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**ELECTRONIC TOLL COLLECTION:  
KEY TO SOLVING URBAN FREEWAY CONGESTION**  
by  
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**EXECUTIVE SUMMARY**

Traffic congestion occurs when demand for a segment of highway exceeds its capacity (supply). For several decades, economists have advocated direct pricing of highway use to resolve congestion problems. Until now this was considered technically and politically infeasible. But new technology and changing socio-economic trends now make "congestion pricing" feasible.

The key advance is electronic toll collection (ETC). Now on the market are systems using a credit-card-size vehicle-mounted tag which can be read by roadside equipment without the vehicle having to slow down. The user's account is automatically debited for the amount of the toll--which can be varied by time of day in accordance with congestion levels.

Demand studies estimate peak-hour charges of between 20 and 60 cents per mile on highly congested urban freeways, to 10 to 15 cents per mile on less-congested suburban freeways. Off-peak charges in many cases would be zero.

Political feasibility will be improved if ETC-based congestion pricing is introduced via demonstration projects, such as adding ETC to an existing tollway, converting a High-Occupancy Vehicle (HOV) lane to a pay lane, or launching a new tollway with congestion pricing from the outset.

Other potential problems--equity considerations, privacy, ownership of the system, and standardization--are all resolvable in various feasible ways.

Coalitions in favor of congestion pricing via ETC will include both traditional highway interests (producers, auto clubs) and advocates of full-cost pricing for highway use (environmental groups and transit advocates). Each stands to gain from the shift to direct pricing, making it feasible to bring this congestion solution into being, now that the technology exists to do it simply and economically.

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## BACKGROUND

Since the 1960s, economists have been advocating direct pricing as the key to dealing with urban traffic congestion. In this country, the pioneer was William Vickrey of Columbia University, while in Britain similar work was carried out at the Road Research Laboratory by Gabriel Roth and others.

The theory of road pricing, or congestion charges, is quite simple. Congestion occurs whenever demand for road use exceeds the available supply. Just as in other parts of our economy (e.g., the telephone system), the solution is to charge higher prices at times of higher demand, adjusting the price upward until demand is in balance with capacity, at an acceptable level of traffic flow. Because urban road use typically has large morning and afternoon peaks, road-pricing proposals emphasize peak-hour pricing. Ideally, the prices charged should vary by time of day, day of week, and season of the year--in short, in accordance with whatever variables markedly affect demand.

Unfortunately, no such congestion-pricing scheme has yet been implemented anywhere in the world. The reasons are twofold. Technical barriers have made it difficult to realize the economists' ideal. And perhaps more formidable have been the political barriers. Electronic toll collection (ETC) systems can overcome both obstacles.

Early road-pricing proposals called for using toll booths or crude mechanisms like dials, weekly, or monthly placards or stickers to be displayed on dashboards or in windows (as has been done successfully in Singapore since 1975). But toll booths add to congestion in urban areas, and neither toll booths nor stickers lend themselves to the time-varying prices needed for effective congestion management. Some early automated toll-collection schemes relied on optical systems, which are unreliable, or on-vehicle meters which are costly. It is only the development of microchip-based ETC systems, especially passive on-vehicle tags, that makes possible widespread use of flexible road pricing.

The political barriers have been especially daunting to road-pricing advocates. During the 1970s the National Science Foundation and the Urban Mass Transportation Administration funded extensive studies of road pricing, by the Urban Institute and others.[1] UMTA was willing to pay cities to serve as demonstration sites for road-pricing experiments. But even with a monetary incentive, no mayor or city council was willing to risk public outcries over being forced to pay directly for what they believed was already theirs by right. Similarly, when California's special Task Force on transportation in 1976 produced a draft report advocating road pricing and other economics-based approaches, political opposition forced it to be rewritten to drop these ideas.[2]

Opposition to road pricing has several dimensions. One dimension reflects dislike for toll booths, per se (i.e., having to wait in line, having to pay in cash, etc.); this dimension can

be virtually eliminated with ETC-based pricing systems. Another concern is over "paying twice"; this is much less of a problem for new capacity than for retrofitting a pricing system to existing "free" capacity, suggesting that new capacity is the best place to introduce a pricing system. Yet another concern is over equity; but this concern coexists with today's general shift towards user-pays approaches, suggesting that road-pricing may be more acceptable today than it was a decade or two ago.

#### WHAT CAN WE CHARGE IN URBAN AREAS?

Using electronic pricing to control congestion requires that we learn how great the demand actually is for urban expressway use. Conventional toll-road studies are based largely on city-to-city toll roads, and have been driven largely by the need simply to recover enough revenue to pay off the system's bonds. Consequently, the perception exists that tolls in the range of 2 to 5 cents per mile are about what people are willing to pay.

This conventional wisdom contrasts sharply with what other studies are showing us about the costs of urban traffic congestion. For example, a Texas Transportation Institute study of 29 major cities (excluding New York, Chicago, Boston, and Washington as not automobile-based) estimated the cost of traffic congestion in 1986 as \$24.25 billion.[3] Heading the list was Los Angeles, at \$9.4 billion, with San Francisco, Houston, Miami, and Dallas all in the over \$1 billion range. Other measures are somewhat lower--e.g., the Southern California Association of Governments puts the cost of congestion in greater Los Angeles at \$2.5 billion per year--but still quite sizable.

Studies of this sort, assuming they use realistic measures of the value people put on their time (and studies tend to underestimate this), give us one way of estimating what people might be willing to pay for increased urban mobility. Those whose time is worth \$10/hour might well pay as much as \$3.33 to cut 20 minutes off their morning commuting time. For a typical 13-mile commute, that would work out to around 25 cents per mile.

This estimate is confirmed by a 1988 study carried out in connection with the E-470 tollway project in Denver. Thomas Adler and Robert Schaevitz reported on this exercise, which used data from "direct utility assessment" surveys to estimate coefficients for a logit-form model for each of four trip types: work, non-work, non-home-based, and airport.[4] The lowest-valued trip type (non-work) was found to be worth \$4.21 in tolls for each hour saved, while the highest-valued (airport) type of trip was worth \$31.41 per hour saved. Using the logit models to forecast toll revenues, the researchers found that the revenue-maximizing toll rate would be between 20 and 25 cents per mile.

Finding out how much people say they will pay to save time is not the only approach. Back in 1975, Theodore Keeler and Kenneth Small carried out a very detailed study of the potential of congestion pricing, using data from the San Francisco Bay Area.[5] Their models varied the type of highway, the value of people's time, and the assumed interest rate. For urban

freeways, and using the more realistic 12% (as opposed to 6%) interest rate, they calculated that optimal peak-hour congestion charges ranged from 26.7 to 38.5 cents per mile. For urban-suburban freeways, the comparable charges were put at 8.1 to 10.6 cents/mile. These figures, of course, were in 1972 dollars. Converted to 1990 dollars, they imply potential peak-hour charges of 79-114 cents/mile for urban tollways and 21-31 cents/mile for urban-suburban tollways.

In 1988, Federal Reserve Bank of San Francisco economist Randall Pozdena, who had worked with Keeler and Small in the 1970s, suggested that to reduce some of today's extreme cases of peak-hour congestion, charges as high as \$4-5 per mile might be necessary.[6] But he also produced long-run optimal congestion charges, updating the Keeler and Small work, estimating peak-hour charges of 65 cents/mile on urban tollways, 21 cents/mile on suburban freeways, and 17 cents/mile in fringe suburban areas.

In their 1989 book, Road Work, Kenneth Small, Clifford Winston, and Carol Evans urge the replacement of the gasoline tax by a system of congestion pricing and truck axle-weight fees, but they offer no new estimates of the level of urban-tollway charges that would be necessary to maintain smooth traffic flow.[7]

Most recently, in 1990, the Bay Area Economic Forum released its proposed "Market-Based Solutions to the Transportation Crisis" of the San Francisco Bay Area.[8] The study called for congestion pricing on heavily traveled freeways in the Bay Area, based largely on Pozdena's work, but did not specify the levels of those charges. Currently, various prices are being tested in computer modeling, in order to determine rates which will be both (a) effective in controlling congestion, and (b) politically acceptable.

#### HOW CAN WE PHASE IN CONGESTION PRICING?

That a high-level business/government group has actually proposed implementing congestion pricing in the San Francisco area contradicts the conventional wisdom in the road-pricing community. If this proposal is actually taken seriously once the proposed price levels have been announced, it will serve as a model for the rest of the country. But if, as seems more likely, the proposal is ruled politically infeasible, then it will be all the more important to look for ways of introducing the idea in less-threatening ways.

One way of demonstrating the benefits of peak-hour pricing would be to introduce it on existing tollways. The ideal facility would be one suffering considerable peak-hour congestion. Following installation and customer acceptance of ETC (as on the Dallas North Tollway, today), the tollway operator could announce a new program to cut congestion and improve traffic flows during rush hours. A new toll schedule would be announced, cutting the rates at off-peak hours and increasing them during peak hours. The changes in rates would be calculated so as to keep total tollway revenues roughly the same as before, for public relations reasons. (Since peak-hour rates would have

to be increased considerably, this might mean very low off-peak rates, perhaps even zero for late-night hours.)

One constraint on such experiments may be the wording of the bond covenants under which the tollway was financed. If they rigidly spell out what the toll rates must be, there may not be sufficient flexibility to introduce this kind of pricing innovation. But such flexibility needs to be provided for in any refinancing of existing tollway bonds and in the issuance of any new bonds to cover additions to existing tollways.

A second possibility for introducing congestion pricing is existing (or new) high occupancy vehicle (HOV) lanes. Ward Elliott of Claremont McKenna College has suggested that--depending on what the required number of persons per car is--many such HOV lanes are underutilized. If non-qualifying drivers were permitted to purchase access to the lane, nearly everyone using the freeway would be better off.[9] Those already using the HOV lane would be no worse off, assuming the price for pay-users were set high enough to maintain smooth traffic flow. Those buying access would be better off, or else they wouldn't choose to pay. And those in the regular freeway lanes would be better off by the removal from their lanes of all those choosing to buy their way onto the HOV lane.

The third place where congestion pricing can be introduced is on new tollways--net additions to the freeway network. Indeed, one useful rule of thumb would be that urban areas should add no more freeways--only tollways.[10] An addition to the system will only come about if the necessary funds are made available. If our highway policies are altered such that gasoline taxes are reserved for maintaining the existing network, then the only way that new capacity can be added is when and where people express a willingness to pay the necessary tolls to make that capacity possible.

A number of urban areas have been adding tollways in recent years, even without an overall policy change such as that proposed above. In several Florida and Texas cities, the tollways have been produced in the public sector. In California and Virginia, new tollways are in the process of being developed by the private sector, under long-term franchise or lease agreements with government. If these tollways adopt congestion pricing (which is being considered in the California private-tollway program), then motorists in those localities will have a vivid demonstration of the effectiveness of such pricing in limiting congestion and maintaining smooth traffic flow.

Indeed, the point of all three of the suggested introductory sites--on existing tollways, HOV lanes, and new tollways--is to produce a demonstration effect. Citizens of a city will have daily evidence that those expressways with high peak-hour tolls flow smoothly, while on the others congestion continues to worsen. It is only after such demonstrations have become well-known in several urban areas that it will become politically feasible to propose extending congestion pricing to existing

congested freeways. Once a demand exists for reduced congestion on those freeways, by means of pricing, politicians will be far more willing to consider the idea.

#### COALITION BUILDING

In their book Road Work, Kenneth Small and his coauthors argue that the traditional pessimism about the political feasibility of congestion pricing should be challenged. "Today strong new forces are at work that could give congestion pricing real popular appeal." Among these are the growing desperation of drivers for relief from freeway congestion, the development of ETC (which makes pricing schemes more user-friendly), growing support for user-pays approaches such as toll roads, and recognition of the fiscal reality that current highway funding mechanisms are not producing sufficient revenues to rebuild and maintain our existing system, let alone to add needed capacity.

Those macro-level trends are all favorable to the acceptance of congestion pricing. But getting specific projects approved will require more than general trends. What is needed is the formation of new coalitions of interest groups to push for tollways and congestion pricing.

The traditional highway coalition had several major components. Producer groups were one of its two core groups--engineering and construction companies and their trade associations, and the related construction trade unions. The other core group was highway users--trucking groups and auto clubs. But in many states, this traditional coalition has lost considerable political clout, as new forces--environmental groups and grass-roots slow-growth movements--have entered the picture. The transit lobby has also been an opponent in certain cases.

But tollways--and in particular tollways using congestion pricing--are potentially a whole new ball game. To begin with, the producer segment of the traditional highway lobby has every reason to favor tollways, as net additions to the transportation system. Indeed, last year's endorsement of private tollways by the American Road & Transportation Builders Association was a clear indication of this premise.

To be sure, the auto clubs and trucking groups have traditionally opposed toll roads. But that opposition appears to be softening, in the face of continued fiscal constraints and the difficulty of making any capacity additions in states such as California. Indeed, now that rush-hour bans on trucks are on the political agenda in California, trucking interests there are showing a new interest in tollways and congestion pricing as alternatives. And more recently, economists from the Auto Club of Southern California have begun talking openly about the merits of congestion pricing, compared with the kinds of controls and restrictions on auto use that are being seriously considered in order to meet air quality goals in the Los Angeles Basin.

But even more surprising is the potential membership in a pro-tollways coalition of environmentalists, slow-growthers, and

transit interests. Yet each group stands to achieve some of its values if our transportation system shifts more towards peak-hour pricing that reflects the full costs of auto and truck use.

For example, one of the long-standing complaints of the Sierra Club in California is that auto use is subsidized in numerous ways by general taxpayers--e.g., the provision of local streets partly via property taxes, the fraction of police and fire department time devoted to auto-related matters, the amount of (untaxed) land taken up by roads and parking facilities, etc. In addition, there are the social costs of automobile use--air pollution, noise, and traffic congestion.

Congestion pricing can be presented as a way of making auto users pay much more of the "full costs" of auto use, just as these groups have been demanding for many years. And indeed, one of the strongest advocates of congestion pricing on existing California freeways is the Sierra Club (though they strongly oppose any additions to freeway capacity). And among the early supporters of the Bay Area Economic Forum's plan for congestion pricing is the Environmental Defense Fund.

Transit groups have made similar complaints about the subsidization of the automobile and what they consider the artificially less-competitive position of transit. Making road users pay directly, especially via high prices at peak hours, is a way of helping to level the playing field between transit and highways. So it is not surprising to find that the California Transit League has already endorsed private tollways in that state, as an important step in the right direction.[11]

Politics, of course, is the art of the possible. Bringing tollways and congestion pricing into existence will require compromises among the various interest groups. But if each can gain a portion of what it would like to have, such compromises may well be feasible. For example, despite their opposition to any new capacity, some environmental groups may well agree to some additions, as long as those additions come equipped with congestion pricing. Today in Southern California, preliminary research indicates that the only plausible way to achieve a major reduction in projected vehicle miles traveled (VMT)--and thereby achieve certain air quality goals--is via congestion pricing. Once that becomes known, it will be hard for environmental groups to argue against it, even if it does require some additional construction as part of the package.

#### OTHER IMPLEMENTATION ISSUES

Implementing congestion pricing via ETC will raise a number of other issues, each of which will affect its perceived political feasibility. This overview is intended to focus attention on them, in the interest of further study.

##### 1. Equity Considerations

Will congestion pricing harm the poor? This concern is generally the first one to be raised, whenever tollways are

proposed in a locality where they have not been known. It will be raised even more strongly when congestion pricing comes onto the political agenda, since we are talking about significant price levels at peak-hour times of day. What can we say about this issue?

The Bay Area Economic Forum has addressed this concern head-on in its market-based transportation plan.[12] They point out the following considerations:

- o Low-income workers tend not to drive to work in the peak direction to the downtown core. Census data indicate that reverse-direction commuters in the Bay Area have significantly lower incomes than peak-direction commuters.

- o Low-income households tend to be users of bus transit services. And transit buses suffer even more than private automobiles (because they are less maneuverable) from freeway congestion. Reducing congestion benefits bus and van riders.

- o Congestion pricing produces revenues that can be used to expand transit alternatives, or to give rebates or subsidies to the poor. By contrast, regulatory approaches (e.g. odd/even driving days) produce no revenues.

- o Many rail transit systems (such as BART), which serve primarily middle-class commuters to downtown, are financed significantly by regressive local sales taxes paid by everyone. By contrast, tollways are financed only by those who use them.

In addition, the Bay Area Forum study points out that present transportation systems--with high urban air pollution and traffic congestion--have helped foster the shift of businesses to the suburbs, leaving the poor with polluted air and fewer jobs. Congestion pricing will help to alleviate both congestion and pollution, making downtowns more viable.

Kenneth Small has studied the impact of congestion pricing on several income groups.[13] If government uses the revenues from the tolls--either to reduce taxes, to subsidize transit, or in some other way that benefits people generally--then all income classes can come out ahead. Small works out several numerical examples to illustrate his point. Yuval Cohen has reached a similar conclusion using a different modeling technique.[14] Small points out that congestion pricing corrects economic distortions, unlike most taxes, which introduce such distortions, often leading to what economists call "deadweight losses" to society. He also notes that vehicle registration fees and fuel taxes are also regressive, and that congestion pricing could easily generate sufficient revenues to permit these taxes to be abolished.[15]

## 2. Privacy

While ETC is essential to make congestion pricing user-friendly, the idea that one's vehicular trips are to be recorded by someone makes many people uncomfortable. Indeed, one of the

reasons for the decision not to implement the proposed Hong Kong AVI road-pricing system (after its demonstration program) was concern over "Big Brother" government being able to monitor people's movements.

While this concern will inevitably be raised, its significance tends to be exaggerated. First of all, road pricing is to most people a very new idea, and therefore is viewed with some skepticism. Yet people have become very much accustomed to having records kept about many other aspects of their lives. The telephone company compiles itemized records of your phone calls. Your bank microfilms all your checks, and keeps computer files of your credit-card purchases. Credit bureaus maintain detailed files on your credit history, as do insurance databanks on your medical history. Even video rental stores maintain computer records of your transactions (as Judge Robert Bork learned when these records were released to a newspaper during his Supreme Court confirmation hearings). These records are one of the prices we pay for convenience, and it is likely that ETC systems will come to be seen in that light by most people.

But it is also important to provide options so as to reduce people's concerns over privacy. The Hong Kong experiment offered only one form of payment: an itemized monthly bill, listing all transactions. By contrast, the Dallas North Tollway sends bills only on request (and charges extra for the service); therefore most of its customers are never confronted with itemized lists. The electronic toll collection system operates on a debit basis. Each customer opens an account for a required minimum deposit; the toll for each use is then deducted from the account balance, until a lower threshold is reached, at which the customer is notified that the account must be replenished. Those wishing not to bother with cash replenishment can authorize periodic billing to their Visa or MasterCard account, to replenish their account balance. The Dallas system even offers a special anonymous account, analogous to a numbered Swiss bank account, for those with heightened concern about privacy. After nearly a full year of operation, there has been virtually no demand for this option.

### 3. Public vs. private

Another question which is already part of the discussion of tollways and congestion pricing is whether the public sector or the private sector should be the owner and operator of these systems. A detailed discussion of the pros and cons of each form of ownership is beyond the scope of this paper. But several points that relate to themes raised earlier are worth mentioning.

In terms of the concern over privacy, there is probably an advantage in private ownership of at least the electronic toll collection system, from the standpoint of public perceptions. In the United States, people are generally distrustful of government. Most people are unconcerned about the telephone company records, bank and credit card records, and video store records which are kept about their transactions. All of these are private businesses, which make and keep the records only for their own business purposes. By contrast, people tend to be more

concerned about the government's motor vehicle records, IRS records, and even census questionnaire data. Why? Because government is not trusted to use these records only for their ostensible, narrow purpose. In this regard, it is worth noting that while the government-operated ETC system in Hong Kong was beset by privacy objections, the Dallas North Tollway's system--operated by Amtech, a private firm--has had virtually no such problems.

There may also be advantages in having private tollways carry the principal marketing burden of pioneering congestion pricing. Over the past decade, people have grown very accustomed to paying extra for superior service from Federal Express and other private express delivery firms. The principle of "you pay your money and take your choice" has permitted the growth of a thriving market of additional services, to supplement the low-priced but lower-quality government postal service. Likewise, the addition of superior-quality urban transportation infrastructure might best be pioneered as a service for those willing to pay significantly more. This is not a role people expect government to perform. If pioneered by the private sector, it will help to legitimize the idea of congestion pricing, making this idea far less controversial when government begins to offer it, as well.

#### 4. Standardization

Electronic toll collection offers the near-term prospect of tollways without toll booths. But that prospect will remain more dream than reality if a number of incompatible ETC systems proliferate during the next decade. The greater the degree of technical standardization, the less need there will be for residual toll booths, to handle out-of-area vehicles.

The trucking industry will have the greatest initial interest in promoting nationwide standardization. But the auto industry and automobile clubs should likewise see that it is in their interest to make the AVI/congestion-pricing revolution as swift and as user-friendly as possible. There are many interests that would like to restrict or ban the private automobile altogether. It is very much in the interest of auto users and producers to bring about a smooth transition to a better-funded, less-congested, less-polluting highway system, which is what ETC will accomplish.

Organizations such as the Highway Users Federation, the International Bridge, Tunnel & Turnpike Association and the Society of Automotive Engineers should make the development of a national ETC standard a high priority.

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