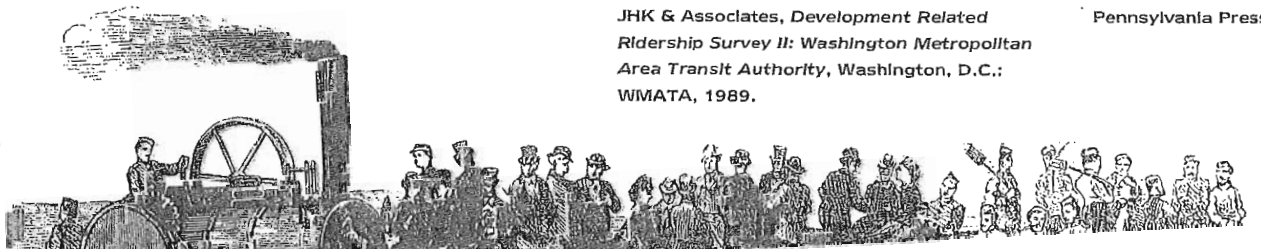
Allan Pisarski, *New Perspectives in Commuting*, Washington, D.C.: Federal Highway Administration, 1992.

C. Purvis, Bay Area T[illegible]
Allan Pisarski, *New Perspectives in Commuting*, Washington, D.C.: Federal Highway Administration, 1992.

C. Purvis, *Bay Area Travel and Mobility Characteristics*, Oakland, California: Metropolitan Transportation Commission, 1992.

Sam Bass Warner, *Streetcar Suburbs*, Cambridge: Harvard University Press, 1962.

Melvin M. Webber, "The Urban Place and the Non Place Urban Realm," *Explorations Into Urban Structure*, Philadelphia: University of Pennsylvania Press, 1964.



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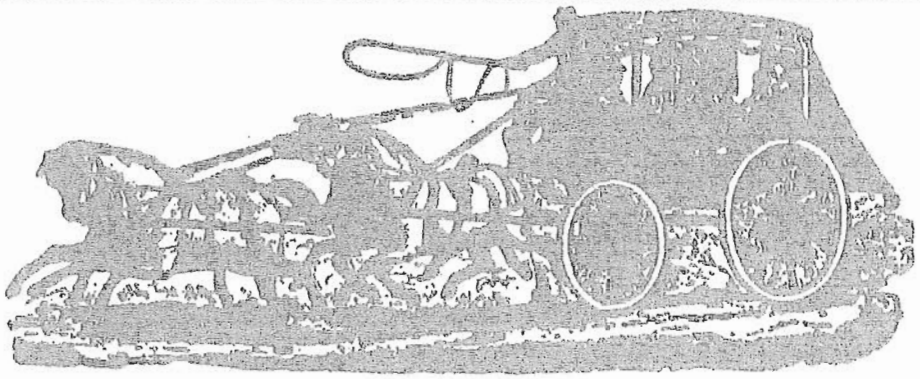

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Studies on the Loma Prieta Earthquake, No. 2 Executive Summary
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"Economic Impacts of the Loma Prieta Earthquake: A Focus on Small Business," Studies on the Loma Prieta Earthquake, No. 3
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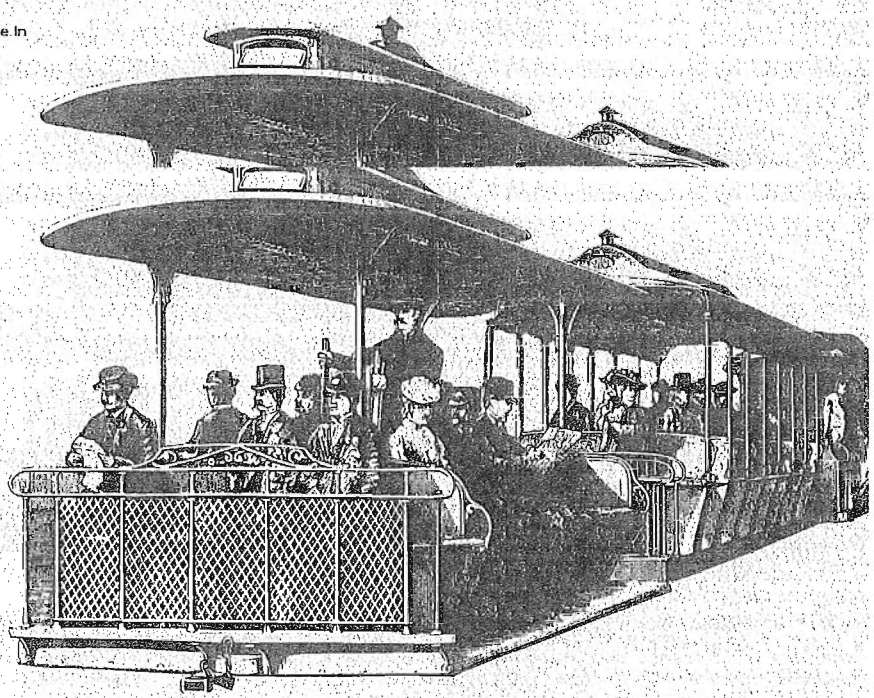

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