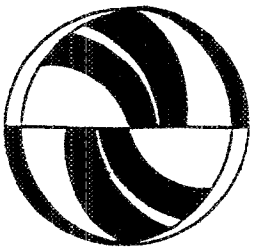

Using the Revenues from Congestion Pricing

Kenneth A. Small

Reprint
UCTC No 480

The University of California
Transportation Center

University of California
Berkeley, CA 94720

The University of California Transportation Center

The University of California Transportation Center (UCTC) is one of ten regional units mandated by Congress and established in Fall 1988 to support research, education, and training in surface transportation. The UC Center serves federal Region IX and is supported by matching grants from the U.S. Department of Transportation, the California Department of Transportation (Caltrans), and the University.

Based on the Berkeley Campus, UCTC draws upon existing capabilities and resources of the Institutes of Transportation Studies at Berkeley, Davis, Irvine, and Los Angeles; the Institute of Urban and Regional Development at Berkeley, and several academic departments at the Berkeley, Davis, Irvine, and Los Angeles campuses. Faculty and students on other University of California campuses may participate in Center activities Researchers at other universities within the region also have opportunities to collaborate with UC faculty on selected studies.

UCTC's educational and research programs are focused on strategic planning for improving metropolitan accessibility, with emphasis on the special conditions in Region IX. Particular attention is directed to strategies for using transportation as an instrument of economic development, while also accommodating to the region's persistent expansion and while maintaining and enhancing the quality of life there

The Center distributes reports on its research in working papers, monographs, and in reprints of published articles It also publishes *Access*, a magazine presenting summaries of selected studies. For a list of publications in print, write to the address below

University of California
Transportation Center

108 Naval Architecture Building
Berkeley, California 94720
Tel 510/643-7378
FAX· 510/643-5456

Using the Revenues from Congestion Pricing

Kenneth A. Small

Department of Economics
University of California
Irvine, CA 92717

Reprinted from
Transportation
Vol 19, no 4, pp 359-381 (1992)

UCTC No 480

The University of California Transportation Center
University of California at Berkeley

Transportation **19**: 359–381, 1992.

Using the revenues from congestion pricing

KENNETH A. SMALL
Department of Economics, University of California, Irvine, CA 92717, USA

Key words: congestion pricing, distributional impacts, road pricing, user charges

Abstract. The economic theory behind congestion pricing relies on using the revenues to help compensate highway users. But can practical methods of using revenues come close to achieving this compensation, and still have salient appeal to important political groups? This paper investigates the possibilities for designing a package of revenue uses that can achieve these twin goals. The suggested approach returns two-thirds of the revenues to travelers through travel allowances and tax reductions, and uses the rest to improve transportation throughout the area, including affected business centers. By replacing regressive sales and fuel taxes, this approach offsets the tendency of the prices alone to have a regressive distributional impact. By lowering taxes, funding new highways, improving transit, and upgrading business centers, the package provides inducements for support from several key interest groups. The potential amounts of money involved are discussed using nationwide data, and in more detail using a case study of ubiquitous facility pricing throughout the Los Angeles region. Illustrative calculations of the effects on various individuals confirm that such a package can create net benefits for a wide spectrum of people and interest groups.

1. Introduction

Congestion pricing is widely recognized to be politically difficult because it prices something previously free. Theory suggests, however, that enough revenue can be generated to more than offset the losses to individual travelers. If this theory applies, it ought to be possible to design a package of congestion charges and revenue uses that looks attractive to most people. Surveys confirm that support for the concept is much higher when it is presented as a complete financial package with explicit proposals for using revenues (Jones 1991).

The ability to design such a package, then, is both a test of the applicability of the economic theory and a challenge to those who wish to implement the concept. The details of the design will largely determine the policy's political feasibility, its fairness, and even the nature of the resulting transportation system.

This paper considers some principles that could guide revenue allocation within a comprehensive program of congestion pricing, one that covers an entire urban region using area pricing or facility pricing or both. In partic-

ular, I investigate the possibilities for making the entire package appeal to the narrow self-interest of most residents. In more formal terms, the question is whether a potential Pareto improvement can be converted into an actual one using real-world fiscal tools and paying attention to the political realities of interest groups.

The paper undertakes this investigation by considering how various categories of people and institutions are affected by congestion pricing, and suggesting measures that would tend to offset negative effects. It also considers measures that would appeal to influential interest groups in order to attract their political support. It then attempts to estimate roughly the magnitudes of revenues and expenditures that might typically be involved, to see what a feasible package could look like. The specific institutional framework considered is that of the United States, but the principles are applicable worldwide.

The results suggest that there is room within a realistic scenario to spread benefits widely, so as to more than fully offset the costs to a majority of residents. Furthermore, these benefits can be made visible and understandable to ordinary citizens and leaders of major interest groups. The key to these results is the large magnitude of the revenues.

Demonstrating that such a package is feasible does not necessarily mean it is the one most likely to achieve political acceptability. To make that deduction would require accepting a theory of politics based entirely on individual and group self-interest. While I do not endorse such a theory, I believe it is a useful benchmark. If there is an institutionally feasible package of revenue uses that makes congestion pricing look attractive on grounds of self-interest, then there is a greater likelihood of finding a package that can attract support in a real political environment.

This paper analyzes the case of highways that are publicly owned and financed. An alternative scenario, not considered here, would be a new road financed through dedicated tolls levied on users. Differentiating the toll by place and time of day is an effective way to increase revenue, especially if the highway competes with a parallel free route subject to peak-period congestion (Small 1992: 140–143; Poole 1992). This potential of congestion pricing has been recognized in planning for at least three privately proposed highways in the United States,[1] but is seldom recognized for roads in the public sector.

Another scenario not considered here would be to commercialize a major portion of the road system: that is, to turn it over to public or private authorities that are largely self-financing. There is reason to believe that in the long run efficient user charges, including congestion pricing, would enable such authorities to break even on the urban portion of the network (Small et al. 1989,

ch. 6). Moving to a commercialized system would require major changes in taxation and cost accounting, as well as a procedure to account for the value of roads already built, so cannot easily be addressed in the context of this paper.

2. Direct impacts of congestion pricing

Adoption of congestion pricing would produce many ancillary changes in markets such as those for labor, land, and retail goods that would affect the ultimate beneficiaries of the policy. Furthermore, the improved efficiency of highway travel would alter many economic activities including trucking, bus transit, deliveries, and the businesses that depend on them. Tracing all these effects is beyond the scope of this paper. However, the first step in any distributional analysis is to determine the direct impacts that would occur ignoring these ancillary market shifts. An analysis of direct impacts is particularly useful for the approach adopted here because the indirect effects derive from the direct ones; hence any package of revenue uses that reduces disparities in direct impacts is likely also to reduce disparities that remain after indirect effects are taken into account.

A congestion pricing program produces four main types of direct effects. Two are negative: (a) the actual fee payments, and (b) the inconvenience to those who change their behavior in order to avoid the fees. (Note that for any given individual, this inconvenience cannot exceed the fee payment for which he would be liable if he did not change his behavior.) The other two are positive: (c) the benefits to travelers who encounter less congestion, and (d) the benefits from uses of the revenues.

The standard theory assumes that, in aggregate, categories (a) and (d) are exactly offsetting: that is, that the fee payment and subsequent use of revenues constitute a transfer of purchasing power with no aggregate effect on welfare. This assumption is overly optimistic if the revenue from congestion pricing is in fact spent unwisely; whereas it is overly pessimistic to the extent that the revenue replaces inefficient taxes or facilitates worthwhile expenditures that are currently foregone for lack of funds. In practice, both of these effects occur in different areas of government operation; disagreement over which effect predominates is at the heart of ideological debates concerning the desirable scope of government.

The standard theory then goes on to find conditions under which the loss of convenience to people priced off the roads (category b) is more than offset by the benefits of reduced road congestion (category c). The theoretically optimal congestion charge is in fact precisely the one that maximizes the difference between (c) and (b). The empirical basis for advocating conges-

tion pricing is the belief that this optimal charge is far higher than current highway user charges during peak periods. (It is also believed to be lower during offpeak periods, providing a rationale for using the peak congestion fees to replace some other user charges.)

The political difficulty addressed in this paper is that these offsets occur only in aggregate, not at the individual level. The people who benefit from congestion relief and revenue uses do not necessarily coincide with those who pay the fees or who suffer inconvenience in order to avoid them. One strategy for designing a scheme of revenue uses, then, is to reduce such disparities. More generally, revenue uses can be chosen to achieve specific goals about the distributional effects of the overall package.

In order to better understand these distributional effects, it is useful to distinguish three categories of people who are most directly affected. I do so by adapting a more detailed taxonomy developed by Gomez-Ibanez (1992).

Existing solo drivers on highways to be priced

People driving alone on congested highways during peak hours will face much higher user fees, coupled with a dramatic improvement in service level. Because it takes only a modest reduction in use to greatly improve travel times, the efficient level of fees will accomplish that reduction and no more. Therefore, the majority of such users will pay the fee and continue to drive. Others will switch to alternative modes, times, routes, or destinations, or will forego the trips altogether.

Users with very high values of time will find the service improvements more than offset the fees, so they will benefit. The rest, especially those for whom the alternatives to driving during peak hours are particularly unattractive, will lose. An exception might be some who find that alternative modes such as carpool or bus become so much faster, due to less congestion, that they are happier using those modes after the policy change than they are driving alone now. (This can happen whether or not carpools are exempted from the fee, since carpooling allows the fee to be divided among two or more people.)

Existing carpool or bus users on highways to be priced

People now using high-occupancy modes subjected to highway congestion will mostly benefit. They receive the full benefit of improved travel time, but with a more modest cost increase per passenger. An exception might be people with low values of time sharing a carpool, if carpools are charged at the same rate as other vehicles.

Existing users of highways not to be priced

Highways outside the scope of the pricing policy, but close enough to be alternative routes, will experience some increase in traffic. This traffic will adversely affect their present users. The effect should be small, because any highway which would suffer major congestion due to diverted traffic should instead be included in the pricing plan.

3. Interest groups

To assess political feasibility, we need to consider not only individuals, but groups likely to be identified in any public debate over congestion pricing.

Traveling public

People who use the transportation system extensively, especially automobile drivers, can be expected to express some common interests that will shape any political debate over congestion pricing. If galvanized on a transportation issue, these people can be a very large voting block, as exemplified by the large membership of the American Automobile Association. Their interests include reducing congestion, improving service on mass transit, and keeping taxes and user charges low.

State and local officials

Political, administrative, and technical officials must reconcile the public's demand for services, including transportation, with strong resistance to taxes. Many of these officials have career interests in constructing public works, whether or not efficient. State and local officials have a strong interest in finding ways to finance transportation projects and other services.

Public transit and taxicab industries

State and local officials in agencies supplying mass transit services are joined by transit unions in seeking increased levels of transit funding. Taxicab operators want to ensure a stable operating environment, continued demand for their services, and authorization to pass on any increases in their costs.

Trucking organizations

While more active at state and national than local levels, these organizations

are dedicated to better highways, full access to trucks, and financing mechanisms that do not target heavy vehicles. They are adamantly opposed to restrictions on truck movements, such as those proposed for Los Angeles. Congestion pricing might be viewed as a substitute for such restrictions.

Business sector

Local businesses share an interest in good public services, including transportation facilities, to support their activities. Some depend crucially on reliable timing of deliveries, and hence care a great deal about the inefficiencies of congestion; but they seek solutions to it that maintain their flexibility. They also share an interest in low business taxes. Beyond that, their interests can be quite divergent, ranging from a desire to increase downtown property values to a desire to promote new outlying development. Developers are especially active in transportation issues, and often play an important role in lobbying officials and shaping public opinion on transportation proposals.

Environmentalists and slow-growth advocates

Successful lobbying groups have formed around issues of environmental degradation due to highways and their associated development. Concerns include scenic values, air pollution, noise, water runoff, and loss of wildlife. Typically these groups oppose most proposals to expand the highway system, although they may be willing to compromise on highways that are smaller and less environmentally damaging.

Low-tax advocates

A number of disparate organizations have successfully united to oppose tax increases, including past versions of the dedicated sales-tax surcharges now in place in many metropolitan areas. Some of these groups are amenable to higher user fees, while others oppose all government charges. Some are interested in privatizing highways.

4. Some guiding principles for using revenues

Because congestion pricing is designed to reduce congestion, the higher user charges faced by peak-period highway travelers are accompanied by reduced travel times. This means that only a portion of the revenues need be used to offset the higher charges in order to fully compensate travelers in the aggregate. Because it is impossible to precisely target those who are most adversely

affected, it is desirable to more than fully compensate the majority. Even so, as we shall see, revenues may be so large that there is money left over to promote general social goals and to garner political support.

In this section, I outline some measures designed to achieve the objectives of offsetting negative impacts, promoting social goals, and garnering political support from interest groups. The strategy is to fund programs with such a variety of distributions of impacts that nearly everyone affected will find at least some offsetting benefits, and a majority will perceive the entire package as an improvement.

Furthermore, each component of the program has a rationale in terms of transportation funding. This has two advantages. First, it facilitates an understanding of the entire package as a transportation measure. Second, it limits the ability of interest groups or political opportunists to see the program as a gigantic revenue windfall to be appropriated for their own purposes.

A simple tripartite division of revenues

Any revenue-allocation scheme is more understandable to the public if it is part of a simple overarching strategy that appeals to common sense. I propose one that keeps the money in the transportation sector, yet through several quite different mechanisms. The proposal is to allocate one-third of the revenues to each of the following categories:

(i) monetary reimbursement to travelers as a group;
(ii) substitution for general taxes now used to pay for transportation services; and
(iii) new transportation services.

This is a rather conservative strategy compared to some that have been suggested. Goodwin (1990) proposes a revenue allocation of one-third to highway improvements, one-third to mass transit, and one-third to either general tax relief or increased general expenditures. However, spending so much of the money on new projects would significantly expand the scope of government and thereby unnecessarily identify congestion pricing with one side of an often divisive ideological debate. Furthermore, such a large increase in transportation funding might not be justified, especially since congestion pricing, as a demand-management tool, can substitute for some otherwise needed expansions of highway capacity.

It is argued by some that the only politically salient case for congestion pricing is to fund new highways (Gomez-Ibanez 1992). Category (iii) can include some explicitly designated and well publicized highway improvements to help meet the desires for such expenditures. Nevertheless, I have not incorporated this motivation as a dominant part of the proposed scheme because,

once again, there is no guarantee that sound investment policy would involve that much new money. This argument applies even more strongly to the suggestion made by the Bay Area Economic Forum (1990) that revenues from each corridor be targeted to highway improvements in that corridor. Tying congestion pricing to the financing of a particular highway may make more sense as part of a small-scale demonstration project, such as suggested by Poole (1993) for a corridor in California, than as part of the areawide implementation analyzed here.

Others argue the opposite extreme: that the system should be revenue-neutral with no increased expenditures. While such a position is defensible and has the virtue of simplicity, many voters will be more convinced by the ability to fund tangible transportation improvements than by the logic of pricing to allocate scarce capacity (Jones 1991). These voters may view a revenue-neutral program as just replacing one set of tax revenues by another.

The scheme proposed here follows a principle advocated by Burtraw (1991) for compensating losers from decisions in environmental policy. Burtraw suggests that "linked compensation," in which losses are offset by measures that directly alleviate the harm done, is viewed by most people as fairer and more understandable than monetary transfers. In our case, the biggest loss *is* a monetary transfer, so the offsetting transfers in categories (i) and (ii) can be understood as linked compensation. For those who avoid the fee by switching to less convenient alternatives, the transportation expenditures in category (iii) offer the possibility to directly redress their losses by improving their trip.

Burtraw's argument, and indeed the whole rationale for category (iii), presumes that the new services will actually be used by people whose travel is affected by the plan. This highlights an important proviso in any compensation scheme: providing gold-plated services that appeal to planners rather than users will not make the package palatable.

Specific measures

I list below seven specific measures that seem to meet the goals outlined here. They are categorized according to the tripartite scheme just suggested. They are chosen to ensure that benefits are widespread, can be made visible through credible publicity, and reach the major categories of people who bear the burdens of the congestion charges.

Reimbursements to travelers

1. *Fund a program of employee commuting allowances*

This measure would subsidize employers who establish a general commuting

allowance, which would offset some of the extra commuting expense incurred by their workers. The allowance would be a fixed amount per month for each employee, regardless of mode or time of travel; this way it will not undermine the incentives that are the main purpose of the congestion charges.

Travel allowances have also been advocated, in combination with priced parking, as substitutes for free employee parking. If desired, the two goals could be coupled in a single program. As has been noted in the literature on parking (e.g. Shoup 1982), one impediment to travel allowances has been their taxability under U.S. tax law.

The great advantage of using congestion-pricing revenues to fund travel allowances is that it puts money directly back in the hands of commuters, while giving them the flexibility to avoid some or all of the higher fees by shifting modes, routes, or times of day if they can do so conveniently. In this way they are partially compensated without undermining the incentive to minimize their contribution to congestion. Furthermore, employers are given a public-relations tool that can help them overcome employee dissatisfaction arising from higher commuting costs. Because the allowance is a fixed amount per employee, it benefits all working people equally and thereby offsets the regressive tendencies in the congestion charges themselves.

2. *Reduce road user taxes*

Another direct way to offset the new user charges is to reduce taxes assessed on highway users. The primary candidates are motor-vehicle license fees and fuel taxes. This measure offsets the impact on those people who actually pay the congestion fees, and more generally benefits highway users.

Motor-vehicle license fees in some states of the U.S. are based upon the value of the vehicle and are thereby deductible from federal income tax; thus if they were rebated or reduced, federal tax liabilities would rise accordingly, so some of the benefit would not accrue to local residents and businesses. An alternative for such states is to lower the fuel tax in the region covered by congestion pricing. Although this might seem at odds with the goal of reducing automobile use, the fuel tax is actually a poor proxy for road use, and is increasingly undermined by improvements to fuel efficiency and introduction of alternative fuels. To the extent that these changes are considered desirable components of environmental or energy policy, there are better tax instruments available in the form of emission charges,[2] taxes on crude petroleum, and taxes on the carbon content of fuels.[3] Furthermore, fuel taxes are regressive because auto ownership and use rise less than proportionally with income; hence reducing them helps offset the regressive effects of the congestion fees themselves.

Reduced general taxes

3. *Remove all or part of any dedicated sales-tax surcharge that applies in the region*

Congestion fees may be viewed in part as a more efficient method of raising funds for transportation programs. A very salient way to make this point is to substitute them for the portion of the sales tax surcharge that, in many metropolitan areas, is dedicated to financing transportation.

The benefits of this measure accrue in proportion to taxable sales. It is therefore progressive because it substitutes for a regressive tax. It also addresses a primary goal of low-tax advocates.

4. *Rebate a portion of property taxes*

Even aside from the dedicated sales tax, a substantial portion of funding for highway construction and maintenance is derived from local general revenues. In 1989, $12.8 billion of the $28.0 billion spent for highways by local governments in the U.S. was derived from property-tax and other general revenues.[4] About one-third of this was explicitly from property-tax revenues, but all of it can be regarded as absorbing local-government tax revenues for which property taxes are the primary source.

A property tax rebate therefore would serve to reduce a hidden subsidy to automobile use, while reducing yet another tax. It would also offset losses in property value that would otherwise occur to some landowners as some of the burdens of the new peak-period charges are shifted to them. This measure would be valued by homeowners, other land owners including businesses, and low-tax advocates.

New transportation services

5. *Fund new highway capacity*

As noted earlier, this is arguably the single most persuasive policy to the public at large, since it meets a widespread desire and has an easily perceived link to highway fees.

Funding more capacity would please the traveling public, the highway industry, and developers and landowners served by the new capacity. It would probably be viewed unfavorably by environmentalists, but there is a redeeming feature for them also: by applying congestion pricing to any new facility, its capacity can be less than it otherwise would be while still providing a better level of service. Hence where highway proposals already have strong support, congestion pricing provides a demand-management tool that permits a smaller and less intrusive facility.

Normally, high-occupancy-vehicle (HOV) lanes should not be included

among improvements to be financed from congestion pricing. A successful congestion-pricing program would reduce congestion to levels for which the advantage of special lanes would be minimal. In fact, one of the side benefits of congestion pricing is that existing HOV lanes could be converted to general use, thereby increasing the overall carrying capacity of the highways and simplifying law enforcement.

6. *Fund improvements to public transit*

This can be viewed both as "linked compensation" to people who switch to public transit because of the fees, and as a provision to meet a general social goal. To some extent it is also a practical necessity, because the increased transit patronage likely to result from modal shifts will require increased service. The measure should appeal to environmentalists, public officials, transit unions, and those concerned with the poor.

It is important that the expenditures be tied to valid projections of actual use of the expanded service. Congestion pricing will be doomed if it becomes a "cash cow" for projects that would otherwise be rejected as cost-ineffective.

7. *Fund improved transportation-related facilities and services in business centers*

Businesses in areas served by congested highways, especially downtown and inner-city areas under areawide pricing, rightly fear that some customers and suppliers will shun them if access is made more expensive. One way to prevent this outcome is to provide other facilities and services which are valuable to those businesses. By limiting these facilities and services to transportation-related ones, we maintain the exclusive transportation focus of the entire package. Examples include street repair and cleaning, lighting, pedestrian walkways and other amenities, bicycle paths, street landscaping, shelters at transit stops, bus pullouts for easier loading, and ride-sharing coordination. Such services are often in drastic undersupply due to cities' fiscal conditions. The measure would work most effectively if business groups in each locality chose the projects to be funded.

It should be noted that fears of lost business due to parking and traffic restrictions have often proved to be unfounded; the improved traffic flow and ease of pedestrian travel resulting from auto restraint can make the area more rather than less attractive, even without additional measures. Nevertheless, targeting a modest portion of revenues to inner-city business areas should help maintain their ability to adapt to the significant change represented by congestion pricing. It should also strengthen adjacent residential neighborhoods by upgrading the physical environment in their proximity.

This measure should appeal to businesses, to public officials who are hard pressed to provide needed services, and to inner-city residents seeking better prospects for local business.

5. Some financial magnitudes for a workable package

Several studies have estimated the magnitude of peak-period prices that would reduce congestion to efficient or at least tolerable levels. A study based on the San Francisco Bay Area suggested that if both prices and investment in highway capacity were optimized, the peak-period congestion charges would range between 5.4 and 36.2 cents per mile in 1990 prices, depending on assumptions and location.[5] The Federal Highway Cost Allocation Study included an analysis supporting congestion fees on the order of 15 cents per mile (1989 prices) for an urban auto under congested conditions, resulting in some $50 billion in estimated revenue if applied nationwide.[6] A well-publicized proposal by the Bay Area Economic Forum (1990) includes a congestion price of 5 cents per mile on the region's most congested 100 miles of highway as a "sample market-based package" (p. 6). Cameron (1991: 40) suggests peak-period congestion fees for the Los Angeles region's expressway system averaging 15 cents per mile, based on an extensive modeling effort that estimated the level of fee needed to raise expressway speeds to 35–40 miles per hour.

It is difficult to draw general conclusions from such figures, but it may be useful to consider the extent of congestion costs recently estimated for 39 urban areas by Hanks and Lomax (1990).[7] For the 20 urban areas with the largest such costs in 1988, estimated total congestion costs (time delay and excess fuel consumption) range from $5,240 million in Los Angeles to $290 million in Minneapolis-St. Paul.[8] The area with the highest congestion cost per registered vehicle is Washington, D.C., with $920 per vehicle; the tenth highest is $420 per vehicle in Atlanta. Making the very crude approximation that the appropriate charge per vehicle-mile would equal the present average congestion cost,[9] the charge for Atlanta in 1989 would be approximately 18.2 cents per vehicle-mile for congested travel on expressways and principle arterial streets, bringing in annual revenues of $760 million.[10] By way of comparison, the direct subsidy from local-government property-tax and general revenues to highways throughout the entire state of Georgia was $358 million in 1989.[11] Therefore, the revenues from congestion pricing in a typical large U.S. city appear far more than ample to eliminate the subsidy from local governments.

6. Case study: Southern California

I now examine in more detail whether the money raised by congestion pricing would be sufficient to fund a variety of programs at significant levels. To do so, I outline a specific package for using the revenues that might be generated from a comprehensive system of congestion fees on all congested freeways and arterials in the five-county Los Angeles region. All figures refer to 1990 conditions.

The starting point is the scenario carefully constructed and analyzed in a study jointly sponsored by the Environmental Defense Fund (EDF) and the Regional Institute of Southern California, in which peak-period charges averaging 15 cents per vehicle-mile are applied to those highways now subject to heavy congestion (Cameron 1991). The study (pp. 9, 19) estimates that in fiscal year 1990–91, the region's highways accommodated about 97 billion vehicle-miles of travel (VMT), of which 28 billion were at congested times and places. I will refer to travel at those times and places as "peak VMT." The average peak-period trip length is estimated to be 10 miles (Cameron 1991: 40).[12]

The charges are estimated to reduce total VMT by 5 percent, or 4.8 billion per year, because of mode shifts and foregone trips (Cameron 1991, Table 3, p. 37). They would shift some additional VMT, which I assume to be half the above amount or 2.4 billion, from congested to uncongested times and places. This implies a 26% reduction in peak VMT, from 28 billion to 20.8 billion. Annual revenues would therefore be 20.8 billion times 15 cents, or $3,120 million.

From these, we must subtract collection costs. Estimates for the electronic system tested in Hong Kong indicate a cost of 6.6 cents per trip in 1990 U.S. prices (Hau 1992: 32), which is far lower than manual collection costs for conventional toll booths. The smart-card system studied for Holland was projected to cost about twice as much per transaction (Hau 1992: 37), but the much higher volume of travel in the Los Angeles region should lower the cost per transaction for either system. The existing automatic toll collection system in New Orleans costs about 4.0 cents per trip (Hau 1992: 23). With these precedents in mind, I assume the collection cost per 10-mile trip would be 6.6 cents, or 0.66 cents per mile. This implies an aggregate collection cost of $137 million, or 4.4 percent of revenues.

Our estimate of available net revenue is therefore $2,983 million. I now describe a package of uses for this revenue that follows the general scheme discussed in Section 4. The specific numbers are chosen to fit within the tripartate division advocated there. This package is summarized in Table 1.

Table 1. A package of revenue uses for the Los Angeles region.

Program	Annual amount ($ millions)
Reimbursements to travelers:	
1. Employee commuting allowance ($10/mo.)	696
2. Fuel tax reduction (5 cents/gal.)	348
Reduced general taxes:	
3. Sales tax reduction (1/2 of transportation surcharge)	525
4 Property tax rebate (eliminate local highway subsidy)	465
New transportation services:	
5. Highway improvements	315
6. Transit improvements	312
7. Transportation services in business centers	322
Total (net revenue)	2,983
Collection costs	137
Total (gross revenue)	3,120

1. *Fund a program of $10/month employee commuting allowances*

This amount is considerably less than typical commuting costs, so is only a modest offset. Still, for some commuters it would more than compensate for the congestion fees paid. Data from the California Economic Development Department suggest a total of 5.8 million employees in the five-county area. Annual cost: $696 million.

2. *Reduce fuel taxes by 5 cents per gallon*

This is the same amount by which the U.S. federal gasoline tax was raised, with great political effort, in 1983; and also the same as the first installment of a multiyear fuel-tax increase approved in 1990 by California voters. In 1990, Californians consumed 15,126 million gallons of taxable fuel.[13] I assume that 46 percent of this derives from the Los Angeles region, that being the region's fraction of VMT in 1991.[14] Annual cost: $348 million.

3. *Replace half of the dedicated sales-tax surcharge*

Four of the five counties in the Los Angeles region have a dedicated sales tax for transportation purposes. The rate is 0.5 percent in Orange, Riverside, and San Bernardino Counties, and 1.0 percent in Los Angeles County. From data provided by the California State Board of Equalization, it appears that

annual revenues at these rates amount to approximately $1,050 million.[15] Reducing these rates by half would thereby require $525 million.

4. *Rebate property taxes in an amount equal to all property-tax and general-fund revenues presently used by local governments for highways*

In 1989, local governments in California allocated $127 million of property-tax revenues and $883 million of general-fund revenues to expenditures on highways.[16] Assuming that the Los Angeles region accounts for 46 percent of this, in proportion to its VMT, total elimination of this subsidy would cost $465 million.

5. *Fund new highway projects by adding 30 percent of funds raised by the present dedicated sales tax*

Since not all the sales-tax proceeds are used for highways, this amounts to more than a 30 percent increase in highway spending from this source. This would provide a significant boost to the region's ability to tackle the extensive backlog of highway projects considered essential by the county transportation commissions. Funding required is 30 percent of $1,051 million, or $315 million.

6. *Fund increased transit services at 130 percent of the amount needed to absorb the expected diversion from peak highways*

Suppose half the 4.8 billion VMT reduction is diverted to transit, the average length of these trips is 10 miles, and new transit service to accommodate the diversion requires a subsidy of $1.00 per trip. (This is less than a typical subsidy for new transit service, but seems appropriate given that much of the new ridership would be on corridors already well served by transit.) The cost to serve diverted passengers is then $240 million. This increased service, besides accommodating the additional passengers, improves the convenience of the mass transit system to everyone by increasing frequency and/or route coverage. An additional 30 percent would provide considerable scope for still further improvement. Total funding: $312 million.

7. *Fund improved transportation-related services in impacted business centers*

This would be a discretionary program, possibly with a formula distribution among employment centers, designed to alleviate adverse effects on businesses and thereby ensure that the policy would not aggrevate urban blight. Specific

items should be determined by affected businesses. The amount is chosen to exhaust the remainder of the revenues. If divided among the 32 employment centers identified in the Los Angeles area by Giuliano and Small (1991), it would provide the average center with $11.8 million, or $254 per employee, a sizeable boost. Total funding: $322 million.

7. Effects on some protypical residents

In order to understand how residents in various circumstances might be affected by the proposed package of congestion pricing and revenue uses, I compute in Table 2 the implications for selected people of the package just outlined for the Los Angeles region. These calculations adopt very simple assumptions and consider only the direct impacts, ignoring any shifting of fee payments, tax burdens, or benefits of time savings. Such shifting would surely occur since ease of travel interacts with many markets including those for labor, land, and retail goods. Hence the calculations to be described should be viewed not as measures of the true changes in people's economic situations, but rather as an indication of the extent to which the direct, immediate impacts of the various provisions would tend to cancel each other. The situations chosen are illustrations, not necessarily averages for classes of people.

Assumptions

The first three columns of the table show three commuters who "stay and pay:" that is, they are solo drivers who continue to drive alone after the pricing is in place. These are the people one would expect to be most disadvantaged by the program. The first has a roughly average value of time of $6.05 per hour;[17] whereas the second and third ("high income" and "low income") have higher and lower values, respectively, intended to represent people at the 80th and 20th percentiles of the income distribution.[18] Column (4) is an average-income commuter who finds it worthwhile to switch to carpool in order to cut the congestion fee in half, despite incurring the equivalent of a 15-minute penalty in travel time. Columns (5) and (6) represent an average-income carpooler and a low-income transit user, respectively, who do not change mode as a result of the scheme.

Key assumptions for each case are given in the first panel of the table. The one-way trip includes 10 miles on congested roads for a person who initially drives alone, 15 miles for the person who initially carpools, and 5 miles for the transit user. For carpoolers, the congestion fee is assumed to be shared equally by two travelers. Average speed on congested roads is assumed to rise from 20 to 30 miles per hour due to the introduction of pricing.

Table 2 Sample effects of congestion pricing and revenue distribution.

	Continuing Auto Driver			Switch to carpool	Continuing carpool	Continuing transit
	Average income	High income	Low income			
	(1)	(2)	(3)	(4)	(5)	(6)
ASSUMPTIONS:						
Travel mode:						
Before	solo	solo	solo	solo	carpool	transit
After	solo	solo	solo	carpool	carpool	transit
Value of time ($/hr.)	6.05	8.23	4.72	4.72	6.05	4.72
1-way road distance (mi.)	10	10	10	10	15	5
Average speed (mi./hr.):						
Before	20	20	20	20	20	20
After	30	30	30	30	30	30
Fuel consumed (gal./year)	400	480	320	256	320	0
Sales tax surcharge relative to average household	1.0	1.2	0.85	0.85	1.0	0.85
Property tax relative to average household	1.0	1.7	0.65	0.65	1.0	0.0
RESULTS:						
Costs ($/year):						
Congestion fees	750	750	750	375	562.5	0
Time savings:						
Amount (min./day)	20.0	20.0	20.0	20.0	30.0	10.0
Carpool inconvenience				−15.0		
Value ($/year)	504	686	393	98	756	197
Monetary benefits ($/year):						
(1) Travel allowance	120	120	120	120	120	120
(2) Fuel tax	20	24	16	13	16	0
(3) Sales tax	86	103	73	73	86	73
(4) Property tax	57	97	37	37	57	0
Total	283	344	246	243	279	193
Net time & money benefits: (time + money − costs)	37	279	−111	−34	472	389
Other benefits ($/year):						
(5) Improved highways	64	64	64	64	64	0
(6) Transit service	32	32	32	32	32	127
(7) Business centers	33	33	33	33	33	33
Total net benefits	166	409	19	95	602	550

Each commuter, except the transit user, is assumed to own an automobile. The average-income solo commuter (column 1) drives 10.000 miles per year including nonwork trips, for an annual fuel consumption (at 25 miles per gallon) of 400 gallons. Savings in fuel consumption due to less congestion are not considered. The high-income solo driver travels 20 percent more than this, the low-income solo driver 20 percent less. Being a carpooler reduces annual fuel consumption by 20 percent.

For purposes of computing benefits from sales- and property-tax relief and from new services, the commuter is treated as receiving all the benefits accruing to his or her household. For sales tax, the average-income commuter's liability for the present surcharge is computed as 80 percent of total surcharge revenues divided by the 4.9 million households in the region in 1990, on the assumption that 20 percent of sales-tax revenues are derived from business rather than household purchases. The high-income commuter is assumed to spend 20 percent more than this average, and the low-income commuter 15 percent less. Similarly, property-tax revenues rebated to the average-income commuter are computed as the aggregate rebate times 60 percent, divided by 4.9 million households; this is on the assumption that 40 percent of property taxes are paid on business rather than residential property. The high-income worker is assumed to receive a 70 percent higher rebate and the low-income worker a 35 percent lower one, representing differing property assessments in line with their differing incomes. The transit user is assumed to be a renter, receiving no rebate. The calculations exclude any indirect benefits arising from reduced taxes on businesses and landlords, even though these may be passed through to consumers and renters.

Quantification of the benefits to individuals from new transportation services (categories 5–7) is more speculative because it would depend on these individuals' usage patterns. As a starting point, I compute the average expenditure per household on each category, given 4.9 million households in the area. Each worker who commutes by car is then assumed to receive benefits equal to this average for highway expenditures (category 5) and one-half the average for transit expenditures (category 6), on the assumption that these workers and their families use transit less frequently than average. The transit commuter receives no benefits from the new highway expenditures, and benefits equal to twice the average per-household expenditure on new transit service. In addition, every commuter receives benefits equal to half the per-household expenditure on business-center improvements (category 7), on the assumption that some of those benefits accrue to local residents, business owners, and customers rather than to commuters.

Results

The results shown in the table for "net time and money benefits" include the fee payments, the value of time savings, and the monetary benefits arising from the first four of the revenue uses outlined earlier. Hence they take into account the immediate impact of the travel allowance and tax reductions, but not the value of expenditures on highways, transit service, and improvements to business centers.

These results indicate that for the continuing driver of average income, the time and monetary benefits alone are enough to offset the fee payments. This comes about because her travel allowance and tax reductions more than offset the difference between her payments ($750 per year) and her valuation of the time savings ($504 per year). For the high-income driver, the continuing carpooler, and the transit user (who has no fee payments), these time and monetary benefits far exceed the fee payments. The reason high-income solo drivers benefit so much is not because they pay less or receive substantially more rebated taxes, but because they value their time savings more. The long-distance carpooler receives a large time savings and divides the fee among two commuters, so comes out a clear winner; so does the transit user, who pays no fee but receives some time savings and substantial monetary returns in the form of commuting allowance and tax reductions.

The low-income driver places less value on the time savings, and so is not fully compensated. However, if he is able to switch to a two-person carpool (column 4), he cuts his congestion fee in half and thereby comes out almost even on a time-plus-money basis, even after taking into account the assumed carpooling inconvenience.

When the value of new transportation services funded by the program is taken into account ("other benefits" in Table 2), all of these commuters come out ahead. Even the low-income captive driver receives enough benefits from the $949 million expenditures on highways, transit, and business centers to more than overcome the net loss from the combination of congestion fees, time savings, travel allowance, and tax reductions. In practice, many low-income drivers would probably find ways to further reduce their fee payments by coming to work early, taking more roundabout routes, or sharing rides on an occasional basis. In addition, they would share indirectly in a number of benefits not quantified in the table: for example, lower sales- and property-tax payments by businesses would be partly passed through to their customers, and the transit improvements and physical improvements to business centers would stimulate upgrading of some residential neighborhoods.

It is easy to misinterpret the large value that high-income people place on time savings as indicating that the program as a whole is regressive. Actually, high-income commuters would shoulder a disproportionate share of its

monetary costs because they are more likely to continue to drive alone despite the fees. Some commentators have assumed that the poor who are "forced off the roads" are the most aggrieved group, but in fact it is those without such flexibility who benefit the least or suffer the most. Those who can shift to other modes, times of day, or locations avoid the full adverse impact of the fees, while still reaping the full benefits funded through the program. This is reflected in a comparison of columns (3) and (4). And as column (6) shows, those low-income commuters who already take transit are clear winners.

Obviously, less favorable cases could be constructed, and someone will be made worse off no matter how the program (or any public policy, for that matter) is designed. For example, a low- or average-income person with a long one-way commute on congested highways and no feasible alternative would suffer. In the longer run, the congestion fee gives such people a very powerful incentive to alter their situations to avoid such heavy charges. They may do this by changing residences, changing jobs, or negotiating new work hours that permit offpeak travel.

8. Conclusion

The scheme proposed here is, of course, just one of many that are possible. My goal has been to combine a theoretical insight – that there is more than enough revenue to fully compensate all losses – with some practical considerations of institutions, politics, and perceptions. The scheme weighs heavily on the side of viewing the revenues from congestion pricing as a substitute for other revenue sources rather than a gigantic windfall for expanded government programs; yet it still provides for substantial new services, which can help attract support from diverse interests provided the services are chosen to serve real needs. Needless to say, the balance among various components can and should be adjusted to fit the desires of the people whose lives will be affected.

Acknowledgments

An earlier version of this paper was distributed by the Reason Foundation in its Policy Insight series (No. 145, Sept. 1991); another was presented at the Congestion Pricing Symposium, sponsored jointly by the U.S. Federal Highway Administration, U.S. Federal Transit Administration, and Reason Foundation, in June 1992. Financial support from these three sponsoring organizations is gratefully acknowledged, as is the generous provision of visiting research facilities by Boston College. I am grateful to Michael Cameron, Genevieve

Giuliano, Amihai Glazer, Timothy Hau, Daniel Klein, Robert Poole, Philip Viton, Martin Wachs, and Clifford Winston for helpful discussions and comments, and to Xuehao Chu for research and editing assistance. None of these people or organizations are responsible for the views expressed or for any errors.

Notes

1. Time-varying prices are being planned for proposed privately built additions to State Routes 91 and 57 in southern California, and are under consideration for the midstate toll road proposed for northern California. These are three of the four projects undertaken under California Assembly Bill 680, passed in 1989. For a full description, see Gomez-Ibanez and Meyer (1991), ch. 4–5. For a general analysis of the feasibility of private toll roads using tolls that vary by time of day, see Viton (1991).
2. See, for example, the proposals in Bay Area Economic Forum (1991) and Cameron (1991).
3. See, for example, Nordhaus (1991) or Jorgenson et al. (1992).
4. USFHWA (1990), Table LGF-21, p. 106.
5. Keeler and Small (1977). The range given is based on that for "urban-suburban" and "central city" areas in their table 6, p. 20. The figures are updated from 1972 to 1990 prices using inflation factor 2.826, based on the composite price trend for federal-aid highway construction, from USFHWA (1990), table PT-1, p. 69; this factor is used because highway construction cost is the primary determinant of the congestion charges in the Keeler–Small analysis.
6. USFHWA (1982), Appendix E, table 12, p. E-53. The figure in the report is 11.2 cents/mile (1981 prices), representing "excess delay" caused by an urban auto at volume-capacity ratio 0.85. I have updated to 1989 prices using average hourly earnings of employees in non-agricultural establishments, which is related to value of time and appropriate to the analysis used in the cost allocation study. For total revenue, see USFHWA (1982), table 14, p. E-59; the $48 billion noted there for urban roads (in 1981 prices) includes charges for air pollution and noise as well as congestion.
7. The published report includes data through 1988; the 1989 data quoted here are from updated tables provided by the authors.
8. Hanks and Lomax (1990), table 17, p. 49.
9. This assumption would be appropriate if travel time were a linear function of travel volume on a given facility, except that it does not account for the lowering of congestion that would occur. Most analyses find travel time to rise faster than linearly with volume, which implies higher charges.
10. This calculation is based on aggregate congestion costs of $760 million per year, from Hanks and Lomax (1990), table 17, p. 49, updated to 1989; and 4,175 million congested vehicle-miles of travel (VMT) per year. The latter is based on daily expressway and arterial VMT from their table 16, p. 45 (updated to 1989) and percent of those VMT that are congested from their table B-7, p. B-7 (updated to 1989).
11. USFHWA (1990), table LGF-21, p. 106.
12. According to unpublished data from Genevieve Giuliano, this coincides roughly with the expressway portion of the average peak-period commute from three local commuter surveys
13. USFHWA (1990), table MF-2, p. 4.
14. Data from the California Department of Transportation.
15. "Revenues Distributed to Special Districts from Transactions and Use Tax, 1990–91." The Orange County tax and half of the Los Angeles County tax went into effect on the same

date, near the end of fiscal year 1990–91. Because revenue distributions of the two halves of the Los Angeles County tax are reported separately, the fraction of a full year's revenues for the newly enacted taxes that were distributed during 1990–91 could be measured at 0.071; the same ratio is assumed to apply to Orange County.

16. USFHWA (1990), table LGF-21 (p. 106).
17. Small (1992, pp 43–45) summarizes measurements of the values that commuters place on their travel time. He concludes that the best supported value is 50 percent of the wage rate. Average hourly earnings for private nonagricultural production and nonsupervisory workers in the Los Angeles region is approximately $11.00 per hour, obtained by taking the average for the three metropolitan areas comprising most of the Los Angeles region (Los Angeles-Long Beach, Riverside-San Bernardino, and Anaheim-Santa Ana). Data are from U.S. Bureau of Labor Statistics, *Employment and Earnings*, vol. 37, no. 7 (July 1990): hourly earnings by locality are from Table C-8, p. 108, and employment (used as the weights to average the three metropolitan areas) are from Table B-8, p 62. Comparable data for managerial, professional, and supervisory employees are not available, so I have added 10 percent for an estimated overall average wage rate of $12.10 per hour.
18. Wages of 170 percent and 65 percent of the median wage are assumed for these two percentiles, based on the approximate relative incomes for those percentiles measured in a 1989 survey of Los Angeles-area commuters. (The survey is described in Brownstone and Golob 1992; the income distribution is not reported there, but was instead calculated directly from data supplied by the authors.) Value of time is assumed to be 40 and 60 percent of the wage rate for the higher- and lower-income worker, respectively; this attempts to approximate the findings from a number of studies showing that value of time rises less than proportionally with income: see MVA Consultancy et al. (1987, pp. 133–135, 150, 152).

References

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

Brownstone D & Golob TF (1992) The effectiveness of ridesharing incentives: discrete-choice models of commuting in Southern California. *Regional Science and Urban Economics* 22: 5–24.

Burtraw D (1991) Compensating losers when cost-effective environmental policies are adopted. *Resources* 104: 1–5. Washington, D C.: Resources for the Future.

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

Giuliano G & Small KA (1991) Subcenters in the Los Angeles region. *Regional Science and Urban Economics* 21: 163–182.

Gomez-Ibanez JA (1992) The political economy of highway tolls and congestion pricing. In: *Exploring the Role of Pricing as a Congestion Management Tool: Summary of Proceedings of the Seminar on the Application of Pricing Principles to Congestion Management* (pp. 5–9). *Searching for Solutions: A Policy Discussion Series*, No. 1. Washington, D C.: U.S. Federal Highway Administration.

Gomez-Ibanez JA & Meyer JR (1991) *Private Toll Roads in the United States: The Early Experience of Virginia and California*. Final Report to the U S. Department of Transportation. Cambridge, Mass : Taubman Center for State and Local Government, Harvard University.

Goodwin PB (1990) How to make road pricing popular *Economic Affairs* 10, June/July: 6–7.

Hanks JW Jr. & Lomax TJ (1990) *Roadway Congestion in Major Urbanized Areas: 1982 to 1988*. College Station, Texas: Texas Transportation Institute.

Hau TD (1992) Congestion charging mechanisms· An evaluation of current practice. Preliminary draft, Transport Division, The World Bank (March).

Jones P (1991) Gaining public support for road pricing through a package approach *Traffic Engineering and Control* 32: 194–196.

Jorgenson DW, Slesnick DT & Wilcoxen PJ (1992) Carbon taxes and economic welfare. *Brookings Papers on Economic Activity: Microeconomics*· 393–454. Washington, D.C.: Brookings Institution

Keeler TE & Small KA (1977) Optimal peak-load pricing, investment, and service levels on urban expressways *Journal of Political Economy* 85: 1–25.

MVA Consultancy, Institute for Transport Studies of the University of Leeds, & Transportation Studies Unit of the University of Oxford (1987) *The Value of Travel Time Savings*. Newbury, England· Policy Journals.

Nordhaus WD (1991) To slow or not to slow: The economics of the greenhouse effect. *The Economic Journal* 101: 920–937.

Poole RW Jr. (1992) Introducing congestion pricing on a new toll road. *Transportation*, 19(4): 383–396 (this issue).

Shoup, DC (1982) Cashing out free parking. *Transportation Quarterly* 36: 351–364

Small KA (1992) *Urban Transportation Economics*. Chur, Switzerland: Harwood Academic Publishers.

Small KA, Winston C & Evans CA (1989) *Road Work: A New Highway Pricing and Investment Policy*. Washington, D.C.: Brookings Institution.

U.S. Federal Highway Administration (USFHWA 1982) *Final Report on the Federal Highway Cost Allocation Study*. Washington, D.C.· U.S. Government Printing Office

U.S. Federal Highway Administration (USFHWA 1990) *Highway Statistics 1990*. Washington, D.C.: U.S. Government Printing Office.

Viton PA (1991) Private roads Unpublished manuscript, Department of City and Regional Planning, The Ohio State University