



ACCESS

A C C E S S N U M B E R 1 8 S P R I N G 2 0 0 1

CONTENTS

3 R&D Partnership for the Next Cars

BY DANIEL SPERLING

9 How Federal Subsidies Shape Local Transit Choices

BY JIANLING LI AND MARTIN WACHS

12 Informal Transit: Learning from the Developing World

BY ROBERT CERVERO

17 The Value of Value Pricing

BY KENNETH A. SMALL

21 Why Bicyclists Hate Stop Signs

BY JOEL FAJANS AND MELANIE CURRY

31 THE ACCESS ALMANAC: Census Undercount

BY PAUL ONG

23 Papers in Print 28 Back Issues 30 Order Form

The University of California Transportation Center, founded in 1988, facilitates research, education, and public service for the entire UC system. Activities have centered on the Berkeley, Davis, Irvine, Los Angeles, Riverside, and Santa Barbara campuses.

University of California Transportation Center
Berkeley, CA 94720-1782
Fax: 510-643-5456
access@uclink4.berkeley.edu
<http://socrates.berkeley.edu/~uctc>

Copyright © 2001 The Regents of the University of California

Authors of papers reporting on UCTC research are solely responsible for their content. This research was sponsored by the US Department of Transportation and the California Department of Transportation, neither of which is liable for its content or use.

Sustainability

DESPITE ever-growing impatience with traffic congestion and persisting complaints about air pollution, the auto-highway system has proved to be remarkably adaptable and sustainable. Even though average annual miles per vehicle have recently declined, cars still consume a lot of energy, exude a lot of noxious gases, and kill far too many people. The immediate causes of congestion and pollution are an increase in the sheer number of cars and trucks. Yet, even in the current economic decline, sales continue to rise.

Surely that's because cars provide superior transport service—door-to-door, no-wait, and without transfers. With cheap used cars widely available, that service is enjoyed even by many people who are poor. Cars are the media for direct access to medical and other services, the means for engaging in recreational activities, and the links connecting family and friends at distant locations. And, of course, they provide access to employment, especially where jobs are dispersed over large areas. Surely the huge market success of the motor car throughout the past 100 years is a direct reflection of its many advantages.

Its popularity poses a dilemma, however, and something of a paradox. Consumer preferences for cars has meant declining transit service and hence increasing reliance on cars. Even though governments have made huge investments in new rail transit systems in recent decades, few of those new systems are notably successful. So, while auto use has exploded over the past ten decades, transit, by comparison, seems to have become unsustainable.

Cars have succeeded, despite their costly externalities, in part because vehicles, roads, and driver skills have been improving over time. Current models pollute less than their recent predecessors: tailpipe emissions are ninety percent cleaner than in 1960 models. Cars are safer than they used to be: fatalities are down about twenty percent since the 1970 peak. Although threatened by the rise of SUVs and light trucks, energy efficiency has vastly improved since the oil

crises of the 1970s. Hybrid-electric cars are already in the market place, and zero-emission fuel-cell vehicles are promised in a couple years, using hydrogen instead of petroleum.

So the clue to resolving our dilemma seems self-evident: The way to make transit more competitive is to make it more like cars. The way to reduce some undesired features of cars is to make cars more like transit.

Further enhancements to personalized vehicles are already in sight. They include more reliance on electric propulsion, electronic sensors and controls, and, eventually, automation. The immediate effects should be greater energy efficiency and lowered reliance on foreign oil, reduced congestion owing to greater lane capacities, cleaner air, and improved safety. Then, if and when fully automated controls do become feasible, the distinction between automobiles and transit might be effectively erased. The once-heralded but long-neglected personal rapid transit (PRT) of the 1970s will at last become technologically feasible. In parallel, so too will simultaneous sustainability of both automobiles and transit.

Meanwhile, modest improvements continue to accumulate. In the following pages, Daniel Sperling's review of the much-touted government-industry partnership finds genuine movement toward a better car, coming as much from outside as inside the partnership. Robert Cervero's review of informal transit worldwide tells about the many taxi-like small-vehicle mass-transit systems that arise spontaneously where markets are open to private operators.

R&D centers throughout the world are actively exploring other ways of exploiting new electronics, emerging new fuels, new materials, and new entrepreneurial organizations. The trajectory points toward a virtual revolution in transportation systems. We may yet see the amalgamation of a new kind of transport combining the desirable attributes of both personal automobiles and public transit. Serving diverse publics more effectively than could either of the present modes alone, a hybrid system of that sort promises to be sustainable as well.

Melvin M. Webber

R&D Partnership for the Next Cars

BY DANIEL SPERLING

IN SEPTEMBER 1993 President Bill Clinton and chief executive officers of Ford, Chrysler, and General Motors created the Partnership for a New Generation of Vehicles (PNGV). Their primary goal was to develop a vehicle with up to three times the fuel economy of midsize 1993 US cars (about eighty mpg) with no sacrifice in performance, size, cost, emissions, or safety. Billions of dollars were to be spent over ten years, split roughly fifty-fifty between government and industry. They planned to select the most promising technologies by 1997, to build a concept prototype by 2000, and to have a production prototype by 2004. The program has adhered to that schedule.

It was a situation ready-made for government initiative and public-private cooperation. It fit the accepted federal government mission of reducing negative market externalities, supporting long term R&D, and promoting the nation's international competitiveness. Also, the timing was propitious for the Clinton Administration, which would benefit politically from forging closer relationships with the auto industry. It would create a new mission for the nation's energy and weapons laboratories and the beleaguered defense industry, which was suffering from the Cold War's end. And the administration saw a new means for environmental improvement, particularly by reducing greenhouse gases in accord with the 1992 Rio de Janeiro Earth Summit Treaty.

PNGV also met the needs of the automakers. They were reluctant to invest their own money in energy improvements, which had little value in the marketplace. More importantly, they saw PNGV's goals as just ambitious enough to fit the legally accepted model of precompetitive research without requiring too much from them. Their true motivations are difficult to document, but the government's lead technical representative says in a Rand report, "It is fair to say that the primary motivation of the industry was to avoid fed-

erally mandated fuel efficiency and emissions standards"—in particular, the national Corporate Average Fuel Economy (CAFE) standards. The program also provided a rationale to resist the Zero Emission Vehicle (ZEV) mandate that had been recently adopted in California, New York, and Massachusetts. Automakers hoped PNGV's outcomes would supercede battery-electric cars and intrusive government mandates.

Automakers were further motivated to gain access to government funding and research labs and to demonstrate industry leadership to stockholders, and they were sincerely committed to forging a more positive relationship with government.

Both sides of the partnership had an interest in reducing fuel consumption and greenhouse gas emissions. US oil imports were steadily increasing, contributing over \$150 million per day to the trade deficit; the fuel economy of new US vehicles had not improved in almost ten years; the expanding international market for vehicles placed high value on low fuel consumption; and battery limitations were undermining the ability of automakers to produce battery-electric vehicles in response to the ZEV mandate.

Rhetoric vs Reality. An early press release described the program as "an all-out effort to ensure the US auto industry leads the world [and a] technological challenge comparable to or greater than...the Apollo project." President Clinton asserted, "We are going to launch a technological venture as ambitious as any our nation has ever attempted."

In fact, however, the government commitment was minimal. PNGV attracted very little if any extra funding. The US General Accounting Office estimates that federal support for the partnership averaged about \$250 million per year from 1995 through 1999, but this sum is overstated because about 45 percent was for activities

*Daniel Sperling is professor of Civil and Environmental Engineering and Environmental Science and Policy and director of the Institute of Transportation Studies at the University of California, Davis (dsperling@ucdavis.edu). This paper is abridged from "Public-Private Technology R&D Partnerships: Lessons from US Partnership for a New Generation of Vehicle," *Transport Policy*, forthcoming.*

only indirectly relevant to the partnership goals and in many cases even unknown to the partnership. These were not new or additional funds. Constrained by Washington's long lead time in budgeting, and later by politics, managers played a shell game. They placed a variety of already existing R&D projects under PNGV, including about \$250 million in hybrid-vehicle research that Ford and GM had been pursuing for a number of years.

Political circumstances largely explain the inability to expand funding and match the rousing rhetoric. PNGV came into being during a period of growing federal budget deficits and skepticism in Congress and elsewhere about governmental capabilities. In November 1994, the Gingrich-led Republicans scored major legislative victories over the Democrats under the banner of less government.

PNGV leaders soon reconciled themselves to the hostile political climate and began downscaling budget aspirations. Indeed, the prevailing opinion of insiders was that, given Congressional budget slashing and accusations of "corporate welfare," only aggressive behind-the-scenes lobbying by the three automakers saved PNGV funding. Congressional concerns about the program continued through the ensuing years, and funding remained static.

Meanwhile, the partners continued to meet program targets. In 1997, on schedule, the large set of candidate technologies was reduced to a few, and then each company chose to develop diesel-electric hybrids. In early 2000, again in line with program milestones, they unveiled concept prototypes. Ford's Prodigy, GM's Precept, and DaimlerChrysler's ESX3 all used lightweight materials and combined small advanced diesel engines with electric drivetrains; they projected fuel economy of sixty to eighty miles per gallon. The next and final target date is 2004, when each company will supply production prototypes.

A MODEL PARTNERSHIP?

The Rand study written by Robert Chapman, recently retired technical head of the government's side of PNGV, notes that "Today, with the exception of some special interest advocacy groups [i.e., environmental groups], the PNGV appears to be viewed quite favorably by the public." It continues to be promoted as a model for national public-private partnerships. Dr. Henry Kelley, then Assistant Director of the White House Office of Science and Technology and a chief architect of the PNGV program, stated in April 2000, "I can't think of one [public-private partnership] that is more important or has more potential than this partnership in PNGV. It has not only yielded enormous technological advances but it redefined the way effective government-industry partnerships can be managed." Indeed, in late 1997 the US Department of Transportation created a major public-private

"Intelligent Vehicle Initiative," and in 2000, DOE created the 21st Century Truck Initiative, both modeled after PNGV.

This image of PNGV as a model partnership has been perpetuated unintentionally by the independent National Research Council. In 1994, NRC formed a standing committee (funded by government sponsors of PNGV) to provide ongoing evaluations, a rather uncommon practice in Washington DC, but recognizing the uniqueness and high profile of the program. The committee's task was to conduct an independent review of PNGV, a mission it interpreted narrowly by assuming, as givens, the vision, goals, and schedules for the program as enunciated by the president and agreed to by the automakers. The committee was thus limited to measuring progress toward predetermined goals.

The six annual NRC reports focused on the program's management and the emphases placed on the different technologies. They did not evaluate program design, goals, overall funding, schedule, or participation. This limited the debate about true costs and benefits and implicitly endorsed the program's goals and design. On the other hand, the NRC committee's efforts did keep PNGV in the public eye and held government and industry managers accountable, much more than is common for large governmental programs.

Benchmarking Progress. PNGV's targeted technologies were central to each company's business plans and increasingly so over time, with the result that their development became highly confidential. What had been seen as precompetitive research quickly became competitive, resulting in communication firewalls within and between companies and the government. The confidentiality of corporate decision-making makes it impossible to obtain direct evidence about the effects of either public R&D funds or the program in general.

The best indirect test of PNGV's effectiveness compares the three US automakers' progress with that of other automakers. General Motors and Ford have been the two largest automotive companies in the world for decades, with 1997 revenues of \$173 billion and \$154 billion, respectively. And yet, in December 1997, Toyota, about half the size of the two large American companies, unveiled a mass-production hybrid-electric car, followed in 2000 by Honda, an even smaller company. Toyota's gasoline-electric four-door Prius was put on sale in the US in summer 2000 for just over \$20,000, and Honda's two-passenger Insight for about \$19,000. Toyota, with plans to sell about 15,000 per year in the US, is besieged with a long waiting list of interested customers, as is Honda.

In the first half of 2000, Ford and then GM announced they would start selling hybrid-electric sport-utility vehicles in 2003 and 2004, respectively, six years after Toyota launched the Prius. In

fuel-cell technology, considered even more promising than hybrid-electric technology, Daimler Benz (ranked 12th in vehicle production in 1997 in the auto industry) pushed ahead of all the others, including Ford, GM, and Chrysler. Its technology, based on fuel-cell stack technology from Ballard of Canada, is acknowledged to be well ahead of the rest of the industry, and it has unveiled a series of increasingly impressive prototypes. Now merged with Chrysler (but using little Chrysler technology), DaimlerChrysler will start selling fuel-cell buses in 2002 and has announced that it intends to begin selling fuel-cell cars in 2004.

In summary, smaller automakers from other countries made faster progress in commercializing new technologies than US automakers. It is true that the Japanese companies used smaller cars than the midsize sedans targeted by PNGV and fell short of the eighty mpg goal, and that firm plans do not yet exist for placing Daimler's fuel cells in mass-produced cars. But these non-PNGV companies made stronger efforts to commercialize advanced energy-efficient technology, and they all focused on technologies with superior air pollution benefits.

Modest Benefits. PNGV has had some successes. It is widely acknowledged that PNGV helped focus federal vehicle R&D programs, increased communication and coordination between automakers and regulators (thereby easing somewhat their adversarial relationship), perhaps helped the Big 3 close a gap with European companies in advanced diesel technology, and stimulated some advances in fuel-cell technologies.

The magnitude of these benefits may be impossible to measure, and the discipline of creating a well-defined program with well-defined objectives, while mostly positive, can have downsides. Some argue that scarce R&D resources were often diverted away from fundamental, long-term problems to near- and medium-term challenges, with little benefit. They argue that these shorter-term problems are most effectively handled by industry directly—especially in this case, where the three US automakers were already spending many billions of dollars annually on R&D.

The Boomerang Effect. PNGV's greatest effect, ironically, may have been to motivate itself indirectly. When PNGV was unveiled to great fanfare, apprehensive foreign automakers in Europe and Japan quickly accelerated their efforts. Many executives in European and Japanese companies readily concede that PNGV was seen as a threat, and it was a catalyst for increased investment in advanced propulsion technology in their own companies. It now appears that a boomerang effect is occurring—US automakers are responding to aggressive commercialization efforts by Toyota, Honda, and the Daimler side of DaimlerChrysler.

PROGRAM DESIGN LESSONS

Program-design decisions made in 1993 appeared reasonable and appropriate at the time to virtually all observers. But circumstances change. The organizational format and style that seemed appropriate in 1993—design goals, timing, and funding strategies—became less appropriate over time. Perhaps the most important lesson to emerge is the need for flexibility in institutional processes to enable mid-course corrections.

Design Goals and Milestones. Consider PNGV's goal: to build affordable family-style cars with performance equivalent to that of 1993 vehicles and emissions comparable to those planned for 2004. While well-intentioned, this goal was interpreted and applied in a narrow and ultimately, one might argue, misguided manner. First, consider affordability. It is a desirable goal. But, in reality, new technologies are almost never first introduced into mainstream products; they typically enter at the upper end of the market. By focusing on affordability for the middle of the market, were they missing more promising opportunities?

The goal of equivalent performance undermined innovation in a different fashion. The requirement was meant to assure that a mass-market vehicle would result. But with proliferating vehicle ownership (over sixty percent of households in the US own two or more vehicles) equivalent performance is not necessarily an appropriate goal; the expectation that all vehicles serve all purposes is outdated. For instance, by imposing equivalent-range requirements, R&D was directed away from hybrid-electric designs that provide extended zero-emissions capabilities and from electric cars, especially small city cars, that use ultracapacitors and batteries. Indeed, the NRC committee reviewing the US Advanced Battery Consortium (USABC), a concurrent automaker-government partnership, pointed out that "if the USABC had viewed the EV not only as a competitor with the gasoline-fueled ICE vehicles [but also as a complement], it might have established more attainable performance goals." The same observation applies to PNGV.

The focus on midsize passenger cars also inhibited innovation. An NRC committee evaluating the primary government partner in PNGV (Office of Advanced Transportation Technologies of the US Department of Energy) stated that "as decisions to narrow the technology focus are made, care must be taken not to discard technologies that are not suited for a midsize car but are capable of providing improvements that meet Goal 3 [tripled fuel economy] requirements in a different segment of the light-duty vehicle fleet." Here they specifically mentioned sport-utility vehicles.

The emissions goal of PNGV was also questionable, considering that the intent was to develop leapfrog technology. The goal used for the 1997 technology selection was the projected Tier-2

emission standards being considered for 2004. They were not very stringent: they were less stringent than those already adopted in California, and considerably less stringent than the final Tier-2 standards actually adopted in late 1999. Taking advantage of PNGV's conservative emissions requirement, automotive managers and engineers turned to a technology that was nearest at hand but also most polluting: a direct-injected diesel engine, combined with an electric driveline and a small battery pack. It is very possible that automakers would not have chosen diesel hybrids if PNGV had adopted more aggressive emissions goals initially—even the Tier-2 standards now in place for 2004. The standing NRC committee evaluating PNGV said that to meet new standards, PNGV may have to shift from the compressed-ignition direct-injection engine to other internal-combustion engines with better potentials.

Diesel-electric hybrids were chosen because they provide relatively high fuel economy (though not a tripling) and easily allowed a prototype to be built within the PNGV time frame. But they have inherently high emissions of nitrogen oxides as well as particulates, the principal pollution problem today. Other more environmentally promising technologies—fuel cells, compact hydrogen storage, ultracapacitors, and electric drivelines hybridized with innovative low-emitting engines—were de-emphasized and in some cases eliminated.

Advanced direct-injection diesel engines under development are far cleaner and somewhat more efficient than today's diesel engines and are already being commercialized. They are likely to play important roles in future vehicles by reducing fuel consumption and greenhouse-gas emissions. But it is uncertain whether such engines will be able to meet the national Tier-2 and "super-ultra-low" (SULEV) emission standards of California. More to the point, they will never match the emissions of fuel cells and advanced hybrid vehicles that use nondiesel engines.

Given performance and design goals established in 1993, PNGV managers behaved rationally. But by 1997, with the Toyota Prius on sale in Japan and Daimler Benz announcing plans to produce 100,000 fuel-cell vehicles by 2003, the appropriateness of those goals was less certain.

Picking Partners. A major issue with PNGV is choice of partners and recipients of government funds. In any automotive R&D program, one must engage the automakers to ensure compatibility of component technologies and to oversee packaging. The three automakers were the architects of the program along with the Clinton Administration; and they played central roles, even while being direct recipients of a relatively small share of total PNGV funding. Most of the funding went to captive suppliers of the Big 3 and to national energy labs. The Big 3 controlled, directly and indi-

rectly, a substantial share of lab funding. For instance, until mid-1996, government funding of fuel-cell research at Los Alamos National Laboratory was through a subcontract from GM. Thus, the three automakers received a relatively modest amount of money, but they played a large role in determining how the money was spent and by whom.

There are three concerns with ceding too much control to the major automakers. First, these large companies have competing political agendas. The three US companies have been engaged in a long-running campaign to defeat more stringent corporate average fuel economy (CAFE) standards and California's zero emission vehicle rules. They are pursuing shareholder interests, not the public interest; and this vested interest undoubtedly affects their performance in commercializing PNGV technologies. It is well known that automakers are reluctant to demonstrate emissions and energy improvements for fear that regulators will codify those improvements into more aggressive, technology-forcing rules. This attitude is exemplified by GM's then-CEO, Roger Smith, who rhetorically asked at the end of his 1990 press conference announcing the Impact electric-car prototype, "You guys aren't going to make us build that car, are you?"

Second, R&D budgets of these large industrial companies swamp public funding, reducing the leveraging effect of public funds. The Big 3 spent \$17.3 billion on R&D in 1996 (about five percent of sales), about 200 times more than they received from PNGV. Though most of their R&D budget goes to routine engineering and design, some significant share goes to advanced technology, most of that related to emissions and energy-efficiency improvements. Ford, General Motors, and DaimlerChrysler reported that in 1999 they collectively spent about five percent of their total reported research funds, or about \$980 million, on research related to PNGV's goals. Toyota, significantly smaller than either Ford or GM, disclosed in 1996 that it was diverting about half its \$1.6 billion annual R&D budget to alternative fuels and alternative propulsion technology, mostly electric-drive designs. Smaller companies, with more modest R&D budgets, would presumably value public funds more highly.

Third, most innovation for leapfrog transportation technologies appears to come from outside major automotive companies and even outside traditional suppliers. The automotive industry is gradually becoming less vertically integrated. The days are long gone when iron ore delivered to a factory complex would emerge as a Model T. GM now depends on suppliers for about 1/3 the value of its vehicles, Ford about 1/2, and Chrysler for 2/3. The shift toward new technologies—batteries, fuel cells, electric drivelines, ultracapacitors—for which today's automakers have little expertise will likely accelerate the trend toward outsourcing of technology development and supply.

The leading designer of vehicular fuel cells, for instance, is not one of the Big 3, but Ballard Power Systems, a small company in Vancouver, Canada, with less than \$200 million in revenue in 1997. As major automakers move downstream, becoming assemblers, marketers, and distributors, they are spinning off supplier subsidiaries and granting more independence and more product innovation responsibility to suppliers. This transition will likely accelerate as PNGV-type technologies are integrated into mainstream vehicle designs.

The net effect is that PNGV seems to have had little influence on the market behavior of the three US carmakers. The major stimulus for accelerating development and commercialization of PNGV-type technologies came from small companies such as Ballard and, via a boomerang effect, from non-US automakers such as Daimler Benz, Toyota, and Honda. One can debate why this was so. The point is not to impugn the Big 3. They are highly successful industrial enterprises with exceptional engineering capabilities. But a compelling hypothesis suggests that their control of partnership decisions and funds did not significantly accelerate technology development and commercialization; and that funds directed elsewhere—directly to independent technology supply companies, with smaller amounts to independent research centers and universities—might have created more competition and more pressure to accelerate commercialization.

Did PNGV Technology Choices Matter? The pivotal decision in 1997 to focus on diesel-electric hybrid technology was the result of conservative interpretation of PNGV affordability, performance, and emissions goals, and a reluctance to reopen the discussion about scheduling and goals. Other technologies, especially fuel cells, provide greater potential for sharp reductions in emissions and energy use. In a larger sense, though, perhaps it didn't matter which technologies were selected in 1997. As is common practice in competitive industries, the three automakers created "firewalls" of varying permeability around their PNGV work. These firewalls are routinely used by companies engaged in collaborative work with competitors to protect themselves against antitrust lawsuits and, more importantly, to ensure confidentiality. They work well with minor innovations that affect a small part of the business, when the protected knowledge is not central to the business interests of the company. But this situation was different. First, virtually all of the targeted technologies were close enough to commercialization that a company would want proprietary rights to any advances. Second, fuel-cell and hybrid propulsion systems promised to be core technologies for these huge companies.

How permeable were those firewalls, and how did companies allocate their human and financial resources between PNGV and

internal proprietary efforts? The answer is known to only a few senior executives and likely resulted from a series of ad hoc decisions. There is plenty of evidence that the three automakers were strongly committed politically to the partnership and commercially to the targeted technologies. Less clear is whether, in the end, PNGV had much effect on technology development and commercialization.

CONCLUSIONS AND SUGGESTIONS

PNGV has clearly been a fruitful partnership, in the sense that both sets of partners are pleased. PNGV did indeed inspire some accomplishments and initiate a dynamic that accelerated commercialization. A sympathetic view sees any shortcomings explained by unforeseen changing circumstances. But there remains the troubling question: In the end, did PNGV serve the public interest?

Did PNGV lead to the best investment of government R&D? Was Congressional R&D funding diminished from what it might otherwise have been? Were regulatory initiatives to reduce fuel consumption and emissions undermined? In summary, did the creation and activities of PNGV accelerate commercialization of socially beneficial technologies? These questions remain unanswered and perhaps unanswerable.

Nevertheless, the PNGV experience provokes the following insights and lessons:

- Unforeseen indirect effects may prove most important
- Mid-course corrections are essential
- Targeted technologies should be far from commercialization because government funds will otherwise have little effect
- Progress is accelerated when partners are wholly committed to the technology-commercialization goals of the partnership
- Great effort must be devoted to recruiting small, innovative companies.

A successful partnership requires an unlikely confluence of insightful designers, flexible and accommodating partners, and astute and effective leaders. It also requires huge resources and institutional investments.

Given these daunting challenges and the earlier cautionary thoughts on societal benefits, perhaps the principal lesson of PNGV is that public-private technology development partnerships as presently conceived may already be an outdated concept for large, concentrated industries like this one. Perhaps public R&D funds assigned to such partnerships are unnecessary and even counterproductive. In this globalizing and networking world, communicating and partnering are more essential than ever. A critical

question, then, is whether there are sufficient incentives for major industrial companies to participate in public-private partnerships, apart from the award of public R&D funds.

So, the essential components of a restructured PNGV-like partnership might be these:

- Inclusion of small innovative companies, universities, and independent research centers as project principals
- Inclusion of energy suppliers (who greatly influence the design and choice of advanced technologies)
- Requirement that an automaker or major automotive supplier be a partner in virtually all projects
- Broadened participation in the partnership's policy and technical committees, including more industry, government, and nongovernment participants
- Few or no public R&D funds disbursed through the partnership—rather public R&D funds awarded on a competitive basis outside the realm of the partnership as seed grants to small innovative companies, nontraditional automotive suppliers, universities, national government labs, and independent research centers.

The automotive industry may be less enthusiastic and less committed to a partnership of this type, though those companies state, in a report to the NRC committee, that “the lack of talented people is a greater handicap than the lack of adequate funding” and that they “need ideas (breakthroughs) more than dollars.” A revamped partnership of the sort suggested here might lead to a more stable relationship, encourage more public investment in socially beneficial technologies, and provoke a broader and better-informed public debate over energy consumption and greenhouse-gas emissions. ♦

FURTHER READING

Robert Chapman, *The Machine That Could: PNGV, A Government-Industry Partnership* (Santa Monica, CA: Rand, 1998).

National Research Council, *Review of the Research Program of the Partnership for a New Generation of Vehicles* (Washington, DC: National Academy Press, annual reports from 1994 onward).

James M. Utterback, *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change* (Boston: Harvard Business School Press, 1994).

How Federal Subsidies Shape Local Transit Choices

BY JIANLING LI AND MARTIN WACHS

SUPPOSE YOU'RE GOING to buy a new car that you'll keep for ten years, and you've reduced the choices to two. The first has a price tag of \$20,000 and an annual operating expense of \$1,500, while the second costs \$15,000 with annual operating costs of \$1,800. If you were making an economically rational decision—all else being equal—the second car would be your least total-cost choice, since your total ten-year cost for the first would be \$35,000 and for the second, \$33,000. But if your rich uncle came along and offered to pay half of the initial purchase, your economically rational choice would change to the first one. Now your net cost for ten years would be \$25,000 for the first and \$25,500 for the second.

ROLES OF FEDERAL SUBSIDIES

Ever since the federal government stepped into mass transit in the 1960s, its subsidy policies have played an important role in shaping local transit-investment decisions through a large amount of financial support and through its conditions governing subsidies from other levels of government. The federal government subsidizes capital investments in public transit—including construction and initial equipment costs—much more readily than it subsidizes annual operating costs, such as labor and energy. In effect, it behaves very much like your uncle.

The transit-investment decision-making process in the US is inherently political and extremely complex. It involves many stakeholders with differing visions and conflicting interests. Considerations include passenger demand, costs of alternatives, funding resources, attractions to business, city image, support from the public, and effects on land-use, parking, traffic conges-

tion, and air pollution. Decision-makers must balance the political interests and satisfy their respective demands under financial constraints. Because federal subsidy is an external funding resource to local governments, there is an incentive for local governments to maximize federal contributions in order to satisfy political desires.

Federal subsidy can change the preferences of local governments the way your uncle's largesse might change your preference for a new car. With its share of new transit capital costs larger than it is willing to pay for annual operating and maintenance costs, the federal government induces local governments to prefer projects with high capital costs and to avoid projects with high operating costs, even when the latter may be cheaper over their entire useful lives.

The Inter-Modal Surface Transportation Efficiency Act (ISTEA) of 1991 is considered a milestone for decentralization in transportation decision making. Many have said that under the Transportation Equity Act for the 21st Century (TEA-21) the federal government further reduced its influence over local decision making by allowing local jurisdictions more discretion when spending federal funds. We suspect this is not always true.

One key change in the TEA-21 transit program was elimination of transit operating assistance for urbanized areas with populations over 200,000. In addition, TEA-21 revised the definition of "capital projects" to include a wider range of projects eligible for federal transit funds. Some expenses that were previously considered operating costs, such as preventive maintenance, were redefined as capital expenses. The federal government will now pay for up to eighty percent of capital costs on some transit projects.

Jianling Li is assistant professor in the School of Urban and Public Affairs at the University of Texas at Arlington (jjli@uta.edu). She received her Ph.D. in Urban Planning at UCLA and spent a year as a post doctoral fellow with the Institute of Transportation Studies at Berkeley. Martin Wachs is director of the Institute of Transportation Studies and professor of Civil and Environmental Engineering and City and Regional Planning at the University of California, Berkeley (mwachs@uclink4.berkeley.edu).

Does this new subsidy policy really reduce the federal government's influence on local transit investment decisions? Our study found it might not. By eliminating operating assistance and increasing the federal contribution for some maintenance costs, the federal government may in some cases pay for a larger proportion of a transit investment and therefore increase its influence over local investment decisions. The policy may provide an incentive for local governments to invest in transit options that are capital intensive and in those that require high maintenance costs.

CLUES FROM SAN FRANCISCO

To discover possible effects of transit subsidy policy under TEA-21, we examined data from the System Planning Study for the Geary Corridor, a major transportation artery in San Francisco. The Geary Corridor study identifies seven alternatives to be considered for new service investment. No final investment decision has been made thus far, but this case study does provide some evidence on the possible effects of federal transit-subsidy policies. It also helps shed light on a question that has been raised but never investigated before.

To simplify for the purpose of illustration, we here use data describing three of the alternatives considered. The first relied heavily on Transportation System Management (TSM), like improved traffic-signal timing and operational changes to the

streets, rather than extensive new construction. The second included construction of a short tunnel and investment in trolley buses. The third was a surface light-rail line. Among the three alternatives, TSM would require the least capital investment, about \$33 million, while the trolley bus and light rail alternatives would require capital investments of about \$485 million and \$334 million, respectively.

We annualized the capital costs of the three alternatives based on the expected lives of the capital components and a discount rate of seven percent, and estimated their annual operating costs using a model derived from San Francisco Municipal Railway (MUNI) historical data. All the costs were adjusted to FY1994 constant dollars. We then evaluated performance of the three alternatives using a set of intermodal performance indicators, and we analyzed the annual financial shares of the federal and local governments according to provisions of ISTEA and TEA-21. (Intermodal performance indicators are a set of standardized indicators that incorporate the principles of life-cycle costing and the variation of vehicle capacity among transit modes. The indicators measure efficiency and effectiveness of all transit modes on a consistent basis.) The results are shown in the two tables.

Among the three alternatives, TSM costs the least per unit of service and per passenger trip, while the trolley bus has the lowest cost of attracting each new passenger trip. The light rail provides

Cost and performance of several San Francisco transit alternatives

| PERFORMANCE INDICATOR | | TROLLEY BUS | LIGHT RAIL | TSM |
|--------------------------------------|-----------------------------|--------------|--------------|--------------|
| Annual Cost (in millions, FY94\$) | Operating | \$15.1 (27%) | \$24.7 (45%) | \$15.4 (78%) |
| | Capital | \$40.7 (73%) | \$30.0 (55%) | \$4.3 (22%) |
| Estimated Travel Time | Minutes | 34.7 | 34.3 | N/A |
| Estimated Passenger Trips* | Passengers Trips/Year | 23,352,400 | 22,088,400 | 19,813,200 |
| Cost Efficiency | Total Cost/RVCM | \$0.41 | \$0.22 | \$0.17 |
| | Total Cost/RVCH | \$3.63 | \$1.65 | \$1.27 |
| Cost Effectiveness | Total Cost/Total Passengers | \$2.39 | \$2.48 | \$0.99 |
| | Total Cost/New Passengers | \$13.25 | \$17.89 | \$41.44 |
| Service Effectiveness | Total Passengers/RVCM | 0.17 | 0.09 | 0.17 |
| | Total Passengers/RVCH | 1.52 | 0.67 | 1.28 |

* Annual passenger trips for year 2010, estimated based on weekday passenger trips and an annual factor of 316 specified in the system planning study report by Merrill and Associates.

N/A: Data not available.

RVCM: Maximum revenue vehicle capacity per *mile* including seating and standing capacities.

RVCH: Maximum revenue vehicle capacity per *hour* including seating and standing capacities.

Comparison of government financial responsibilities (\$millions/year annualized construction costs)

| LEGISLATIVE BASIS | TROLLEY BUS | | | LIGHT RAIL | | | TSM | | |
|-------------------|-------------|--------------|--------------|------------|--------------|--------------|--------|-------------|--------------|
| | TOTAL | FEDERAL | LOCAL | TOTAL | FEDERAL | LOCAL | TOTAL | FEDERAL | LOCAL |
| TEA-21 | \$55.8 | \$35.6 (64%) | \$20.2 (36%) | \$54.6 | \$32.3 (59%) | \$22.3 (41%) | \$19.7 | \$6.9 (35%) | \$12.8 (65%) |
| ISTEA | | \$32.9 (59%) | \$22.9 (41%) | | \$24.6 (45%) | \$30.0 (55%) | | \$3.8 (19%) | \$15.9 (81%) |
| Difference | | +\$2.7 | -\$2.7 | | +\$7.7 | -\$7.7 | | +\$3.1 | -\$3.1 |
| % Change | | +5% | -5% | | +14% | -14% | | +16% | -16% |

the largest service capacity. In terms of efficiency and effectiveness, TSM is a better choice. However, the other two alternatives attract more new passenger trips.

Compared with ISTEA, federal shares of costs under the provisions of TEA-21 increase in all the three circumstances. As seen in the table, Muni would receive between \$2.7 million and \$7.7 million more from the federal government for individual alternatives under TEA-21 than ISTEA. This suggests that eliminating the federal operating subsidy does not necessarily shift financial responsibility from the federal government to local governments.

The results also indicate that the change in federal policy would likely reward transit modes with higher maintenance costs. According to Muni's 1994 Section 15 Report, preventive maintenance costs for motor bus, trolley bus, and light rail were about 28, 25, and 42 percent of their annual operating costs, respectively. Light rail has the highest preventive maintenance cost among the three modes. Because TEA-21 redefines costs of preventive maintenance as capital expenses and subsidizes a higher proportion of those costs, the light rail alternative would receive about \$7.7 million more in subsidy from the federal government under the provisions of TEA-21 than under ISTEA. In comparison, the trolley bus, which requires the lowest maintenance expenditures among the three alternatives, would receive the lowest increase in federal subsidy.

IN SUM

The data indicate that neither ISTEA nor TEA-21 would provide incentives for local governments to choose low capital-cost approaches, though TEA-21 narrows the gap between the federal subsidy and local investment in such alternatives. For instance, the trolley bus requires the highest capital investment among the

three alternatives. However, the local share of financial responsibility would be lowest for the trolley-bus option under either transportation law. In comparison, the TSM alternative requires the lowest capital investment and would receive the least financial assistance from the federal government.

Federal financial assistance under the newer law can weigh just as heavily when local governments make choices among transit investment alternatives as it did under previous federal assistance programs. The new law continues to encourage local governments to choose projects that maximize federal funding contributions. Those projects might not in the end be the most cost-effective ones.

This single case study cannot lead to general conclusions about the effects of federal transit subsidy policies, but it does raise the question of whether the new law really reduces federal influence on local transit investment decisions. It also suggests that federal influence may in some circumstances lead to the selection of inefficient investment alternatives. Such questions deserve further investigation as more data become available. ♦

FURTHER READING

José A. Gómez-Ibáñez, "A Dark Side to Light Rail? The Experience of Three New Transit Systems," *Journal of the American Planning Association*, v. 51, no. 3, pp. 337-351, 1985.

George W. Hilton, *Federal Transit Studies* (Washington: American Enterprise Institute for Public Policy Research, 1974).

Charles Lave, "It Wasn't Supposed to Turn Out Like This: Federal Subsidies and Declining Transit Productivity," *ACCESS*, no. 5, 1994.

Don H. Pickrell, "A Desire Named Streetcar: Fantasy and Fact in Rail Transit Planning." *Journal of the American Planning Association*, v. 58, no. 2, pp. 158-176, 1992.

Informal Transit: Learning from the Developing World

BY ROBERT CERVERO

CONSUMER CHOICE is the American way. We have come to expect variety, for example, in our supermarkets. Twenty-five years ago salad lovers were largely stuck with iceberg lettuce; today, however, we find a wide choice of butterhead, romaine, and ruby-leaf lettuces in the vegetable section. Salad consumption is up, and perhaps we're a little healthier for it. Why do we not enjoy comparable variety and choice in our urban transit sectors? ,

Transit systems can be remarkably versatile. Left to their own devices, they respond and adapt to emerging markets and technologies. In an open and competitive setting, transit operators are keenly aware of the slightest changes in market conditions and accommodate to them. Quick to adjust and eager to make a profit, they deliver what travelers want—a wealth of service options, ranging from motorized three-wheelers to van-size carriers to minibuses, priced at levels the market will bear.

The developing world provides a window into the potential benefits (and drawbacks) of a more diverse urban transportation marketplace than what we have in the US. There one finds a kaleidoscope of transit services, marked by vehicles of different sizes, operating speeds, service coverage, seating capacities, and levels of comfort. Fares vary accordingly. Free-lancers own and operate most of the vehicles, serving populations that are largely poor—many of them very poor. And yet operators are able to earn enough to cover costs and make a living, while charging fares their customers can afford.

The rich mix of entrepreneurial services found in the third world evolved spontaneously, without central control or direction. Nobody planned or orchestrated either the sector or the individual operators. Rather, it is largely a product of marketplaces allowed to run their own courses.

LAISSEZ-FAIRE TRANSIT

Entrepreneurial transit is about as close to laissez-faire transportation as you can find. Through the invisible hand of the marketplace, those who are willing to pay for transport services hook up with those who are willing to provide them. Many carriers are not licensed; hence “informal.”

The hallmark of informal entrepreneurial transit is open competition. Services are designed and priced to satisfy customers. Operators receive no subsidies or capital assistance. Unencumbered by rules and bureaucracy, independent operators are ultra-responsive to emerging and shifting market trends. Typically, hard work and no-frill services keep costs in check. The presence of private carriers alongside public buses and rail systems sets in motion competitive pressures on formal operators. This has happened in numerous Brazilian cities where, prior to *clandestino* vans, the quality of bus services was slipping at the same time that prices were rising.

In the world's poorest settings, entrepreneurial transit fills the service voids of publicly owned buses and metros. As protected monopolies, government-run bus systems lack incentives to contain costs, operate efficiently, innovate, or respond to shifting market demand. In cities like Jakarta and Lagos, most buses are old, they break down frequently, and they get stuck in traffic. Fares are kept low to help the poor, but lack of revenue precludes service improvements. Public transit finds itself in a free-fall of deteriorating service and falling revenues. It is only because regulations and rules are laxly enforced that unlicensed operators are able to step in “informally” and pick up where public transit operators have left off.

In many megacities, informal carriers provide much-needed and much-valued mobility for the poor. They enable tens of thousands of janitors, assembly-line workers, street vendors, and

*Robert Cervero is professor of City and Regional Planning at the University of California, Berkeley (rbertc@uclink.berkeley.edu). This paper was drawn from a recent publication, *Informal Transport in the Developing World*, prepared for the United Nations Commission on Human Settlements (Habitat).*

chambermaids to reach their jobs. During night shifts, when buses are no longer running, they sometimes are the only means of getting around. Increasingly, informal carriers are catering to the middle class. In Bangkok and São Paulo, informal commercial vans today vie head-to-head with public buses. Because they offer time savings, air-conditioned rides, and guaranteed seating (in return for premium fares), they are winning the competition.

Public bus companies complain, often vehemently, that private carriers are cheaters, poaching customers and creaming the lucrative markets. While these are legitimate charges in some instances, other benefits are often overlooked. For instance, because fewer passengers are served on feeder and distribution routes, the cost per rider tends to be high. Small, private services can aid mainline bus routes by improving connectivity and absorbing high-cost services. And in cities like Nairobi and Phnom Penh, private transit has absolved the public sector from the burden of running bus services altogether, providing the only alternative to walking or bicycling for the vast majority of households without cars.

DIVERSITY

In America and much of the developed world, transit riders typically face one and only one choice—a fixed-route, fixed-schedule, fifty-passenger bus that comes by every thirty minutes. For most of the middle class, this is not an acceptable alternative, so they drive. As America becomes increasingly diverse, so do its mobility needs. One-size-fits-all transit is an anachronism.

The developing world shows just how diverse mass transit can be if free-lancers and micro-enterprises are permitted to select, customize, and operate their own vehicles. Manila is a wonderful case in point. Filipinos have a long tradition of devising low-cost yet effective ways of moving around cities and the countryside. After the Second World War, enterprising young men began converting surplus US army jeeps into *jeepneys* that carry between 15 and 25 passengers. Manila's colorful and ornately decorated jeepneys are today the workhorses of the city's transportation system, carrying some 35 percent of passenger trips. Jeepneys are popular because they are cheap, operate virtually all the time, and stop and pick up anywhere. Their intermediate sizes are an advantage as well: compared to buses, they can more easily navigate Manila's crowded streets.

Manila's jeepneys provide mainline services, plying main thoroughfares and competing head-to-head with government-subsidized light-rail services. In recent years, they have faced stiff competition from Tamaraw (Toyota) FX vans—air-conditioned, comfortable ten-seaters that appeal to the professional class. Complementing jeepneys and vans are Manila's secondary net of carriers—privately owned and operated taxis, pedicabs (both

human-powered and motorized), and horse-drawn carriages (*calasas*). These modes function as feeders to mainline services.

Also notable are several one-of-a-kind, indigenous forms of entrepreneurial transit. Go to the railroad tracks in some of Manila's poorest neighborhoods today and you will find several hundred young men pushing bamboo trolleys fitted with roller skates that glide along the rails, providing lifts to school kids, matrons with groceries, and businessmen in suits and ties (who are known to exit taxis and board the "skates" to get around traffic tie-ups). In the Philippine countryside, hundreds of industrious farmers have attached passenger carts to the hand tractors they use to harvest crops, creating a unique farm-to-market mode, the *kuliglig*. My point, of course, is not to suggest we emulate such homespun technologies, but rather to highlight the astounding efficiencies and inventiveness that can be unleashed in an open, free-ranging transportation marketplace.

A core distinction of entrepreneurial transit is whether it is "taxi-like," providing door-to-door connections, or "bus-like," following more or less fixed routes (see table). In general, small-vehicle services, like pedicabs, motorcycle taxis, and minibuses, operate akin to taxis (but at a fraction of the fare). Included here are Bangkok's *tuk-tuks*, Jakarta's *bajajs*, and the motorcycle taxis of Nigeria (*okada*), Dominican Republic (*moto-concho*), and Cambodia (*moto-dub*). Taxi-like carriers function mainly as feeders. With larger passenger loads, service providers ply fixed routes because of limitations on delivering lots of unrelated customers to assorted destinations. Thus, the vehicles of choice for bus-like services are station wagons (Buenos Aires's *remises*), vans (Salvador's *kombis*), pick-up trucks (Managua's *camionetas*), and minibuses (Hong Kong's Public Light Buses).

I don't mean to give the impression that entrepreneurial transit is universally of low quality. In Kingston, Jamaica, private entrepreneurs have begun operating express, premium minibus services, complete with morning coffee, pastries, and newspapers. These services have been hugely successful, but would never have been mounted by Kingston's cash-strapped public bus operators.

THE DOWNSIDE

Of course, informal transportation services are not problem-free. As free-reign services in cities with high unemployment, they can breed over-zealous competition and predatory behavior. Over-competition gums up busy streets and poses accident risks. Accordingly, critics argue that private carriers should be heavily regulated, if not banned outright.

Third-world cities with many informal carriers are congested, and the surfeit of vehicles makes for chaotic and collectively damaging operating practices—drivers cut each other off, stop in middle

lanes to load customers, and weave erratically across lanes. The worst problems occur around busy marketplaces and bus terminals. In Kingston, Jamaica, illegal operators called “robots” (most driving station wagons) have been known to kick everyone off their vehicles, turn around, and head in the other direction when more money can be made going the other way. In Rio de Janeiro, illegal van operators hire touts to hang around bus terminals and coax waiting customers to hop aboard nearby vans.

Unregulated transportation also generates safety and pollution problems. Hyper-competition and its by-products—fatigued drivers, vehicle overloading, roadway violations, under-inflated and bald tires, etc.—increase accident rates. Overcrowding invites pickpocketing and bullying, epidemic problems on jitneys and minibuses in parts of central America. Minibuses, motorized pedicabs, and for-hire station wagons are also gross polluters owing to their aging vehicles with under-tuned engines, frequent acceleration and deceleration in congested traffic, and diesel and low-stroke engines. Delhi’s vast population of 1.8 million two-wheel motorcycles and 80,000 two-stroke auto-rickshaws emit more hydrocarbons and carbon monoxide per kilometer than even fully loaded buses.

It’s easy to argue that such “externalities” are good reasons for banning entrepreneurial transit in first-world cities. In truth, such problems exist because most third-world countries are too poor to invest the resources needed to license and monitor private carriers and to enact and enforce regulations governing driving practices and vehicle fitness. Given our long and substantial experience with common-carrier regulation, this would not be a problem in the United States.

We should distinguish between regulating for public safety and welfare versus regulating to set service standards and prices. The need for the former is unassailable—especially because small carriers are physically more vulnerable, thus more likely to lose out in a collision. The need for the latter is questionable.

Experiences show the marketplace can better regulate service levels and prices than can bureaucrats.

Moreover, reputed problems of informal transport are sometimes a smoke screen for class-based reasons for wanting to ban jitneys and minibuses. They typically include pressure from foreign vendors seeking to export modern transport technologies to developing regions; a mind-set among public officials that pedicabs and jitneys tarnish their image as modern states; and a cultural predisposition among foreign transportation consultants to focus on expediting traffic flows without an inkling of the vital roles microvehicles play in providing mobility for poor passengers and jobs for poor drivers.

SELF-REGULATION

Transit entrepreneurs are keenly aware that ruthless competition is collectively damaging and that survival depends on some degree of self-policing and self-restraint. In contrast to the hierarchical structures of regional transit authorities, entrepreneurial transit is held together by grass-roots alliances of drivers, brokers, parts suppliers, creditors, and sometimes “parasites” (e.g., street hustlers and corrupt local officials who routinely demand bribes).

Route associations are the glue that holds the entrepreneurial transit sector together. They exist to bring order to an environment that breeds cutthroat competition and anarchy in the streets. They set the ground rules and seek a reasonable balance between supply and demand, minimal duplication of routing and scheduling, orderly customer boarding and alighting, and some level of civility and good citizenship among members. Some associations even run their own traffic courts, where alleged interlopers or customer poachers go before their own peers and, if found guilty, must pay the consequences. In middle-income countries, associations provide other services, such as access to credit, group discounts on insurance and fuel, and (by hiring “plants”) radio-relayed information on how best to avoid police stake-outs and traffic jams. In Rio

Classes of transit and paratransit services

| CLASS | SERVICE FEATURES | | PASSENGER CAPACITY | SERVICE NICHE | SERVICE COVERAGE |
|----------------------|------------------|------------|--------------------|---------------|------------------|
| | ROUTES | SCHEDULES | | | |
| Conventional Bus | Fixed | Fixed | 25–60 | Line-Haul | Region/Subregion |
| Minibus/Jitney | Fixed | Semi-Fixed | 12–24 | Mixed | Subregion |
| Microbus/Pickup | Fixed | Semi-Fixed | 4–11 | Distribution | Subregion |
| 3-Wheeler/Motorcycle | Variable | Variable | 1–4 | Feeder | Neighborhood |
| Pedicab/Horsecart | Variable | Variable | 1–6 | Feeder | Neighborhood |

de Janeiro, associations of informal van operators publish newsletters and stage events for the press in an all-out campaign to show the “clandestine van” industry in a positive light.

Over time, some route associations may evolve into price-fixing cartels. That happened in Santiago following deregulation in the 1980s. Oligopolies are just as harmful in the urban transportation sector as they are in the airline industry. However this does not mean it’s necessary to clamp down so hard as to regulate transit entrepreneurs out of existence. Rather governments should exercise restraint and good judgment, restricting oversight mainly to matters of promoting safety and fair competition, and leaving matters of supply, service, and price principally to the marketplace.

LESSONS

In technical fields like transportation, we often think knowledge transfer runs from the first world to the third world. The experiences with entrepreneurial transit suggest that the poorer parts of the world have at least four lessons to offer the rest of us.

1. Competition is, on balance, healthy.

The inherent flexibility and profit motivations of entrepreneurial services mean they are acutely market-responsive. Transit entrepreneurs are more likely than public authorities to craft new, tailor-made services in response to trends like increased suburb-to-suburb commuting, trip-chaining, and off-peak travel. As a result, many entrepreneurial services are today oversubscribed, with customers queuing for rides at off-street terminuses. Surveys in India reveal many people opting for cycle rickshaws because, compared to public buses, they are more affordable and more reliable. Surveys of *clandestino* customers in Brazil reveal that their preferences for vans over conventional buses are because of speed advantages (cited by 44 percent of respondents) and comfort levels (25 percent).

Stepped-up competition no doubt hurts public bus operators in their bank accounts. In Rio de Janeiro, surveys found that 65 percent of van customers previously commuted by public buses. To blame entrepreneurial transit for these losses is unfair; such outcomes reflect the unwillingness of protected bus franchisees to downsize and change their business-as-usual habits.

2. Regulations should be relaxed.

Heavy-handed regulation makes sense only where natural monopoly conditions exist (or where public policies call for cross-subsidization of services). Increasingly the urban transportation sector needs economies of *scope*—that is, an array of transit service and price options—which entrepreneurs can best provide, rather than economies of *scale*, which often exist only on mainline corridors that can support subways and busways.

In coping with entrepreneurial transit, public authorities must decide upon an appropriate level of intervention. In most cases, this should entail a policy of *recognition*, rather than *regulation*. The main difference is that recognition allows the marketplace to mediate supply levels and prices; under regulation, market entry is externally controlled. Recognition involves the issuance and enforcement of rules and standards, mainly concerning areas of operations, safety, vehicle specifications, and labor practices. All carriers who meet minimum standards are then free to start and run a business. The aim is to make sure vans, minibuses, and microvehicles act as complementary carriers. Where they are allowed to compete directly with formal bus and train services, the aim is to assure that they do so fairly. As long as a reasonably fair and contestable marketplace can be maintained, governments should generally stay clear of matters related to service design, pricing, and hours of operation.

We already know what happens when local US officials deregulate paratransit by turning their heads the other way. The unlicensed vans that swarm around major bus terminals in the Jamaica section of Queens, New York, provide door-to-door, guaranteed-seat services at a profit. They have much in common with their counterparts in the Caribbean—indeed, many drivers plied the streets of Kingston and Montego Bay at an earlier time in their lives. While I am not suggesting that New York and other cities discard rules governing driver licensing, curbside behavior, and vehicle fitness, I am suggesting that relaxed restrictions on market entry would enhance mobility options by filling the huge chasm between conventional fixed-route buses and exclusive-ride taxis.

3. Market distortions should be reduced.

Heavy subsidies to public transit systems—monies that studies show often go to fatten workers’ and administrators’ paychecks without commensurate improvements in service—continue to suppress America’s paratransit industry. We need to move away from “provider-side” subsidies and toward “user-side” subsidies that go directly to the intended beneficiaries—the transportation-needy. With transportation vouchers in hand, travelers could decide whether a traditional bus, a jitney, or a taxi-like microvehicle best serves their particular travel needs.

4. Promotion is also needed.

Governments should not be watchdogs only. They can also help empower entrepreneurial transit. For example, capital grants could go toward providing off-street terminals and staging zones. A good example is the multi-story terminals built to house private jitneys and vans in San Juan, Puerto Rico, funded by the US Federal Transit Administration. On-street provisions, like dedicated high-occupancy vehicle lanes, would likewise aid paratransit.

Government might also pilot-test ideas like “curb rights” to ration scarce curbside space along crowded streets. Intelligent transportation systems might also have a place in the paratransit sector. Two-way pagers are today widely used by Bangkok’s van associations for communicating between terminal managers, dispatchers, and drivers. Many South African *kombivan* associations have introduced stored-value debit cards as a means of not only streamlining fare transactions but also as a hedge against theft and assaults.

TOWARD AN OPEN MARKETPLACE

Surely there is as much latent capacity for innovation in America’s transit sector as there is in the third world. There experience shows that a more open marketplace enriches mobility options. Here, onerous regulations and heavy-handed oversight have squelched competition. High standards—e.g., insistence that there be brand-new taxis, limits on where customers can be picked up, curfews on when services operate—continue to stand in the way of entrepreneurial transit in America.

There is tremendous diversity in today’s urban transportation marketplace. Some want fast, comfortable services and are willing to pay premium fares for them. Others are satisfied to travel more slowly and give up some comfort in return for a break at the fare-box.

Entrepreneurial transit stands the best chance of enriching urban transportation offerings in America today. If we could tone down regulations and invite open competition, we might one day find as much choice and variety in our urban transportation sector as is presently found in much of the developing world. ♦

FURTHER READING

Robert Cervero, *Paratransit in America: Redefining Mass Transportation* (Westport: Praeger, 1997).

Robert Cervero, *Informal Transport in the Developing World* (Nairobi: United Nations Commission on Human Settlements, 2001).

Daniel B. Klein, Adrian T. Moore, Binyam Reja, *Curb Rights: A Foundation for Free Enterprise in Urban Transit* (Washington, D.C.: Brookings Institution Press, 1997).

Gabriel Roth and George Wynne, *Learning from Abroad: Free Enterprise Urban Transportation* (New Brunswick, New Jersey: Transaction Books, 1982).

Isaac Takyi, “An Evaluation of Jitney Systems in Developing Countries,” *Transportation Planning and Technology*, v. 44, no. 1, pp. 163-177, 1990.

Melvin M. Webber, “The Marriage of Autos & Transit: How to Make Transit Popular Again,” *ACCESS*, no. 5, 1994.

The Value of Value Pricing

BY KENNETH A. SMALL

SEEKING WAYS to ease highway financing and alleviate traffic congestion, policy makers have put toll roads on the national agenda. The public is skeptical of the idea, to say the least. So the federal government has been sponsoring demonstration projects, both to gain practical experience and to increase public familiarity with road-pricing concepts and the ways they work.

Although most of the demonstrations are merely studies, two are currently operating on real roads in California. They show that the hardware and software work well, that transactions and enforcement are manageable, and that drivers easily adjust to pricing.

One project, the SR91 express lanes in Orange County, is a privately financed ten-mile roadway that parallels the Riverside Freeway (SR91), a notorious bottleneck. Drivers using the new roadway pay electronically according to a fee schedule that varies by time of day and day of week. Three-person carpools use the lanes at a discount. When the new lanes opened, typical peak-hour delays on the original lanes on this ten-mile section fell from over thirty minutes to less than ten minutes.

The second demonstration project, located on an eight-mile section of Interstate 15 (I-15) just north of San Diego, applies a more radical pricing concept. The carpool lanes there were underused, leaving a lot of concrete unoccupied. Solo drivers can now buy their way into this spare capacity, at a price that might change at any moment and that is set to maintain free-flow speeds in the fast lanes. This so-called “dynamic pricing” means that users do not know the exact price until just before they make the lane choice.

Each of these projects is attractive because of the way they use pricing. The SR91 express lanes show that the private sector can finance a needed road by charging tolls. It’s too early to know how successful it will prove to be for its investors, but it has produced none of the close brushes with default that have plagued some other toll roads. The original lanes are still free of charge and are much less congested than before; meanwhile, many people voluntarily pay up to \$4.25 for better service on the express

lanes. On I-15, similarly, there seem to be no losers: more people have the express-lane option, it is voluntary, and it removes some traffic from the free lanes.

These indications of success are interesting, but they say more about how capacity can be provided than about the nature of road *pricing*. To evaluate the projects as pricing demonstrations, we need to ask somewhat different questions, such as: what are the advantages and disadvantages of using time-varying prices on roads?

VALUE PRICING

To answer, we need to look closely at one key feature of both projects: that is, there is a free alternative to the tolled lanes. Free alternatives are not a *necessary* part of road pricing, but they characterize most of the current examples of it. The term “value pricing” is being applied to situations offering a choice like this, the idea being that one has the opportunity to pay to get extra value. The term, coined to market the SR91 express lanes, proved so attractive that Congress applied it to the entire demonstration program when it was reauthorized in 1998 (although its previous name, “congestion pricing,” more accurately describes the projects).

As a demonstration of pricing, however, the concept has an Achilles’ heel. To show the difference that pricing can make, it is essential that there be significant speed differences between free and priced roadways. This means that the free roadway must remain congested; if improvements on it or on parallel routes were to eliminate heavy traffic, there would no longer be an incentive to pay a toll. Such projects can work only if we fail to make significant progress toward reducing congestion overall. Herein lies a political volcano waiting to explode.

Vulnerability exists whether the project is private or public. Suppose you are an entrepreneur thinking of building a toll road parallel to an existing congested road. You need to recoup your investment from the toll revenue, so you include a “non-compete” clause in your contract that says the state highway agency must promise not to build new capacity that would reduce congestion on

Kenneth Small is professor of Economics and Social Science at the University of California, Irvine (ksmall@uci.edu)

the existing road. This is exactly the situation on SR91, where the operator recently invoked this franchise provision and ignited a great controversy. (Resentment was exacerbated by the operator's attempt to sell out to a newly created nonprofit corporation.) Or suppose you are a public agency opening an existing carpool lane to paying solo drivers. To maintain the service for carpools, you cannot let too many cars onto the express lanes; and in order to have anything to exchange for the prices you charge, solo drivers must save a substantial amount of time.

So, whether the express roadway is public or private, the need to recoup costs or retain incentives for carpoolers requires tolls high enough to restrict use of the faster roadway significantly. By contrast, if the objective were to reduce total travel delay for all travelers, the operator would set low tolls, attract more users to the faster roadway, and thereby also speed up the slower roadway.

HOW MUCH DIFFERENCE DOES IT MAKE?

These problems are quantified in two studies in which I've participated—the first with Jia Yan, the second with Erik Verhoef. Happily, the studies also identify a number of factors that alleviate these problems. We use simulations because we want to explore pricing options that could have been adopted but weren't—including not pricing anything, which we take as the default option. To focus on pricing, we compare current policies with other possible uses of the total capacity that now exists, not with the situation before the new lanes were built.

It turns out that one critical factor is user diversity. After all, an underlying rationale for value pricing is the idea that choice is beneficial because people are not all alike. So we describe different types of motorists by assigning them different time values, i.e., different trade-offs between time and money savings. The study with Yan does this by defining two types of solo drivers, one with a high and one with a low time value; in addition, it assumes there are three-person carpools with time value *per person* equal to the solo drivers' average. The study with Verhoef uses a continuum of time values, based on surveys in the Netherlands.

Another critical factor is the size of the toll. Rather than arbitrarily setting prices, we define several alternative objectives and compute a toll to meet each objective. We then estimate the resulting traffic speeds and densities. Finally, we compute the net benefits of the policy, *relative to a policy of no toll*. Net benefits relate to all users, being the total value of their trips minus the total time costs. Toll payments are not subtracted, nor are toll revenues added—that is, we assume that benefits lost to users through toll payments are balanced by benefits gained in the public sector from using toll revenues.

RESULTS FOR STATE ROUTE 91

We calibrated parameters for the simulations to match conditions on SR91 in summer 1997. The table shows results for a case where the time values of solo drivers are \$20.70 and \$6.90 per hour. We assume carpools of three or more people use the express lanes for free, as was the practice on SR91 in summer 1997. We define three types of pricing strategies:

- *Revenue-Maximizing Value Pricing*: The express toll is set to maximize revenues, given that the rest of the road is free.
- *Benefit-Maximizing Value Pricing*: The express toll is set to maximize net benefits, given that the rest of the road is free.
- *Highest Net Benefits*: Tolls are charged on both roadways, and set to maximize net benefits.

The first column of numbers in the table shows the effects of a zero toll on both roadways. Traffic equalizes at a speed of 39 mph. Net benefit is \$0, since this is the baseline against which we compute benefits of other policies. It's not a representation of any actual situation, because we assume new capacity exists but is unpriced.

The second column portrays the situation in summer 1997, in which the operator maximizes revenue. The toll we calculate is \$2.84, very close to the toll of \$2.75 actually charged at that time (parameters of the model were in fact calibrated to achieve this match). Speeds are 58 mph on the express roadway, but only 32 mph on the regular roadway. Net benefits average \$0.30 per vehicle. These benefits arise from two sources: high-time-value cars (including carpools) are speeded up at the expense of low-time-value cars, and some less important trips are removed entirely from the peak period.

The third column shows another form of value pricing, which maximizes net benefits when most of the road must remain unpriced. The toll is lower—\$2.03—and net benefits compared to the no-toll case are higher, averaging \$0.40 per vehicle.

The last column shows how dramatically full-fledged road pricing would differ from even the best case of value pricing. Here, both roadways are priced, with prices set to maximize net benefits. Because users are diverse, this best-case policy still offers two options: \$3.51 for a fast trip and \$2.84 for a slightly slower trip. In equilibrium, carpools and high-time-value solo drivers choose the faster road. Net benefits are almost twice that of other scenarios, averaging \$0.72 per vehicle.

The table shows that the revenue-maximizing toll is 40 percent higher than the benefit-maximizing value-priced toll, and its

Simulation results for ten-mile corridor: Two user types (time values of \$20.70 and \$6.90) plus carpools; moderate time value difference

| | No Toll | Revenue-Maximizing Value Pricing | Benefit-Maximizing Value Pricing | Highest Net Benefits (Full-Fledged Road Pricing) |
|---|---------|----------------------------------|----------------------------------|--|
| TOLL (\$/trip): | | | | |
| Express lanes | \$0 | \$2.84 | \$2.03 | \$3.51 |
| Slower lanes | \$0 | \$0 | \$0 | \$2.84 |
| SPEED(mi./hr.): | | | | |
| Express lanes | 39 | 58 | 52 | 57 |
| Slower lanes | 39 | 32 | 34 | 48 |
| Net benefits per vehicle compared to "no toll" alternative (\$/trip) | \$0 | \$0.30 | \$0.40 | \$0.72 |

Source: Calculations described in Small and Yan (2001).

net benefits are 25 percent less. The higher toll creates too much of a quality differential between the two roadways. The same is true of another scenario, analyzed but not shown here, which replicates the legal restrictions imposed on I-15 in San Diego: traffic on the express lanes must be kept low enough to provide Level of Service C.

The table also shows that the benefits of value pricing are not very large—only forty cents per trip or less. The reason is that this ten-mile segment was not very congested in summer 1997, when average peak-period travel delay on the free lanes was only eight minutes. However, by 1998 this delay had already grown to thirteen minutes. In simulations where we consider projected traffic growth, we find much bigger effects from pricing.

Finally, the table shows that neither of the value-pricing scenarios comes close to achieving the full potential benefits of road pricing. It may be worth sacrificing these benefits for the political appeal of offering people a choice to pay or not, but this poses a risk: the whole concept of pricing may be endangered because one imperfect form of it does not provide sufficient benefits.

Our simulations can answer other interesting questions. For example, who stands to lose when we adopt value pricing on a previously free road? Allowing for many types of users, Verhoef and I obtain a surprising answer: it's not the people with lowest time value, but rather those with intermediate values, who suffer most or gain least. This is because offering only two choices allows the policy to cater only to people at the high and low ends of the distribution. It's as though the only options in air travel were propeller planes or supersonic jets; a lot of people would be left wishing for something in between.

FACTORS FAVORING VALUE PRICING

By varying key parameters in our simulations, we can identify a number of factors that improve the performance of value pricing:

- *Greater diversity of users* The more users' time values differ from each other, the more benefits the value-pricing scenarios provide. At the other end of the scale, where users are all alike, revenue-maximizing value pricing confers *negative* benefits—that is, it is worse than not pricing at all.
- *Higher demand elasticity* The results described above assume that few people will stop using the corridor if conditions worsen or the price rises. If instead demand is very sensitive, and people readily change their routes or modes, the revenue-maximizing toll performs better because it significantly curtails total peak-period traffic, increasing net benefits.
- *Inherent route differences* Suppose the toll road is faster not just because of less congestion, but because it is shorter or better aligned. Verhoef and I find that the benefits from value pricing are then greater.

Another factor improves the performance of some but not all types of value pricing:

- *Pricing more of the capacity* Typically, less than half the capacity is priced. What if instead *most* of the capacity were priced? Both studies find that this would dramatically increase the effectiveness of benefit-maximizing value pricing. However, revenue-maximizing pricing performs poorly under this scenario.

CONCLUSION

Value pricing is hard to do right. It works only when the unpriced part of the network remains congested, and it works best when the price charged and quality offered are both on the low side. But these are pitfalls if you want to use value pricing to demonstrate principles of road pricing. If the configuration is not quite right for success, there is a good chance that the concept of road pricing in general will be tarnished in the minds of policy makers and the public.

Furthermore, the benefits of value pricing depend strongly on the diversity of users. This makes it all the more important to increase our knowledge of people's varying attitudes about time and money savings. It also highlights an interesting potential role for private enterprise, which has proven adept at identifying and exploiting user diversity in several deregulated transportation industries.

Road pricing seems neither the wave of the future, nor an idea whose time is gone, and we are likely to see more experimentation. This creates opportunities for researchers to help guide experiments in promising directions. ♦

FURTHER READING

Joy Dahlgren, "Are HOV Lanes Really Better?" *ACCESS*, no. 6, 1995.

Louie Nan Liu and John F. McDonald, "Efficient Congestion Tolls in the Presence of Unpriced Congestion: A Peak and Off-Peak Simulation Model," *Journal of Urban Economics*, v. 44, pp. 352-366, 1998.

Kenneth A. Small and Jia Yan, "The Value of 'Value Pricing' of Roads: Second-Best Pricing and Product Differentiation," *Journal of Urban Economics*, v. 49, pp. 310-336, 2001.

Erik T. Verhoef, Peter Nijkamp, and Piet Rietveld, "Second-Best Congestion Pricing: The Case of an Untolled Alternative," *Journal of Urban Economics*, v. 40, no. 3, pp. 279-302, 1996.

Erik T. Verhoef and Kenneth A. Small, "Product Differentiation on Roads: Second-Best Congestion Pricing with Heterogeneity Under Public and Private Ownership," Irvine Economics Paper 99-00-01, University of California at Irvine, 1999.

Why Bicyclists Hate Stop Signs

BY JOEL FAJANS AND MELANIE CURRY

A BIKE COMMUTER has a lot to consider before leaving for work. What route to take, considering hills and traffic? What clothes to wear, considering ease of movement, comfort, perspiration, distance, and weather? But these questions fade when compared to the safety, speed, and energy issues bicyclists deal with en route. Transportation planners know that incorporating bicycles into the transportation system can help ease traffic congestion by substituting bikes for cars; they also know that mixing cars and bikes can be tricky. But they seldom account for the bicyclist's concerns—matters that don't occur to the typical car-driving planner. Unless planners take bicyclists' concerns seriously, their efforts will do little to increase the numbers of bicycles or help bicyclists and drivers coexist safely.

Take a simple stop sign. For a car driver, a stop sign is a minor inconvenience, merely requiring the driver to shift his foot from gas pedal to brake, perhaps change gears, and, of course, slow down. These annoyances may induce drivers to choose faster routes without stop signs, leaving the stop-signed roads emptier for cyclists. Consequently streets with many stop signs are safer for bicycle riders because they have less traffic. Indeed, formal bike routes typically include traffic-calming devices like barriers, speed bumps, and stop signs to discourage car traffic and slow down those cars that remain. However, a route lined with stop signs is not necessarily desirable for cyclists. While car drivers simply sigh at the delay, bicyclists have a whole lot more at stake when they reach a stop sign.

ENERGY EFFICIENCY

Bicyclists can work only so hard. The average commuting rider is unlikely to produce more than 100 watts of propulsion power, or about what it takes to power a reading lamp. At 100 watts, the average cyclist can travel about 12.5 miles per hour on

the level. When necessary, a serious cyclist can generate far more power than that (up to perhaps 500 watts for a racing cyclist, equivalent to the amount used by a stove burner on low). But even if a commuter cyclist could produce more than a 100 watts, she is unlikely to do so because this would force her to sweat heavily, which is a problem for any cyclist without a place to shower at work.

With only 100 watts' worth (compared to 100,000 watts generated by a 150-horsepower car engine), bicyclists must husband their power. Accelerating from stops is strenuous, particularly since most cyclists feel a compulsion to regain their former speed quickly. They also have to pedal hard to get the bike moving forward fast enough to avoid falling down while rapidly upshifting to get back up to speed.

For example, on a street with a stop sign every 300 feet, calculations predict that the average speed of a 150-pound rider putting out 100 watts of power will diminish by about forty percent. If the bicyclist wants to maintain her average speed of 12.5 mph while still coming to a complete stop at each sign, she has to increase her output power to almost 500 watts. This is well beyond the ability of all but the most fit cyclists.

We decided to test these calculations on an officially designated bike route in Berkeley, California Street. The street is about 2.25 miles long and nearly flat (average grade 0.5 percent). Traffic is very light, which is nice for cyclists. But California Street has 21 stop signs and a traffic light. More than two-thirds of the route's 31 intersections require a stop—that's one every 530 feet. A parallel route, Sacramento Street, runs one block west of California Street. Sacramento has four lanes of traffic and can be very busy, especially during rush hours. With cars parked along both sides of the street, Sacramento has little room for cyclists. But it has only eight traffic lights along the section parallel to California's bike route,

Joel Fajans is professor of Physics at the University of California, Berkeley (joel@physics.berkeley.edu). Melanie Curry is managing editor of Access (curyme@uclink4.berkeley.edu). Both commute by bicycle.

and no stop signs. Since, on average, only half the lights will be red, there's only one stop every 2,800 feet.

One of us (Joel Fajans) found that keeping exertion constant¹, he could ride on Sacramento at an average speed of 14.2 miles per hour without straining. At the same level of exertion, his speed fell to 10.9 mph on California if he stopped completely at every sign. Thus Sacramento was about 30 percent faster than California. By increasing his exertion to a fairly high level, his average speeds increased to 19 mph on Sacramento and 13.7 mph on California, so Sacramento was then 39 percent faster. While a drop of a few miles per hour may not seem like much to a car driver, think of it this way: the equivalent in a car would be a drop from 60 to 45 mph. Because the extra effort required on California is so frustrating, both physically and psychologically, many cyclists prefer Sacramento to California, despite safety concerns. They ride California, the official bike route, only when traffic on Sacramento gets too scary.

These problems are compounded at uphill intersections. Even grades too small to be noticed by car drivers and pedestrians slow cyclists substantially. For example, a rise of just three feet in a hundred will cut the speed of a 150-pound, 100-watt cyclist in half. The extra force required to attain a stable speed quickly on a grade after stopping at a stop sign is particularly grating.

CONSERVING ENERGY

One way cyclists conserve their energy at stop signs is to slow down, but not stop. A cyclist who rolls through a stop at 5 mph needs 25 percent less energy to get back to 10 mph than does a cyclist who comes to a complete stop. Blasting through a stop sign is a bit dangerous (though less dangerous than it seems because visibility at most intersections is good from a bicycle², and if the cyclist has slowed to some reasonable speed, there's typically plenty of time to stop.) Of course a sensible cyclist will always slow substantially at a stop sign if there's a car anywhere nearby. But the car-bike protocol at stop signs is not clear. Drivers (and bicyclists) are unpredictable. Will drivers take turns with bikes in an orderly way as they do with other cars? Will they start to go, notice the bicyclist, and suddenly stop again to wait, whether the cyclist is stopped or not? Will they roll through the

stop without seeing the bicyclist? Will they roll through the stop even though they see the bike? An experienced cyclist knows anything is possible. For example, if she guesses correctly that the car will wait for her, she'll want to start pedaling again as soon as possible, preferably without having slowed much, thereby conserving energy and inertia. Indeed, traffic flow is improved where cyclists do not come to a complete stop, for drivers need not wait long for the bikes to clear the intersection.

Clearly, stop signs are tricky for bicyclists. On one hand, they increase safety by decreasing the number of cars on a road, and slowing the remaining ones. On the other hand, they make cyclists work much harder to maintain a reasonable speed. For a commuter choosing between a car and a bicycle, the extra exertion can be a serious deterrent.

GETTING ALONG

Car drivers say they are confused by the presence of bicycles on the road, and some wish the two-wheelers would just go away. Bicyclists know that cars cause most of their safety concerns. Traffic planners need to find ways to help bikes and cars coexist safely. A good place to begin is by taking the special concerns of bicyclists seriously, and not assuming that they will be served by a system designed for cars. Reducing the number of stop signs on designated bike routes would make bicycle commuting considerably more attractive to potential and current riders. Allowing bicyclists to treat stop signs as yield signs, as some states do, could solve the problems in a different way.

Perhaps cities should buy bikes for their traffic engineers and require that they ride them to work periodically. There's probably no better way for them to learn what it's like to ride a bike in traffic than actually to experience its joys and hazards. ♦

FURTHER READING

John Forester, *Effective Cycling* (Cambridge, Mass: MIT Press, 1984).

Frank Rowland Whitt and David Gordon Wilson, *Bicycling Science* (Cambridge, Mass: MIT Press, 1982).

<http://socrates.berkeley.edu/~fajans/Teaching/bicycles.html>

¹ One can keep one's exertion approximately constant by fixing one's heart rate. For instance, the slower speeds (14.2 and 10.9 mph) were obtained by maintaining a heart rate of 125 beats per minute (bpm). This is an easy rate for many cyclists. The faster speeds (19 and 13.7 mph) required a heart rate of 165 bpm. This high a rate is difficult enough to discourage commuting at this pace.

² Because bicyclists can see over the roofs of cars, they can anticipate the flow of traffic many cars upstream. However they cannot see over the roofs of SUVs, pickups, and vans, and the growing number of these vehicles dramatically decreases riders' safety. The problem is compounded by the increased use of tinted glass, which prevents cyclists from seeing through the windows to the traffic ahead.

- * **Albert, William S., and Reginald G. Golledge**
"The Use of Spatial Cognitive Abilities in Geographic Information Systems: The Map Overlay Operation"
1999 UCTC 477
- * **Ang-Olson, Jeffrey, Martin Wachs, and Brian D. Taylor**
"Variable-Rate State Gasoline Taxes"
2000 UCTC 482
- Blumenberg, Evelyn, Steven Moga, and Paul M. Ong**
"Getting Welfare Recipients to Work: Transportation and Welfare Reform"
1998 UCTC 389
- * **Boarnet, Marlon G. and Saksith Chalermpong**
"New Highways, Urban Development, and Induced Travel"
2000 UCTC 426
- * **Brodrick, C.J., M. Farsh-chi, H.A. Dwyer, D. Sperling, S.W. Grouse, W. Doelling, J. Hoelzer, and M. Jackson**
"Urea-SCR System Demonstration and Evaluation for Heavy-Duty Diesel Trucks"
1999 UCTC 493
- Brodrick, Christie-Joy, Daniel Sperling, and Christopher Weaver**
"Multiple Smoke Opacity Measurements as Indicators of Particulate Emissions for Heavy-Duty Diesel Vehicle Inspection and Maintenance Programs"
2000 UCTC 421
- Brown, Jeffrey, Daniel Hess, and Donald Shoup**
"Unlimited Access"
2000 UCTC 420
- Burke, Andrew F. and Marshall Miller**
"Assessment of the Greenhouse Gas Emission Reduction Potential of Ultra-Clean Hybrid-Electric Vehicles"
1998 UCTC 376
- * **Cervero, Robert**
"Transport and Land Use: Key Issues in Metropolitan Planning and Smart Growth"
2000 UCTC 436
- * **Cervero, Robert**
"The Planned City: Coping With Decentralization, An American Perspective"
1998 UCTC 443
- * **Cervero, Robert**
"Road Supply-Demand Relationships: Sorting Out Causal Linkages"
2000 UCTC 444
- Cervero, Robert and John Beutler**
"Adaptive Transit Enhancing Suburban Transit Services"
2000 UCTC 424
- Cervero, Robert and Jonathan Mason**
"Transportation in Developing Countries: Conference Proceedings"
1998 UCTC 387
- * **Cervero, Robert, Onésimo Sandoval, and John Landis**
"Transportation as a Stimulus to Welfare-to-Work: Private Versus Public Mobility"
2000 UCTC 435
- Chan, Shirley, Matthew Malchow, and Adib Kanafani**
"An Exploration of the Market for Traffic Information"
1999 UCTC 390
- * **Contadini, J. Fernando, Robert M. Moore, Daniel Sperling, and Meena Sundaresan**
"Life-Cycle Emissions of Alternative Fuels for Transportation: Dealing with Uncertainties"
2000 UCTC 492
- Crane, Randall and Richard Crepeau**
"Does Neighborhood Design Influence Travel? A Behavioral Analysis of Travel Diary and GIS Data"
1998 UCTC 374
- * **Dahlgren, Joy**
"High Occupancy Vehicle Lanes: Not Always More Effective Than General Purpose Lanes"
1998 UCTC 504
- * **Dahlgren, Joy**
"HOV Lanes: Are They the Best Way to Reduce Congestion and Air Pollution?"
1995 UCTC 503
- * **Dahlgren, Joy**
"In What Situations Do High Occupancy Vehicle Lanes Perform Better Than General Purpose Lanes?"
1996 UCTC 502
- de Castilho, Bernardo**
"High-Throughput Intermodal Container Terminals: Technical and Economic Analysis of a New Direct-Transfer System"
1998 UCTC 388
- * **Deakin, Elizabeth, Greig Harvey, Randall Pozdena, and Geoffrey Yarema**
"Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy, and Equity Impacts"
2000 UCTC 434
- * **Dill, Jennifer, Todd Goldman, and Martin Wachs**
"California Vehicle License Fees: Incidence and Equity"
1999 UCTC 481
- Dill, Jennifer, Todd Goldman, and Martin Wachs**
"The Incidence of the California Vehicle License Fee"
2000 UCTC 414
- DiMento, Joseph, et al.**
"Court Intervention, the Consent Decree, and the Century Freeway"
1998 UCTC 381
- * **Fielding, Gordon J.**
"Private Toll Roads: Acceptability of Congestion Pricing in Southern California"
1994 UCTC 497
- * **Garrison, William L.**
"Innovation and Transportation's Technologies"
2000 UCTC 496
- * **Garrison, William L.**
"Technological Changes and Transportation Development"
2000 UCTC 495
- * **Gersbach, Hans and Amihai Glazer**
"Markets and Regulatory Hold-Up Problems"
1999 UCTC 449
- Gillen, David W., Mark Hansen, and Robson Ramos**
"Free Trade in Airline Services: Accessing the Proposals to Liberalize the Canada—US Air Transport Bilateral"
1999 UCTC 407
- * **Glazer, Amihai**
"Inducing Investments and Regulating Externalities by Command Versus Taxes"
1997 UCTC 448
- * **Glazer, Amihai**
"Time Consistency of Congestion Tolls"
2000 UCTC 451
- * **Glazer, Amihai and Esko Niskanen**
"Parking Fees and Congestion"
1992 UCTC 453
- * **Glazer, Amihai and Esko Niskanen**
"Which Consumers Benefit From Congestion Tolls?"
2000 UCTC 450
- * **Glazer, Amihai and Esko Niskanen**
"Why Voters May Prefer Congested Public Clubs"
1997 UCTC 454
- * **Glazer, Amihai and Kai A. Konrad**
"Ameliorating Congestion by Income Redistribution"
1993 UCTC 452
- * **Golledge, Reginald G.**
"Geographical Theories"
1996 UCTC 471
- * **Golledge, Reginald G.**
"The Relationship Between Geographic Information Systems and Disaggregate Behavioral Travel Modeling"
1998 UCTC 473
- * **Golledge, Reginald G., Jack M. Loomis, and Roberta L. Klatzky**
"A New Direction for Applied Geography"
1997 UCTC 472
- * **Golledge, Reginald G., James R. Marston, and C. Michael Costanzo**
"Attitudes of Visually Impaired Persons Toward the Use of Public Transportation"
1997 UCTC 478

* *Not previously listed*

- * **Golledge, Reginald G., James R. Marston, and C. Michael Costanzo**
"The Impact of Information Access on Travel Behavior of Blind or Vision-Impaired People"
2001 UCTC 479
- * **Golob, Thomas F.**
"A Simultaneous Model of Household Activity Participation and Trip Chain Generation"
2000 UCTC 439
- * **Golob, Thomas F.**
"Joint Models of Attitudes and Behavior in Evaluation of the San Diego I-15 Congestion Pricing Project"
1999 UCTC 440
- * **Golob, Thomas F., and Amelia C. Regan**
"Impacts of Highway Congestion on Freight Operations: Perceptions of Trucking Industry Managers"
1999 UCTC 447
- Gosling, Geoffrey D. and Mark M. Hansen**
"Practicality of Screening International Checked Baggage for US Airlines"
1999 UCTC 401
- Hansen, Mark and Adib Kanafani**
"Hubbing and Rehubbing at JFK International Airport—The ALIGATER Model"
1999 UCTC 408
- Hansen, Mark and Adib Kanafani**
"International Airline Hubbing in a Competitive Environment"
1998 UCTC 402
- Hansen, Mark and Qiang Du**
"Modeling Multiple Airport Systems: A Positive Feedback Approach"
1999 UCTC 404
- Hansen, Mark, David Gillen, Allison Dobbins, Yuanlin Huang, and Mohnish Puvathingal**
"The Air Quality Impacts of Urban Highway Capacity Expansion: Traffic Generation and Land Use Change"
1999 UCTC 398
- * **Hansen, Mark, David Gillen, and Mohnish Puvathingal**
"Freeway Expansion and Land Development: An Empirical Analysis of Transportation Corridors"
1998 UCTC 511
- Hansen, Mark, Mohammad Qureshi and Daniel Rydzewski**
"Improving Transit Performance With Advanced Public Transportation System Technologies"
1999 UCTC 392
- Hårsman, Björn and John M. Quigley**
"Education, Job Requirements, and Commuting: An Analysis of Network Flows"
1998 UCTC 378
- * **Hill, Mary C., Brian D. Taylor, Asha Weinstein, and Martin Wachs**
"Assessing the Need for Highways"
2000 UCTC 483
- * **Innes, Judith E., and Judith Gruber**
"Bay Area Transportation Decision Making in the Wake of ISTE: Planning Styles in Conflict at the Metropolitan Transportation Commission"
2001 UCTC 514
- Jacobs, Allan B., Elizabeth S. Macdonald, Diana Marsh, and Clark Wilson**
"The Uses and Re-uses of Major Urban Arterials: A Study of Recycling, Revitalizing, and Restructuring 'Gray Area' Transportation Corridors"
1997 UCTC 371
- * **Jacobs, Allan B., Yodan Y. Rofé, and Elizabeth Macdonald**
"Guidelines for the Design of Multiple Roadway Boulevards"
1997 UCTC 500
- * **Jacobs, Allan B., Yodan Y. Rofé, and Elizabeth S. Macdonald**
"Another Look at Boulevards"
1996 UCTC 501
- Jia, Wenyu and Martin Wachs**
"Parking Requirements and Housing Affordability: A Case Study of San Francisco"
1998 UCTC 380
- Johnston, Brian, et al.**
"The Design and Development of the University of California, Davis Future Car"
1998 UCTC 375
- * **Johnston, Robert A. and Caroline J. Rodier**
"Regional Simulations of Highway and Transit ITS: Travel, Emissions, and Economic Welfare Effects"
2000 UCTC 430
- Johnston, Robert A. and Dorriah L. Page**
"Automating Urban Freeways: Financial Analysis for User Groups"
2000 UCTC 427
- Johnston, Robert A. and Raju Ceerla**
"Systems-Level Evaluation of Automated Urban Freeways"
2000 UCTC 428
- Johnston, Robert A. and Raju Ceerla**
"The Effects of New High-Occupancy Vehicle Lanes on Travel and Emission"
2000 UCTC 429
- * **Johnston, Robert A. and Raju Ceerla**
"Travel Modeling With and Without Feedback to Trip Distribution"
2000 UCTC 431
- Johnston, Robert A., and Mark A. DeLuchi**
"Evaluation Methods for Rail Transit Projects"
2000 UCTC 418
- Johnston, Robert A., and Tomas de la Barra**
"Comprehensive Regional Modeling for Long-Range Planning: Linking Integrated Urban Models and Geographic Information Systems"
2000 UCTC 510
- Johnston, Robert A., Daniel Sperling, Mark A. DeLuchi, and Steve Tracy**
"Politics and Technical Uncertainty in Transportation Investment Analysis"
2000 UCTC 417
- Kanafani, Adib**
"Methodology for Mode Selection in Corridor Analysis of Freight Transportation"
1999 UCTC 397
- Kanafani, Adib and Mark Hansen**
"Hubbing and Airline Costs"
1999 UCTC 410
- Kanafani, Adib, Asad Khattak, Melanie Crotty, and Joy Dahlgren**
"A Planning Methodology for Intelligent Urban Transportation Systems"
1999 UCTC 395
- * **Kean, Andrew J., Robert A. Harley, David Littleton, and Gary R. Kendall**
"On-Road Measurement of Ammonia and Other Motor Vehicle Exhaust Emissions"
2000 UCTC 491
- Kiesling, Max K. and Mark Hansen**
"Integrated Air Freight Cost Structure: The Case of Federal Express"
1999 UCTC 400
- Kirchstetter, Thomas W., Brett C. Singer, Robert A. Harley**
"Impact of California Reformulated Gasoline On Motor Vehicle Emissions. 1. Mass Emission Rates"
2000 UCTC 411
- Kirchstetter, Thomas, Brett Singer, and Robert Harley**
"Impact of California Reformulated Gasoline on Motor Vehicle Emissions. 2. Volatile Organic Compound Speciation and Reactivity"
2000 UCTC 413
- Klein, Daniel B., Adrian Moore, and Binyam Reja**
"Property Rights Transit: The Emerging Paradigm for Urban Transportation"
1998 UCTC 382
- * **Kurani, Kenneth S., Daniel Sperling, Timothy Lipman, Deborah Stanger, Thomas Turrentine, and Aram Stein**
"Household Markets for Neighborhood Electric Vehicles in California"
1995 UCTC 462
- * **Kurani, Kenneth S., Thomas Turrentine, and Daniel Sperling**
"Testing Electric Vehicle Demand in 'Hybrid Households' Using a Reflexive Survey"
1996 UCTC 461

* *Not previously listed*

- Kwan, Mei-Po, Jon M. Speigle, and Reginald G. Golledge**
 "Developing an Object-Oriented Testbed for Modeling Transportation Networks"
 1999 UCTC 409
- Kwan, Mei-Po, Reginald G. Golledge, and Jon M. Speigle**
 "A Review of Object-Oriented Approaches in Geographical Information Systems for Transportation Modeling"
 2000 UCTC 412
- * **Li, Jianling and Martin Wachs**
 "A Test of Inter-Modal Performance Measures for Transit Investment Decisions"
 2000 UCTC 485
- * **Lipman, Timothy E. and Daniel Sperling**
 "Forecasting Electric Vehicle Costs with Experience Curves"
 1996 UCTC 465
- * **Lipman, Timothy E., and Daniel Sperling**
 "Forecasting the Costs of Automotive PEM Fuel Cell Systems: Using Bounded Manufacturing Progress Functions"
 1999 UCTC 494
- * **Lipman, Timothy E., Kenneth S. Kurani, and Daniel Sperling**
 "Incentive Policies for Neighborhood Electric Vehicles"
 1994 UCTC 456
- * **Lipman, Timothy E., Kenneth S. Kurani, and Daniel Sperling**
 "Regulatory Impediments to Neighborhood Electric Vehicles: Safety Standards and Zero-Emission Vehicle Rules"
 1994 UCTC 458
- Loukaitou-Sideris, Anastasia**
 "Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes"
 1998 UCTC 384
- * **Loukaitou-Sideris, Anastasia**
 "Revisiting Inner-City Strips: A Framework for Community and Economic Development"
 2000 UCTC 499
- * **Loukaitou-Sideris, Anastasia**
 "Transit-Oriented Development in the Inner City: A Delphi Survey"
 2000 UCTC 498
- Loukaitou-Sideris, Anastasia, and Tridib Banerjee**
 "The Blue Line Blues: Why the Vision of Transit Village May Not Materialize Despite Impressive Growth in Transit Ridership"
 2000 UCTC 425
- Loukaitou-Sideris, Anastasia, Robbin Liggett, Hiro Iseki, and William Thurlow**
 "Measuring the Effects of Built Environment on Bus Stop Crime"
 2000 UCTC 419
- Maillebiau, Eric and Mark Hansen**
 "Demand and Consumer Welfare Impacts of International Airline Liberalization: The Case of the North Atlantic"
 1999 UCTC 403
- Malchow, Matthew, Adib Kanafani and Pravin Varaiya**
 "Modeling the Behavior of Traffic Information Providers"
 1999 UCTC 396
- Malchow, Matthew, Adib Kanafani and Pravin Varaiya**
 "The Economics of Traffic Information: A State-of-the-Art Report"
 1999 UCTC 393
- Marston, James R. and Reginald G. Golledge**
 "Towards an Accessible City: Removing Functional Barriers for the Blind and Vision Impaired: A Case for Auditory Signs"
 2000 UCTC 423
- * **Marston, James R., and Reginald G. Golledge**
 "Improving Transit Access for the Blind and Vision-Impaired"
 1998 UCTC 476
- * **Marston, James R., and Reginald Golledge**
 "Removing Functional Barriers: Public Transit and the Blind and Vision-Impaired"
 1997 UCTC 475
- * **Marston, James R., Reginald Golledge, and C. Michael Costanzo**
 "Investigating Travel Behavior of Non-driving Blind and Vision Impaired People: The Role of Public Transit"
 1997 UCTC 474
- Mokhtarian, Patricia L. and Dennis Henderson**
 "Analyzing the Travel Behavior of Home-Based Workers in the 1991 Caltrans Statewide Travel Survey"
 2000 UCTC 415
- Mokhtarian, Patricia L., Elizabeth A. Raney and Ian Salomon**
 "Behavioral Response to Congestion: Identifying Patterns and Socio-Economic Differences in Adoption"
 1998 UCTC 373
- Mokhtarian, Patricia L., Michael N. Bagley, and Ian Salomon**
 "The Impact of Gender, Occupation, and Presence of Children on Telecommuting Motivations and Constraints"
 1998 UCTC 383
- * **Nesbitt, Kevin and Daniel Sperling**
 "Myths Regarding Alternative Fuel Vehicle Demand by Light-Duty Vehicle Fleets"
 1998 UCTC 466
- Noland, Robert B. and Kenneth A. Small**
 "Simulating Travel Reliability"
 1998 UCTC 372
- * **Raney, Elizabeth A., Patricia L. Mokhtarian, and Ian Salomon**
 "Modeling Individual's Consideration of Strategies to Cope with Congestion"
 2000 UCTC 490
- * **Recker, W. W. and A. Parimi**
 "Development of a Microscopic Activity-Based Framework for Analyzing the Potential Impacts of Transportation Control Measures on Vehicle Emissions"
 2000 UCTC 442
- * **Recker, W. W., C. Chen, and M. G. McNally**
 "Measuring the Impact of Efficient Household Travel Decisions on Potential Travel Time Savings and Accessibility Gains"
 2000 UCTC 441
- * **Recker, Wilfred W.**
 "A Bridge Between Travel Demand Modeling and Activity-Based Travel Analysis"
 2000 UCTC 446
- * **Recker, Wilfred W.**
 "The Household Activity Pattern Problem: General Formulation and Solution"
 2000 UCTC 445
- * **Regan, Amelia C. and Thomas F. Golob**
 "Freight Operators' Perceptions of Congestion Problems and the Application of Advanced Technologies: Results from a 1998 Survey of 1,200 Companies Operating in California"
 1999 UCTC 437
- * **Regan, Amelia C. and Thomas F. Golob**
 "Trucking Industry Perceptions of Congestion Problems and Potential Solutions in Maritime Intermodal Operations in California"
 1999 UCTC 438
- Rhoades, Krista, Shomik Mehndiratta, and Mark Hansen**
 "Airlines and Airport Ground Access: Current Arrangements and Future Opportunities"
 1999 UCTC 399
- * **Rodier, Caroline J. and Robert A. Johnston**
 "Method of Obtaining Consumer Welfare from Regional Travel Demand Models"
 2000 UCTC 432
- * **Rodier, Caroline J. and Robert A. Johnston**
 "Travel, Emissions, and Welfare Effects of Travel Demand Management Measures"
 2000 UCTC 433
- Rodier, Caroline J., and Robert A. Johnston**
 "A Comparison of High Occupancy Vehicle, High Occupancy Toll, and Truck-Only Lanes in the Sacramento Region"
 2000 UCTC 422
- * **Salon, Deborah, Daniel Sperling, and David Friedman**
 "California's Partial ZEV Credits and LEV II Program"
 1999 UCTC 470

* *Not previously listed*

- * **Salon, Deborah, Daniel Sperling, Susan Shaheen, and Dan Sturges**
“New Mobility: Using Technology and Partnerships to Create More Sustainable Transportation”
1999 UCTC 469
- * **Setiawan, Winardi and Daniel Sperling**
“Premium Gasoline Overbuying in the US: Consumer-Based Choice Analysis”
1993 UCTC 457
- * **Shaheen, Susan, Daniel Sperling, and Conrad Wagner**
“Carsharing and Partnership Management: An International Perspective”
1999 UCTC 468
- * **Shaheen, Susan, Daniel Sperling, and Conrad Wagner**
“Carsharing in Europe and North America: Past, Present, and Future”
1998 UCTC 467
- Shoup, Donald C.**
“Evaluating the Effects of Parking Cash Out: Eight Case Studies”
1998 UCTC 377
- * **Shoup, Donald C.**
“In Lieu of Required Parking”
1999 UCTC 507
- * **Shoup, Donald C.**
“The Trouble with Minimum Parking Requirements”
1999 UCTC 508
- * **Shoup, Donald C., and Jeffrey Brown**
“Pricing Our Way Out of Traffic Congestion: Parking Cash-Out and HOT Lanes”
1998 UCTC 509
- * **Shoup, Donald C., and Mary Jane Breinholt**
“Employer-Paid Parking: A Nationwide Survey of Employers’ Parking Subsidy Policies”
1997 UCTC 506
- * **Singer, Brett C., Thomas W. Kirchstetter, Robert A. Harley, Gary R. Kendall, and James M. Hesson**
“A Fuel-Based Approach to Estimating Motor Vehicle Cold-Start Emissions”
1999 UCTC 505
- Small, Kenneth A.**
“Project Evaluation”
1998 UCTC 379
- * **Small, Kenneth A.**
“Using the Revenues from Congestion Pricing”
1992 UCTC 480
- * **Small, Kenneth A., and Jia Yan**
“The Value of ‘Value Pricing’ of Roads: Second-Best Pricing and Product Differentiation”
1999 UCTC 512
- Small, Kenneth and José A. Gómez-Ibáñez**
“Road Pricing for Congestion Management: The Transition from Theory to Policy”
1999 UCTC 391
- * **Sperling, Daniel**
“Rethinking the Car of the Future”
1997 UCTC 464
- * **Sperling, Daniel**
“The Case for Electric Vehicles”
1996 UCTC 463
- * **Sperling, Daniel and Michael Replogle**
“Intelligent and Environmentally Sensible Transportation System: An Alternative Vision”
1995 UCTC 459
- * **Stein, Aram G., Kenneth S. Kurani, and Daniel Sperling**
“Roadway Infrastructure for Neighborhood Electric Vehicles”
1994 UCTC 455
- Taylor, Brian D.**
“Public Perceptions, Fiscal Realities, and Freeway Planning: The California Case”
1998 UCTC 385
- Taylor, Brian D. and Paul M. Ong**
“Spatial Mismatch or Automobile Mismatch? An Examination of Race, Residence and Commuting in US Metropolitan Areas”
1998 UCTC 386
- * **Taylor, Brian D., Asha Weinstein, and Martin Wachs**
“Reforming Highway Finance”
2001 UCTC 488
- * **Turrentine, Thomas and Kenneth S. Kurani**
“The Household Market for Electric Vehicles: Testing the Hybrid Household Hypothesis—A Reflexively Designed Survey of New-Car-Buying Multi-Vehicle California”
1995 UCTC 460
- Vetrovsky, Dan and Adib Kanafani**
“The Potential Role of Airports as Intermodal Terminals: Lessons from International and Domestic Experiences”
1999 UCTC 406
- * **Wachs, Martin**
“Linkages Between Transportation Planning and the Environment”
2000 UCTC 486
- * **Wachs, Martin**
“New Expectations for Transportation Data”
2000 UCTC 484
- * **Wachs, Martin**
“Refocusing Transportation Planning for the 21st Century”
2000 UCTC 487
- * **Wachs, Martin**
“The Motorization of North America: Causes, Consequences, and Speculations on Possible Futures”
1998 UCTC 489
- * **Webber, Melvin M.**
“The Joys of Spread-City”
1998 UCTC 513
- Youssef, Waleed and Mark Hansen**
“The Consequences of Strategic Alliances Between International Airlines: The Case of Swissair and SAS”
1999 UCTC 405
- Cervero, Robert**
Paratransit in America: Redefining Mass Transportation (Westport, CT: Praeger Press, 1997)
- Cervero, Robert and Michael Bernick**
Transit Villages for the 21st Century (New York: McGraw Hill, 1996)
- Daganzo, Carlos F., ed.**
Transportation and Traffic Theory (Amsterdam: Elsevier Science Publishers, 1993)
- DeCicco, John and Mark Delucchi, ed.**
Transportation, Energy, and Environment: How Far Can Technology Take Us? (Washington, D.C.: American Council for an Energy-Efficient Economy, 1997)
- Garrett, Mark and Martin Wachs**
Transportation Planning on Trial: The Clean Air Act and Travel Forecasting (Beverly Hills: Sage Publications, 1996)
- Greene, David L. and Danilo J. Santini, ed.**
Transportation and Global Climate Change (American Council for an Energy Efficient Economy, 1993)
- Jacobs, Allan B.**
Great Streets (Cambridge: MIT Press, 1993)
- Klein, Daniel B., Adrian T. Moore, and Binyam Reja**
Curb Rights: A Foundation for Free Enterprise in Urban Transit (Washington, DC: The Brookings Institution, 1997)
- Sperling, Daniel**
Future Drive: Electric Vehicles and Sustainable Transportation (Washington, DC: Island Press, 1995)
- Sperling, Daniel and Susan Shaheen, ed.**
Transportation and Energy: Strategies for a Sustainable Transportation System (American Council for an Energy Efficient Economy, 1995)

V I D E O S

- Jacobs, Allan B., Yodan Y. Rofé and Elizabeth S. Macdonald**
“Boulevards: Good Streets for Good Cities” (20 min.)
1995 Video 1

* Not previously listed

- Abdel-Aty, Mohamed Ahmed**
 "Investigating the Factors Influencing Route Choice: New Approaches in Data Collection and Modeling"
 1995 Diss 27
- Adler, Jeffrey L.**
 "An Interactive Simulation Approach to Systematically Evaluate the Impacts of Real-Time Traffic Condition Information on Driver Behavioral Choice"
 1993 Diss 18
- Ben-Joseph, Eran**
 "Subdivision Guidelines and Standards for Residential Streets and their Impact on Suburban Neighborhoods"
 1995 Diss 29
- Brown, Jeffrey Richard**
 "Trapped in the Past: The Gas Tax and Highway Finance"
 1998 Thesis 38
- Chatti, Karim**
 "Dynamic Analysis of Jointed Concrete Pavements Subjected to Moving Transient Loads"
 1992 Diss 9
- Chen, Wan-Hui**
 "Contributing Factors in Traffic Crashes: A Method for Variable Identification and Selection in Statistical Models"
 1998 Diss 40
- Chu, Xuehao**
 "Trip Scheduling and Economic Analysis of Transportation Policies"
 1993 Diss 16
- Dahlgren, Joy W.**
 "An Analysis of the Effectiveness of High Occupancy Vehicle Lanes"
 1994 Diss 25
- Delucchi, Mark A.**
 "Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity"
 1991 Diss 6
- Du, Yafeng**
 "Fleet Sizing and Empty Equipment Redistribution for Transportation Networks"
 1993 Diss 11
- Garcia, Reinaldo C.**
 "A Pareto Improving Strategy for the Time-Dependent Morning Commute Problem"
 1999 Diss 45
- Goulias, Konstadinos G.**
 "Long Term Forecasting with Dynamic Microsimulation"
 1991 Diss 21
- Guensler, Randall**
 "Vehicle Emission Rates and Average Vehicle Operating Speeds"
 1994 Diss 19
- Handy, Susan L.**
 "Regional versus Local Accessibility: Variations in Suburban Form and the Effects on Non-Work Travel"
 1992 Diss 5
- Kim, Seyoung**
 "Commuting Behavior of Two-Worker Households in the Los Angeles Metropolitan Area"
 1993 Diss 22
- Kockelman, Kara Maria**
 "A Utility-Theory-Consistent System-of-Demand-Equations Approach to Household Travel Choice"
 1998 Diss 41
- Kurani, Kenneth Stuart**
 "Application of a Behavioral Market Segmentation Theory to New Transportation Fuels in New Zealand"
 1992 Diss 15
- Kwan, Mei-Po**
 "GISICAS: A GIS-Interfaced Computational-Process Model for Activity Scheduling in Advanced Traveler Information Systems"
 1994 Diss 24
- Lee, Richard W.**
 "Travel Demand and Transportation Policy Beyond the Edge: An Inquiry into the Nature of Long-Distance Interregional Commuting"
 1995 Diss 30
- Lem, Lewison Lee**
 "Fairness or Favoritism? Geographic Redistribution and Fiscal Equalization Resulting From Transportation Funding Formulas"
 1996 Diss 34
- Levine, Jonathan Charles**
 "Employment Suburbanization and the Journey to Work"
 1990 Diss 12
- Levinson, David Matthew**
 "On Whom the Toll Falls: A Model of Network Financing"
 1998 Diss 39
- Li, Jianling**
 "Inter-Modal Transit Performance Indicators"
 1997 Diss 35
- Macdonald, Elizabeth Suzanne**
 "Enduring Complexity: A History of Brooklyn's Parkways"
 1999 Diss 46
- Mannering, Jill S.**
 "Determinants of the Decision to Telecommute: An Empirical Analysis"
 1994 Thesis 43
- McCullough, William Shelton III**
 "Transit Service Contracting and Cost Efficiency"
 1997 Thesis 36
- Nesbitt, Kevin Abolt**
 "An Organizational Approach to Understanding the Incorporation of Innovative Technologies into the Fleet Vehicle Market with Direct Application to Alternative Fuel Vehicles"
 1996 Diss 33
- Newman, Alexandra Mary**
 "Optimizing Intermodal Rail Operations"
 1998 Diss 42
- Pendyala, Ram Mohan**
 "Causal Modeling of Travel Behavior Using Simultaneous Equations Systems: A Critical Examination"
 1993 Diss 14
- Picado, Rosella**
 "Non-Work Activity Scheduling Effects in the Timing of Work Trips"
 1999 Diss 47
- Raphael, Steven Paul**
 "An Analysis of the Spatial Determinants and Long-Term Consequences of Youth Joblessness"
 1996 Diss 32
- Rubin, Jonathan D.**
 "Marketable Emission Permit Trading and Banking for Light-Duty Vehicle Manufacturers and Fuel Suppliers"
 1993 Diss 13
- Shaw, John**
 "Transit, Density, and Residential Satisfaction"
 1994 Diss 28
- Smith, James E.**
 "A Comparative Study of Entrepreneurial Strategies among African-American and Latino Truckers in the Los Angeles and Long Beach Ports"
 1993 Diss 23
- Song, Shunfeng**
 "Spatial Structure and Urban Commuting"
 1992 Diss 8
- Souleyrette, Reginald R. II**
 "Transportation Services and Innovation in the Housing Industry: A Study of the Relations Between Transportation and Production"
 1989 Diss 7
- Steiner, Ruth Lorraine**
 "Traditional Neighborhood Shopping Districts: Patterns of Use and Modes of Access"
 1996 Diss 37
- Turrentine, Thomas**
 "Lifestyle and Life Politics: Towards a Green Car Market"
 1995 Diss 26
- van Hengel, Drusilla**
 "Citizens Near the Path of Least Resistance: Travel Behavior of Century Freeway Corridor Residents"
 1996 Diss 31
- Walls, W. David**
 "Open Access Transportation, Network Competition, and Market Integration in the Natural Gas Pipeline Industry"
 1992 Diss 17
- Yim, Youngbin**
 "The Relationship between Transportation Services and Urban Activities: The Food Retail Distribution Case"
 1990 Diss 20

ACCESS NO. 1, FALL 1992

Cars and Demographics

Charles Lave

Compulsory Ridesharing in Los Angeles

Martin Wachs and Genevieve Giuliano

Redundancy: The Lesson from the Loma Prieta Earthquake

Melvin M. Webber

Environmentally Benign Automobiles

Daniel Sperling, et al.

Pavement Friendly Buses and Trucks

J. Karl Hedrick, et al.

Commuter Stress

Raymond W. Novaco

ACCESS NO. 2, SPRING 1993 (Out of Print)*

Cashing Out Employer-Paid Parking,

Donald C. Shoup

Congestion Pricing: New Life for an Old Idea?

Kenneth A. Small

Private Toll Roads in America—The First Time Around

Daniel B. Klein

Investigating Toll Roads in California

Gordon J. Fielding

Telecommuting: What's the Payoff?

Patricia L. Mokhtarian

Surviving in the Suburbs: Transit's Untapped Frontier

Robert Cervero

ACCESS NO. 3, FALL 1993

Clean for a Day: California Versus the EPA's Smog Check Mandate

Charles Lave

Southern California: The Detroit of Electric Cars?

Allen J. Scott

The Promise of Fuel-Cell Vehicles

Mark Delucchi and David Swan

Great Streets: Monument Avenue, Richmond, Virginia

Allan B. Jacobs

Why California Stopped Building Freeways

Brian D. Taylor

THE ACCESS ALMANAC: Trends in Our Times

Charles Lave

*Photocopies of Access No. 2 can be obtained for \$10, payable to UC Regents.

ACCESS NO. 4, SPRING 1994

Time Again for Rail?

Peter Hall

No Rush to Catch the Train

Adib Kanafani

Will Congestion Pricing Ever Be Adopted?

Martin Wachs

Cashing in on Curb Parking

Donald C. Shoup

Reviving Transit Corridors and Transit Riding

Anastasia Loukaitou-Sideris

THE ACCESS ALMANAC: Love, Lies, and Transportation in LA

Charles Lave

ACCESS NO. 5, FALL 1994

Highway Blues: Nothing a Little Accessibility Can't Cure

Susan Handy

Transit Villages: From Idea to Implementation

Robert Cervero

A New Tool for Land Use and Transportation Planning

John D. Landis

It Wasn't Supposed to Turn Out Like This: Federal Subsidies and Declining Transit Productivity

Charles Lave

The Marriage of Autos and Transit: How to Make Transit Popular Again

Melvin M. Webber

THE ACCESS ALMANAC: The CAFE Standards Worked

Amihai Glazer

ACCESS NO. 6, SPRING 1995

The Weakening Transportation-Land Use Connection

Genevieve Giuliano

Bringing Electric Cars to Market

Daniel Sperling

Who Will Buy Electric Cars?

Thomas Turrentine

Are HOV Lanes Really Better?

Joy Dahlgren

THE ACCESS ALMANAC: Slowdown Ahead for the Domestic Auto Industry

Charles Lave

ACCESS NO. 7, FALL 1995

The Transportation-Land Use Connection Still Matters

Robert Cervero and John Landis

New Highways and Economic Growth: Rethinking the Link

Marlon G. Boarnet

Do New Highways Generate Traffic?

Mark Hansen

Higher Speed Limits May Save Lives

Charles Lave

Is Oxygen Enough?

Robert Harley

ACCESS NO. 8, SPRING 1996

Free To Cruise: Creating Curb Space for Jitneys

Daniel B. Klein, Adrian T. Moore, and Binyam Reja

Total Cost of Motor-Vehicle Use

Mark A. Delucchi

Are Americans Really Driving So Much More?

Charles Lave

SmartMaps for Public Transit

Michael Southworth

Decision-Making After Disasters: Responding to the Northridge Earthquake

Martin Wachs and Nabil Kamel

THE ACCESS ALMANAC: Autos Save Energy

Sharon Sarmiento

ACCESS NO. 9, FALL 1996

There's No There There: Or Why Neighborhoods Don't Readily Develop Near Light-Rail Transit Stations

Anastasia Loukaitou-Sideris and Tridib Banerjee

The Century Freeway: Design by Court Decree

Joseph DiMento, Drusilla van Hengel, and Sherry Ryan

Transit Villages: Tools For Revitalizing the Inner City

Michael Bernick

Food Access for the Transit-Dependent

Robert Gottlieb and Andrew Fisher

The Full Cost of Inter-city Travel

David Levinson

The Freeway's Guardian Angels

Robert L. Bertini

THE ACCESS ALMANAC: Travel by Carless Households

Richard Crepeau and Charles Lave

ACCESS NO. 10, SPRING 1997

The High Cost of Free Parking

Donald C. Shoup

Dividing the Federal Pie

Lewis Lee Lem

Can Welfare Recipients Afford to Work Far From Home?

Evelyn Blumenberg

Telecommunication vs. Transportation

Pnina Ohanna Plaut

Why Don't You Telecommute?

Ilan Salomon and Patricia L. Mokhtarian

THE ACCESS ALMANAC: Speed Limits Raised, Fatalities Fall

Charles Lave

ACCESS NO. 11, FALL 1997

A New Agenda

Daniel Sperling

Hot Lanes: Introducing Congestion-Pricing One Lane at a Time

Gordon J. Fielding and Daniel B. Klein

Balancing Act: Traveling in the California Corridor

Adib Kanafani

Does Contracting Transit Service Save Money?

William S. McCullough, Brian D. Taylor, and Martin Wachs

Tracking Accessibility

Robert Cervero

THE ACCESS ALMANAC: The Pedigree of a Statistic

Donald C. Shoup

ACCESS NO. 12, SPRING 1998

Travel by Design?

Randall Crane

Traditional Shopping Centers

Ruth L. Steiner

Simulating Highway and Transit Effects

John D. Landis

Cars for the Poor

Katherine M. O'Regan and John M. Quigley

Will Electronic Home Shopping Reduce Travel?

Jane Gould and Thomas F. Golob

ACCESS NO. 13, FALL 1998

Congress Okays Cash Out

Donald C. Shoup

Global Transportation

Wilfred Owen

Taxing Foreigners Living Abroad

David Levinson

Parking and Affordable Housing

Wenyu Jia and Martin Wachs

Lost Riders

Brian D. Taylor and William S. McCullough

ACCESS NO. 14, SPRING 1999

Middle Age Sprawl: BART and Urban Development

John Landis and Robert Cervero

Access to Choice

Jonathan Levine

Splitting the Ties: The Privatization of British Rail

José A. Gómez-Ibáñez

Objects in Mirror Are Closer Than They Appear

Theodore E. Cohn

THE ACCESS ALMANAC: Gas Tax Dilemma

Mary Hill, Brian Taylor, and Martin Wachs

ACCESS NO. 15, FALL 1999

Requiem for Potholes

Carl Monismith as told to Melanie Curry

Instead of Free Parking

Donald Shoup

Partners in Transit

Eugene Bardach, Timothy Deal, and Mary Walther

Pooled Cars

Susan Shaheen

Travel for the Fun of It

Patricia L. Mokhtarian and Ilan Salomon

ACCESS NO. 16, SPRING 2000

What If Cars Could Drive Themselves?

Steven E. Shladover

Power from the Fuel Cell

Timothy E. Lipman

Should We Try to Get the Prices Right?

Mark Delucchi

An Eye on the Fast Lane: Making Freeway Systems Work

Pravin Varaiya

On Bus-Stop Crime

Anastasia Loukaitou-Sideris and Robin Liggett

ACCESS NO. 17, FALL 2000

Brooklyn's Boulevards

Elizabeth Macdonald

A Question of Timing

Rosella Picado

Taking Turns: R_x for Congestion

Carlos Daganzo

What Can a Trucker Do?

Amelia Regan

The Road Ahead: Managing Pavements

Samer Madanat

THE ACCESS ALMANAC: The Parking of Nations

Donald Shoup and Seth Stark

O R D E R F O R M

ACCESS NUMBER 18, SPRING 2001

| UCTC # | AUTHOR | TITLE | QUANTITY |
|--------|--------|-------|----------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Try our website first: Many papers are available for downloading (www.uctc.net)

Papers and ACCESS back issues are free, but please limit your request to subjects of genuine interest to you

Dissertations and theses are \$15, payable to UC Regents

To receive future issues of ACCESS, please check here

Center Director

Elizabeth E. Deakin

Editor

Melvin M. Webber

Associate Editor

Charles Lave

Managing Editor

Melanie Curry

Design

Mitche Manitou

Manager

Diane Sutch

VISIT OUR WEBSITE AT

www.uctc.net

NAME _____

AFFILIATION _____

ADDRESS _____

PHONE _____

Send to:

Publications, University of California Transportation Center

University of California, Berkeley, CA 94720-1782

Fax (510) 643-5456

postmaster@uctc.net

A D D R E S S C O R R E C T I O N

Attach incorrect mailing label here

Delete name from Access mailing list

New address provided on order form above

Census Undercount

BY PAUL ONG

THE DECENNIAL CENSUS is America's single most important effort to collect data on its population, and yet the count always comes up short. Over the years, the counts have been getting somewhat better, although it's still nearly impossible to include everyone. Estimates of the uncounted population declined steadily from 5.4 percent in 1940 to 1.2 percent in 1980, then increased to 1.8 percent in 1990. Preliminary estimates for 2000 range from 0.96 to 1.4 percent.

One troubling aspect of the undercount is the sizable variation among groups—what's called the “differential undercount,” because groups are undercounted differently. Preliminary estimates for the 2000 census show undercount rates for minorities that are several times higher than rates for non-Hispanic whites—three times higher for African Americans, four times higher for Hispanics, and seven times higher for American Indians on reservations. Undercount rates also vary by region, level of urbanization, and home ownership.

It's still too early to estimate differential undercount rates for commuters in 2000, but we do have data for 1990 that are probably indicative of the 2000 patterns. Estimated 1990 undercount rates in 22 metropolitan areas were 1.3 percent for solo drivers, 2.2 percent for carpoolers, 2.3 percent for pedestrians and bicyclists, and 3.2 percent for mass-transit riders—two and a half times the undercount rate for solo drivers. This is not surprising, given that minorities and low-income workers are disproportionately over-represented among mass-transit riders.

Figure 1 shows the ranges in undercount rates among the 22 metropolitan areas. Pittsburgh, Philadelphia, and Boston had the lowest; Houston, Miami, and Los Angeles had the highest.

Variations across metropolitan areas reflect both socioeconomic differences within labor forces and differences in distributions of income and ethnic groups. Moreover, there was variation in differential undercount rates across transportation modes. They were higher for mass-transit riders than for solo drivers in all 22 metropolitan areas, but the size of the gap varied. For example, Newark had the largest, a gap of 2.7 percentage points, but in Seattle the undercount difference was only 1.4 percentage points.

Figure 2 shows estimated undercount rates by income level for mass-transit riders and solo drivers. As expected, undercount rates varied inversely with rising incomes, approaching zero at the highest income levels; and they varied directly with percentage of minorities, as depicted in Figure 3.

The absence of accurate data on low-income and minority commuters can distort transportation policy and financial allocations. Planners are unable to accurately assess transportation needs when the number of people who rely on transit for access to employment is miscounted. Unintentionally and systematically, they are likely to underestimate the importance of public transportation relative to private transportation, leading to inadequate support for mass transit.

The degree of distortion in transportation policies will depend on how the differential-undercount problem is addressed. Accurate statistics on commuters, their demographic characteristics, and the ways they travel to work are prerequisite to sound transportation plans and a fair allocation of public resources among modes. In turn, access to the required information calls for statistical corrections to ensure that commuter data from the 2000 Census will include everyone. ♦

Paul Ong is professor of Urban Planning at the University of California, Los Angeles (p.ong@ucla.edu)

Commuter undercount rates in 22 metropolitan areas, 1990 census

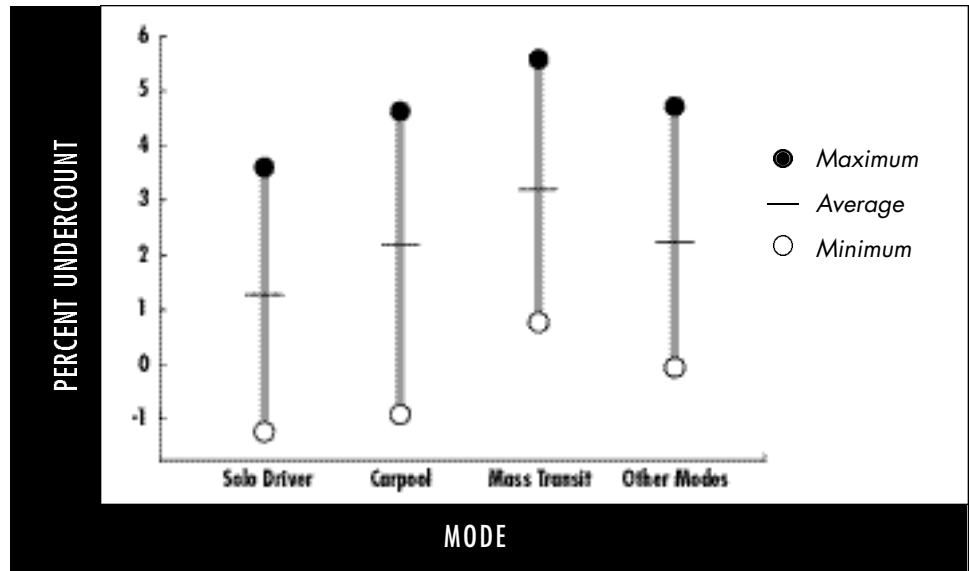


Figure 1: Mode

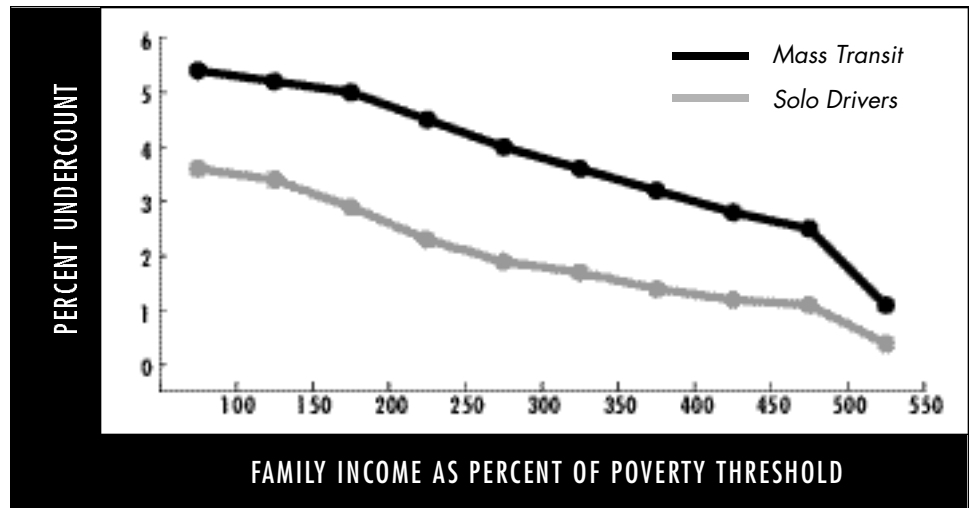


Figure 2: Income level

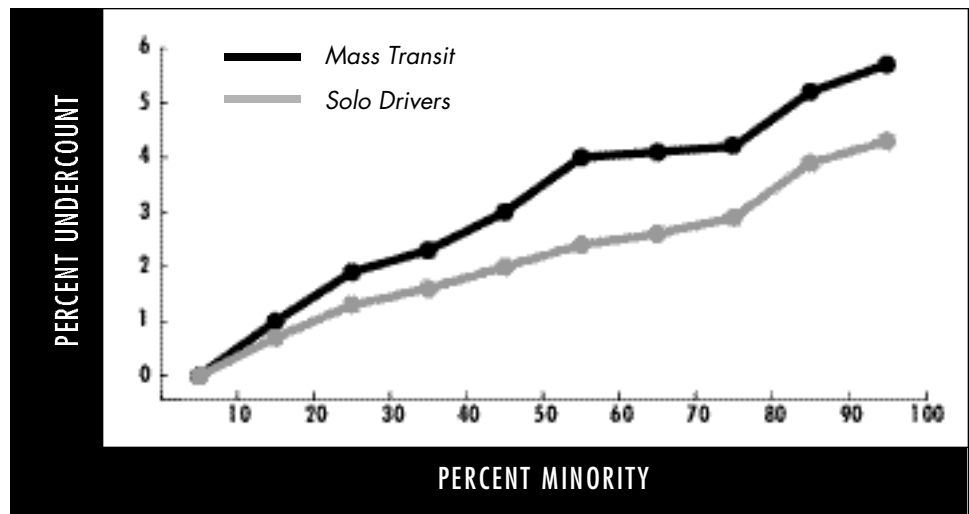


Figure 3: Minority population