The Pricing of Urban Transportation

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Introduction

For urban transportation, as for other economic goods, the first rule of efficient pricing is that every activity should be priced according to its full marginal social cost. Two additional considerations may affect an economic decision as to what prices ought to be charged for urban transit. First, sometimes the cost of collecting a fee is so great that it is more efficient to allow an activity to go unpriced than collect a fee for it. Second, when it is not possible or not efficient to charge for one activity, considerations of the "second best" will generally imply that it is appropriate to charge more than the full marginal social cost for complementary activities that are priced, and less than the full marginal social cost for substitute activities that are priced.

The above principles will be applied first to urban transportation by private automobile and then to urban transportation by public transit systems.

Automobiles

Some of the marginal social costs of transportation by private automobile are reflected in the private cost of the activity. In this category would be the cost of purchase and repair of the automobile and the cost of the time of the travelers. It is conceivable that there are some external economies associated with automobile ownership, arising from economies of scale in the production of automobiles. If so, that is a possible reason for subsidizing automobile purchase, or reducing what would otherwise be the most appropriate level of taxes on automobiles.

In the other direction, it is possible that private markets underprice fuel for automobiles. This can occur if those who extract crude oil for the production of fuel believe that in the future their right to do so will be challenged successfully or taxed, so that they have an incentive to extract crude oil at an inefficiently rapid rate. The incentive for such inefficient rapid extractions can be eliminated by eliminating the uncertainty surrounding extraction rights. This can be accomplished either by assuring those who extract that their right to do so will never by challenged or taxed, or by immediately levying upon those who extract a tax whose present value will not vary with the timing of their extractions. Since such a tax, to be fully effective, would have to be levied on a uniform world-wide basis, a single nation that cannot achieve this goal might reasonably wish to levy a tax on the extraction or importation of crude oil, with the amount of the tax per barrel of oil increasing at the interest rate. When oil is being extracted inefficiently rapidly on a world-wide basis, some such measure is needed to insure that the full marginal social cost of depletion crude oil reserves is reflected in the price of fuel.

Additional externalities (discrepancies between marginal private cost and marginal social cost) occur when fuel is burned, because burning fuel produces air pollution. However, the pollution cost from burning fuel varies with the manner and the place in which the fuel is burned. Some automobile engines burn fuel very cleanly, while others are quite dirty. In addition, the generation of air pollution in urban areas is generally more costly than the generation of the same pollution in rural areas. (Although it is to be noted

that among the costs of automotive air pollution in rural areas is its contribution to the death of forests.)

The final principal discrepancy between the marginal private cost and the marginal social cost of transportation by private automobile is the additional congestion that is caused by additional traffic. The cost of congestion is measured by the value to other traveler's of getting to their destinations sooner. One common assumption about the value of the time of travelers is that each traveler's time has a value equal to his or her wage. But this is only an approximation. A more accurate answer would be obtained by observing how much travelers are willing to pay in tolls and extra fuel and vehicle wear to take routes that are longer or more expensive but faster.

Because the externalities from the air pollution and congestion generated by automobiles are greater in urban areas than in rural ones, it is desirable to reflect these externalities in measures that raise the cost of operating automobiles by more in urban areas than in rural areas. If it is not prohibitively expensive, an attractive way to price these externalities would be to install in each automobile a device that would identify it when interrogated by a monitoring device. A network of monitoring devices would be installed throughout the city, and as each automobile passed the device its identifying code would be noted, and an amount for the externalities associated with the use of that automobile in that place at that time would be added to the owner's monthly bill.

There is a possible objection to such a system from the perspective of civil rights. People might object to the creation of a record of the movements of all automobiles. There are two possible responses to this objection. First, it would be possible to compile the bill without making a permanent record of the movements of automobiles. However, this approach might not be satisfactory because people who wished to dispute their bills would want to know exactly what they were being charged for. Another response is to vary the technology. Instead of identifying each automobile, install in each automobile a device like a postage meter that would have its balance decremented by a computed amount whenever the automobile passed a checkpoint. Then the matter of whether a record of the movements of the automobile was kept would be a matter of how the meter was constructed.

Whether it would be prohibitively expensive to have such a system for internalizing the externalities of urban transit by private automobile is an empirical question whose answer can be expected to change over time. Hong Kong was recently on the verge of installing such a system but backed off, I believe, at the last minute. I suspect that the reasons were more political than economic.

The virtue of a system that bills automobiles individually is that the charges can reflect variations in externalities over time (charging more when congestion is more severe than when it is less severe), over space (charging more in the more crowded ares of the city than in the less crowded areas) and among automobiles (charging more for those that pollute more than for those that pollute less). However, if such a system is economically or politically infeasible, then there are other measures that can be taken, as second-best responses. Fuel can be taxed (preferably more in urban areas than in rural areas). Automobile registration can be taxed (again, preferably more in urban areas than in rural areas). If all automobiles polluted to the same degree, it would be sensible to charge for externalities when fuel was purchased rather than when automobiles were registered, as it would be reasonable to expect externalities to be proportional to the amount of fuel consumed.

However, if automobiles pollute to different degrees, and if it is not possible to reflect these differences in the price of fuel for different cars, then, as a second-best measure, it is sensible to have an annual registration fee that is greater for automobiles that pollute more than for automobiles that pollute less. If there are any bridges, tunnels or highways where tolls for automobiles are collected, the existence of the externalities associated with automobile use will be a reason for raising such tolls higher than they would otherwise be. The externalities are also a reason for levying taxes on public parking facilities (in proportion to the number of customers served), and on parking facilities provided by employers (including government agencies). The service of arranging car pools for workers may be subsidized. But all of these measures are "second best," in the sense that they cannot be adjusted to reflect variations in externalities nearly as well as a system that charges cars individually, when they pass checkpoints.

Public Transit

The pricing of public transit will be considered first under the assumption that private automobile transportation is priced efficiently, and then under the assumption that the negative externalities associated with automobile transportation are not fully reflected in the private costs of using private automobiles.

Public transit by bus is another form of automotive transportation, and as such its efficient pricing requires that buses be charged for their externalities, in the form of pollution and traffic congestion, just as cars are charged. Trains that operate on their own tracks by electric motors, on the other hand, generate neither of these externalities. Thus the charges on buses serve to identify the full cost of operating buses and direct more of the urban transit traffic to trains and less to buses.

Once the full costs of operating buses and trains are identified, one can turn to the matter of the prices that riders are to be charged. The first principle is again one of identifying the full marginal social costs of transit use. For a bus, one might begin by taking account of the cost of stopping a bus for a passenger. If the number of passengers is so great that it is virtually certain that more than one passenger will enter or leave at each stop, then the cost of slowing down and of accelerating back to speed are fixed costs of the system, not to be charged to any passenger. On the other hand, when passengers are sparse and the bus stops just to pick up or discharge one passenger, the marginal social cost of serving a passenger must include a component for the probability that the bus will have to slow to a stop and then resume speed in order to serve the passenger. This charge should reflect fuel costs, equipment costs, the cost of the driver's time, road congestion costs, and costs to other passengers. The fact that one is more likely to be the only one for whom the bus stops when traffic is light will tend to make this charge higher at times when traffic is light. On the other hand, at times of moderate traffic, the components of this charge from road congestion and from delaying other passengers will be greater. At times of greatest traffic, the very low probability that the bus will stop for just one passenger will make this component of cost virtually zero. If a train is run according to a rule that it stops at every station whether anyone requests it or not, then this component of cost is always zero for trains.

The next component of cost is the cost of the time it takes for a passenger to enter or leave the vehicle. Here there are costs of the driver's

time, costs of the time of other passengers, and, in the cases of buses, costs of additional traffic congestion. The latter two components of cost will be greater when traffic is heavy than when traffic is light.

Next comes the additional cost of moving a vehicle because of the additional weight of one passenger. This component of cost can be expected to be the same when traffic is heavy as when traffic is light, but, unlike the earlier components of cost, it is greater for long trips than for short trips. For a trip of a given length, it is greater when the vehicle stops many times than when it stops few times.

Next comes the cost of additional congestion within vehicles. When traffic is so light that everyone has a place to sit, this cost is essentially zero. As the number of passengers on a vehicle increases, this cost goes up. When traffic is so heavy that additional vehicles are needed to accommodate additional traffic, this cost is measured by the cost of operating an additional vehicle, divided by the number of passengers that an additional vehicle can accommodate. For this case, the daily capital cost of the vehicle (interest plus the component of depreciation not related to wear) must be allocated to the hours of peak traffic, when all vehicles are in use. In additional to the capital cost, there are costs of drivers' wages and all material costs of running the vehicles.

An ideal system of fares would vary the fare that a passenger was charged with all of the sources of variation in the marginal social cost of carrying a passenger. When such detailed variations are not possible, it is desirable at least to vary the fare, if this can be done without excessive cost, with the length of the journey and the time when it is taken. It is possible that the marginal social cost of travel in evenings will be so low that it will not be worth collecting any fare at all.

When fares are set according to the marginal social cost of carrying passengers, there is no guarantee that fares will cover the total costs of the transit system. In fact, it is generally the case that the sum of marginal costs will be considerably less than total cost. Thus the difference between the total cost of the system and the sum of the marginal costs of carrying all passengers must come from some other source if the fares that promote efficiency are to be charged. The natural source of such revenue is a charge on the land in the vicinity of the transit stops, with the amount of the charge varying with distance from the transit stop and distance from the center of the city, but not with how the land is used. In a market economy, the rent of land near transit stops rises when the transit system is introduced, and the charge upon land simply collects this socially created value from individuals who would otherwise appropriate it and have no respectable claim to it.

The foregoing analysis was conducted under the assumption that transportation by private automobile was priced according to its marginal social cost. However, if it is not feasible to internalize the externalities from the use of private automobiles by special charges, then there is a second-best argument for subsidies for the use of public transit. More precisely, in the calculation of the marginal social cost of public transit, one must now subtract the expected value of the reduction in negative externalities from automobile use consequent upon the additional use of public transit. This revision in the calculation of the marginal social cost of public transit will result in lower optimal fares and therefore in a greater fraction of the cost of public transit being financed by charges on land in the vicinity of the transit stops.