PRINCIPLES and APPLICATIONS of CONGESTION PRICING

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The primary objective of congestion pricing should be to optimize the efficiency with which transportation facilities are used.

Efficient Pricing

To induce the efficient use of existing facilities, congestion charges should reflect as nearly as is practical the short-run marginal social externality cost of each trip. These costs should represent the damage imposed on others as a result of taking the trip (e.g., increasing the time of the trip); the wear and tear on the infrastructure; and possibly environmental impacts (e.g., noise, air, and water pollution). As a general principle, travelers should weigh the full social costs against the benefits of taking the additional trip. Without the application of congestion charges, most travelers look only at the marginal benefit relative to their private costs.

Introducing a toll or charge (to reflect damage to others, or social costs) will motivate travelers, when choosing the type, time, route, and mode of trips, to balance the advantages to themselves of the various alternatives against the damages or costs they would impose on others. Indeed, under ideally competitive conditions, the free market would tend to produce prices that have just this effect.

The marginal social cost is measured not only by the conditions prevailing at the time of the trip, but also by the effect on those who make the trip later. Thus, for example, in a simple bottleneck situation resulting in a queue, the toll charged to a new automobile entering the queue should reflect the costs to the other automobiles in the queue. This cost is proportional to the length of the interval from the time the new automobile passes the bottleneck to the time the queue is worked off and a gap appears in the traffic flow, so that there is no further impact of the automobile on later traffic flows.

Construction Costs Are Largely Irrelevant

In terms of efficiency, it is usually a mistake to attempt to relate the level of congestion charges to the cost of construction of the facility. Construction costs should be considered only at the time the construction decision is made, ideally on the basis of a cost-benefit analysis under efficient pricing.

Trial and Error in Congestion Charge Optimization

Introduction of congestion charges would represent a drastic change in the circumstances under which transportation facilities are currently used. With little experience on which to base charges, it is impossible to predict in advance what the appropriate tolls should be. It will be necessary to adjust rates at frequent intervals as traffic patterns change.

In the case of queues that occur at toll bridges and tunnels, average delays over a month or so can be observed at various times of the day and week; these delay times can be multiplied by an estimated average value of delay time per vehicle, and the result used as an initial differential toll schedule. Subsequent adjustments can be made by raising the toll at times of day when there is usually a substantial queue, and lowering the toll at times of day when the flow typically falls below capacity, ultimately to a base off-peak toll, if there is one.

Varying Charges Smoothly Over Time

It is essential that the charges should vary smoothly over time, and not jump suddenly from an off-peak to a peak level and back again. A jump in the toll would have an adverse effect on driver behavior as drivers race to beat the increase, or delay to wait for the decrease. Moreover, if the peak toll is uniform over a substantial period, drivers at the height of the peak would have to shift their travel time by large amounts to obtain the lower toll, and few are likely to do so. If the toll varies smoothly, however, there will be an advantage to shifting the time of the trip by 10 or 15 minutes. Limiting toll variation to a single peak-hour rate could sacrifice at least half the potential efficiency gain from congestion pricing.

Efficient Congestion Charges Can Increase Traffic Flow

It is a mistake to assume that the chief effect of efficient congestion pricing would be to decrease traffic flow. In many of the situations in which such pricing is most urgently needed, the effect would be to increase total traffic flow over the day by increasing the efficiency with which facilities are used, as well as decreasing travel times throughout the day.

In a queuing situation, such as the one at the Lincoln Tunnel, efficient toll variation would eliminate most of the queuing delays, leaving only the minor delays resulting from unpredictable day-to-day variation in traffic demand that cannot be precisely suppressed by toll variation. Drivers could start their trips by as many minutes later as the queue has been diminished, get through the bottleneck, and arrive at their destinations at the same time as they would have done with an earlier departure under the situation without tolls; the toll variation would take the place of the queue variation in motivating the selection of planned arrival time. If the base off-peak toll is unchanged, the additional toll would typically be equivalent to the value of the extra time at home. If the

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revenue from the peak surcharge is used to lower the base toll, nearly everyone would be better off. Drivers could even be offered the option of waiting in a lay-by for a time equal to the former delay and then getting a voucher allowing them to pay only the former toll, guaranteeing that no one is made worse off.

To the extent that there are variations in the value of time, either because of high income, emergencies, or special travel needs (i.e., catching a plane), additional gains would be realized. Users who place a high value on their time would pay a toll at a level controlled primarily by reference to those with a lower value of time. In a mutually advantageous trade with lower-time-value users, high-time-value users would move closer to their desired arrival times. Additional savings could occur from improving the flow of cross traffic previously delayed by the queue, although not directly traversing the bottleneck. Fuel consumption and air pollution would also be reduced.

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Efficient congestion pricing would also encourage carpooling, because the savings in toll costs would be greater than they are under present conditions. There might also be some shifting of lower-time-value trips out of the peak-capacity flow period to be replaced by high-time-value trips formerly deterred by the delay. Total flow would thus increase rather than decrease.

Assessing Charges

An economical, simple, and tamper-proof method of assessing charges is to require that all vehicles entering a congested area or facility be equipped with an automated vehicle identification (AVI) unit, which is about the size of a thick credit card. This card can be placed in the corner of a windshield (or eventually incorporated in the license plate), scanned by units placed at all crossings of zone boundaries (the charge being based on the presumed trajectory from entry to exit from the zone), and billed at suitable intervals to the registered owner. Passage of a delinquent or nonconforming automobile could actuate a videocamera.

Taxicabs would need a special unit so that charges could be accumulated on a mileage basis, at a rate determined by a signal from the scanner at the entrance to the zone, and passed along to customers. Others concerned with privacy, or wishing to see the charges as they accumulate, could elect to be charged as taxis, provided they purchase the necessary equipment.

Air Pollution Control

The charges assessed with an AVI system could readily be adjusted to include a charge reflecting the contribution of the vehicle to air pollution, according to the pollution rating of the car as well as the prevailing weather conditions at the time and place of operation. Automobile owners would have an incentive to defer or avoid less urgent trips at times when air quality levels are poor. Emission charges would also encourage owners to sell high-pollution automobiles or limit their use to weekend trips outside the affected area, or shift to electric and other low-pollution automobiles. By these charges, a given amount of pollution abatement could be obtained at a far smaller sacrifice of convenience and cost than by any other method.

TRB Holds Congestion Pricing Symposium

The Transportation Research Board's Studies and Information Services Division is conducting a study on congestion pricing for the Federal Highway Administration and the Federal Transit Administration. Martin Wachs of the University of California, Los Angeles, serves as the chairman of the study committee. The committee sponsored a symposium in June to discuss the political and administrative barriers to congestion pricing. A summary of the symposium will be published in the September–October issue of *TR News*. Discussed at the symposium was the potential impact of congestion pricing on travel, equity, land use, and air quality. Also addressed were political and administrative feasibility, the state of the art in electronic toll collection, and the potential of future technologies.