Number 148
September 1992

MANAGING TRANSPORTATION DEMAND: MARKETS VERSUS MANDATES

by

Genevieve Giuliano
and
Martin Wachs

EXECUTIVE SUMMARY

The increasing concern over congestion and air quality problems in Southern California, as well as recent federal legislation, has focused new attention on transportation demand management (TDM). The purpose of TDM is to reduce the demand for trips in order to cope with pollution problems and other difficulties associated with growth.

There are two general approaches to TDM: a regulatory approach and a market-based approach. The regulatory approach, such as mandatory trip-reduction programs, involves requiring a class of individuals to achieve a specific performance target established by fiat, *e.g.* a particular average vehicle ridership. In contrast, a market-based policy creates incentives for socially desirable action but allows for discretionary market choices on the part of individuals. For example, the congestion pricing of expressways provides incentives for individuals to shift travel to non-peak times or to carpool, but it also allows individuals to pay premium fees if they so choose.

This study compares the regulatory approach with the market-based approach, by focusing on a paradigm example of each. The South Coast Air Quality Management District's Regulation XV (a mandated employer-based trip-reduction program) is contrasted with the potential for congestion pricing on southern California's freeways. The reduction in vehicle miles traveled (VMT) from congestion pricing is projected to be at least 12 times as great as that produced by Regulation XV. Even though regulatory techniques like Regulation XV are considered more politically acceptable, market-based strategies such as congestion pricing are more effective and more efficient, and should be considered the TDM policy tool of choice.

I. CHANGES IN U.S. TRANSPORTATION POLICY

U.S. transportation policy has historically been based on accommodating travel demand, and enhancing mobility and accessibility. The private automobile has been particularly favored, as demonstrated by the Interstate Highway program, state and local regulatory policies, and auto-oriented land development policies (Altshuler, Womack and Pucher, 1981; Dunn, 1981; Cervero, 1989). As environmental and energy concerns emerged in the decades of the 1960s and 1970s, public policy focussed on reconstructing and expanding the nation's mass transit systems, making operational improvements to the highway system and promoting use of vanpools and carpools. Glaringly absent from this list of policy choices was any attempt to restrict use of the private auto.

By the end of the 1980s, however, the fundamental purpose of transportation policy was beginning to be questioned, as traditional approaches to solving transportation problems appeared to be less viable. First, the correlation between highway system expansion and growth in vehicle miles of travel (VMT) has suggested to some observers that such expansion is self-defeating. Providing more capacity, which is typically justified as a means for reducing congestion and air pollution, will induce more travel, which in turn will ultimately result in more congestion (Newman and Kenworthy, 1988). If highway capacity is constrained, some travelers will make other choices (*e.g.* use public transit, make shorter trips or make fewer trips). And if the level of congestion on an existing freeway is reduced, new users who were formerly deterred by the level of congestion, are likely to be attracted back, thereby increasing the level of congestion once more. This problem is referred to as “latent demand.”

Second, efforts to reduce auto use by providing more public transit have been largely unsuccessful. Despite massive investments in new vehicles and facilities, public transit's market share has failed to significantly increase, and has remained low: the National Personal Transportation Study (NPTS) data show that public transportation modes accounted for just 2.3 percent of daily person-trips in 1983 and 2.5 percent in 1990 (Office of Highway Management, 1991). These factors have led to a growing consensus among policy-makers that “we can't build our way out” of urban congestion problems. Accommodating growing demands for auto travel may simply no longer be feasible, and coaxing auto users onto mass transit has proven ineffective.

Additional pressure is being brought to bear on transportation policy by growth management advocates and environmentalists. Those opposing new development proposals often focus on their traffic impacts (Giuliano and Wachs, 1992). Major transportation projects are frequently opposed on the basis of their “growth inducing” effects; this growth is seen as causing more traffic congestion. Environmental advocates hold complementary views, and have been successful in directly influencing transportation policy through the Clean Air Act Amendments of 1990 and the conformity provisions contained in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). There is growing advocacy for policies to control or manage the private automobile.

Policy makers have responded to these changing views by placing increased emphasis on managing the transportation system and increasing its efficiency. On the supply side this emphasis is most

obviously manifested in the myriad new technology programs currently underway (e.g. Intelligent Vehicle-Highway Systems) that seek to increase highway vehicle capacity. On the demand side, increasing reliance is being placed on TDM. Trip reduction ordinances, mandated employer TDM programs and trip-related zoning caps are being implemented throughout the United States. Despite growing pressures to control private auto use, however, policies that *directly* affect auto travel demand are rare. The weakening consensus regarding the goals of transportation policy, the barriers to traditional solutions for transportation problems and the growing burden of TDM regulations has prompted renewed interest in so-called "market-oriented" strategies, or TDM policies that alter the cost or convenience of alternative modes.

II. A TYPOLOGY OF TDM POLICIES

Mandatory TDM, however structured or implemented, is a form of regulation. It is justified like any other environmental policy: auto use generates costs (externalities) in excess of what individual users pay, and therefore government must assess these costs in some way. Economic theory suggests a fee equivalent to the costs of the externality generated by the marginal user. In practice, however, policymakers do not agree that pricing is either feasible or appropriate.

Economists and policymakers identify two classes of environmental policy measures: "command and control" and "market-based" measures. Command and control measures impose some form of performance standard that must be attained by all members of the regulated group. Market-based measures use economic principles to alter consumption or production decisions. These include the institution of market exchange mechanisms or the establishment of prices that reflect true costs. There is a great debate raging in the environmental policy community between advocates of each approach, and transportation policy constitutes only part of this debate. For example, in 1989 President Bush announced a proposal to control acid rain and to reduce automobile pollution by introducing marketable emissions permits. Congressional leaders on environmental issues vigorously opposed the proposal primarily because it relied heavily upon market mechanisms. Instead, they favored an approach that relied more directly upon national tailpipe standards and similar command and control alternatives. While proponents of market-based approaches regarded them as a far more cost-efficient way of achieving the objective of cleaner air, proponents of the uniform national standards argued that their approach was more equitable and more politically acceptable (Hahn and Noll, 1990).

This debate has had the unfortunate effect of oversimplifying the array of TDM policy measures and their characteristics. The term "command and control," drawn from military jargon, implies regulations imposed by a central authority that are uniformly applicable to all who are regulated. It turns out, of course, that nearly all environmental and transportation regulations have these characteristics, including those that create market-like mechanisms. The significant differences among environmental and transportation regulations relate to whether they impose uniform standards of performance (e.g. miles per gallon or average vehicle occupancies) on all who are

regulated, or whether they instead use prices or other market-like signals to induce some socially desired behavior. For this reason in the following sections we prefer to compare "performance based" with "market based" approaches, while recognizing that many other authors label the former as "command and control" measures. We propose a two dimensional description which, though still simple, captures methods of implementation as well as the method of regulation. The method of regulation is market-based or performance-based (e.g. the conventional dichotomy). The method of implementation describes the relationship of the regulation with respect to the source, in this case the individual traveler. Direct regulation is placed on individuals; indirect regulations are placed on organizations, for example employers or auto manufacturers. These two dimensions result in four categories of TDM policies, as shown with some examples in Table 1.

TABLE 1

TYPOLOGY OF TDM POLICIES

	DIRECT	INDIRECT
MARKET	fuel tax VMT fee parking fee congestion pricing	third party van subsidies trip reduction credits
PERFORMANCE	CA smog control program alternate drive days fuel rationing	trip reduction ordinance CAFE fuel standards parking space minimums

The direct market-based policies are well known. For example, fuel taxes reflect the opportunity cost of using scarce energy resources, and parking fees reflect the cost of land and improvements devoted to providing parking spaces. Indirect market-based policies are perhaps the least common. Third party vanpools refer to subsidies that are given to employers or other organizations that in turn offer these to commuters. Trip reduction credits may be offered to developers as a way of allowing more intensive development. If the developer can implement a ridesharing program that reduces commuting trips, for example, additional development on the site may be approved. Direct performance standards are uncommon. Gasoline rationing and alternative driving days are reserved for crisis situations. The California smog inspection control program, which requires vehicle owners to maintain specific emission standards on their vehicles is one example currently in operation. Finally, indirect performance-based policies are perhaps the most common type of TDM policy. These include a variety of trip reduction ordinances, which require landowners or employers to provide ridesharing incentive programs to their employees. Often specific trip reduction targets must be reached. It should be noted that the resulting programs are direct policies: employees are offered various incentives or disincentives to use alternative commute modes. However, the target of the

regulation is the organization, and therefore such policies are indirect.

Debates over the various policy approaches are complex. It is therefore important that the major arguments be summarized before undertaking a specific evaluation of market-based and performance-based TDM policies. In the next sections we review some of the major attributes of each of these categories of policies in order to arrive at insights regarding their applicability to transportation policy.

A. Performance versus Market-Based Approaches to Public Policy

Performance-based approaches to public externality problems consist of rules and regulations which are centrally enacted and administered, and which apply to all members of the community that is so regulated. As stated above, performance-based approaches can target individuals or organizations. Their common characteristic is the specification of performance standards that must be achieved, e.g. fuel efficiency targets, maximum emissions levels, vehicle occupancy targets, etc. These standards apply uniformly within classes of individuals or organizations. For example, trip reduction ordinances typically require all developments of a certain type to achieve a given trip reduction target.

Market-based approaches are also centrally enacted and administered, and also apply to all members of the regulated community, but responses are discretionary, market choices. Consider a vehicle registration surcharge based on emissions rates. People who prefer bigger, less efficient cars would pay the extra fee, while others would shift to cleaner cars. It is important to note that not all price increases related to pollution or congestion constitute market-based approaches, and many pricing policies do not necessarily have these favorable characteristics. If the emissions-based vehicle registration fee were imposed as a flat fee on all vehicles, for example, it would not create an incentive to shift to less polluting cars, and it would not charge users in proportion to their contributions to the problem. It would simply raise the price of owning an auto for all auto users, and thus would effectively be equivalent to the effect of a uniform tailpipe emissions standard. Such a policy should not properly be regarded as "market based," since it fails to provide the incentives for socially desirable behavior which is the goal of market approaches. In California, for example, each annual automobile registration fee includes a four dollar charge based on the fact that vehicles impose costs on society by polluting the air. The proceeds of the fee are used to fund agencies and projects which combat air pollution, but the fee itself is not structured to provide incentives to purchase vehicles which produce lower emissions, nor does the fee structure reward people who drive their vehicles fewer miles each year. Price elasticities for automobiles are such that a four dollar annual increment in the cost of owning an automobile undoubtedly has no effect on automobile ownership rates. Thus, this fee hardly constitutes a market mechanism in support of environmental improvement. It is merely a tax on vehicle ownership.

The actual outcome of market-based policies is uncertain because they depend on elasticities of demand which cannot be forecast with certainty. It should be noted, however, that performance

measures which are centrally enacted and uniformly applied may also involve a great deal of uncertainty. The standard automobile inspection and maintenance program, for example, is based on simple tests of carbon monoxide and hydrocarbon emissions when the engine is idling. The extent to which an automobile actually pollutes is only poorly correlated with the results of a static test at the idle, however, and recent research shows that some automobiles which are “dirtiest” when accelerating or while operating at high speed consistently meet the performance standards when tested at the idle. In addition, performance-based measures may invite creative methods to avoid compliance, such as disconnecting smog control devices after inspection tests.

Critics of performance-based approaches believe that such regulations can be effective, but often at higher cost and with greater restriction on personal freedom than would be the case with alternative market-based approaches. There are three major criticisms of performance-based approaches. First, there is little incentive to achieve more than the minimum standard. Those who are subject to the regulation have nothing to gain from exceeding the standard or from reaching the standard earlier than required. Such action would increase the cost of compliance, but would not result in any reward for doing so.

Second, those subject to performance-based regulation have every incentive to exaggerate the costs and technical difficulty that would be associated with achieving proposed standards. Opposition to performance standards is clearly in the interest of the regulated community, since the least costly alternative will always be to do nothing. Regulators of course expect such exaggeration, and thus may discount the real difficulties involved in reaching the standard. The outcome of such opposition may be the adoption of standards that are far from economically efficient.

Third, since performance-based approaches are uniformly applied, the costs borne by those regulated may have little relationship to their contribution to the problem. For example, uniform tailpipe emissions standards are designed to meet air quality standards in the nation's most polluted cities. These standards add to the cost of all automobiles, and they therefore impose costs on all motorists, including those living in rural areas and in cities already meeting the standard. Trip reduction ordinances similarly may require equal proportions of workers to shift from driving alone to other modes, regardless of differences in the convenience and availability of alternative modes between worksites. In this case, the costs of complying with the uniform standard may vary greatly from one employer to another.

Market-based approaches have contrasting advantages. In any situation where one must “pay to pollute” it is advantageous to stop polluting both as quickly as possible and as much as possible (e.g. to the extent that it is economically efficient to do so). Thus market-based approaches could lead to larger and more rapid pollution reductions. Market-based approaches also provide less motivation for debates over the cost or technical feasibility of pollution reduction, because an unambiguous metric is used to determine the level of pollution reduction. Consider again the emissions-based vehicle registration fee. The size of the fee (which we assume is based on the social cost of the emissions) determines the extent to which less polluting vehicles will be purchased. Moreover, auto

manufacturers have a clear incentive to produce less polluting cars. Finally, such fees come much closer to imposing costs in proportion to contribution than uniformly applied standards.

Market-based approaches are criticized for two main reasons. First, critics consider pricing strategies to be inequitable, or unfair to lower-income population groups. Fees or surcharges increase the price of the products on which they are placed, and these price increases will affect the consumption patterns and welfare of lower-income groups more than those of higher-income groups. For example, congestion pricing would impose a greater burden on lower-income travelers. These travelers would shift to less preferred modes or travel schedules to avoid the toll. If these options were not acceptable, they would pay the toll. In either case, they would find themselves worse off with the toll. In contrast, high income travelers would pay the toll, save time, and be better off with the toll.[1] Parking surcharges would have a similar impact: lower-income travelers would be more likely to carpool or use transit to avoid the charge than would higher-income travelers, all else equal.

Also related to the perceived unfairness of market-based approaches is the argument that such fees are a "license to pollute," because the choice of driving alone or owning a "gas guzzler" still remains. Since higher-income travelers are most willing to pay the fees, they will continue to pollute, while the burden for cleaning up the air will be borne by lower-income groups. The availability of choices is considered a major benefit among market proponents, but a major shortcoming by critics primarily concerned with fairness.

Proponents argue that the distributional incidence of market-based policies can be altered by the revenues they generate. Revenues can be used to subsidize ridesharing, or to offset other regressive taxes. It can also be argued that poorer people tend to reside in the central areas of American cities which are the communities most impacted by pollution, and that in general poor people are more likely than higher-income people to be living in areas which are negatively impacted by poor air quality. Thus, to the extent that pricing strategies result in cleaner air, poor people might benefit to a greater extent than would the non-poor.

A second criticism of market-based approaches is rooted in skepticism that such policies will actually generate the benefits promised by their proponents. Fees or pricing structures are based on very little empirical data; consequently, their impacts cannot be predicted with much certainty, and the amount by which pollution or congestion will actually be reduced is unknown. Of course if pricing policies are imposed, prices can be adjusted until the desired outcome is achieved; however, critics question whether numerous or significant price changes are politically feasible. Performance-based policies, on the other hand, *appear* to guarantee a certain outcome (as long as enforcement is effective). The greater certainty associated with the outcome of performance based policies is politically more attractive than the uncertainty of outcomes which is perceived to be associated with market-based approaches, because a higher degree of control over the outcome easily translates into a feeling of greater political power. Critics also argue that complex administrative procedures will be required to operate and maintain market-like structures, and that these added costs will significantly offset the expected social benefits. Finally, some opponents simply do not believe that pricing

mechanisms will substantially affect individual choices, and consequently such fees will do little more than drive up the cost of traveling for everyone. While in concept congestion fees can be raised until they sufficiently affect travel behavior, for example, many critics believe that the political will may not exist to charge tolls which are high enough to clear congested facilities of sufficient traffic to alleviate delays associated with congestion.

B. Direct versus Indirect Regulatory Policies

Regulatory policies can be imposed directly on the source of the problem, or they can be mediated through one or more organizations or institutions. From the point of view of efficiency, we would expect direct policies to be preferred. If the single occupant automobile is the problem, the most effective solutions are controls on solo drivers. In the realm of transportation policy, however, measures that impose controls directly on travelers are rare. While there is a long history of levying user fees directly on the traveler, for example in the form of gasoline taxes, those fees are generally seen by policymakers to be tools for the generation of revenue and not as levers for changing traveler behavior. Controls on the automobile are very unpopular and therefore politically risky. For political expediency, then, regulatory policies are usually indirect. For example, the two policies that have (to date) most significantly reduced automobile emissions are the Corporate Average Fuel Economy (CAFE) standards and the national tailpipe emissions standards.[2] Proposals to impose pollution fees of any sort on auto owners are notable for their consistent rejection by policymakers.

Mandatory TDM policies are almost universally indirect. This may be explained by tradition as well as political expediency, as these policies have been grafted onto pre-existing policies or programs. Thus trip reduction requirements or parking limitations placed on new development take advantage of existing municipal zoning powers. Trip reduction ordinances that require employers to provide ridesharing incentives take advantage of traditional voluntary programs that were already common among large employers and large employment centers.

The method of implementation of mandatory TDM policies has not been the subject of public debate. Rather, indirect policies are viewed as "command and control," because the regulated community is mandated to perform the given activity, and some form of monitoring by the regulating agency is typically involved. As was pointed out earlier, however, these mandated programs do not preclude market-based strategies, such as parking fees or carpool subsidies. An ordinance recently passed by the City of Los Angeles provides an interesting example: the ordinance requires employers who subsidize employee parking to also offer $15 per month transit passes to employees.

Indirect mandatory TDM policies have three major shortcomings. First, they impose a usually significant administrative burden both for the regulating agency and the targets of the regulation. Reporting requirements, compliance approvals, program monitoring and enforcement imply significant administrative costs. When these programs are performance-based the administrative burden is even greater. The measurement of trips reduced, for example, is not straightforward, and

thus elaborate methods for demonstrating performance must be devised. Of course, indirect market approaches are also less efficient than direct market strategies in that they also impose administrative costs by creating layers of intermediaries.

Second, indirect policies are inefficient. Most indirect TDM policies mandate actions rather than performance targets. Thus they commonly require that employers participate in a local Transportation Management Association (TMA), or that ridesharing services be made available, or that specific facilities (e.g. bike racks and showers) be provided, etc. These actions are only weakly related to actual mode choice decisions on the part of employees. Even when performance targets are established, they are not necessarily enforceable. For example, a local trip reduction ordinance that mandates trip generation caps as a condition of development can only be monitored after the fact, e.g. after the development is approved, constructed, and in use. If the trip generation caps are then found to be exceeded, local municipalities are faced with the difficult choice of withdrawing the development's conditional use permit or certificate of occupancy, or with renegotiating the trip reduction agreement.

Indirect TDM policies are also inefficient because they invariably apply only to certain groups. Trip reduction requirements on new development, for example, apply only to new development. Even in rapidly growing areas, new development typically accounts for a small proportion of traffic. Employer-based mandatory TDM policies apply to employers in specific areas (downtowns, major centers) and of specific size (companies with 100 or more workers). As we will show in the following section, even the most ambitious programs apply to only part of the target population.

Finally, the limited application of mandatory TDM policies makes them inequitable *within* population groups or classes. Employer-based TDM programs may apply only to large employers. Aside from the practical matter of program monitoring and enforcement, there is no justification for singling out large employers. Targeting downtowns or large employment centers may seem reasonable because such areas have more localized congestion, but given today's dispersed travel patterns, the traffic flows into and out of such areas are only part of the congestion problem. An even more serious inequity is caused by focussing on the work trip rather than on peak travel in general. While most work trips take place at the peak, it does not follow that all peak trips are work trips; in Los Angeles it is well known that non-work trips are the most rapidly increasing component of peak-hour traffic. Thus mandatory TDM policies potentially discriminate between new and existing development, between employers in different locations and of different size, and between work and nonwork trips.

Indirect policies, on the other hand, have proven to be more feasible to implement. Indirect policies diffuse the responsibility of the regulatory agency by targeting intermediary agents. Thus employers are responsible for changing their employee's commuting behavior, and developers are responsible for the eventual patterns of use of their developments. Indirect policies also can make the costs of regulation less apparent. The actual relationship between the price of a new automobile and tailpipe emissions control equipment is not obvious. Even less obvious is the cost of an employer's TDM

program and its impact on employee commuting.

These alternative regulatory strategies have contrasting advantages and disadvantages. Some specific examples can help to further evaluate them. We turn now to a comparison of the two extremes of the array of policy choices: congestion pricing and a performance-based TDM regulation.

III. PERFORMANCE-BASED TDM: THE REGULATION XV TRIP REDUCTION PROGRAM

A. Background and Description of the Regulation

Southern California, for eighty years the symbol of automobile-oriented lifestyles, is today engaged in a far-reaching experiment aimed at reducing commuters' reliance on the single-occupant automobile for the journey to work. The severe air quality problem in the Los Angeles area has given rise to Regulation XV of the South Coast Air Quality Management District (SCAQMD). Also known as "The Commuter Program," this regulation is an important element of the region's air quality management plan. An example of an indirect performance-based measure, it requires employers to take responsibility for encouraging workers to consider alternatives to driving to work alone, including public transit, carpooling, vanpooling, walking, telecommuting, and cycling. Because the 1990 federal Clean Air Act Amendments require a number of other "non-attainment areas" to initiate programs of this type, experience with Regulation XV has national significance.

Regulation XV was adopted by the Board of the SCAQMD in October of 1987, and its implementation began on July 1, 1988. It requires that public and private employers (firms, government agencies, schools, hospitals, etc.) having 100 or more workers at any work site complete and file a plan for that site by which they intend to increase the Average Vehicle Ridership (AVR) to a specified level within one year of the SCAQMD's approval of its plan. AVR is determined by surveying the work force, and is defined roughly as the quotient of: the number of employees reporting to work between 6:00 and 10:00 A.M., divided by the number of motor vehicles driven by these employees. Employers are required to achieve a response rate of at least 75 percent when surveying their workers, and employees who do not respond to the survey are assumed to be driving to work alone. The survey records travel over a five-day work week and the AVR is calculated over that period to account for the growing use of modified work weeks. Certain adjustments are made to the ratio to account, for example, for employees who telecommute, and to give credits for employees who travel to work in automobiles powered by clean fuels such as methanol, propane, and electricity. Employment sites in the central area of Los Angeles are assigned a target AVR of 1.75, and employers in low density, outlying areas are expected to aim for a target AVR of 1.3. Intermediate areas, which constitute most of the area covered by the regulation, have AVR targets of 1.5. The regulation also requires every covered work site to have a trained "employee transportation coordinator" (ETC), and it requires the employer to implement the plan once it has been approved.

After passage of one year, the employer again receives notice, and must again determine the AVR of its work force. If it has failed to meet its target AVR, it must revise its plan and implement the revisions during the second year. Failure to achieve the target AVR is not a violation of the regulation, but failure to implement the plan is a violation punishable by fine. Hefty fines have been levied by the SCAQMD in cases of violation, reaching as high as $150,000 for a major regional retailing chain which failed to fulfill its obligations under the regulation. Employers are subject to audits by the SCAQMD, on short notice, to determine whether the plan is being implemented.

The South Coast Air Quality Management District estimates that there are about 6,200 firms, agencies, and institutions which employ 100 or more workers at individual sites and are subject to this regulation. Together they employ approximately 2.3 million workers. Implementation began on July 1, 1988 when the District began notifying firms having work sites with 500 or more employees. Later, smaller employers were noticed, and today all work sites which presently fall under the regulation have been required to submit and implement plans.

B. Impacts of Regulation XV on Travel Behavior

The authors are conducting an ongoing evaluation of the effectiveness of Regulation XV because of its national significance. The study includes monitoring the effects of the regulation on a panel of employment sites over several years, interviewing ETCs at a sample of employment sites drawn from that panel, and conducting in-depth case studies of a few of the work sites which are part of the panel (Giuliano, Hwang and Wachs, 1992; Wachs and Giuliano, 1992).

The results of the investigation so far indicate that the regulation is having a measurable impact on the travel patterns of the affected work sites. For our panel of 1,110 work sites which have completed one full year of implementation, overall average vehicle ridership, as defined by the SCAQMD, has increased from 1.22 to 1.25, a statistically significant increase with an average increase among all the work sites of 3.4%. For a smaller sample of 243 work sites at which the regulation has been implemented for two full years, the AVR continued to rise in the second year to 1.30. Of the 1,110 employment sites included in our full panel, about 69% experienced increases in AVR during the first year, with just about 20% of the employment sites experiencing increases of more than 10% in their AVRs, and half of the sample having increases of up to 10%. At another 31% of the work sites AVR decreased during the first year of program implementation.

Among the 1,110 employment sites in our full sample, the proportion of workers driving to work alone decreased from 75.7% in the first survey to 70.9% in the second. Among our smaller sample of 243 work sites for which data are available for two years, the proportion of workers driving alone declined by the end of the second year to 65.4%. The largest shift in mode was toward carpooling, while vanpooling also increased significantly. The public transit share and the proportion of workers walking and cycling, however, did not increase significantly. There was great variation in the extent to which employment sites are meeting the goals of Regulation XV, and many firms have done

much more poorly than others. In general, the greatest improvement in AVR was found among employers whose initial AVR values were among the lowest, and interestingly we found that the size of the work force at a given site was not statistically associated with the extent of improvement in its AVR (Giuliano, Hwang and Wachs, 1992).

The purpose of Regulation XV is to reduce auto emissions by reducing peak period VMT. Accurate calculation of VMT reduction would require identification of the employees who changed mode and the mode to which each changed. Employee information is not available, and we therefore estimated VMT reduction based on the overall number of trips reduced in our data set. We expanded this calculation to the population of companies subject to Regulation XV to generate the regional VMT impact: 1.3 million daily VMT, or a reduction of 0.4 percent of annual VMT. This estimate constitutes a "best case," because we are not making any allowance for latent demand. Given the level and extent of congestion in the region, it seems reasonable to expect that any reduction in peak-period work trips would be offset by increases in other types of trips which are not currently subject to regulation.

Under Regulation XV individual employers may design programs consisting of mixes of incentives and disincentives which seem most appropriate to their particular circumstances, and the incentives chosen vary considerably from one organization to another. More than two-thirds of the worksites in our sample included some form of preferential parking arrangements for carpools and vanpools, for example, while only three percent of the worksites introduced parking pricing as a strategy to encourage ridesharing. In addition to preferential parking locations, the most widely adopted incentives included financial incentives to users of public transit (46% of employers), a guaranteed ride home program (45% of employers), promotional prize drawings for ridesharers (45% of employers) and the installation of showers and lockers for cyclists (43% of employers).

During the first year of the program most employers adopted simple, low-cost incentives to encourage a shift in modes, and we expect additional measures to be implemented during the coming years of the program.

Very important to the evaluation of Regulation XV is an estimation of the costs which it imposes upon the regulated worksites. Unfortunately, it is extremely difficult to come up with authoritative cost estimates in which we can have a great deal of confidence. For a variety or reasons, the regulated community exaggerates the costs, attempting to assign to Regulation XV the costs of all ridesharing programs, including those which existed prior to the inception of the regulation. Often, worksites do not have systematic accounting methods which demonstrate the amount of time that ETCs actually spend on implementing the Regulation. We found, however, in a survey of 182 ETCs that 79% of the respondents reported no employees working full time on the implementation of Regulation XV at their worksites. Only 19% of the ETCs reported working full time on their Regulation XV duties, and 43% stated that although they were the designated ETC they were spending less than 10% of their working time on implementing the regulation.

When asked to estimate how much their employers were spending on regulation XV programs (including program fees paid to SCAQMD, staff time and training costs, plan preparation costs, and direct costs of incentives), an extremely wide variation in estimates was obtained. This probably reflects the difficulty of properly accounting for costs. However, the mean estimated annual expenditure on implementing Regulation XV was $31 per employee, and the median was $20 per year per employee. The maximum value was $250 per employee per annum and the standard deviation was $39.

We also conducted case studies of five companies as part of our research. The case studies included a detailed examination of Regulation XV costs. These ranged from $12 to $263 per peak-employee per year, and excluded the costs of any ridesharing activities that preceded the Regulation XV plan.

IV. A DIRECT, MARKET-BASED APPROACH: CONGESTION PRICING

Economists consider congestion pricing to be the most efficient means for solving congestion problems. It therefore provides the best contrasting example to performance-based TDM. Congestion pricing is a pricing system that is aimed at minimizing the total cost of travel over all travelers on a given transport system. It corrects the market failure inherent in the passenger transport system. As the volume of traffic demand on a roadway approaches its capacity, each additional vehicle causes the speed of all traffic to decline by some increment, and the rate at which speed changes is increasing. As demand increases, then, delay (in the form of extra travel time) increases at an increasing rate. Each additional traveler incurs some delay by having to travel at a slower speed, but imposes more delay by slowing down all other travelers. Since individual travelers incur only the cost of their own delay, they do not pay the full social cost of their trips. Since individual travelers do not pay full costs, demand is inefficiently high. By charging a fee equivalent to the incremental delay generated by the marginal traveler (*i.e.* marginal cost), total cost to all travelers would be minimized. The effect of the fee would be to divert some trips to other modes or times and to reduce the total delay on the system.

It is important to distinguish congestion pricing from other types of fees, such as downtown area cordon fees, bridge and other tolls, mileage-based fees, emissions fees, etc. At present, Singapore is the only city in the world where congestion pricing exists. It is a simple scheme: a flat toll is charged for entry into the Central Business District during A.M. and P.M. peak periods. Congestion pricing is the only fee system that is aimed specifically at managing peak period demand. All other fees are fixed and unrelated to traffic congestion. Downtown area cordon fees such as those existing in several Norwegian cities, for example, are in effect all day. These fees are used to raise revenue and to discourage auto travel in the downtown area. Bridge and other toll fees are charged to cover the costs of facility construction, maintenance and operation. Such fees certainly affect automobile travel demand, but they do not specifically affect peak demand, and thus are not examples of congestion pricing.

It is also important to note that the economist's prescription for automobile pollution costs is not congestion pricing. Auto pollution is related to congestion through travel speed; autos operate less efficiently and therefore emit more pollution at slow speeds. However, emissions are more directly related to VMT and cold starts. Thus VMT fees would be the preferred pollution pricing device.

Congestion Pricing Applied in the Los Angeles Region

As noted earlier, there are no domestic examples of congestion pricing. In order to make estimates of the costs and benefits of congestion pricing, a simulation study was conducted. In order to conduct this comparison, two recent studies of potential congestion pricing applications in the Los Angeles region were used. A region-wide pricing scenario is most comparable with the goals and scope of Regulation XV. Using very different methods, both studies estimated an *average* congestion toll of $.15/VMT and a resulting reduction in annual VMT of 4 to 6 percent, or 8 to 12 percent of congested VMT (The Urban Institute/KT Analytics, 1991; Cameron, 1991). The toll would be $3 per day ($750 per year) for an average commute trip of 10 miles. If the toll is applied to all congested VMT, annual toll revenues would be in the range of $2.6 to $2.8 billion, based on 1990 VMT and prices.

A very approximate comparison of the costs and outcomes of the alternative policies is given in Table 2. The comparison is based on 80 billion annual VMT. Congestion pricing reduces annual VMT by about 5 percent, or 4 billion VMT, with total fees of $2.7 billion (the midpoints of the estimated ranges). The first year results of Regulation XV reduce annual VMT by about 0.4 percent, or 325 million VMT, with total employer costs of $150 million.[3] Again, this is an optimistic estimate, because we are not considering possible effects of latent demand.

TABLE 2

COMPARISON OF CONGESTION PRICING AND REGULATION XV

	Congestion pricing	Regulation XV
Annual VMT base	80 billion	80 billion
User fee	$.15/VMT	N/A
Employer cost	N/A	$80/peak-emp/yr
Total annual cost/rev	$2,700 million	$150 million
Annual VMT reduced	4,000 million	325 million
% AVMT reduced	5.0 %	0.4 %

The meaning of these costs are of course quite different. The congestion fees are paid by users and are offset for society as a whole by time savings. The Regulation XV costs are paid by employers, and to the extent that they are accounted for by staff time they are not passed on to society as benefits. The net social outcome depends in both cases on the ultimate incidence of these costs and on the ability of the programs which they fund to influence travel behavior.[4] Given our understanding of the potential effects of congestion pricing, we expect positive net social benefits, whereas the net effects of Regulation XV are quite uncertain.

V. COMPARATIVE EVALUATION

Public policy alternatives are usually evaluated on the criteria of efficiency and equity. Efficiency refers to net benefits, or to the success of the policy in meeting stated objectives per unit of cost. Equity refers to the distributional incidence of the policy, usually with special emphasis placed on lower-income population groups. We present a list of more specific criteria for TDM policies in Table 3.

TABLE 3

TDM POLICY EVALUATION CRITERIA

EFFICIENCY Administration/enforcement Certainty of outcome Pay in proportion to responsibility
EQUITY Impact on lower income groups Equity within groups

A. Efficiency Considerations

Administrative burden includes the costs of implementation, monitoring and enforcement. Administrative costs of Regulation XV are substantial. The regulation has created an entire new department within the SCAQMD, created a new profession (the ETC), and has vastly expanded the local transportation consulting market. Since administrative and enforcement costs incurred by the SCAQMD are supported by program fees which must be paid by the regulated work sites, there is no incentive to hold these costs down. As discussed earlier, estimating the costs of Regulation XV is difficult and subject to much uncertainty. The best resource for estimating the administrative costs

borne by employers is the five case studies. The costs of administration or incentives were allocated based on detailed interviews and examination of financial records. Administrative costs include program and training fees, consultant costs, and salary costs related to administration. The median administrative cost share is 53 percent, and the range is 24 to 80 percent.

In contrast, estimates of the congestion pricing administrative cost share are much lower. Small (1992) estimates administrative cost to be 6 percent of toll revenues in his Los Angeles case study, assuming widespread use of electronic toll collection. Existing highway toll administration cost estimates for the New Jersey Turnpike and the New York Thruway (based on conventional toll booths) are between 11 and 18 percent of revenue, and Hau (1992, p. 46) reports that toll collection costs are 16 percent of toll revenues for the existing downtown cordon pricing project in Bergen, Norway, which also uses conventional toll booths.

A critical issue for any new policy is whether it will work. The impacts of market-based policies can only be estimated, as they ultimately depend on demand elasticities. The effect of congestion pricing is particularly uncertain because of the absence of experience and the number of possible traveler responses to congestion tolls, especially if they were imposed only on selected facilities. Indeed, uncertainty regarding the actual effect of congestion tolls is a significant source of opposition to the concept.

Uncertainty may be a particular problem in heavily congested areas like Los Angeles. Outside of downtown Los Angeles, nearly 80 percent of all workers drive alone, and about 13 percent carpool. The transit share is just 2 percent. Traveler surveys show that work and work-related travel account for 80 to 90 percent of all peak trips on congested freeways (Giuliano, 1992). Traffic volume data show that the region's congested freeways operate at near-capacity volumes all day—from early in the morning to 7 or 8 P.M. These conditions imply that peak demand is quite inelastic. Travelers have limited choices in attempting to avoid the tolls; thus tolls must be high in order to divert a sufficient proportion of trips.[5]

There are two sources of uncertainty under these conditions. First, if selected locations or facilities are tolled, how much traffic may be diverted to untolled facilities? If enough diversion occurs, congestion may simply be redistributed, and the anticipated benefits may not be realized. Second, are high tolls politically feasible? Historical evidence suggests that they would not be (unless offset by other tax reductions): there are no auto tax programs of comparable magnitude in existence. The estimated toll revenues of the Los Angeles example discussed here is equivalent to an annual tax of $530 to $570 per household and is more than twice what a one cent regional sales tax would generate. If tolls are not set sufficiently high, congestion reduction goals will clearly not be realized.

In contrast, performance-based policies have more predictable outcomes as long as the standards can actually be monitored and measured. In the case of Regulation XV, AVR is the standard, and very detailed methods of measuring AVR are specified. The air-quality benefits of the regulation are extrapolated from VMT, which is in turn extrapolated from AVR. Of course, the goal of Regulation

XV is cleaner air, and the extent to which changes in AVR measure changes in air quality is actually dependent upon assumptions necessary to complete these calculations. Although a clear, measurable standard is established, it does not in fact measure the effectiveness of the regulation with respect to its stated goal.

Ideally, policies that seek to correct externalities should impose fees or costs that are commensurate with the individual's contribution to the problem; That is, those who pollute the most should pay the most. Congestion pricing fulfills this objective. Those who use congested roadways will pay the tolls; those who travel at other times or on other uncongested routes will not. Those who travel longer distances at peak times will pay more than those who travel shorter distances. Regulation XV clearly does not fulfill this objective. Travelers subject to the regulation are those who are employed at a site with 100 or more workers and who arrive at work between 6 and 10 A.M. Travelers who are employed at a site with 90 workers, or who arrive at 5:50 A.M., etc., are exempt. Travelers who are not going to work are also exempt, no matter what their contribution to congestion or pollution might be.

B. Equity Considerations

The distributional fairness of congestion tolls has been a subject of concern from the time they were first proposed, and concerns regarding distributional impacts of market-based policies continue today. Distributional fairness refers to the incidence of policy costs and benefits relative to one another, as well as relative to income classes. Most discussions of distributional fairness in transportation policy have considered individual policies in isolation, rather than relative to existing conditions. The arguments summarized here follow this approach, and thus do not address whether these policies would improve or worsen equity relative to the current situation.

The distributional impact of congestion pricing depends both on the relative propensity of various income groups to drive to work on congested facilities and the disposition of toll revenue. Thus it is very difficult to predict the distributional consequences of proposed tolls. If it is assumed that revenues are not redistributed in any way, congestion tolls will generally result in gains for upper-income groups and losses for lower-income groups (Else, 1986; Cohen, 1987). Time savings for upper-income travelers will be greater than the toll. For lower-income travelers, the toll will be greater than the value of time saved, or the money saved by avoiding the toll will be less than the inconvenience incurred by shifting to another mode or travel schedule.

However, toll revenues *can* be redistributed. If revenues are redistributed among income classes at least in proportion to each class' toll contribution, net benefits to all income classes is possible (Small, 1983). Revenues could be used to replace existing regressive taxes, to provide direct user subsidies, or to subsidize alternative modes. It is important to note, however, that no matter how revenues may be redistributed, some individuals may be made worse off, since congestion tolls do not lead to Pareto optimal outcomes.[6]

How likely is it that tolls would be redistributed to offset inequities? Recent surveys conducted in Great Britain showed that congestion pricing was considered most acceptable when linked with a program of expanded public transit, lower transit fares and selected expansion of the road system (Jones and Harvey, 1991). U.S. analysts consider new facilities or added capacity to be the most likely target of the first congestion pricing applications, because revenues could be linked with specific facilities (Gomez-Ibanez, 1991; Giuliano, 1992). On the other hand, programs of revenue redistribution seem less likely. Public skepticism of congestion pricing is high. Given public skepticism, it is difficult to imagine that a redistribution of revenue via tax reductions or refunds would be politically acceptable. Moreover, public agencies have a clear incentive to allocate the revenue to other uses, particularly to other transportation uses. If tolls are dedicated to alternative modes, they may not be used efficiently. They may be used to fund costly rail transit capital facilities, for example, as is the case with tolls in a number of European countries. Thus although toll revenues may be more than sufficient to offset the inequities that congestion pricing may generate, it does not necessarily follow that they will in fact be used for this purpose.

It is far more difficult to predict the distributional impacts of Regulation XV. Because Regulation XV leaves design of the ridesharing program to employers, it is certainly possible to offer a redistributive program, for example by offering larger subsidies to low-wage workers. Our case studies revealed, however, that employers much preferred offering equal benefits to all employees. From the perspective of the commuter, experience to date shows that employers have overwhelmingly chosen to offer ridesharing incentives rather than disincentives.

Another aspect of fairness is equal treatment within income classes. Regulation XV is more unfair than congestion pricing in this regard, because it applies *systematically* only to some commuters and to some trips, as discussed earlier. Furthermore, it applies only to some employers. Firms within the same industry, facing the same competitive environment, may or may not be subject to the regulation, depending on their size; and, if subject to the regulation, may face different performance standards, depending on their respective geographic location.

VI. CONCLUSIONS

Our analysis reveals that congestion pricing and Regulation XV have both advantages and disadvantages. We summarize them in this section. First, neither market-based nor performance-based measures are necessarily effective. Effectiveness of performance-based measures depends on enforcement capability, and there are many ways that enforcement can be thwarted. For example, suppose alternate driving days are introduced in extreme non-attainment areas, with driving days assigned by license plate number. Such a program appears to be easily enforced: autos with invalid license numbers can be ticketed and fined. Alternate driving days would be a very unpopular regulation, however, and travelers could respond in many ways. We might expect a thriving black market in counterfeit license plates, numerous requests for exemptions (e.g. salespeople, medical personnel, households with three cars having odd number licenses, etc.), and perhaps even increased

auto sales. All of these responses would reduce the impact of the regulation.

In other cases, the need for a measurable standard may cause the enforcement standard to have little relationship to the actual objective of the regulation. Regulation XV provides an example: the performance standard for Regulation XV is AVR, which as we have noted does not in fact measure the actual target of the regulation, namely auto emissions. Furthermore, the regulation stops short of actually enforcing the standard; enforcement is based on procedural compliance. Thus there is no penalty for not reaching the target AVR, and there is no guarantee that the expected emissions reductions would occur even if AVR targets were attained, because only a limited portion of peak travel is affected by the regulation.

Effectiveness also depends on the capability of the policy to promote extensive or significant change. It would appear that command and control regulations like Regulation XV are generally aiming to achieve marginal reductions in peak-hour commuting, and that they have a practical upper limit which many experts have estimated to be in the range of a fifteen or twenty percent reduction the use of single-occupant vehicles for work trips at the peak hour (Wachs and Giuliano, 1991). In contrast, congestion pricing can in concept eliminate congestion because the tolls can be raised high enough to clear the tolled facility of heavy traffic, and because the tolls apply to trips of all purposes and not exclusively to work trips.

The effectiveness of command and control measures like Regulation XV can be limited by the presence of congestion on the highway network. To the extent that they succeed, command and control regulations reduce that congestion while leaving the monetary price of travel unchanged. Thus, other travelers may choose to take the place of those who have been induced by the regulation to leave the traffic stream, causing congestion to rise again toward its former level. In principle, congestion pricing can avoid the problem of latent demand because all travelers face a toll which is set equal to the marginal cost of travel. As people are induced to travel by the reduction of congestion, travelers are simultaneously discouraged from traveling by the rising cost. Under congestion pricing the price can always be raised so that an equilibrium can be reached at which congestion is avoided. Thus, latent demand is not able to defeat congestion pricing the way it might defeat some command and control approaches.

The effectiveness of market-based measures depends on demand elasticities and the availability of substitutes. If congestion tolls are too low, for example, they will have little impact on congestion. Similarly, congestion tolls imposed on specific facilities could simply redistribute traffic to alternative, untolled routes. On the other hand, if tolls are set at high enough levels, and if suitable substitutes (e.g. transit, vanpools, flexible work hours, etc.) are available, congestion tolls will be effective. Effectiveness of market-based measures also depends on appropriateness. The downtown cordon fees in Norway, for example, do not affect congestion. In fact, peak demand is more inelastic; thus the fee deters more off-peak traffic than peak traffic (Hau, 1992).

Our second conclusion is that political considerations favor indirect, performance-based measures

over direct, market-based measures, despite the former's likely ineffectiveness. We have seen a rapid proliferation of such programs in recent years, while at the same time direct, market-based measures continue to be debated. Not only has congestion pricing been consistently opposed, but auto fees or taxes have been as well. Recent gasoline gallonage tax increases have been very small, yet were the subject of much debate. In Los Angeles, the SCAQMD has strongly lobbied employers to impose parking charges on employees to increase AVR, but efforts to impose these charges have frequently resulted in serious labor-management conflicts.

An additional source of opposition to market-based measures is the public perception that such measures are really taxes, and that their fundamental objective is to raise revenue. It bears noting that this perception is frequently correct. Proposals for market-based measures often end up being compromised to the point that they effectively become taxes, as in the case of the $4 California vehicle registration surcharge described earlier. From this perspective, performance-based measures are clearly favored, because they focus on the desired outcome and their costs are obscurred.

VII. POLICY RECOMMENTATIONS

Given that direct, market-based approaches are more efficient, but indirect, performance-based measures are more politically acceptable, we propose some possible compromise solutions for addressing congestion and air pollution problems. First, the inequities of performance-based policies can be reduced. Trip reduction policies should be applied on a regional basis to an entire population. There is no justification other than administrative convenience for singling out employers of a certain size or trips of a certain type. Second, in order to make such application feasible, policies should emphasize straightforward, market-based measures. For example, instead of Regulation XV, market rate parking fees or VMT fees could be mandated throughout the metropolitan area. In either case, all auto travel would be affected, and the burdensome administration and monitoring of Regulation XV type programs would be eliminated.

Third, policies for managing congestion and air pollution should be developed separately. They are two different externality problems that call for different solutions. We recognize that in the current policy environment air pollution concerns are determining transportation policy. Nevertheless, transportation policy solutions are not equally effective with respect to each problem. The most effective air pollution policies would focus on shifting to less polluting vehicles as quickly as possible, as well as on reducing auto travel. On the other hand, there is no comparable “technological fix” for congestion, and thus effective solutions must focus on promoting changes in travel behavior.

Finally, direct, market-based policies are more effective and thus merit our best effort in developing measures that are politically acceptable. Road pricing measures should be pursued on new facilities in selected locations. Pollution pricing alternatives should be pursued at the regional or state level. These would eliminate the need for elaborate regulatory programs, but would also help assure their

success should they remain in existence.

ABOUT THE AUTHORS

Genevieve Giuliano is Associate Professor of Urban and Regional Planning at the University of Southern California. She has written extensively on the productivity and efficiency of public transit services, transportation systems management, and land use-transportation relationships. She is a faculty associate of the Lincoln Institute of Land Policy, and North American Co-editor of the international journal *Urban Studies*.

Martin Wachs is Professor of Urban Planning, University of California, Los Angeles. The author of three books and more than 80 articles on transportation planning and policy, his research includes studies of fare and subsidy policy in urban transportation, crime in public transit systems, and methods for the evaluation of alternative transportation projects. He has served as the Associate Editor on the international journal Transportation, and has received fellowships from the Guggenheim Foundation and the Rockefeller Foundation.

REFERENCES

Altshuler, A., J. Womack, and J. Pucher (1981) *The Urban Transportation System*. Cambridge, MA: MIT Press.

Cameron, M. (1991) *Transportation Efficiency: Tackling Southern California's Air Pollution and Congestion*," Los Angeles, CA: Environmental Defense Fund and Regional Institute of Southern California.

Cervero, R. (1989) *America's Suburban Centers: The Land Use - Transportation Link*. Boston, MA: Unwin Hyman.

Cohen, Y. (1987) "Commuter Welfare Under Peak Period Congestion Tolls: Who Gains and Who Loses?" International Journal of Transport Economics and Policy, Vol. 14, No. 3, pp. 239-266.

Crandall, R. (1992) "Corporate Average Fuel Economy Standards," *Journal of Economic Perspectives*, Vol. 6, No. 2, pp. 171-180.

Dunn, J. (1981). *Miles to Go: European and American Transportation Policies*. Cambridge, MA: MIT Press.

Else, P. (1986) "No Entry for Congestion Taxes?" *Transportation Research A*, Vol. 20A, No. 2, pp. 99-107.

Giuliano, G. (1992) "An Assessment of the Political Acceptability of Congestion Pricing," *Transportation*, forthcoming.

Giuliano, G., K. Hwang, and M. Wachs (1992) "Mandatory Trip Reduction in Southern California: First Year Results," *Transportation Research A*, forthcoming.

Giuliano, G., and M. Wachs (1992) "Responding to Congestion and Traffic Growth: Transportation Demand Management," in J. Stein, ed., *Growth Management and Sustainable Development*. Newbury Park, CA: Sage Publications, forthcoming.

Gomez-Ibanez, J. A. (1991) "The Political Economy of Highway Tolls and Congestion Pricing," Paper presented at the Seminar on the Application of Pricing Principles to Congestion Management, Federal Highway Administration, Washington, D.C.

Hahn, Robert W. and R. G. Noll (1990) "Environmental Markets in the Year 2000," *Journal of Risk and Uncertainty*, Vol. 3, No. 4 (1990), pp. 351-368.

Hau, T. (1992) "Congestion Charging Mechanisms: An Evaluation of Current Practice," Transport Division, Infrastructure and Urban Development Department, The World Bank.

Jones, P. and S. Harvey (1991) "Urban Road Pricing: Dealing with the Issue of Public Acceptability - A UK Perspective," Working Paper TSU-669, Transport Studies Unit, Oxford University, Oxford, England.

Newman, P. and J. Kenworthy (1988) "The Transport-Energy Trade-off: Fuel Efficiency vs. Fuel Efficient Cities," *Transportation Research A*, Vol. 27A, No. 3, pp. 163-174.

Office of Highway Management (1991) "1991 National Personal Transportation Study Early Results," Federal Highway Administration, U.S. Department of Transportation, Washington, D.C.

Small, K. (1992) "Using the Revenues from Congestion Pricing," *Transportation*, forthcoming.

Small, K. (1983) "The Incidence of Congestion Tolls on Urban Highways," *Journal of Urban Economics*, Vol. 13, pp. 90-111.

The Urban Institute/KT Analytics (1991) *Congestion Pricing Study*, Final Report. Los Angeles, CA: Southern California Association of Governments.

Wachs, M. and G. Giuliano (1991) "What Can We Expect From Ridesharing? *Transportation Planning*, Vol. 18, No. 2 (Summer), pp. 11-15.

Wachs, M. and G. Giuliano (1992) "Employee Transportation Coordinators: A New Profession in Southern California," Transportation Quarterly, Vol. 46, No. 3 (July), pp. 411-427.

ENDNOTES

1. This example does not consider disposition of toll revenues. Revenues could be used to offset welfare losses to lower income classes.

2. Crandall (1992) argues that the fuel efficiency improvements of U.S. manufactured automobiles during the late 1970's and early 1980's were the result of market forces (consumer demand for fuel efficient autos) and not of the CAFE standards.

3. Employer cost estimate is based on the median of our case study data, which is $80/peak employee/year.

4. Note that we *assume* congestion fees are paid directly by travelers. There is nothing to prevent employers from reimbursing their employees for these fees, for example, and consequently the distinction made here is somewhat oversimplified.

5. Economists point out that congestion pricing generates the largest benefits when congestion is extensive. We do not dispute this; our point is that those who end up paying the toll for lack of better alternative, or those who shift to a significantly less preferred alternative incur a large welfare loss.

6. See Small (1992) for a revenue disposition proposal based on the Los Angeles example.