Incremental Method of Allocating Highway Costs

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● THE foundation of the incremental method is the fact that vehicles of different dimensions and weights differ in their requirements for highway facilities. The approach involves an attempt to differentiate the costs attributable to vehicle weight and size and to assign these costs to vehicles in graduated weight-and-size-increment groups. There is no one set of procedures which can now be considered essential to a legitimate incremental-cost solution. The time may come when one solution may be generally accepted as more accurate and more valid than others, but much experimentation will be required to determine the choice.

The incremental method has been used in efforts to appraise the soundness of past road expenditures and tax structures, current expenditures and motor-vehicle tax structures, and as a basis for adjusting the structure of taxes for future road support. Appraisals of past and current motor-vehicle taxes serve to indicate the soundness and consequences of past practices. They may serve as a guide to future policy but only in a general way. Future patterns of expenditure may bear little resemblance to past patterns.

Only by applying the incremental method to anticipated expenditures can it serve most effectively as a guide to public policy. The method has been so applied in a comprehensive study of highway finance now nearing completion under the author's direction in Louisiana. There have been two other similar studies made recently to which brief reference may be made here.

The first of these was made in Ohio by D. F. Pancoast for the Ohio Department of Highways; it was published in December 1953.[1] The other study was made by the Public Administration Service of Chicago for the State of Minnesota and was released in mimeographed form in August 1954.[2]

The Minnesota study is an exact replica of the statistical computations used in the Ohio study, without explanation of procedures and with few references to sources of data. The text of the Ohio study is more complete. As the trail blazer in a difficult terrain, it deserves high praise; without its guidance, my own task would have been immeasurably more difficult. However, the Ohio study also fails to give a complete explanation of the derivation of some of its data and of the exact nature of some of its procedures.

Only by an unrelenting critique of data and procedures used can more-appropriate and more-accurate data be provided and the method be improved. The remainder of this paper consists of a reexamination of the method as employed in the Louisiana study.

At one stage in our work, my assistant, L. J. Melton, now at the University of Florida, commented half seriously that he had arrived at one definite conclusion: "You can't make an incremental analysis." The numerous assumptions and tremendous amount of statistical detail which are required in applying the method, even when the data available are reasonably complete, do threaten at every turn to overwhelm one who undertakes the solution.

The first problem to be confronted is that of apportioning total road costs between highway users and other taxpayers. The problem is fundamental to the incremental solution and, one might add, to any other method (such as the straight ton-mile solution) which may be used as a guide to motor-vehicle tax policy.

A decision is required as to which road costs are chargeable directly to the highway user or motor-vehicle owner and which are chargeable to the general public. Some attempt to measure relative use in terms of the proportions of the different types of traffic served by the different highways, roads, and streets is basic to any apportionment which

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[1] D. F. Pancoast, Allocation of Highway Costs in Ohio by the Incremental Method, Columbus, December, 1953, 78pp.

[2] An Incremental Cost Analysis Based upon the Ten-Year ASF Proposed Highway Program, Public Administration Service Chicago, August 16, 1954 (Mimeographed).

is determined. The costs assignable to the motor-vehicle owner will be greater on those facilities which carry a high volume of through traffic. The portion of costs assignable to the motor-vehicle owner on local roads and residential streets serving primarily access and community service purposes will be small. The use of roads by public vehicles must also be taken into consideration.

The apportionment used in the Louisiana incremental analysis involves a feature originated by Melton. The objective is to separate those highway costs chargeable to the highway user from those which should not be charged to the highway user. The incremental approach holds that there are certain highway costs which are clearly attributable to the existence on the highways of larger and heavier commercial vehicles. These costs must be separated for use in the incremental solution to the problem of apportioning costs between vehicle types. It seems quite logical to isolate these costs as a partial solution to the apportionment of total highway costs between highway users and nonusers. The remaining costs, which are assignable in part to all highway users and in part to the general public, still had to be assigned on a relative-use basis, but the magnitude of the task was reduced. Although some question was raised by Bureau of Public Roads personnel as to the validity of this procedure, perhaps because the process had not been tried before, it is believed that the accuracy of the result was increased (see Table 1).

TABLE 1

RATIOS OF COSTS ATTRIBUTABLE TO VEHICLES IN EACH AXLE-WEIGHT INCREMENT WHICH WERE ASSIGNED TO THE HIGHWAY USER

Axle-Weight Increment	Surface Type				
	High	Medium	Low	Gravel	Total
lb.	%	%	%	%	%
14,001 - 18,000	100				100
10,001 - 14,000	100	100			100
6,001 - 10,000	100	100	100		100
0 - 6,000	90	60	40	20	68

The resulting distribution of highway-user costs by weight increment was then employed in the incremental apportionment of highway-user costs between vehicle types and axle-weight groups. The share of costs assigned to the general public was thus deducted entirely from the cost of providing roads for vehicles in the basic axle-weight increment (0 to 6,000 lb.). This appeared to be the only procedure consistent with the objective of matching price and marginal cost of providing the more-elaborate facilities required by commercial vehicles and facilitating an economic allocation of resources among transport media. It is also true that most publicly owned vehicles fall into the basic axle-weight increment and land access and community service traffic will involve largely the low-weight vehicles. This too is a procedural innovation believed to have merit.

The Louisiana Highway Finance Study has been conducted in conjunction with a comprehensive engineering study of highway needs within the state. Thus complete and up-to-date data with respect to anticipated highway costs in Louisiana were available. Furthermore, the engineering study data are on IBM cards; machine tabulations were used to correlate traffic, cost, and other relevant data in the form needed for use in the financial analysis.

Louisiana is the only state in the nation which registers trucks and trailers by load-carrying axle weight. An axle-weight breakdown of commercial vehicles is essential to the incremental solution; in Louisiana alone such a breakdown exists in ready-made form. It was not necessary to attempt the difficult and uncertain task of adjusting from gross-weight registration data to axle-weight data on the basis of loadometer samples,

which seldom indicate the incidence of over-weight vehicles among those registered for less than the maximum legal weight.

No adjustment was made in registered axle-weight groupings for loaded and empty travel of commercial vehicles. Highways are constructed and commercial vehicles are licensed to carry maximum axle or gross weights. It does not seem unreasonable to expect such vehicles to pay their appropriate share of the total cost of constructing such highways to meet their maximum requirements, whether all travel is with maximum legal load or not. Using loadometer data to develop axle-weight groupings, the Ohio and Minnesota studies produced data which presumably were adjusted for loaded and unloaded travel.

The Louisiana study, like the other two studies, distributes weight-related costs between vehicles falling into the various weight increments on an axle-mile basis. The Ohio and Minnesota studies distribute nonweight costs, other than the costs of state highway police administration and vehicle registration and drivers license administration, on a vehicle-mile basis. The Louisiana study distributes nonweight costs on an axle-mile basis. The choice of axle-miles rather than vehicle-miles was dictated by the judgment that axle-miles give a fairer distribution of costs between passenger cars and multi-axle commercial vehicles than vehicle-miles. The choice also eliminated the necessity of determining whether combinations of vehicles should be considered as one vehicle or more and, if the latter, how many. The costs of state highway-police administration and vehicle registration and drivers-license administration are distributed on a per-vehicle basis in all three studies.

The Ohio and Minnesota studies used average road inventory figures (the miles of road of each surface type in the entire road system of the state at the beginning of the improvement program plus the miles of each type proposed for the entire system at the end of the improvement program divided by two) in distributing costs and traffic in their solutions. In these states, where the change in surface types on each system from the beginning of the program period to the end will not be significant, the choice of average inventory figures for use in the solution was a logical step and probably the most-valid procedure.

In Louisiana, where many miles of road will be up-graded from gravel and low-type bituminous surfaces to medium and high-type paved surfaces, the problem of selecting the most-valid inventory figures for the solution was an extremely difficult one. Average inventory figures are clearly more valid for the allocation of maintenance costs. On the other hand, ultimate inventories (the miles of road of each surface type expected to exist at the end of the improvement program) are more valid for use in allocating construction costs; this is true because the motor-vehicle owners who use those highways which will ultimately be constructed to higher standards should be the highway users who pay for the improvements.

The use of either set of figures for the distribution of both maintenance and construction costs involves some distortion. However, careful consideration of the alternatives produced the conclusion that the magnitude of the distortion would be far greater if average inventory data were employed. In fact, examination of the Louisiana data showed that, since the larger maintenance costs are involved on the lower type surfaces on which few heavy vehicles travel, the distortion in the allocation of maintenance costs resulting from the use of ultimate inventory figures was reduced to insignificance. Thus the decision was made to employ ultimate inventory figures in the Louisiana solution.

In most recent studies in which the incremental method is discussed, particularly in those studies which have been sponsored by the various states to be used as a guide to public policy, the task of developing the engineering cost increments for each vehicle weight and size group has been cited as the most-perplexing problem of the solution; it is the obstacle cited most often as dictating a decision against use of the method. The experience in Louisiana has been that the engineering-design sections of state highway departments are engaged daily in making cost estimates for constructing highways or sections of highways designed to specific standards. In Louisiana, the development of cost increments was accepted by the highway department as quite plausible, even for the hypothetical roads designed for lower vehicle weight groups in the case of the higher types of surfaces. Some assistance was received from Hugo Duzan, of the Bureau of

Public Roads, in developing the increments for the Louisiana Study.[3] However, complete cooperation was given by the engineers of the Louisiana Department of Highways; a thorough job was done; and considerable confidence was evidenced in the results obtained.

The next problem confronted in the solution, one which is critical, was the problem of distributing total traffic by road-surface type and by vehicle-use type and weight group. The task proved a difficult one, despite the availability of perhaps the most-complete statistical data for the purpose in existence anywhere in the nation. The distribution of total traffic by proposed surface type was accomplished automatically by IBM tabulation of traffic count data for each section or portion of the road system. This known distribution of current traffic was assumed to hold generally valid for the improvement program period, and the traffic projection to the midpoint of the program period for use in the solution was made on the basis of this distribution pattern.

In Louisiana, the classification of trucks and trailers for registration purpose is more elaborate and apparently more complete than in most other states. There are five use types: private use, common and contract carrier, forest product, city use only, and farm. Trailers are registered independently; in each of the above use categories there are five vehicle types, regular trucks with a single load-carrying axle, regular semitrailers, tandem trucks, tandem semitrailers, and full trailers. Registration is by maximum load-carrying axle weight; the weight increments are 0 to 3,5000 lb., 3,501 to 6,000 lb., and increments of 2,000 lb. each from 6,001 to 18,000 lb., the latter being the maximum legal load limit. The registration fees are graduated upward for each vehicle-use type from the lowest to the heaviest weight increments; but within each vehicle-use type, the fee per load-carrying axle is the same for each weight increment, regardless of the vehicle type involved. The complexity that this system of classification introduces into the problem of distributing truck traffic by use type, vehicle type, and weight increment is obvious.

Recent visual counts of vehicles, by type of vehicle (autos, regular trucks, etc.), in traffic on the state system were available. Adjustments had to be made to make these data applicable to the parish road system and to the municipal street system, but the data served as the basis for the distribution of traffic by vehicle type on the various systems.[4] The registered axle weight and use type of sample vehicles had been recorded in making a recent loadometer study in Louisiana. These data were tabulated and provided the statistical basis for distribution of traffic by use type and registered axle-weight increment on the state system. Again, adjustments had to be made to make these data applicable to the parish and the municipal systems.

Because both the visual-classification-count data and the loadometer data were assembled with objectives other than use in an incremental solution, obvious incongruities were found in some use and vehicle classifications. Most of these discrepancies, however, were subject to logical interpretation and the direction of the adjustment required was easy to determine. Despite the fact that much more complete traffic data by system, use type, vehicle type, and by weight increment would have been desirable, the data which were available and which have been made the foundation of the traffic distribution in the Louisiana study would seem to demonstrate beyond question the desirability of the traffic survey approach to the traffic distribution problem in the incremental solution.

A reference in the Ohio study to the need for more adequate information for dealing with this problem suggests that "commercial vehicle operators are probably in the best position to gather the necessary data."[5] It is true that a final check on the reliability of a distribution of commercial vehicle traffic for use in an incremental solution is the aver-

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[3] Acknowledgement is also made of the advice and assistance received from C. A. Steele and G. P. St. Clair, likewise of the Financial and Administrative Research Branch of the Bureau of Public Roads, during the development of the incremental analysis in Louisiana. Full responsibility for the choice of procedures employed, nevertheless, rests with the writer.

[4] The Louisiana Motor-Vehicle Use Study and Origin-and-destination studies for a number of Louisiana cities served as the basis for the adjustments.

[5] Pancoast, op. cit., p. 29.

age annual travel figures which it produces for the various commercial vehicle types. The more complete the information available as to the average annual mileage of the various vehicle types, the more adequate will be the check on the traffic distribution produced by statistical methods from traffic survey data.

The average annual mileage data will also serve as a guide to adjustments where incongruities do appear in the results obtained from the statistical approach; average annual mileage data available for commercial vehicles in Louisiana served this purpose in the Louisiana study. On the other hand, the implication of the Ohio study is that the entire problem of traffic distribution for the incremental solution should be approached from the standpoint of average annual travel data for commercial vehicles. The Louisiana experience would seem to suggest that the problem should be approached from both ends.

State highway departments should design and conduct their traffic surveys so as to provide the statistical data needed for the incremental solution. Commercial truckers, who should be interested in finding the most-accurate answer possible to the problem of highway finance and taxation, would also make a useful contribution to progress in this area by undertaking to assemble more-reliable information with respect to the average annual travel of the various types of commercial vehicles.

The comparisons that have been made between the Louisiana study and the Ohio and Minnesota incremental solutions indicate that there are many similarities but, also, many variations between the former and the latter two studies. The possibilities of further variations and refinements in the method are numerous. The claim which the Louisiana solution may have to greater reliability and precision than the other two rests largely upon the fact that the basic data available in the state were more directly adaptable to the incremental solution and were more complete.