EFFICIENT HIGHWAY FINANCE AND THE YUGOSLAV USER CHARGE STRUCTURE

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I. PRINCIPLES OF HIGHWAY FINANCE

I.1. Introduction

The argument has been made many times and on many grounds that load users need not pay for the full expenditure on roads — indeed efficiency requires otherwise. Reasoning in this respect has sometimes been applied to total expenditure for all users, and sometimes to the cost shares imputed to individual used classes or subclasses, where cost shares are taken to be proportional to vehicle-miles or ton-miles. (In this paper the word »proportional«, unless qualified, will always be used in this sense.) In what follows, I will attempt to develop the principles for efficient user charge policy by analyzing the traditional arguments for less-than-full cost pricing. These arguments can be classified under six headings: 1) income distribution, which would be directly frustrated by seeking full cost recovery; 2) national security; 3) declining average cost of highways, in which case a subsidy is required from the society as a whole; 4) the joint nature of the highway facillities, requiring disproportionately large contributions from automobile users; 5) the inability, (because of prohibitively high costs) of discriminating among users, creating externalities in land rents which can subsequently be tapped for road contributions; and 6) timing — keeping in mind that road investment is made to-day, but the road lasts a long time. Our analysis will show that the ton-mile share or vehicle-mile share approach for the road as a whole of for most components will indeed be inefficient, since ton- or vehicle--miles do not reflect either the road cost structure or the demand patterns of the used classes. The principles for the allocation of most of the expenditure components should be defined and allocation should be carried out according to discernible cost and demand relationships, which we shall call »true cost shares«.

Our approach to highway finance and used charge principles is suggested as an alternative to the traditional methods of welfare economics and fiscal management. Part II of the study applies the principles developed in Part I to analyze the used charge and financing structure of Yugoslavia.

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I.2. Income Distribution

Many income distribution goals can be handled through the road sector. The most obvious example in developed countries is the complementarity to school provision in rural areas, permitting the next generation an income advantage over what it would otherwise be given. In underdeveloped countries, or in low per capita income regions of advanced economies, income distribution aims are more direct. Here, road construction can enable the generation to grow an exportable surplus which could not itself cover the cost of a road over its lifetime. Or a government may wish to pursue such a policy of road building in preference to resettlement and retraining. In these two cases, the part of the road program in question should be isolated for separate support from the central budget. In North America, many writers handle school support income distribution by deducting some percentage, e.g. 0 percent, from the cost of the secondary or rural road system. The second case can be allowed for simply by leaving those expenditures which are known to relate to poor areas out of the road account to be charged to road users in general.

I.3. National Security

A road network permits more rapid military mobilization, and indeed, some networks, such as the prewar German autobahn network, were built with little else in view. Therefore, it is argued, road construction costs should be recovered at least in part from society at large since the entire population benefits from them. But there is another alternative urged frequently by students of public finance,[1]) to price all users, including the military, according to the same standard principles. In this way, the public can know better what it is spending for security and reach more intelligent budget decisions through the polls.

I.4. Declining Cost on Uncongested Roads

The justification of declining cost on uncongested roads is undoubtedly the one most often invoked by economists for general public sector support of the roads. According to one recent statement of the problem[2]) marginal cost is taken to be the same as incremental maintenance cost, with the annual »fixed« maintenance cost (see be-

[1]) See e.g. O. H. Brownlee and W. H. Heller, »Highway Development and Financing,« *American Economic Review*, May 1956, p. 236.

[2]) Alan Walters, *The Economics of Road Charges*, John Hopkins University Press — IBRD, 1968.

low), as well as the construction cost, coming out of general budget. However, I doubt that the answer can be so straightforward even within the framework of a single road. In reality, two cases must be distinguished: a) a road already built, where sunk costs need not be recovered, and b) a new road where the incremental or marginal cost for the society is the cost of building the road, in which case the price for the users in the area should reflect this cost. Since a single road, by definition, stands alone i.e. it is not part of a network, full or nearly full cost recovery in case (b) is possible through a two-part tariff structure for the users, who can be isolated (they are isolated!), and no inefficiency need result.

However, the single road declining cost model fails to take account of the external costs which occur when increasingly sophisticated highway engineering design denies the opportunities for budget allocations to altogether different sectors of the economy.[3]) Therefore, the single road framework cannot be readily generalized to include a growing network and dynamic and heterogeneous traffic patterns.

What is marginal cost in the network framework? The cost of an additional ton-mile per year? The cost of allowing larger trucks to use the present network (which may or may not involve higher ton-mileage)? The cost of improving the network to allow larger trucks to use the network? The cost of building a new link on arc AC in a network? The cost of allowing an extra automobile to travel on the existing network? Etc.? Output has no simple definition.[4]) Gonsequently the marginal cost of output is an extremely ambiguous concept though the invocation of marginal cost-price equalization gives the spurious impression that agreement on what *should* be done can easily be reached, once we are given the accounts of any particular (highway authority[5])

Although the marginal cost-pricing rule cannot be applied to a network (since marginal cost is an indefinable category in the highway network context) we can realize the spirit of marginal cost-price equalization. The marginal cost-price dictum is based on the notion that output should be increased as long as the extra cost imposed on so-

[3]) See my »Theory of Multi-Product Output and Pricing Under Joint Costs and Variable Technology«, *Journal of Political Economy*, July/August 1970, for an attempt to incorporate this aspect of highway cost.

[4]) Of course, there are many marginal costs in the single road fremework, as well. But, as suggested, this problem can be resolved by a discriminating monopolist using a two--part tariff with variation of each part according to different use dimensions.

[5]) Indeed, even following the same approach and using essentially the same accounting information, it is possible to reach very different recommendations on the level of marginal cost and the actual price to charge. Walters for example, estimates the annual fixed maintenance cost as the intercept in a linear regression in which expenditure is taken as a function of average daily traffic (ADT). op. cit.; pp. 194—199.) If, instead, we went behind annual data to the original field accounts, we see that maintenance on any road is actually perfomed in one or a few months (if it were performed continuously throughout the year one colud hardly speak of a fixed annual component). Suppose, for simplicity, that maintenance on any road in the network is all performed in a single month. On each road, there will then be one positive expenditure observation and 11 zero expenditure observations (with traffic fluctuating seasonally and stochastically about the annual ADT for that road). A regression line fitted to these observations would then have a slope which would almost surely not differ significantly from zero, a very low correlation coefficient, and a fixed monthly maintenance expenditure (Y intercept) somewhat greater than one-twelfth of that in the first regression. In this case, we would have to conclude that the marginal cost of the highway network was zero. Obviously, however, this fluke arises simply through reorganization of the data and can say nothing about the underlying technological or economic relationships.

ciety is less than the utility which some member of society (and, therefore, society) receives from consumption of one more unit. In the next section we will argue that each incremental component of a highway technology, such as the reduction in maximum grade from eight percent to five percent, should be paid for by all the user groups according to their demand for that component and not just by the vehicle classes whose expected use of the network has prompted the move to the more stringent standards. Correspondingly, maximum grade should be reduced as long as the benefit arising in grade reduction exceeds the cost of reduction. If a budget constraint is imposed, the highway authority can discriminate among users to recover either all of this cost, or, if perfect discrimination is not possible, a good deal more than would be possible through proportional pricing. If complete recovery is not possible, it will be argued in Section I.6, the shortfall should be borne by local sources.

I.5. The Joint Nature of the Network Components

Many writers and interest groups have argued that the road network is a joint product which should be priced according to the demand elasticities of various user classes. This is an argument for more- or less-than-proportional cost imputation to individual user classes and need not imply advocacy of less-than-full cost pricing for the facility or network as a whole. The argument is valid as it applies to those portions of the project which are fixed, such as land acquisition, basic grading, etc. and can even apply to some portions of the investment which are nominally undertaken for certain classes of traffic only. For example, low maximum grades may be imposed by engineering rules in recognition of the heavy traffic expected. But the cars do, in fact, also benefit from all components of the project and a greater social benefit can usually be achieved by discriminatory pricing.

The definition of the components of the project which should be subject to discriminatory pricing varies. In the mountains of Slovenia, a one-meter sub-base may be required to offset the effects of ground freezing and discriminatory pricing may be efficient for this base, while elsewhere the sub-base relates primarily to the expected load. Evidently no absolute classification of components can be given. A guideline is *that any part of the road should be considered a joint component for those user groups whose demand for those components is positive.*[6])

[6]) This approach does not even rule out the possibility that automobiles may, quite rationally, appear to be paying for part of the incremental specifications of the payement and sub-base required to support heavy trucks. Suppose that heavy trucks represent a net addition to traffic, rather than a consolidation of smaller loads, and that they would not have appeared without the higher specifications. Assume that there are two road designs called »sophisticated« and »elementary«, and that the latter represents an indivisible minimum road required by the car and small truck traffic. The sophisticated technology represents increments to the design. In this case the heavy-truck demand for the fixed components of the elementary road will be zero, but the demand for the same components when the road design is increased to the sophisticated version, will be positive. Presumably, the small trafic would be wiling to pay some part of the incremental design in order to shift the big truck demand

The pricing of the part of the project which is variable — the pavement depth and design, for example, — must be done according to the cost imposed.[7]) Here the basic relationship, analyzed under controlled conditions most exhaustively by the AASHO road test, shows increasingly severe damage per ton-mile with increasing weight;[8]) the burden imposed, as measured by the number of repetitions needed to achieve a given unserviceability level in most situations, rises up to twenty times when doubling the axle load from 5 to 10 tons. (The precise relationship depends on type of pavement and number of axles.) The relationship is, of course, difficult to determine by observations of actual everyday situations owing to the great variability of climate, traffic mix, and road type.

I.6. Inability to Discriminate

Inability to discriminate among users is another frequent justification for less-than-full cost pricing. Thus, even if the relationship between vehicle damage and weight can be determined, it is in practice very costly to try to charge each vehicle precisely on the basis of this relationship. Constant supervision would be necessary, assisted by scales, toll booths, and limited access roads, all of which impose costs in terms of personnel, capital and driver and vehicle delay. It would be difficult even to charge each vehicle on the basis of its average load (to allow for partial returns), since this would require that a use charge be keyed to each specific vehicle, or, if a grosser tax is accepted, to each vehicle class. (Some price-cost deviations begin to intrude at this point, already, although they would be too costly to administer). On the other hand, an annual tax by itself would have the effect of encouraging heavier utilization and cause distortions. Ultimately, therefore, one accepts the notion of fuel tax coupled with annual fee as tax structure which does not impose too high collection costs, and which could follow the basic cost patterns of vehicle use,

curve for the elementary road fixed components. For example, if small vehicles contributed $1,000,000 to the incremental specifications, the big truck traffic demand for the elementary fixed road components would shift and the big trucks might now be willing to contribute $1,500,000 for the elementary road fixed components. But a moment's reflection will show that this is all consistent with what has been said about discrimination based on elasticities, rather than use shares. The problem of empirical determination of the demand functions remains. In practice, however, the heavy truck demand most probably will represent a consolidation of smaller loads, except in countries where cars and very small trucks comprise the total traffic, due to strict administative controls on trucking. In such countries, relaxation of these controls would probably see immediate shifts of transportation from rail to road of large volumes of goods which are suitable for large trucks. In the general case, therefore, there would be positive demand for all the fixed components of the elementary road by the potential large truck traffic. Moreover roads are not so neatly classified into elementary and sophisticated; rather than the single basic indivisible road hypothesized here, there would be a wide range of designs varying with traffic density and vehicle size, even for smaller vehicles.

7) An exception which may or may not be consequential, depending on the traffic mix, arises in the fact that construction of deeper pavements and encouraging larger vehicles, will permit consolidation of some traffic, reducing the number of vehicles, and, probably, speeding traffic flows. To the extent that this is, important, it should be discriminatorily priced.

8) *AASHO Road Test, Proceedings*, 1962, pp. 415—425. The AASHO test is undoubtedly the most extensive controlled experiment to determine the relation between pavement deterioration and road traffic. Different rigid and flexible pavement desingns were subjected to repetitions of different vehicle size and design to derive road performance curves, relating traffic to terminal serviceability.

the fuel tax proportional to the mileage of any given vehicle class, and the license fee proportional to size. Moreover since, vehicle size and annual mileage tend to increase together, this combination of taxes could yield a rising user charge revenue per ton-mile. However, in imposing such a combination of taxes, it may occur that individual units of some kinds of traffic will be unable to pay the price demanded by the average relationships for that traffic. For example, if a high annual fee for large trucks is based on an assumed 100,000 kilometer annual run, it could not be paid by a truck driving 50,000 milometers a year. The high rate would force some of the traffic out and reduce the benefit substantially. A way out could be a unit charge lower than the average true truck related cost for the class in question; for other truck classes, e.g. small trucks carrying valuable cargoes which benefit through reduced congestion on higher grade roads, the price may be higher, i.e., it may be efficient to allocate some of the true truck related cost share discriminatorily among the truck classes. For some large truck users — especially in minerals and building materials — the user charge will be almost equal to the benefit originating in the traffic, while for others — some farmers, manufacturers, and marketing organizations — external benefits will develop, i.e. they would be willing to pay more than the price charged directly for their use of the road and in the absence of higher prices, their incomes are higher. Part of this externality could be tapped to close the revenue gap through voluntary or compulsory contributions which can be imposed by the abutting communities in which the external beneficiaries live. This argues, then, for local rather than centralized supplementary contributions.

I.7. Timing

A sixth justification offered in support of less-than-full cost user charges is the question of timing. The facility will last for many years. Why should it be paid for in a single year?

Evidently, this argument applies to the question of annual expenditure not cost. A proponent of this view could agree that users should pay their true cost shares (where cost is the investment expenditure transferred into an annual amortization stream plus annual maintenance, evaluated in terms of the variable and joint component principles presented here, rather than in terms of their share in the investment expenditure as it occurs). This could be acceptable if a way could be devised to generate the revenues in later years. Apart from toll roads, I know of no case where such a financing policy has been implemented, and popular attitudes regarding road investments are so »sunk-cost« oriented that it is very difficult to imagine that the sector would ever organize itself to repay such loans.

There is, on the other hand, one persuasive argument that justifies the current investment expenditure as a target revenue to be recovered from users. Consider the following:

When the investment is used to expand the existing network through the construction of parallel roads on congested links, realignment or grade amelioration, or additions of lanes, users on the entire network benefit. Users of the network not using the new road itself will also benefit since some of the traffic will divert to the new or improved link (or, at least, traffic will not increase as fast on the unmodified links). The benefit can be assumed to decrease with distance from the expanded segment.

Owing to transaction costs, the pricing mechanism is, as we have seen, necessarily somewhat gross, and it is impossible to price precisely according to the demands on the various segments of the network (although some approximation to it is possible through regional differentiation of fuel and registration tax rates). All users on the network will therefore contribute towards the construction of the new facility. This should create no problem since in some future year, even if not immediately, the user of today's old road will have a new road that he can use, paid for in part by the tax contributions of the trucker who is the immediate beneficiary of the road being built today. In other words, as the road program develops, we can imagine »loans« within the highway sector, from users in one area to those in another, both in a fairly homogenous region. This, of course, is a very different situation from a penetration road policy where roads are built by fuel tax transfers from local areas to regions far removed, or a policy of general budget support of penetration roads, such as the situation in Brazil of several years ago where at the federation level a very large road program with a large mileage of penetration or »development« roads was in operation. It is also very different from the US interstate highway system where a large part of the financing of high grade roads originates in a non-related use — fuel consumed in cities.[9])

The pricing approach just described does not guarantee coverage of current expenditure — the »intra-network loans«. which are related to the demand of user groups for roads should cover cost shares over time (if they do not, the road should not have been built) but not necessarily the expenditure in each year. Whether they do or not depends on the size of the annual program in relation to the network and to demand factors. If the expenditure is small, it will probably be covered; if it is large, it may not be. In Yugoslavia, this network modification is relatively small: the present road network is around 25,000 paved kilometers. The investment program (modernization, reconstruction and new construction) will be around 2,000 kilometers a year, of which probably no more than 300 kilometers will be completely new construction (and much or most of that parallel to existing roads, i.e. there will be little in the way of penetration roads). If in individual regions, the network grows much faster the existence of administrative subdivisions allows for some user charge variation.

[9]) In an attempt to incorporate other non-related tax revenues, the US highway lobby in 1971 tried to get Congress to earmark a portion of the alcoholic beverage tax. The Senate approved the Bill, which was later killed in joint House-Senate Conference. (»Light in the Tunnel«, *N. Y. Times* 12/20/71, p. 31.

The subsidy could, in principle, come from anywhere. However, this presupposes a level of skill in project evaluation far beyond the scope of present techniques. In spite of recent advances in project appraisal, many problems remain in the comparison, for example in the comparison of an irrigation system project in Macedonia, an aluminum plant in Serbia, or a road in Slovenia. One of the problems is the irreconciliability of the benefit measures employed — e.g. a consumer surplus measure in a road investment versus national income generation in an export industry. To put the latter on equivalent basis would require that a labor supply or disutility function for the new employment be introduced into the calculation. Moreover, even comparison between two roads may rely on different criteria since penetration roads are usually evaluated in terms of national income generation.

Finally, discrepancies arise in the comparison of consumer surplus measures between full-employment and unemployment regions. While this problem is generally acknowledged, lack of consensus on how to deal with it in practice raises serious doubts about the ability of a central planning board to allocate investment interregionally. Moreover intersectoral comparisons are frail. Consequently local jurisdictions are in the best situation to assess their investment needs since they can draw upon non-market ballot box information from the local constituency, whereas the central planning board cannot get hold of this information without considerable accompanying noise.

I.8. Summary of Principles

Before evaluating the Yugoslav user charge structure, it will be useful to summarize the principles which have been elaborated.

1. Support for roads from outside the road sector may be based on income distribution considerations. In this case no attempt is made to recover the expenditure from users or beneficiaries. Ideally, transfers should be made from the general national budget to the poor region in question for subsequent efficiency-evaluated allocation within the poor region. These transfers should not emanate from a national earmarked road fund, and the projects for which they are meant should be isolated from the road program itself (hereafter called simply the road program).

2. A joint component of a project is a component for which several classes have a positive demand. This is a general classificatory criterion which will have very different implications in actual application as we showed by the following examples:

i) It is most probable that the incremental design specifications associated with heavy vehicle classes, e.g. low maximum grades, will have joint demand, since the lighter vehicles will also benefit through their execution;

ii) It is possible for a component to be joint in some geophysical situations while size-variable in others (e.g. the sub-base);

iii) It is even conceivable that the basic road, which is usually a joint component for all the traffic classes, can be a non-joint component demanded exclusively by cars if the heavy truck traffic which requires incremental design specifications represents new shipments (e.g. transfers from railroads) rather than consolidation of existing shipments.

3. User classes should contribute to the road according to both their demand elasticities for the joint components and the specific costs which they impose.

4. Although automobile demand might be inelastic enough to pay for the entire road expenditure, it should not be asked to do so because many parts of the road are truck-variable, i.e. they deteriorate differentially under use by different vehicle sizes or, conceivably, are demanded exclusively by trucks.

5. What has been said of costs can be applied to the annual expenditure for the road program (i.e. that part of total road activity which is viewed as improvement of the network in built-up areas). This probably relates to most of the road activity.

6. Outside support of the road program may be justified when discrimination is inefficient, i.e. when to discriminate would imply a foregone benefit of unrealized traffic. Outside support is likely to be more efficient when provided by local communities rather than by centralized sectoral or regional transfers, owing to the imperfections of project evaluation techniques.

II. EVALUATION OF THE YUGOSLAV STRUCTURE

Between the foregoing statement of principles and the final evaluation, however, there are many decisions in the determination of demand, the definition of size-variable components, the estimation of present user contributions, and so on have to be made. In assessing the results of this investigation, any reader will be able to find something to object to — some number or the treatment of some relevant factor. To try to help the reader appreciate the special conditions at play in Yugoslavia, I have tried to explain carefully the treatment of factors relevant for important decision making (e.g. the treatment of sales taxes. Quite different treaments of the variable may be justified in other countries, and some possibilities are indicated in the course of exposition. For example, in other countries different weights will surely be assigned the different traffic classes, which, of course, does no violence to the essential principle that the true joint components must be priced according to demand. This point has been stressed repeatedly and is offered now as an added caution lest the reader attempt indiscriminate translation of the numerical estimates derived here to some other country. Nor have the weaknesses of the data base escaped the author's notice. But in spite of their shortcomings, the available Yugoslav data are in many ways more complete and suitable for the purposes of this analysis than is the information which is available in many other countries, probably, in most developing countries at any rate. Therefore, it will be more fruitful to use Yugoslavia as a case study when illustrating the implementation of the principles of Part I for the evaluation of user charge structure, and when pointing out some of the kinds of compromises which inevitably must be made in evaluating user charges according to the given (or, indeed, any) standards. Such compromises necessarily reduce the efficiency of the final estimates of the warranted user charges. But to abandon the attempt to make estimates simply because they are somewhat imperfect and to settle instead for the far less perfect pricing systems which in effect in most countries today could scarcely be the next best alternative.[10]) (In most countries, the analysis of the pricing systems is essentially, if at all, done in terms of total revenue from all user sources vs. total expenditure and this revenue undoubtedly contains a large urban subsidy to interurban users).

II.1 Size-Variable Costs

Following the generally accepted notions of economic efficiency, the sunk cost of constructing the existing highway network will not be considered as a current cost. That part of the investment which is subject to wear and which must be replaced (chiefly the pavement and sub-base) is a current cost and must be assigned to the traffic classes which impose the deterioration. The AASHO road test coefficients are undoubtedly the best measure of the deterioration imposed on different pavement designs by traffic components and will be applied to the allocation of size variable costs in this chapter. In the following discussion, truck designations will refer to the payload. Three truck sizes will be used in the analysis: small (4-ton load); medium (10-ton load); and large (20-ton load). The loads are converted to gross vehicle weights, — the basis of the AASHO equivalence coefficients — by applying U.S. Department of Transport vehicle specifications as given in its publication *Road User and Property Taxes, 1970.* Metric-ton adjustments are made where appropriate.

The AASHO coefficients are calculated 1) for twelve flexible and rigid pavement designs; 2) with respect to four different levels of deterioration and unserviceability; and 3) for 40 different vehicle weights and axle designs. Accordingly, their accurate application requires,

[10]) The International Road Federation in its annual yearbook, for example, compares total road sector revenue to total expenditure to show that the road sector is self-paying, and, by implication, efficient. Total revenue is defined to include all sales taxes and automobile fuel tax revenues, etc. Thus, the possibility that many vehicle class and urban-interurban distortions may exist is overlooked. Moreover, total expenditure recovery from users in any individual year is itself a questionable criterion. See IRF, *World Road Statistics*, 1966—1970, Geneva and Washington, 1971, pp. 152—171. The recent debate on highway economics in Canada has started from the notion that revenue-expenditure is a good approach, with the earliest papers focussing primarily on the handling of various revenue sources and expenditure items. (See M. Q. Dalvi, *op. cit.*, and D. W. Conklin, J. E. Tanner, and L. S. Zudak, *op. cit*. Finally, in Brazil, contributions originate primarily in automobile use, which is predominantly city- rather than intercity-oriented. (For discussion see Alan Abouchar, »Brazilian Highway Expenditures and the Construction Maintenance Mix«. Fourth Higway Symposium of the Brazilian Institute of Road Research, Rio de Janeiro, 1968.)

first, knowledge of the distribution of pavement designs in the network, and, if there are serious differences in the pavement distribution on sub-networks, analysis of the latter. Unfortunately, no systematic and sufficiently detailed inventory of the links in the network exists. However, the relative deterioration by large and small trucks is of the same order of magnitude for a wide range of pavement designs and the precision that could be derived from this additional detail is not consequential. Table 1 shows the deterioration coefficients which express the equivalence of each vehicle class to a vehicle bearing a nine-ton (single) axle load for different pavement designs. In our calculation we will assume the road stock to be distributed equally between rigid and flexible pavements, and use simple averages of the AASH coefficients. This will make little difference in the final estimates: for example, use of the rigid pavement coefficients would raise the warranted user charge of the 20-ton capacity trucks by only 10 percent, whereas the effect on smaller vehicles would be negligible.

The coefficients are calculated for two levels of unserviceability, as measured by expert evaluations. Again, the order of magnitude of the differences in the coefficients to reach any unserviceability level is fairly stable, so that the choice of one rather than another will not affect the relationship between the warranted user charge estimates for different vehicle classes. We will base our calculations on an unserviceability level of 2.0, which is the lower of the two measured ones, reflecting in part the need to stretch out the life of capital in poor countries.

There are also differences in the damage inflicted by single and double-axle vehicles, and some attempt should be made to weight each vehicle class by the axle distribution of the class. As Table 1 shows, the tandem axles inflict less damage than single axles. But information is not available to weight each class by its axle distribution. We will assume single-axle loads for small and medium vehicles, and tandem axle ones for the large trucks. This reflects the administrative axle-load limitations and the apparently good supervision of these regulations in Yugoslavia.

It is also necessary to estimate the stock of the various vehicle classes and their annual runs, and, finally, the total annual deterioration. To estimate stock we proceed from the official transportation and communications yearbook *(Saobraćaj i veze)*. In 1970 there were about 850,000 vehicles registered in Yugoslavia including: 720,000 cars, 120,000 trucks (including truck tractors) and 15,000 buses. The average run for trucks is 50,000 kilometers, and for buses 70,000. The average run for large trucks will be assumed to be 75,000 kilometers, for medium trucks 65,000 kilometers, for small trucks 40,000 kilometers, and for cars 15,000 kilometers. A further calculation will be based on an annual run of 115,000 kilometers for large trucks. (The interurban shares of these mileages, as well as the detailed distribution of trucks will have to be calculated). We will assume that the medium 10-ton capacity trucks number 40,000 and the 20-ton capacity trucks number 30,000 (the statistics lists 30,500 truck tractors). This involves some simplifications, but in the absence of more complete census and sample data, no other alternative exists.

There is, of course, no physical indicator of annual deterioration, and we will base our deterioration estimate on the annual financial accounts. Yugoslav road expenditure data is classified by maintenance, reconstruction and modernization, and new construction. Reconstruction is supposed to refer to improvements to existing roads, including base works, while modernization is supposed to refer to simple repaving. There is undoubtedly some overlap here, but it is unimportant because both of these activities are vehicle-size variable in the sense used here, i.e. they represent efforts to rebuild a deteriorated pavement. More important is the overlap between modernization/reconstruction and maintenance, on the one hand, and new construction on the other. It is very likely that new construction contains some blacktopping or upgrading of gravel roads, both of which are vehicle-size related. We will assume that half of maintenance and one-third of new construction are really vehicle-size related.

Table 2 shows total average annual expenditure by category for 1969—70. It is assumed that all reconstruction and modernization, one half of maintenance, and one-third of new construction are size variable in the sense used here. Unfortunately, however, we must work with 1971. user charge data, so it is necessary, to estimate 1971 expenditures, which have not yet been reported by the federal government. To do this we project the 1970 expenditure forward by 25 percent, a rate which is consistent with informal estimates in Yugoslavia.

To determine the size-variable cost per unit, we must first convert total traffic into equivalent traffic units (ETU) by applying the AASHO coefficients to the estimated traffic. The ETU calculations are shown in Table 3. Backhauls are assumed to be half-loads, and other procedures are explained in notes to the table. The total ETU of 5,687 million units is then divided into the total size-variable cost of D 2.3 billion from Table 2. This gives a variable cost of 40.4 paras per ETU.[11]) For each class this is then multiplied by the average of the loaded and backhaul coefficients, divided by the total gross vehicle tonnage, and then adjusted to a metric ton basis. For example, for the 20-ton capacity truck we get: 40.4 (1.92 + .42) .5 = 47.3 paras per vehicle kilometer. This gives 47.3/(36 + 25) .5 = 1.55 paras per ton kilometer, or 1.7 paras per metric ton-kilometer.

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[11]) 100 paras = one dinar.

II.2. Demand-Related Charge

The balance of maintenance and new construction should be priced according to demand. For new alignments, the differential price that a truck should be willing to pay is equal to the cost reduction from the new road. This can be approximated by saving in driver time. We will assume that route rectification combined with faster hourly speeds doubles the hourly mileage calculated in terms of the old route (i.e. if on the old route the 400 kilometers between points A and B could be travelled in the hours, on the new route they could be done in five hours). The 1970 average truck driver wage was about D 1,250[12]), or D 8.4 per hour. Dividing this by the 40-kilometer per hour effective distance saving gives an average saving of 21.0 paras per vehicle-kilometer. To get the saving per gross ton-kilometer the saving per kilometer is then divided by the average gross vehicle tonnage (as shown in Table 4). Since there are usually two drivers on long-distance shipments, the gross ton-kilometer saving for 20-ton capacity trucks must be doubled.

The estimated saving will be realized only by those using the new roads. If we assume that this amounts to 20 percent of traffic in any given year, to obtain the average saving per vehicle the saving must be divided by 5. We will disregard the savings accruing to vehicles on other routes as inconsequential. Also neglected is the saving through reduced fuel consumption and vehicle maintenance. The final demand-related components for the four truck classes are shown in Table 5.

Although in deriving the demand-related charges many assumptions had to be made, they will not affect our final conclusions significantly. The above charge are small in relation to the variable cost component for the medium and large vehicles, whereas for the small vehicles the estimated present user contributions are already large enough to allow for large errors in calculation (as Table V—5 shows).

II.3. Estimation of User Contributions and Comparison with Warranted User Charges

Estimation of user contributions is shown in Table 4. The Yugoslav data on license fees are given in terms of truck capacity. In order to calculate contributions per gross ton, gross vehicle weights had to be derived. This was done, as before, by applying U.S. Department of Transport specifications quoted in its publication.

[12]) The average income for all truck drivers in 1969 was D 1173. Data for 1970 were not yet available. The 1970 truck driver wage is assumed to grow at the same rate as overall wages in the economic sector (six percent). See Statistički Godišnjak, 1971, pp. 268, 270.

The most controversial point in the user contribution calculations is the treatment of the turnover tax *(porez na promet)*. Many Yugoslav observers (including roadbuilding agencies, road user groups, and manufacturers) believe that the part of all turnover taxes which is in excess of a »basic« rate should be counted as user contribution. But this conflicts with the essence of the turnover tax, as indeed, does actual tax practice. In the past turnover tax has been levied almost wholly on final goods at rates which are progressive with respect to the presumed income level of the respective consumer classes, e.g. it is zero on food and books, has a basic rate of 18 percent on some consumer goods, rising to around 35—40 percent on luxuries. Where final goods serve as intermediate goods also the tax is, in principle, rebated. One taxation expert from the Secretariat for Finance has expressed the belief that the rebate mechanism works effectively. In view of these caracteristics of the turnover tax, it is appropriate to regard the whole of the turnover tax paid by trucks as road user charges and all that paid by cars (about 35 percent of retail price) as an excise. In addition, of course, we consider the narrowly defined road fuel. tax *(naknada za puteve)* as part of the user contribution. Fuel consumption rates required to estimate the user contributions per kilometer are taken from the U.S. Department of Transport as indicated in Table 4.

Table 5 brings together the warranted user charges and user contributions. Column 5 shows the user contribution relative to the warranted charge, calculated in Column 3. The very large trucks fall short in their user contributions, as do the 10-ton capacity diesel trucks, although neither class by very much. The apparent paradox of a lower variable cost for the 10-ton truck occurs because the larger truck has a tandem axle, which on the road is relatively less burdensome per ton of gross weight than the single axle 10-ton truck.

The disprepancies which have been uncovered are less serious than might have been expected, and it is possible that they can be explained by the roughness of the data and our need for simplifying assumptions along the way. The calculations show that all vehicle classes are paying more than their directly-variable cost, as defined in this paper, plus a demand-related contribution towards the joint component costs. The answer to whether the excess paid is sufficient to cover the analogous costs for cities, including congestion or other externalities, cannot be given without additional study. The data for such a study (in the necessary detail) are, of course, lacking. It can be seen, however, that the excess of actual over warranted charge does decline with rising vehicle size. This is probably consistent with the costs that they impose in urban networks since a higher fraction of city use probably consists of small vehicle traffic.

II.4. Supplementary Beneficiary Contributions

The foregoing price-cost comparisons relate to the directly-variable costs and to a demand component of the true joint costs. The demand component reflects the estimated average minimum savings for each vehicle class in the entire system — on the improved arcs (with new additions or rectifications) and on the rest of the network as well. This will not necessarily cover total expenditure in any single year and may lead to a requirement for non-user supplementary financing, which, we have recommended, should originate in the local communities. The analysis of the overall financial account of the road network shows that in 1969 the communities contributed around 15 percent of the total. As a result, around 3/4ths of total revenues originated in sources which we define as direct beneficiary groups — users and abutting communities.[13]) Federal participation (including army activity, grants from the Fund for Development of Backward Regions, and other unidentified federal grants) was about 12 percent. Republic participation (around 10 percent) is a grey area between beneficiary and non-beneficiary participation. It is not included in the estimated 3/4ths direct beneficiary share, although part of it undoubtedly should be. Whether the non-beneficiary contributions were consistent with income distribution goals, or simply constituted an attempt to close the gap between desired investment plans and the capacity of the road sector to generate user charge revenues cannot be determined.

To conclude, then, a set of road pricing and financing principles can be devised by analyzing the joint components and the directly variable costs. Flexibility in interpreting the nature of the components is essential — it is impossible to state categorically that any particular physical part of roads falls under one rubric or other. It depends, rather, on the geophysical, engineering and economic characteristics of the road as well as on demand. This is believed to be more meaningful than the global financial approach for analysis of potential price distortions which can arise in the highway sector of any economy.

(Rad primljen aprila 1974.)

[13]) In this estimate the turnover tax is treated as described in II. 3 for the purposes of calculating present user contributions, i. e. the turnover tax on automotive fuel is treated as an excise or general revenue tax, while that on estimated truck gasoline and diesel fuel consumption is treated as a user contribution.

ANNEX

Table 1

EQUIVALENCE FACTORS FOR TEN VEHICLE DESIGNS AND FOUR PAVEMENT DESIGNS

(Entries give number of repetitions of 18,000—1b. single axle load which damage the road the same amount as given vehicle)

Thickness of Surface Weight of Vehicle tons	Single Axle				Tandem Axle			
	Rigid Pavement		Flexible Pavement		Rigid Pavement		Flexible Pavement	
	6″	11″	Light Duty	Heavy Duty	6″	11″	Light Duty	Heavy Duty
2	0.0002	0.0002	0.0002	0.0002	—	—	—	—
10	0.09	0.08	0.08	0.08	0.01	.01	0.01	0.01
18	1.0	1.0	1.0	1.0	0.14	0.13	0.07	0.07
26	4.76	5.02	5.36	4.96	0.63	0.62	0.32	0.33
40	32.18	32.57	39.57	31.25	8.36	8.79	5.10	4.83

Source: *The AASHO Road Test*, pp. 422—3. Light and heavy duty flexible pavements refer to the lightest and heaviest pavement and base combinations. The coefficients in the table relate to lowest unserviceability level (2.0).

Table 2

ESTIMATION OF EXPENDITURE CATEGORIES AND SIZE-VARIABLE SHARES, 1971

	Average Annual Expenditure 1969 — 70		1971		Percent of Estimated Expenditure in this Category
	D. Billion	% of Total	Estimated Expenditure D. Billion	Size Variable Cost Share D. Billion	
Reconstruction & Modernization	1.3	54	1.690	1.690	100
New Construction	.5	21	.660	.220	33
Maintenance	.6	25	.780	.390	50
Total	2.4	100	3.130	2.300	—

Total 1971 expenditure assumes 25 percent annual growth over 1970. (1970 assumed to be D 2.500 billion). Annual 5-year plan calls for average 1971—75 expenditure of D 5.2 billion.

Table 3

CALCULATION OF EQUIVALENT TRAFFIC UNITS FOR FIVE TRAFFIC CLASSES, 1970

Description of Vehicle	(a) Load	(1) Stock (000)	(2) Vehicle Avg. Wt. (tons)	(3) Avg. Annl. Run (000)	(4) T-K's (bills) 1×2×3	(5) Percent of total T-K	(6) Weight per axle (000)	(7) Average AASHO Equiv. Coeff. (b)	ETU Veh. kilo. (millions) (1)×(3)×(7)	Percent of total.
1. Cars	3 pass.	720	2.2	15	23.4	14.2	2.2	.0002	2	negl.
2. Trucks										
(Small (4-ton cap)	full	50	7.5	20	7.5	4.5	7.5	.035	35	.6
(RUP No. 5	half	50	5.5	20	5.5	3.3	5.5	.01	10	.2
3. (Medium (10 ton cap)	ful	40	20.0	32.5	26.0	15.8	20.0	1.57	2041	35.9
(RUP No. 8)	half	40	14.0	32.5	18.2	11.0	14.0	.34	442	7.8
4. (Large (20-ton cap)	full	30	36.0	37.5	40.5	24.5	36.0	1.92	2160	38.0
(Tandem Axle RUP No. 12)	half	30	25.0	37.5	28.1	17.0	25.0	.42	472	8.3
5. Buses	40 pass.	15	15.0	70.0	15.8	9.6	15.0	.5	525	9.2
Total					165.0	100.0			5687	100

Note:

a) Truck capacity-loaded weight relations based on data presented by U.S. DOT in *Road User and Property Taxes*, 1970. RUP designations refer to specifications on pages 10—11.

b) Weights for which coefficients are calculated relate to heaviest axle burden (middle axle), assumed to be 50 percent of total. Part of the cab and tractor weight is on the front tractor axle, although this is probably no more than 10 percent of total gross weight on medium and heavy vehicles. 2.2 tons is undoubtedly high as an estimate of average Yugoslav automobile weight. It is used because two tons is the minimum weight for which AASHO coefficients are calculated, Since the coefficients are virtually negligible even for this size the final estimates are not affected.

Table 4

CALCULATION OF USER CONTRIBUTIONS, 1971

(all weights metric tons)

Vehicle Class[a]	(1) Average[b] Vehicle Weight (metric tons)	(2) Annual Mileage (000 kls.)	(3) Registration fee (Dinars)	(4) Fuel[c] Consump. (liters)	(5) User Cost[d] Per Lit. Dinar	(6) Total Fuel Cost. (5)×(4)	(7) Total User Cont. (6)+(3)	(8) Total Tons-kils (000) (1)×(2)	(9) Total User Cont. per t-k (paras) (7)÷(6)
Car (Medium)	2	15	170	2,160	.55	1,190	1,360	30	4.5
Trucks									
Small (4-ton cap)	5.9	40	1725	10,620	1.2	12,740	14,465	236	6.1
Medium (10-ton cap):									
Gas	15.4	65	6000	29,250	1.2	35,100	41,100	1001	4.1
Diesel	15.4	65	6000	22,500	.64	14,490	20,490	1001	2.0
Large (20-ton cap.) Diesel				33,750	.64	21,735	35,235	2,078	1.7
Moderate use	27.7	75	13,500						
Heavy use	27.7	110	13,500	49,500	.64	31,880	45,380	3,047	1.5
Buses (40-passengers) diesel	13.6	70	2,000	25,200	.64	16,130	18,130	952	1.9

a) See note (a) Table 2.
b) Average of forward and backhaul, converted to metric tons.
c) Based on DOT, RUP fuel consumption.
d) For cars — reimbursement 3a roads only.
For trucks — reimbursement 3a roads plus turnover tax.

Table 5

WARRANTED USER CHARGE AND ACTUAL USER

Contribution per metric ton, trucks only.

Vehicle	(1) Variable Cost (a)	(2) Demand Related Component(b)	(3) Total Warranted User Charge	(4) Actual Contrib. (Table 4)	(5) Actual/ Warranted
4-ton capacity	.15	.71	.72	6.1	8.4
10-ton capacity					
gas	2.27	.27	2.54	4.1	1.61
diesel	2.27	.27	2.54	2.0	.79
20-ton capacity	1.7	.28	1.98	1.7	.85

Notes to Table 5

(a) Variable cost is determined from the relationship P_{ETU} (1.1) $(C_L + C_{1/2})$ / $(L_L + L_{1/2})$ where P_{ETU} = the average cost of size-variable components (Reconstruction and modernization + 1/2 maintenance + 1/3 new construction); 1.1 is a metric-ton conversion factor; C_L and $C_{1/2}$ are the AASHO coefficients for full loads and half-loads; and L_L and $L_{1/2}$ are the gross tonnages under full and half-loads. For large trucks, we have

$$P_{ETU} = \frac{2.3\ (10'')\ \text{para}}{5{,}687\ \text{mil.}} = 40.4\ \text{para.}$$

Var. Cost = [40.4 (1.92 + .42)/(36 + 25)] 1.1

= 1.7 paras per metric ton-kilometer

(b) Demand-Related Component is determined by dividing the hourly wage — 8.4 dinar — by the increase in speed permitted by the new construction (assumed to be 40 kilometers). The saving per kilometer is then divided by the average gross vehicle tonnage (Table 4). This is then assumed to represent the saving per ton-kilometer of 20 percent of the traffic in class.

EFIKASNO FINANSIRANJE PUTEVA I STRUKTURA PUTARINA U JUGOSLAVIJI

Alan ABOUCHAR

Rezime

U radu su izneti principi efikasne politike određivanja putarine putem analize tradicionalnih argumenata o određivanju cene ispod nivoa punih troškova. Tradicionalni principi se mogu klasirati u šest

grupa: 1. raspodela dohotka — koja bi bila sasvim poremećena ako se traži puni povraćaj troškova; 2. nacionalna bezbednost; 3. opadajući prosek cene puteva (što zahteva dotaciju društva); 4. složena priroda transportnih sredstava koja zahteva neproporcionalno velike doprinose od strane korisnika putničkih autbomobila; 5. nemogućnost diskriminisanja korisnika (zbog izuzetno visokih troškova) koja ima spoljašne efekte na zemljišnu rentu a kasnije na doprinos za puteve; 6. vreme — investiranje za puteve se vrši u sadašnjosti a putevi se koriste i u budućnosti. Analiza ovih argumenata će pokazati da nameti na bazi tona po milji ili vozila po milji za put u celini ili za veći deo njegovih komponenata nisu efikasni, budući da odnosi tona/milja i vozilo/milja ne odražavaju strukturu cena puteva merenu po sistemu koeficijenta oštećenja AASHO za pojedine klase korisnika. S druge strane, biće moguće definisati principe alociranja najvećeg dela komponenata rashoda i alocirati ih u zavisnosti od vidljivih odnosa troškova i tražnje. Ove poslednje ćemo nazvati »stvarnim delom troškova«.

1.2. Raspodela dohotka

Mnogi zadaci raspodele dohotka se mogu rešiti putem deonica puteva. Najočitiji primer je stvaranje nacionalnog dohotka u spoljnoj trgovini. Ovo stvaranje može dobiti adekvatan tretman ako ponuda radne snage za novostvorena radna mesta postane jedan od parametara kalkulacije. Pri tom se mora voditi računa da se preko stvorenog nacionalnog dohotka ocenjuju ne svi, već samo novotrasirani putevi.

Najzad, neusklađenosti nastaju i u merenju viška potrošača u regionima sa punom zaposlenošću i onima sa nezaposlenošću. Mada je ovaj problem opšte priznat, ne postoji saglasnost u pogledu tretmana, što dovodi do ozbiljnih sumnji u sposobnost centralnog zavoda za planiranje da alocira investicije po regionima. Ove sumnje, kao i krhkost međusektorskih upoređenja, dovode do zaključka da bi lokalne vlasti najbolje mogle odrediti svoje investicione potrebe, budući da se one mogu koristiti podacima koji nisu uneti u analizu na višim nivoima. (Ovi mogu dospeti u centralni zavod za plan samo uz velike diskusije, pa se zato izostavljaju).

1.3. Rezime principa

Principi na kojima se zasniva analiza mogu se svesti na sledeće:

1. Učešće drugih privrednih grana u izgradnji puteva može biti zasnovano na raspodeli dohotka i ne zahteva povraćaj troškova. U idealnom slučaju, treba izvršiti globalni transfer od opšteg nacionalnog budžeta u budžete siromašnijih regiona a da se dotičnim regionima ostavi sloboda naknadnog alociranja na osnovu ocene efikasnosti. Sredstva za ove svrhe ne treba da potiču iz nacionalnih sredstava namenjenih za puteve, a putevi koji se njima izgrade ne treba da ulaze u program izgradnje puteva.

2. Zajednička komponenta izgradnje puteva je komponenta za koju je pozitivno zainteresovano nekoliko klasa korisnika. Ovo je opšti kriterij klasifikacije koji ima vrlo različite implikacije u stvarnoj primeni (što je pokazano na nekoliko primera).

3. Doprinosi pojedinih klasa korisnika treba da budu u skladu sa elasticitetima njihovih tražnji za zajedničku komponentu kao i sa specifičnim troškovima koje one nameću.

4. Iako tražnja automobila može biti dovoljno neelastična da može snositi ukupne troškove puta, to od nje ne treba zahtevati s obzirom da se mnogi delovi puta troše različito kad ih koriste vozila različitih veličina ili pak imaju datu specifikaciju samo zbog toga što kamioni to zahtevaju.

5. Ono što je rečeno o ceni može da se primeni i na godišnje troškove za program puteva, tj. za onaj deo programa koji se stara o poboljšanju mreže u naseljenim oblastima. (Ovo se verovatno odnosi na veći deo programa).

6. Pomoć sa strane u izvođenju programa puteva može biti opravdana kad je diskriminacija neefikasna tj. kad bi diskriminacija značila gubljenje profita zbog neostvarenog saobraćaja. Ova pomoć će svakako biti efikasnija ako je pružaju lokalne vlasti nego ako se ostvaruje putem transfera sa centraliziranih sektora ili regiona, zbog toga što u ovom drugom slučaju nedostaci metoda ocenjivanja projekta dolaze do većeg izražaja.

U tabelama 1—4 dati su osnovni podaci koji se mogu koristiti pri ocenjivanju obaveznog nameta korisnicima. Oslanjamo se na podatke dobivene iz zvaničnih statistika o voznom parku i godišnjoj kilometraži kao i na podatke o oštećenju puteva i o odnosu habanja i tereta za Sjedinjene Američke Države.

Tabela 5 upoređuje obavezne namete korisnicima sa doprinosima korisnika. U koloni 5 su dati doprinosi korisnika dok je obavezan namet obračunat u koloni 3. Nameti se sastoje od komponente oštećenja AASHO i komponente koja je u vezi sa tražnjom a zasniva se na prosečnoj uštedi do koje se dolazi izgradnjom novog puta. Doprinosi najvećih kamiona i dizel kamiona od po deset tona su nešto ispod očekivanih. Prividni paradoks niže varijabilne cene za kamione od deset tona dolazi usled toga što veliki kamioni sa dvostrukom osovinom opterećuju puteve relativno manje po toni bruto težine nego kamioni od deset tona sa jednom osovinom.

AN ECONOMIC ANALYSIS OF PERU'S SOCIAL PROPERTY LEGISLATION

*Roberto ABUSADA-SALAH**

I. INTRODUCTION

Since its arrival to power on October 3, 1968 the government of Peru has been implementing a series of reforms aimed at the transformation of the productive structure. On May 2, 1974 the »Social Property Law« was issued to define a new sector within the economy, composed of worker managed firms which according to the government represents the most important step towards the goal of building a social democracy of full participation. Thus it has been repeatedly stated that this new form of economic organization will be predominant within the context of a pluralistic society. Other participatory schemes have already been implemented. The introduction of labour communities *(comunidades laborales,* CL) in private firms in 1970 was designed to give workers control of 50 percent of the firm's outstanding stock which is gradually acquired by the *comunidad laboral* with deductions made from the firm's pre-tax income. In the case of the manufacturing sector 15 percent is deducted each year and used to buy new or existing shares. Once the 50 percent is reached, the CL issues its own securities and distributes them to its members (all full-time workers) in proportion to the time worked in the firm. The CL is represented initially on the board of directors by one member and thereafter in proportion to the shares owned. Small private firms (5 or less workers) are not required to have a *comunidad laboral.* In addition, the process of agrarian reform spawned two type of collective agricultural enterprises. In the coastal region, the large and highly productive plantations were given to its workers organized in Agrarian Production Cooperatives *(Cooperatives Agrarias de Produccion,* CAP). The land and equipment received by the CAP from the State must be paid for out of each year's surpluses. In the Andean highlands the expropriated latifundia were converted into cooperatives. The cooperative, in turn, is integrated into a larger organization called

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