

General Discussion

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● FAR MORE intensive reading and analysis than has been possible in the time available is essential to full and final evaluation of the papers previously presented. Therefore, this presentation is limited to discussion of general points.

The first point to be stressed is the wide area of agreement, explicit or implicit, in the several papers on the economic propositions that construction, maintenance, and operation of highways require scarce resources that could be utilized in other types of production, either in other transport or in other fields; that the values of such resources in other uses comprise the opportunity costs of their devotion to highway use; and that all such opportunity costs must be taken into account in highway investment decisions and possibly in pricing decisions.

In placing highways in an economic setting, Professor Brownlee has admirably stated, in simple terms, the condition that must be fulfilled in order for highway investment and pricing to be optimal in an economic sense. Thus, comparisons of highway service prices and costs can show which highway needs should be satisfied and which should not if the prices are "good approximations as to what things are worth" and the costs "yield accurate estimates of what must be sacrificed." Viewing the highway function in terms of the economy as a whole, rather than as an entity having no consequences for resource allocations in other areas, Brownlee implies that far more consideration than in the past must be given to the rates of return which capital can earn in other employments and to imputed property taxes on highways if comparisons of prices and costs are to yield fully economic highway investments. Without adding in those cost components—that is, interest at the opportunity rate rather than the government rate, and imputed property taxes—the total costs to be justified by priceable benefits are understated and a tendency exists to overinvest in highways more or less continuously.

A second point is the general recognition in these papers that although there are indirect benefits to be considered, in most cases the highway users should pay highway costs. Brownlee makes this point explicitly in supporting "the contention that the benefits from investment in highways have properties such that a highway investment can be evaluated in the same manner as can any investment designed to produce goods and services that are to be sold." Although the studies by Baker and his associates were intended as purely engineering studies, it is to be noted that comparisons were made of the cost responsibilities for various highway groups and the taxes paid, with the interesting conclusion that the "effect of the revenue derived from the axle-mile tax... is to make cost responsibility more consistently equal to taxes paid (1)." Kafoglis gives a theoretical case for a nonuser share in joint demand possibilities, but stresses that where the socially desirable amount of highway service clears the market at a cost-determined price, such a share is not needed and windfalls to nonusers can become a source of general tax revenues. He also finds that as "highways are built for actual or potential highway use and little more... the physical by-products of highway development do not provide an important basis for a nonuser share." Where highways are truly needed more than other things, there is little reason to believe that the effective demand at appropriate user fees, tolls, or road taxes (where differential user fees are unworkable) will not yield a volume of priceable benefits equal to the total costs involved in adding to highway supply (with possible exceptions for undeveloped areas.) Finally, Kuhn states as a principle that "public projects should compete, as it were, on equal terms with private ones and logical priorities for all of them should be based on the expected efficiencies of capital for the various ventures."

Kuhn's interesting paper deals in some detail with economic criteria for highway investment. Recommending a broader planning horizon than for private entrepreneurial investment and the widest consideration of external economies (indirect benefits) and external diseconomies (social costs), Kuhn sets forth the ideal as "the maximization of social benefits and the minimization of social costs."

However attractive in an abstract sense, there are numerous difficulties with such broad criteria as guides to economic highway investment. First, although the difficulties of measuring social benefits and costs not considered in the market are mentioned, no formula is given for their concrete evaluation. Second, some highway benefits mentioned for consideration, such as transportation cost, production cost and distribution cost savings accruing to the entire economy, are no different than similar general gains to the economy from an improvement in the art of railroading or in the manufacturing of steel. In any case, double counting may be involved if savings to users are counted as benefits and if they are again counted in terms of effects on the entire economy. Third, Kuhn appears to stress the difficulties of the market mechanism in determining the optimum highway investment without substituting anything as workable as the market, with all its defects, has been in toll road investment and in many areas of "free" road investment on the basis of user fee revenue, traffic, and other indicia of effective demand. Kuhn admits that under his criteria "a large proportion of government outlay, because of the familiar difficulties of measurement, will not be subject to the economic cost/net return calculus and will thus presumably be determined by collective political judgment." In the United States many failures to attain optimal highway investment, involving both overinvestment and underinvestment, can be attributed precisely to the vagaries of such collective political judgment. Perhaps more effort should be given to the task of improving the market in which highway services are produced and sold, including attention to tolls as selective supplements to user fees, off-and-on peak pricing to encourage or discourage utilization and to lessen tendencies toward overinvestment, adjustment of user fee schedules to reflect use more fully, and differentiation in user fees according to cost and quality variations.

Another general point worth emphasis is that these excellent papers reveal the close and dovetailing relationships between engineers and economists so far as the highway function is concerned. Economists must depend on engineers for knowledge of design, maintenance, and operating practices and the facts needed for making explicit the assumptions basic to the application of economic analysis to highway investment and pricing problems. Engineers, at least in most cases, must depend on the economists for the principles of resource allocation and use that comprise the economic way of thinking. Engineers cannot avoid economic questions and economists trying to apply economic principles to highways cannot avoid engineering questions. But because it is impractical to expect engineers to be full-scale economists and economists to be professional engineers, what is urgently needed is the willingness of both engineers and economists to assume the responsibility of assisting members of the other discipline to comprehend the technical knowledge and principles sufficiently well for each group to do its principal job better and for the joint product of the two professions to assist state legislatures and the Congress to establish sound highway and general transport policies.

The mutual dependence of engineers and economists on one another can be illustrated from the stimulating conceptual paper by Kafoglis. In treating the problem of establishing an economic user price structure, he assumes that "geometric design imposes only common cost," whereas "pavement thickness . . . imposes special cost." After making this division of design costs into those (geometric costs) for which all vehicles are responsible and those (weight costs) for which only the vehicles with heavier-than-basic vehicle axle loads are separately responsible, he then suggests that engineering studies of highway capacity have established the volume relationships relevant to the geometric design. However, he states that "volume or quantity relationships for pavement thickness are not as well established as those for geometric design." He notes that "the pavement thickness . . . may be affected by the number and frequency of repetitions of a particular axle load," but concludes that "pavement design does not consider this relationship in a manner such that a definite relationship between number of repetitions and pavement thickness can be determined."

Nevertheless, two rather significant inferences were drawn for marginal cost pricing. The first is that no geometric costs need be considered as special long-term marginal costs for the heavy and large vehicles. The second is that the weight costs that are separable for the heavy vehicles do not impose short-run marginal costs with use by such vehicles because "high-volume roads are designed for an infinite number of repetitions of a legally permissible maximum axle load."

The pricing implications of these cost behavior generalizations which Kafoglis has drawn from engineering fact are rather sweeping. If pavements on primary highways can stand "infinite" repetitions of the maximum axle load, then "the marginal cost of pavement is zero because the addition of one more vehicle does not increase the total cost of pavement." Such cost conditions would justify low highway service prices for heavy vehicles to encourage use and the risking of revenue "losses" equal to special pavement cost. However, recognizing that special pavement cost must be recovered if the highway pavement service is to be continued, lump sum charges such as graduated registration fees without a mileage or use component are suggested as appropriate pavement charges. On the other hand, Kafoglis states that should it be confirmed that "pavement cost is a continuous function of number of repetitions, an additional vehicle will impose additional pavement cost and a price based on use should be employed."

Obviously, with such widely and significantly different marginal cost increments resulting in the short run depending on whether pavements are designed for infinite repetitions or according to number of repetitions of special axle loads, it is of critical importance that this engineering question be solved as rapidly as possible. So long as such important functional relationships are not known or are practically unascertainable by economists, they cannot with confidence prescribe economic highway service prices even if the rule that such prices should be equated with marginal costs is adopted as the general economic guideline. However, even if it were confirmed that engineering design of pavements is uniformly on the basis of infinite repetitions of the maximum axle load, the question would still arise as to the short-run marginal costs of vehicles having axle loads above the designed maximum load. It is highly doubtful that they could be regarded as equally at a zero level. And the question of long-run marginal costs of pavements must be faced, since heavy axle-load traffic is increasing, highway construction (as acknowledged by Kafoglis) is a continuous process, vast sums will be invested in the future in supplying the strength essential for bearing heavy axle loads, legal or nonlegal, and the increments of investment cost for this purpose will apparently vary according to the magnitude of the axle load and the relative repetitions of the different nonbasic vehicle axle loads.

The assumption of Kafoglis that all geometric costs are common, since highway capacity is created on behalf of all vehicles, also appears to require additional engineering confirmation. Incremental cost studies in the past have assumed, on the basis of expert engineering opinion and design practices, that some lane and shoulder width, some curvature requirements, and some grade reductions or passing lanes on steep hills have been required because of the size and power characteristics of large vehicles. If these elements are not essential for the basic vehicles, then the long-term investment costs involved must be attributable to the larger vehicles and those without power to take hills at average light-vehicle speeds. Although it would be desirable to simplify calculation of the special investment and use costs for the large and heavy vehicles, this should not be done to the point that special-vehicle and basic-vehicle costs are lumped together for convenience.

In describing the problems of initiating studies of highway cost relationships with vehicle size such as those done at Ohio State, Baker concludes that the "theoretical" approach of utilizing only rational expressions relating cost with vehicle size "is not a practical possibility because of the many functions which have not been established on a rational base." He then assumes that any solution achieved during the next few years will require empirical techniques, and views current design techniques as the best source of differential cost relations. Even on this basis, it appears that detailed studies of cost, such as the Ohio State report, have thrown much technical light upon differential costs. Nevertheless, as it is not made operationally clear how important elements of highway cost vary with vehicle dimensions and highway use, more research was recommended.

The practical question can be raised: Will multiplying technical studies ever result in sufficiently clear and reliable differential cost relationships that highway improvement and pricing decisions can be taken by the policy makers with full reference to their economic significance under marginal cost pricing or some alternative scheme

of economic pricing? One practical answer to this question calls for interdisciplinary teams of engineers and economists to work together to increase mutual understanding and to determine the best approximations of cost functions that are possible. With all the highway research appropriations currently authorized, it would seem sensible to authorize experimentation along those lines.

A final general point concerns the economist's ideal that highway service prices should equate with marginal cost. In addition to the point already made that much cost and technical information about highways is not in such form as to permit ascertaining relevant marginal cost, it should be recognized that not all economists postulate the equation of price with marginal cost as ideal pricing for efficient resource allocation(2). Depending on the assumptions made with respect to cost behavior and the period of time relevant to the question at issue, either price equality with marginal cost or with average cost can satisfy ideal conditions. Even where the short run is the pertinent period for pricing and great excess capacity exists, as on many secondary roads, holding prices to marginal costs when below average or program costs, as suggested by Kafoglis, may be pointless if, as also was assumed, the demand is infinitely or highly inelastic. In this case, other than for administrative reasons, the highway user price might well be established at a figure considerably higher than marginal cost without depressing highway use. And considering the fact that traffic congestion is widespread and quickly develops even on new and improved facilities, at least at peak periods, short-run marginal cost pricing may be more feasible in temporarily limiting highway demand, bringing about reroutings over less congested highways, and possibly in lessening the ultimate investment through encouraging better use of existing facilities. However, in cases where tolls have been set too high, greater utilization of toll roads can be induced, as the Ohio experience apparently indicates, by lowering tolls, possibly to equality with short-run marginal cost.

In conclusion, the papers under discussion give food for much thought and discussion by both engineers and economists. Just as engineering facts concerning critical highway cost functions are hard to come by, the economic way of thinking in a function as complex as highways is difficult to perceive, except abstractly. Whatever is ultimately done concerning benefits to those other than direct users in testing highway investment and in determining prices, it seems that what the economists are saying is that all costs, including opportunity costs, must be counted. In addition, they are contending that highway costs must ultimately be expressed in terms relevant to economic reasoning if optimal highway investment and utilization are to be stimulated. Furthermore, it seems clear that more effort is desirable to cast highway benefits into demand schedules and to determine the effective demand for highway services to the extent practicable.

REFERENCES

1. Baker, R. F., Chieruzzi, R., and Bletzacker, R. W., "Highway Costs and Their Relationship to Vehicle Size." Eng. Exper. Sta., Bull. 168, p. 228, Ohio State University, (Mar. 1958).
2. Haldi, J., "Pricing Behavior: Economic Theory and Business Practice." Current Econ. Comment, 20:55-56 (Nov. 1958).

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● THE PAPERS contained here have presented highly stimulating and varied ideas which should contribute to improved highway investment and financing. However, there are three troublesome aspects of the application of the pricing theory to highway finance which need some comment.

First, one is forced to wonder what the results would be if the pricing theory were applied to the immediate highway financing issue before the Congress; namely, the

financing of the National System of Interstate and Defense Highways. Would it be proper to require the highway users to defray the entire cost of this system when five trans-continental routes, for example, were not justified by use of the pricing theory of economics and, in the writer's opinion, all five cannot be so justified?

Second, under the pricing theory the cost of a highway would include an interest charge, or a rate of return, on the investment. Highways in the United States are being financed predominantly on a pay-as-you-go basis, therefore highway users and other payers of special highway taxes in effect provide highway capital in advance of highway construction. Consequently, it would appear to be unfair to impose upon them the kind of interest imposed when borrowed funds are being used.

Third, in the meeting of the Committee on Highway Costs the statement was made that a political reality is the necessity of taking care of the problem of financing local and secondary roads before attempting to solve the problem of financing state highways. In view of this political reality, one wonders how the pricing theory can be applied to the local and secondary road problems.

The comment that several routes of the Interstate System cannot be justified by application of the economic pricing theory and Brownlee's reply to the effect that highway users should not be expected to pay for economically unjustified highways, may have created the impression that the writer is critical of the Interstate System. Actually his view is that the Interstate System is well designed to meet the realities of the current political structure and the requirements of national security. With regard to the latter, recognition was given the fact that the United States is faced with a serious military threat and needs a system to encourage decentralization of the major metropolitan cities, to distribute the population and industry more widely, and to provide alternate routes in the event enemy attacks should cause massive destruction.