Abridgment

Elements of Short-Run Marginal Costs of Highway Use

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An investigation of the costs imposed on society by the highway system in a short-run marginal cost (SRMC) framework revealed few elements of social cost that are quantifiable. The SRMC concept applied to highway use implies that only costs that vary with highway use (variable costs) are valid elements for user charges. Analysis of each element included investigations to determine whether vehicle size and weight characteristics create additional costs or benefits to nonusers and whether estimated values of the impacts are available. The SRMC elements analyzed here are certain accident costs, traffic interference with nonmotorists, visual effects, neighborhood disruption, effects on rare and unique resources, ecological effects, and water and soil pollution. Most of the costs were found to be unquantifiable, but based on the nature of the impacts it could be determined that they generally do not vary across vehicle classes in significant amounts. Those with estimated values were substantial and this seems to indicate that significant impacts are now borne by society in general.

The importance of short-run marginal cost (SRMC)-based road user charges is that they bring to the attention of the highway user the costs that users impose on society when they make a trip decision, which produces efficient use of the existing road capacity.

A person contemplating an automobile trip makes a decision about the importance of the trip. Other elements, such as added congestion created by that trip, wear and tear on the roadway, and other factors, are not considered in that decision. In this paper, we are assessing the impacts that are beyond the normal tripmaker's considerations when the trip decision is made.

Some costs not considered in the tripmaker's decision are covered in part by other means. For example, premiums charged for automobile insurance reflect the costs associated with traffic accidents, including property damage, personal injury, and, to a lesser extent, death, pain, and suffering. Premiums are only loosely related to the amount of travel, but for each trip drivers are aware that if they cause an accident, their insurance premiums are likely to increase. When private markets thus force users to consider social costs of their trips, it is not necessary for the public sector to impose charges for those costs.

By their very nature, social costs are hard to quantify. Those components of SRMC theory that are fairly tractable--pavement wear, congestion, and air and noise pollution costs--are the subject of other research studies for the 1982 Federal Highway Cost Allocation Study (1). This paper analyzes the more intractable items. It is anticipated that most of the items cannot be expressed in monetary terms or quantified.

Without reliable estimates of nonuser costs in monetary terms, they cannot appropriately be incorporated into the final determination of highway cost allocation. It is still desirable, however, to document what is known about these items.

This paper will analyze the following SRMC elements not internalized by users: certain accident costs, traffic interference with nonmotorists, visual effects, disruption of the neighborhood, effects on rare and unique resources, ecological effects, and water and soil pollution. Each cost will be examined as follows: (a) a background section describing each item of cost and evaluating the components of each cost, (b) a section describing how the cost varies by vehicle class (size and weight), and (c) a section estimating the monetary value or relative magnitude of each cost.

NONINTERNALIZED ACCIDENT COSTS

Some costs--vehicle insurance and user fees that are already paid for by the highway user--will be ignored in this paper. Other accident costs are not covered by the user and they will be the focus of the following discussion.

When a highway traffic accident occurs, a series of events is set in motion that creates costs not normally considered highway user costs. Police response, fire and emergency vehicle response, traffic delays, losses to employers, prosecution, and probation and court costs that are directly related to traffic accidents are all costs created by highway use.

The heavier a motor vehicle, the more severe an accident that occurs. With greater volumes of heavy motor vehicles, severe accidents are more prevalent. Truck hazardous-cargo spills can create chaos that readily affects users and nonusers.

Vehicle size has some effect on vehicle safety. Long vehicles make passing more difficult and unsafe. Wide vehicles restrict visibility for following vehicles. The trend is toward larger trucks and smaller cars, which will further exacerbate these safety problems.

A few studies done in the last decade have estimated societal costs of motor vehicle accidents. One study, 1975 Societal Costs of Motor Vehicle Accidents, by the U.S. Department of Transportation, estimated the costs of accident investigations, losses to others, and traffic delay and legal and coroner costs (2, p. 25). Updating the 1975 data and using 1978 accident counts yields an estimate of about $7 billion for noninternalized annual accident costs.

DELAYS TO NONMOTORISTS

The highway system creates delays for nonmotorists. The most obvious example of this is pedestrians waiting for an opportunity to cross the street. Other types of nonuser delays exist, which include the possibility of increased damage incurred in a fire due to fire trucks delayed by congestion. The main thrust of this analysis, however, is directed at the largest delays--those incurred by pedestrians and bicyclists waiting at crossings.

Several studies have found that pedestrians value their travel time two to three times more highly than do motorists (3, p. 24). Pedestrians are more exposed to the weather, more threatened and intimidated by vehicles, and, in some cases, are limited in physical ability.

The amount of pedestrian delay is directly related to the traffic volume of the highway system. On the Interstate system and other limited-access freeways, there is no opportunity for pedestrian crossing except at underpasses, overpasses, or specific pedestrian bridges or tunnels. On the primary and other federal systems, the delay is at traffic lights or unsignalized intersections. Urban areas with high traffic and pedestrian volumes experience the highest nonuser delays.

Vehicle size has an impact on the delay experienced by pedestrians. A truck whose place in the traffic queue could be occupied by three cars is contributing three times as much to pedestrian delay as one passenger automobile. Total delay costs should be attributed to vehicle classes in proportion to the space they occupy.

Not enough information is available to estimate the value of nonuser delay. One study (3, p. 24) estimates 1978 pedestrian travel-time values of 20 cents/min for the central business district and 15 cents/min for other locations. None of the literature, however, estimated the number of people delayed by traffic nor average time of delay. Without these other values, the total nonuser delay due to traffic volumes cannot be estimated.

VISUAL EFFECTS

Highways can create negative visual effects for users and nonusers of the system. Litter and the use of adjacent land for billboards are dependent on traffic volume. Trash along the roadway from vehicles is a function of traffic volume, the existing surroundings, and the level of control and enforcement. Billboards are a function of traffic volume, since the advertiser is out to reach as many people as possible and carefully assesses possible locations for this attribute.

Although heavy vehicles such as trucks may well be more significant in the traffic stream in blighted, littered areas, they are not, in general, the cause of the litter or billboards. Trucks can cause unusual amounts of litter when states do not have laws requiring a cover for loads that can blow out of the truck (4, p. 21).

Estimated values for society's or the individual's perception of visual effects are available.

DISRUPTION OF NEIGHBORHOODS

Increasing traffic volume creates neighborhood disruption. This manifests itself in many ways: reduced neighboring, reduced community cohesion, disrupted living patterns, and reduced efficiency of community facilities. Reduced community cohesion is caused when traffic volumes on unlimited-access highways create disruption of residents' ability to meet and associate freely. The traffic reduces opportunities to meet casually, and as traffic becomes greater, it discourages outside activities for children and adults (5, p. 71). These reduced opportunities reduce the efficiency of community facilities. Parks and playgrounds become inaccessible. Stores lose customers and may go out of business. Getting to and from school becomes more difficult and dangerous.

Large volumes of heavy vehicles in the traffic stream create more than ordinary disruption of neighborhoods. Trucks are intimidating in residential neighborhoods. In sum, they create additional traffic burdens in neighborhoods.

It is impossible to estimate the value of neighborhood disruption due to highway traffic. In a pure experiment, two neighborhoods, otherwise identical but for traffic levels, would show differing property values as the cost of neighborhood disruption. Some studies have taken this approach, but the other factors inherent in the real world have so muddied the waters that the results are not sufficiently clear (6, p. 33).

TRAFFIC VOLUME IMPACT ON RARE OR UNIQUE RESOURCES

The term "rare and unique resources" includes the following: archaeological and paleontological resources, historic properties, wilderness areas, and national parks. Conflicts may arise between the use of highway systems and damage to rare or unique areas or resources. Popular national parks may be inundated with traffic, which lessens the enjoyment of the area for all. Wilderness areas lose their remoteness by popular use. Paleontological sites are picked over and archaeological sites are destroyed when disturbed. Historic districts lose atmosphere when the streets are packed with traffic.

It may be the case, in specific situations, that heavy trucks are the prime cause of loss of ambiance to a historic district, but in general terms the impacts discussed in this section are not due to differences in vehicle weights. Truck and bus size has a visual barrier effect, which reduces the visibility in a historical district.

There is no direct way of estimating the cost to society imposed by automobile tripmakers on rare and unique resources. These resources are of different values to different people and estimation is extremely difficult under these conditions. Methods of estimating some of these values have been attempted in past studies (7).

ECOLOGICAL IMPACTS

Traffic volumes on the highway system can create an unattractive habitat to wildlife and plants. Greater traffic increases the chances of vehicle-animal collisions. It appears that many species become adjusted to some aspects of traffic volume. A case has been cited of elk being unconcerned with traffic until a vehicle stops on the side of the road (8). Some potential impacts have been predicted but not documented and others may exist that we know nothing about (9, p. 43).

Ecological impacts are not sensitive to vehicle class except that heavy trucks may cause additional noise and vibration. Truck size has no effect on ecological impacts.

While there is a value to these impacts on the ecology, it is practically impossible to develop a reasonable cost estimate for SRMC user charges of ecological impacts.

WATER AND SOIL POLLUTION

Water pollution is significantly influenced by highway runoff. Substantial amounts of oil and grease are leaked onto the roadway and part of this is washed off in rainstorms. Road salt in winter creates a large amount of troublesome runoff. If the storm sewers lead into streams or rivers, the highway contributes to pollution directly. If the sewers lead into a municipal sewer system, the runoff is treated. In heavy rainstorms, however, the additional load on the sewer system may cause the dumping of untreated municipal waste directly into streams. With an estimated one-fifth of an average city's total land area dedicated to transportation uses (mostly streets and highways), a heavy rain could quickly overload a combined sewer system (10, p. 115).

Besides impacts on flowing surface water, highway pollutants find their way into the groundwater. This is considered by some as the more important of the two impacts. The severity of groundwater impacts is not known due to lack of knowledge about salt and other contaminants in groundwater (11, p. 86).

Soils are also affected by concentrations of toxins and heavy metals. Asbestos, lead, acids, copper, zinc, cadmium, iron, nickel, chromium, and other traces can be found in the soil (12, p. 68). Greater traffic flows mean higher concentrations of these toxins near the roadway.

Those vehicle classes with larger engines, more tires, and brakes are contributing greater amounts of pollutants that originate from those parts. Greater distances of travel [vehicle miles of travel

(VMT)] contribute proportionally larger amounts of pollution and make greater use of roads cleared with road salt in winter snow.

There is no way to estimate the value of water pollution spillovers due to highway traffic.

CONCLUSION

The SRMC elements of highway use analyzed in this paper are, in many cases, not quantifiable. All the above elements are a function of traffic volumes and therefore vary with highway use. In designing a system of user charges based on SRMC, these elements should be accounted for in the variable-with-use portion of a user charge.

Most of the SRMC elements are not attributable to specific classes of highway users. The following items should be considered common costs, that is, to be shared by all vehicle classes equally: visual effects, most neighborhood disruption (other than noise and vibration), most impacts on rare and unique resources, and ecological impacts.

Heavier vehicles, in general, occasion greater costs in safety, water, and soil impacts because they tend to travel greater distances. These costs should be attributed by the VMT of the vehicle. Larger vehicles occasion greater costs in safety, nonmotorist delay, and rare and unique resources because of their size.

In all, a sum that would be a particular vehicle's short-run marginal cost as considered in this paper would be made up of components for VMT, vehicle weight, vehicle size, and a common cost spread across all vehicles equally. To this sum would be added the other SRMC costs not covered here but in other parts of the Highway Cost Allocation Study. However, as this analysis shows, there is not enough solid cost evidence to place actual values on the cost analyzed.

REFERENCES

1. Federal Highway Cost Allocation Study. FHWA, Final Rept., Jan. 1982.
2. 1975 Societal Costs of Motor Vehicle Accidents. National Highway and Traffic Safety Administration, U.S. Department of Transportation, Washington, DC, 1976.
3. R. Brown and M. Roddin. Quantifying the Benefits of Separating Pedestrians and Vehicles. NCHRP, Rept. 189, 1978.
4. 1974 Litter Study. FHWA, 1975.
5. D. Appleyard and others. Livable Urban Streets. Univ. of California Press, Berkeley, 1981.
6. C.O. Flacke and L.W. Kozimor. Changes in Property Prices Within the Highway Impact Zone. FHWA, July 1980.
7. J. Knetsch and R. Davis. Comparisons of Methods for Recreation Evaluation. In Water Research (A. Kneese and S. Smith, eds.), Johns Hopkins Press, Baltimore, MD, 1966.
8. A.L. Ward and others. Effects of Highway Construction and Use on Big Game Populations. Univ. of Wyoming, Laramie; FHWA, 1976.
9. R.J. Sampson and M.T. Farris. Domestic Transportation: Practice, Theory, and Policy, 2d ed. Houghton Mifflin, Boston, 1971.
10. E.S. Mills. The Economics of Environmental Quality. W.W. Norton and Co., New York, 1978.
11. R.C. Terry, Sr. Road Salt, Drinking Water, and Safety: Improving Public Policy and Practice. Ballinger Publishing Co., Cambridge, MA, 1974.
12. Constituents of Highway Runoff. FHWA, 1981.

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Net Benefits from Efficient Highway User Charges

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The purpose of this paper is (a) to estimate what a complete set of efficient highway prices would look like in terms of dollar magnitudes and their relationships to travel by particular vehicles under particular conditions and (b) to measure the gains that would result from imposing the efficient prices instead of the ones now charged. Because the scope of this effort is large and because no comprehensive set of marginal cost highway user charges has been estimated previously, the result of the current work is still very rough. At present, the concepts and methods are at least as important as the numerical results.

Were there no constraints--no budgetary revenue requirements, not more than one level of government involved in setting charges, no concern for income transfers or indirect impacts, and all other public and private enterprises efficiently priced--on setting highway user charges, efficiency (in the allocation of highway investment resources and available capacity) would be the sole objective in designing such charges. In reality, numerous compromises must be made for numerous reasons. The issue then becomes the degree to which efficient resource allocation should be sacrificed for other purposes.

Although whether they are cost occasioned has been routinely cited as a basis for designing highway user charges, efficiency in the utilization of scarce resources has not received much attention until recently. Now, however, highway professionals and policymakers at all levels of government are increasingly interested in finding the most productive use of the nation's resources as well as in the fairness of revenue instruments.

OBJECTIVES IN HIGHWAY PRICING

Application of the economist's concept of efficiency to public policy implies that the government should seek to maximize the net social benefits resulting from the activities in which it engages. Efficient highway user charges are those that will lead to the greatest surplus of benefits over costs for a given stock of capital facilities. Investment in the highway system should follow the same criterion, namely, increase output as long as the marginal benefits exceed the marginal costs. The research reported here, however, is directed at the pricing portion of efficiency rather than the investment portion.