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ECONOMIC EVALUATION OF TRANSPORT PROJECTS

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BY

HANS A. ADLER

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IX

Economic Evaluation of Transport Projects

HANS A. ADLER*

THE ECONOMIC ART of evaluating transport projects in less developed countries is still primitive, but whether the discrepancy between theory and application is greater than in medicine, for example, is difficult to judge. This article describes the generally prevailing status of the art among those who have perhaps the greatest experience with it, discusses some of the major problems, and makes a number of suggestions for further improvements. The main emphasis is on the evaluation of highways because they usually present greater difficulties for economic evaluation and because in the future their expansion is likely to be more important in most developing countries than that of other modes of transport. However, the methods and techniques discussed are of general applicability.

The economic evaluation of public works projects has been developed most extensively in connection with water-resource measures, such as flood control, navigation and soil conservation. It received its initial impetus in the United States in the 1930's when legislation required the Bureau of Reclamation, the Army Corps of Engineers and other agencies to measure costs and benefits and to use such measurements in the selection of particular projects. There have been many of these studies in the last 10 years, with particular emphasis on water resources.

In the transportation field, the evaluation of railway projects and to some extent also of shipping and port projects, was usually limited

* The author is a transportation economist with the World Bank. While the article is based in large part on the Bank's experience in project evaluation, the views expressed do not reflect any official views of the World Bank.

to a financial analysis to determine whether future revenues could cover costs. In recent years a few railroads have adopted more formal capital budgeting methods. Economic evaluations, however, became a necessity with highways since they do not generally produce direct revenues. The first ones were made by engineers in state highway departments in the late 1930's. Their use in less developed countries did not become extensive until a few years ago under the impetus of various foreign aid programs.

There is, of course, no causal relation between the backwardness of the economics of transport evaluation and the fact that until a few years ago it was virtually the exclusive domain of engineers. On the contrary, this condition is to a considerable extent due to the failure of economists to interest themselves in this area even though it is one in which close cooperation between economists and engineers is especially important. As a result, some of the most common mistakes in project evaluation result from the failure to apply economic criteria correctly or at all; a few of these, such as the failure to distinguish between private and public costs and benefits and between average and marginal costs, are discussed below.

A very special problem in less developed countries is the absence of basic statistics; this is frequently decisive for the degree of accuracy and refinement possible in the analysis. Most of these countries have, for example, initiated only very recently the collection of highway traffic data. Where statistics are available, they are usually limited to simple traffic counts; information on origin and destination of traffic or on the types of commodities carried on highways is hardly ever available. Little is usually known about vehicle operating costs on different types of highways or about road maintenance expenditures on different types of surfaces. As a result, most new investments and the allocation of maintenance expenditures have usually been made virtually without any detailed economic analyses of priorities. It is no doubt true that, within limits, some of the most obvious investments can be made simply by looking at a map and at the location of major industries and population centers. But this is not true after the most obvious highways have been constructed, nor does such a simple approach permit an adequate judgment about priorities over time, among the modes of transport, or between transport and investments in other fields. The absence of basic statistics, however, is not only a cause of the backward status of much analysis

in this field but also an effect: because until recently economists have not focused on the right questions, there has been little incentive for collecting the right statistics.

Preliminary Steps

Before a specific transport project can properly be evaluated, two preliminary steps are highly desirable and usually essential in order to gradually reduce the consideration of alternatives to the project. The first step consists of a general economic survey of the country. Such a survey has two major functions. The first is to establish the country's overall transportation needs by exploring, for example, the rate of economic growth and the resultant expansion in traffic. The second is to provide a basis for appraising the transport needs as against the requirements of other sectors of the economy. This is not something that can be done very precisely, and it depends heavily on qualitative judgments. It is interesting that several such surveys have suggested that too much was being spent on transport investments. A recent survey of Colombia, for example, found that investments in education, housing and health deserved a greater priority than the marginal investments in transport.[1] Such surveys are also needed to help decide whether by changes in the location of industries, the total demand for transport can be reduced, and at what cost. The failure to make such surveys has led to transport investments, as well as recommendations for additional investments in some countries, which are out of line with the total investment resources of the country and with the priorities of other sectors.

The second step should be a detailed transportation survey of the country in order to determine the priorities within that sector. Examples of this are transportation surveys made recently in Argentina, Colombia, Ecuador and Taiwan under World Bank auspices. Such surveys, if they are to be of maximum usefulness, should not only establish the broad framework of priorities for each mode of transport, such as the listing of highways in order of their importance, but should also indicate the proper role for each mode and the priorities among them. Such a transport program will be subject to

[1] Cases mentioned in this chapter are products of research by the World Bank, much of it unpublished. Published material that is available is listed in the Bibliography.

later revision when specific projects are analyzed in detail. Unless both a general economic and a transportation survey precede the evaluation of a specific project, there is a considerable risk that the evaluation may be sufficiently incomplete as to lead to a misallocation of resources.

Problems of Project Evaluation

The basic purpose of the economic evaluation of a project is to measure its economic costs and benefits in order to determine whether its net benefits are at least as great as those obtainable from other marginal investment opportunities in the particular country. There are, of course, many costs and benefits other than economic ones, such as the cultural opportunities from greater travel and the military and administrative advantages, and sometimes disadvantages, from greater mobility. These are not considered here because they have been excluded by definition, and also because, for better or for worse, they are not a main consideration for lending by most sources of foreign finance whose primary purpose is to stimulate economic development. Nevertheless, these other benefits and costs are quite real and should be taken into account by the country involved.

It is sometimes stated that the value of a project should be measured by its contribution to the growth of national income as conventionally measured. This is not inconsistent with the above formulation, but it is not a practical approach. For one, it would exclude certain benefits altogether, such as greater comfort from an improved highway, or the time saving used for more leisure, which would not be reflected in national income. More important, the national income approach is too complicated and indirect and in underdeveloped countries is simply not possible. For example, if transport costs are reduced, an analysis would have to be made on how the freed resources are used in the future in other sectors of the economy to determine the resultant increase in national income. However, the national income approach is useful in focusing on costs and benefits from the point of view of the economy as a whole and not merely of the parties directly involved. In this way it helps in selecting the benefits to be included and those to be omitted and in avoiding counting the same benefit twice in different forms, such as when an improved

highway reduces transport costs and increases land values. It is helpful in identifying economic costs and benefits, but not in measuring them.

In evaluating a project which consists of a number of separable and independent subprojects, separate economic analyses should be made of each subproject. Otherwise it is quite possible that the extra large benefits of one subproject may hide the insufficient benefits of another. For example, in the case of a port expansion project in Central America, the engineers recommended the construction of two new wharfs. The economic justification indicated an economic rate of return on the investment of about 12 percent, which was a satisfactory rate in the particular country. However, when separate analyses were made for each wharf, it turned out that the rate of return on one was nearly 20 percent, while that on the other was only about 4 percent even after allowance was made for the extra costs of building it separately; the second wharf was clearly not justified. The same principle applies especially to various degrees of highway improvements and frequently also to different highway sections.

In order to measure economic benefits and costs and to compare them with other investment opportunities, they must be expressed in monetary terms, which is the only practical common denominator. This presents a problem since market prices do not reflect real costs to the extent that workable competition does not prevail in major sectors of the economy. In addition to any generally applicable limitations on competition in less developed countries, there are two special problems in the transport field. The first one arises from the fact that some transportation services by their very nature are oligopolistic or even monopolistic so that the prices charged for these services frequently have no direct relation to costs. The most obvious example is the historic pricing of railway services whereby freight rates for particular commodities are not based on the costs of transporting these commodities but on the value of the commodity. A second related problem arises from the direct and indirect subsidization of many transportation services by governments. A generally applicable example is the provision of highways. In most developing countries gasoline taxes and other charges on the beneficiaries do not cover the costs of highways (including maintenance, depreciation, interest, and administration); even where they may cover overall costs, there

is usually no direct relation between specific user charges and the differing costs of the various transport services, such as those of trucks, buses and passenger cars.

In spite of these difficulties, monetary terms are the only practical common denominator, and they can be made substantially more useful by the use of "shadow prices" to reflect real economic costs and benefits more closely.

Measuring Economic Costs

Measuring the economic costs of a project is substantially simpler than measuring its economic benefits and can usually be limited to making adjustments in the actual expenses to the extent that they do not adequately reflect real economic costs. Three classes of costs for which such adjustments are usually necessary, i.e., for which "shadow prices" must be determined are discussed below.

The Use of Shadow Prices

The first example is sales and other indirect taxes. The tax on gasoline, for example, is a cost to those who pay the tax, but it does not necessarily reflect economic costs to the country as a whole in the sense that an increase in the tax does not mean that more economic resources are required to produce a given volume of gasoline. It is interesting that the famous report *Road User Benefit Analyses for Highway Improvements* by the American Association of State Highway Officials erroneously includes taxes in its measurement of fuel costs and thus fails to distinguish between private and public costs (and benefits).[2] Similarly, license fees and import duties should be excluded, and adjustments should be made for the costs of imports at artificial exchange rates including a subsidy.

A second example is wages. In most countries minimum wage laws and other regulations and inflexibilities have the result that some wages actually paid do not correctly measure the real costs of labor. Where an economy is marked by extensive unemployment or underemployment, the real costs of the type of labor involved are much

[2] Washington, D.C., 1960. Reprint of 1952 report without basic change except for use of 1959 unit costs.

less than actual wage rates. When this is a widely prevailing condition and is likely to remain so for some time, as in many less developed countries, the cost of labor, especially unskilled labor, should be calculated at substantially less than actual wage payments. On the other hand, it would also appear that the real costs of skilled labor may be greater than the wages paid. The same considerations are also applicable on the benefit side. In measuring the benefits of labor-saving equipment, the real benefit is substantially less if the replaced labor remains unemployed for a significant period during the economic life of the equipment.

A final example is interest. Interest actually paid is the financial cost of capital, which frequently has no relation to its economic cost, i.e. the opportunity cost of capital. Investment funds provided by governments for transportation are often made available at rates below the cost to the government; and even if they cover the government's costs, the latter do not reflect economic costs if the funds were obtained by the government under direct or indirect compulsion, such as by taxation or by requiring banks to lend to the government below market rates. Funds obtained from foreign sources very frequently carry interest rates substantially below the opportunity cost of capital in less developed countries.

The economic cost of capital is very difficult to determine in the absence of free markets, especially since prevailing interest rates also reflect such factors as inflation and risk. The World Bank has made a number of studies attempting to measure the opportunity cost of capital in selected countries. While they do not permit any definitive judgments, they do indicate a range from about 6 to 12 percent for the particular countries selected, and there is reason to believe that in most developing countries the rate is at least 8 percent and frequently more than 10 percent. Whether market interest rates or a lower (or perhaps higher) social rate should be used in discounting costs and benefits is beyond the scope of this article. As a practical matter, however, investments in less developed countries with rates of return below 8 percent deserve very special scrutiny.

The problem of the appropriate interest rate can be minimized somewhat in the evaluation of many projects by expressing the results in terms of an internal rate of return on the investment, rather than in terms of benefit-cost ratio. This is discussed further below in the final section.

Other Types of Adjustments

In addition to the use of shadow prices, there are other types of adjustments which are frequently necessary for an economic evaluation. The three examples given below are selected primarily because they illustrate mistakes which occur frequently.

In calculating the costs of a project, engineers usually include a contingency for unforeseen expenses. These are of two types. First, costs may be greater than anticipated because the work turns out to be more difficult or more extensive; for example, more earth may have to be moved or the soil conditions may be less favorable than indicated by the sample data on which the cost estimate was based. In another case, costs may be greater because generally prevailing inflationary conditions increase wages and prices. For the purpose of economic analysis, this second element of the contingency allowance should not be included under costs, nor should a general inflation in the prices of benefits be taken into account. However, changes in relative prices should be allowed for to the extent that they are foreseeable and are likely to affect costs and benefits differently.

A second common error involves the treatment of interest during the construction period. Such interest is usually included in the costs of those projects which are financed by loans, such as new equipment for a railroad or the construction of a toll road, but it is frequently excluded where the project is financed by grants from general revenues, as in the case of most highways. This important financial distinction has no significance as far as the economic costs of the project are concerned since the real resources used—labor, material, equipment, etc.—are the same regardless of the source of financing. Money is the means of procuring these real economic resources, so that interest should not be included in the economic costs of the project.

However, interest is relevant in a quite different sense. Since the benefits of a project do not begin until sometime after the project has been started and costs have been incurred, it becomes necessary to compare costs and benefits beginning in different years and having different time streams. Regardless of the financing method, the timing of costs is an important element since a cost incurred this year has a different economic value than the same cost incurred sometime in the future. To measure the difference, future costs can be

expressed in terms of present values by discounting them at an appropriate interest rate. The proper method of comparing benefits and costs with different time streams is, therefore, to discount all future costs *and benefits* as of the time a *cost* is first incurred. Under this method, interest (as well as depreciation) is implicitly allowed for, so that adding interest to the costs would involve double counting.

An alternative method which is sometimes used includes interest during construction and discounts benefits as of the first year they begin, which is generally sometime after the first costs are incurred. This tends to confuse the financial with the economic analysis since usually the interest included in costs is the interest actually paid. In most cases, this has no direct relation either to the opportunity cost of capital or the internal rate of return by which the benefits should be discounted, so that, in effect, the costs are discounted by a rate different from that used for benefits. It should also be noted that this method actually overstates costs where benefits begin before the project is completed, which occurs quite frequently in highway construction. There seems to be no particular advantage to discounting costs and benefits to a year other than the year in which the project starts, which is nearly always the first year in which costs are incurred.

A third mistake, which only deserves mention because it occurs quite often, arises from the failure to define properly the scope of the project with the result that project costs do not include all relevant costs. For example, a toll road authority in a developing country included in the costs of a new road only the expenses for which it would be responsible. This, however, failed to take into account the necessity for improving access roads. Since the improvement of access roads was essential for the effective utilization of the toll road, the costs involved should have been included in the project costs for the purpose of economic evaluation, even though they could properly be excluded for an analysis of the authority's financial position. In this particular instance it was probable that the access roads would have been improved in time in any case. Therefore, it became necessary to establish the additional costs of making the improvements earlier than would otherwise have been the case and of the higher design standards needed for the greater volume of traffic caused by the toll road.

Measuring Economic Benefits

Measuring the economic benefits of transport projects is usually much more difficult than measuring their economic costs. There are a number of reasons for this. First, some benefits, even though quite direct—such as the increased comfort and convenience from an improved road—are difficult to express in monetary terms since there are usually no market prices for such benefits. Second, monetary benefits, such as reduced transport costs, benefit a great number of people over a long period of time, requiring difficult long-range forecasts. Third, many benefits are indirect, such as the stimulation to the economy from improved transportation; and for these benefits to materialize, investments in fields other than transport are frequently necessary.

The most important benefits from transport projects include: (*1*) reduced operating expenses initially to the users of the new facility and also usually to those who continue to use the existing facilities; (*2*) lower maintenance costs; (*3*) fewer accidents; (*4*) savings in time for both passengers and freight; (*5*) increased comfort and convenience; and (*6*) stimulation of economic development. Not all of these benefits exist in all projects, and their respective importance differs from project to project. At the present state of the art of project evaluation, those listed near the beginning can frequently be measured in monetary terms more easily than the others. This article will not deal with the measurement of maintenance costs and of comfort and convenience. The former offers probably the least difficult conceptual problems, and the latter would seem to have a relatively low social value in developing countries, even though to judge by differences between first- and second-class railway service, it has a considerable private value.

Before discussing the problems of measuring the remaining benefits, it may be useful to refer to a matter which is rarely considered in their evaluation, i.e. the distribution of benefits among the beneficiaries. For example, if the improvement of a port reduces the turnaround time of ships, much of the benefit might go initially to foreign ship owners; the degree to which they pass it on to the country paying for the investment depends largely on the degree of competition in shipping. Similarly, the improvement of a scenic highway may

initially benefit foreign tourists primarily or those from other areas of the country. A government could, of course, adopt a policy of recouping some or most of these benefits by appropriate user charges. The matter of the distribution of benefits is important therefore in the selection of a policy of user charges which will channel the benefits to the desired recipients.

Perhaps even more important is the fact that the distribution of benefits affects their overall size. For example, if a railway maintains previously existing freight rates even though a transport improvement has lowered costs, the consumers would not benefit directly, but the railway might have higher profits; a determination of the net benefits to the economy would depend on weighing what the railway would do with its higher profits (or the government with its "savings" from reduced losses) as against the benefits from lower freight rates. An important consideration is that if the rates are not lowered, the transport improvement would hardly stimulate new traffic. Where there is reason to believe that the likely distribution of benefits either reduces their overall size or is inconsistent with other public policies, the problem deserves greater attention than it now usually receives, with special emphasis on appropriate user charges.

Reduced Operating Expenses

The most direct benefit from a new or improved transport facility, and frequently also the most important one and the one most easily measurable in monetary terms, is the reduction of transport costs. While this benefit accrues initially to the users of the facility, competition or the desire to maximize profits leads them to share it in various degrees with other groups, such as producers, shippers and consumers. The cost reduction therefore benefits the nation as a whole and not merely the users of the facility.

Traffic Growth

The first step in measuring the benefit from reduced costs is to estimate the future use of the facility, i.e. the future traffic during its useful life.[3] This traffic can be broken down into three main types:

[3] The useful life of a facility is limited primarily by economic change and tech-

the "normal," the "diverted" and the "generated" traffic. The "normal" traffic growth is that which would have taken place on the existing facilities in any case, even without the new investment. This type of traffic benefits by the full reduction in operating costs made possible by the new facility, since, by definition, this traffic would otherwise have traveled even at the higher (and perhaps steadily increasing) costs of the existing facility.

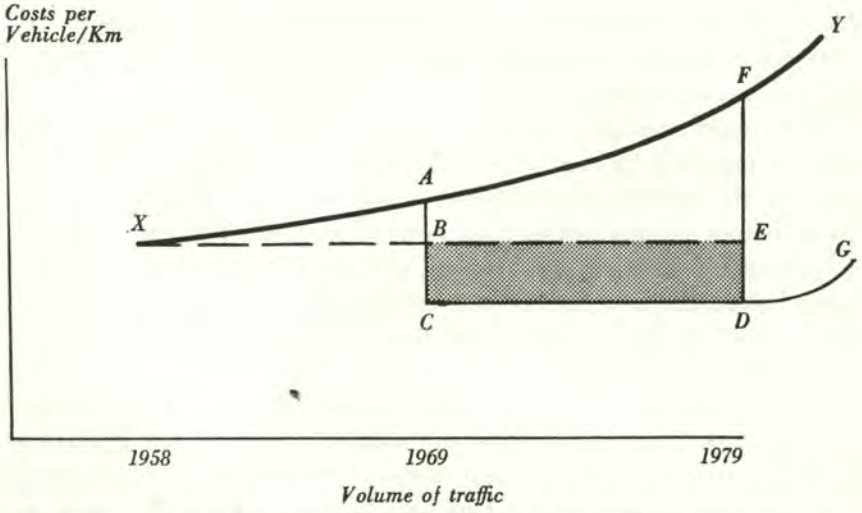
The proper standard for measuring the savings in vehicle operating costs is provided by the "with and without" test: what will the costs be with the new facility and what would they have been without it? In numerous project evaluations, however, a quite different standard is mistakenly applied—the "before and after" test: what were the costs before the new facility was constructed and what will they be afterwards? As shown below, this test usually leads to a serious underestimate of economic benefits.

For example, in connection with the evaluation of a new expressway in Japan, the responsible authorities measured the operating costs of a truck on the existing highway in 1958; they were about U. S. 15 cents equivalent per kilometer, excluding taxes. The costs on the new expressway, which is scheduled to be opened in 1969, were estimated at 11 cents, or a saving of 4 cents per truck/kilometer. This saving was then applied to the estimated truck traffic for the years 1969 to 1979; no increase in traffic was assumed thereafter because the so-called design capacity of the expressway would then be reached and vehicle operating costs would thereafter begin to increase. This approach, which is based on the "before and after" test, illustrates a number of common mistakes. The first is that the comparison of costs on the existing highway in 1958 with those on the new expressway in 1969 fails to take into account the important fact that the increasing congestion on the existing highway will have increased operating expenses considerably by 1969 over those prevailing in 1958. Secondly, the operating costs on the existing highway would have continued to increase after 1969, while those on the new expressway are likely to remain relatively stable for 10 years and the

nical obsolescence, such as new or improved processes and changes in markets. These are much less predictable than the facility's physical life. While forecasts of service life are therefore to some extent inevitably speculative, the discounting of far-off periods makes these relatively unimportant. In many cases, for example, it will make little difference whether the life of a highway is taken at 25 or 30 years.

increase thereafter is likely to be less sharp than on the existing highway. The situation is illustrated by Figure IX-1.

FIGURE IX–1



XY represents the truck operating costs on the existing highway, assuming the expressway is not built. It slopes upward in time because of increasing congestion. By the time the expressway is opened in 1969, they have already increased somewhat over the 1958 level. The reduction in operating costs per truck, according to the "before and after" test is *BC* throughout the life of the new investment and the benefits (until 1979) are represented by the shaded area *BCDE*. Actually, the reduction is *AC* when the facility is opened in 1969, *DF* by 1979, and the benefits are at least *ACDF*. Also, it is questionable whether no increase in traffic should be assumed after 1979. The concept of highway capacity is hardly a scientific one and the traffic on the existing highway is more than double the design capacity. The real issue is at what point new investment is justified in order to increase capacity further. Since such investment is likely to be lumpy, the decision involves weighing the costs of increased congestion on the existing highway as against the net benefits of additional capacity. Depending on the lumpiness of the investment, traffic increases substantially beyond design capacity may be justified before expanding the capacity further.

It is sometimes stated that when the increasing costs of growing

congestion are properly taken into account, i.e. the difference between the *CG* and the *AY* curves, the growth in vehicle operating savings tends to be twice as great as the growth in traffic. While such generalizations have to be treated carefully, a few actual cases indicate that it may sometimes serve as a rough approximation. For example, a study of a road improvement in Jamaica indicated that it would reduce operating costs by about £40,000 in 1963. If this benefit is increased by the estimated annual traffic growth of 12 percent, it would reach £70,000 in 1968 and £120,000 in 1973. If, however, the increasing costs of further congestion are allowed for, the benefit would be £90,000 in 1968 and £250,000 in 1973. The difference would become even greater in the following years.

The application of the erroneous "before and after" test can lead to curious results. In connection with a proposed highway improvement in Syria, investigation showed vehicle operating costs on the existing highway to be quite reasonable; it had a fair surface and a satisfactory width. Unfortunately, the highway was not constructed to carry the prevailing heavy loads, and engineers advised that it would break up in about two years and that (even with heavy maintenance expenditures) a complete reconstruction would be necessary. However, vehicle operating costs would not be significantly lower thereafter. The "before and after" test indicated that the reconstruction would bring only modest benefits and would not be justified, at least not at that time. The "with and without" test, however, indicated that without the new investment, vehicle operating costs would go up very sharply, to say nothing of maintenance costs; the avoidance of this increase should in this case have been the proper basis for the economic evaluation of the benefits.

The above examples have been limited to highways, but the analysis is in principle identical for railways or ports. For example, in 1963 the Spanish Railway developed a 10-year modernization and expansion program estimated to cost about U.S. $1 billion equivalent. In addition to evaluating the benefits from individual components of the program, it was also desired to measure the return on the program as a whole. Analysis showed that the program would reduce operating costs by about 25 percent between 1963 and 1973. When this benefit was measured against the investment costs of the modernization part of the program, it showed an internal rate of return of about 15 percent. This "before and after" approach, however, under-

stated the benefits significantly since in the absence of the new investments, operating costs would not have remained at the 1963 level, but would have increased. When allowance was made for this, the rate of return on the investment became about 18 percent.

The second type of traffic is that which is diverted to the new facility either from other modes of transport or from other routes.[4] The benefit for diverted traffic is measured by the difference in transport costs on the old route or mode of transport and on the new facility. There are, however, two special problems which should be kept in mind in measuring this benefit. The first one is that the relevant costs in this connection are not the average costs of transport, on both facilities, but the avoidable costs, i.e. the amounts that would be saved. If, for example, traffic is diverted from a railway to a new highway, the benefits cannot be measured by comparing the transport costs on the new road with either railway charges or even average railway costs, but by comparing them with the marginal costs of carrying the diverted traffic by railway. If, for example, the diverted traffic is only a small part of the railway's total traffic and if the railway has excess capacity, the marginal savings would be substantially less than indicated by a comparison of average costs; this is probably the usual case. While the available data in most developing countries do not permit precise estimates of marginal costs, the understanding of the correct concepts is essential for making the best use of the data which are available.

Comparing costs of different transport modes presents a further practical problem in that the transport services provided by each mode usually differ substantially and must therefore be reduced to a common denominator. Total distribution costs are the primary concern, not just the cost of shipment. For example, comparing the costs of coastal shipping traffic diverted to a highway must take into account not merely shipping costs, but also such additional costs as loading and unloading, storage, insurance, breakage, delays, etc. These additional costs may readily add 50 percent to the basic shipping costs.

[4] Another type of diverted traffic consists of a change from one type of conveyance to another on the same route, such as passenger trips previously made by bus but now made by private car. In this case, the higher relative operating costs of a private car are evidently outweighed by its qualitative advantages, especially the greater convenience and comfort; it is usually not possible to measure this difference in monetary terms.

Similarly, in comparing the costs of railway and highway transport, adequate allowance must be made for the fact that trucking is a door-to-door service, while railway service will generally require two loadings and unloadings, which, in addition to the direct costs, frequently involves delays and breakage.

While the benefits to the economy are measured by the reduction of social costs (e.g. excluding taxes), it is not the social but the private costs which are relevant in estimating the amount of traffic diversion. In fact, since many people make decisions on driving largely on the basis of out-of-pocket costs, it is the difference between these and railway rates actually charged (regardless of cost) which will largely decide the amount of passenger traffic which will divert from a railway to a highway.

The third type of traffic is that which is newly generated as a result of the lowering of transport costs and which previously did not exist at all. This includes traffic both from increases in industrial or agricultural production caused by the cheaper transport as well as transport not involving an increase in production, such as the transport of commodities previously sold locally but now transported to markets where a better price can be obtained.

As far as reductions in transport costs are concerned, it would not be appropriate to apply the total reduction in unit operating costs to this traffic since it would not have materialized without the reduction. If there is reason to believe that in a particular situation the traffic would have been generated with a transport cost reduction of only a quarter the actual reduction, it would be appropriate to apply three-quarters of the unit cost reduction to the generated traffic. In the many situations where the available data do not permit a judgment on the relationship between the degree of transport cost reduction and the volume of generated traffic, perhaps the most reasonable assumption is that this traffic would have developed in proportion to the reduction in transport costs; if so, it would be appropriate to apply approximately one half of the unit cost reductions to this traffic.

To the extent that the main purpose of a new transport facility is to open up new lands for cultivation or to otherwise make possible new economic development, reductions in transport costs for generated traffic are not a significant measure of the economic benefits of the project. In this situation, the benefit consists of the new production

made possible; the problems of measuring this benefit are discussed later.

Accident Reduction

Accident reduction is clearly an economic benefit, but not every transport improvement reduces accidents; whether it does or not must be investigated in each case. For example, it is quite possible that an improved highway may initially increase not only the number of accidents, but, more importantly, the accident rate per vehicle/km and the severity of each accident. This could happen where the increased speed is not offset by additional safety factors, especially in a country where automobile driving is still in its initial stages and the discipline required for safe driving is equally underdeveloped. Accident reduction is apparently most significant for expressways with divided lanes and controlled access.

Measuring the economic benefits involves two main steps. The first is to estimate the reduction in accidents, which entails, for example, comparing the accident rate on the existing highway as it would be in the absence of the improvement with the rate on higher standard highways within the country or, if necessary, in other countries (but making allowance for national differences).

The second step is to estimate the value of the accident reduction. For this purpose, it is useful to consider three types of damages. The one most readily measurable in monetary terms is property damage, usually to the cars involved in the accident. Police statistics in Japan, for example, indicate that the average property damage per accident is about U.S. $600 equivalent; this may not be an unreasonable figure —though it should be adjusted for excise taxes, for example—since about two-thirds of the traffic is accounted for by trucks and buses, with a relatively low average age. The cost of injuries is more difficult to measure. In the Japanese studies this was estimated at about U.S. $100 equivalent per accident, which includes an allowance for both loss of earnings and the cost of medical treatment for the injured who were over 14 years of age.

Finally, to measure fatality reduction, there is the problem of putting a value on life. In the Japanese case, this was calculated by capitalizing the average annual income per worker over a 30 year period. This is obviously a highly controversial proposition. At a mini-

mum there should be deducted from gross income the resources needed to produce that income. It would be too callous to suggest that if a country is overpopulated, the social and the private values of the fatality reduction would be quite different. On balance, it would seem preferable not to express fatality reduction in monetary terms.[5] In any case accident reduction in the less developed countries is likely to be of minor significance compared to other benefits, and the reduction of fatalities is only a small part of accident reduction. Fatalities can either be neglected in most cases or simply expressed in terms of the number of deaths involved.

Time Savings

Even though most transport improvements reduce travel time, the value of time for passengers and freight is frequently omitted from project evaluations. This may lead to a serious underestimate of benefits since time savings can be substantial.

As far as persons are concerned, time can be money, but it need not be. Whether it is, depends primarily on how the opportunities made possible by the increased availability of time are used—whether for increased production or voluntary leisure, on the one hand, or for involuntary idleness, on the other. Unfortunately, in many developing countries there is extensive underemployment, so that time savings may merely make the situation worse. But even here, time savings for entrepreneurs, for example, may be very valuable.

What can be done to measure the value of time may be illustrated by a recent study in Japan, where a new expressway was to reduce travel time very substantially. All travelers were divided into two classes: the relatively few who can afford to travel in private cars, and the many who travel in buses. As a first step, the average value of time was related to the per capita income of the two classes. This showed that in one hour, travelers in cars could earn at least U.S. $1 equivalent, while those in buses at least U.S. 20 cents. Since there are ample employment opportunities in Japan, this calculation was not unreasonable.

However, to check on its validity, these average values were com-

[5] However, if the purpose of a project is to reduce accidents, such as safety measures in the aviation field, for example, it becomes quite essential to express fatality reduction in monetary terms.

pared with the amounts people are actually willing to pay for time. For this purpose, a study was made of surcharges imposed by the railway for different types of trains running between the same cities. On the Tokaido line, for example, travelers have a very ample choice between different trains, ranging from slow, local trains to very fast expresses. While between some of these trains speed is not the only difference, convenience and comfort being others, it is the most important one and between at least two of them it is probably the only difference. An analysis of these surcharges indicates that travelers are willing to pay at least U.S. $2 equivalent in first class and U.S. $1 equivalent in second per hour saved. These findings and those based on the earnings method give a clear indication of the range of values that might be given to time savings of passengers. They suggest that in Japan, at least, many individuals prefer to take these time savings in the form of leisure even if they could devote them to income producing activities. This is probably not true in most underdeveloped countries. In any case, since the time savings will presumably exist for the life of the project, allowance should be made for the increasing value of time as per capita income grows.[6]

Time saved on the shipment of freight may well be more valuable in the less developed countries than those already more advanced. Freight tied up during transit is in fact capital, and is therefore of particular importance where capital is in short supply. This saving can be measured by the price of capital; i.e. the rate of interest. In addition, faster delivery which is usually accompanied by more reliable delivery reduces spoilage and makes possible lower inventories, which in turn is an additional form of capital saving. Beyond this, where larger inventories are not possible, a delay may immobilize other resources, as where the absence of a spare part may prevent the utilization of expensive equipment.

As in the case of time savings for travelers, a study was made in Japan on the prices shippers are willing to pay for different types of transport services, where time is by far the major and in some cases perhaps the only difference. The study covered a dozen important

[6] Time savings for truck and bus drivers are generally allowed for under calculations of vehicle operating savings.

commodities and indicated, for example, the following prices actually paid for a saving of one ton/hour (in U.S. cents):

Dairy products	35
Fresh fish	21
Vegetables	20
Fruit	14
Minerals	1

The relative importance of time savings as against other benefits depends of course on the nature of the particular project. That it can be very significant is indicated by the project for which the above studies were made. In this case, the value of time savings was nearly half as great as the benefits from lower vehicle operating costs.[7]

Economic Development

It is frequently assumed that all transport improvements stimulate economic development. The sad truth is that some do, some do not, and that even some of those that do may not be economically justified in the sense that there may be better investment opportunities. Each project must therefore be investigated individually and no helpful generalizations appear possible until more research may show that certain definite correlations do exist.

Before any transport improvement can be said to have stimulated economic development at all, a number of conditions must be met. The most important is showing that the economic development would not have taken place in any case even without the transport improvement. A second is that the resources used in the new development would otherwise have remained unused or used less productively. Finally, it is essential that the economic activity stimulated does not replace activity which otherwise would have taken place.

These conditions may be obvious, but it is surprising how often they are forgotten in practice. In the sophisticated Japanese studies previously referred to, extensive research was undertaken to measure the growth in industrial output in the area of influence of a new highway, and there were strong reasons to believe that the highway and the output were indeed causally related. While this was very useful from a local point of view, it had much less significance for the economy as a whole. Further inquiry indicated that most of the resources used

[7] The time saving for the vehicles is usually covered in the lower depreciation allowance made in vehicle operating costs.

in the new production would not otherwise have remained unemployed and that the firms responsible for the new output had planned to expand in any case and picked a location near the new highway because of its advantages. From a national point of view, therefore, the highway cannot be regarded as having contributed significantly to stimulating new economic development. This is not to say that the locational shifts caused by the highway involved no economic benefits other than lower transport costs; they may have facilitated more efficient production, but this benefit can only be a fraction of the total net output.

Where a transport facility does lead to increased output and the above conditions are met, the net value of this additional output is the proper measure of the economic benefit.[8] In many situations, however, the transport facility is not the only new investment needed to achieve the increased production. This raises the problem of allocating the benefit, i.e. the increased production, among the transport and the other investments. For this there exists no correct theoretical answer but there are at least three practical approaches. One would be not to make an allocation at all and relate the total benefits to the total investments. A second would be to annualize the other investment costs and deduct them from the benefits. And a third would be to allocate the benefits in the same ratio as the transport investment has to the other needed investments.

Each of these solutions is appropriate in different situations. For example, in the actual case of new coal mining in Sarawak, it was necessary to build a road to transport the coal from the mine to a port. The estimates indicated that the coal would account for more than 90 percent of the total traffic using the new road. The road was an integral part of the coal mining scheme—just as integral as the mining equipment—and had virtually no other use. In this case an allocation of benefits between the road and the investments in the mine would be meaningless. On the other hand, where a road is being built to facilitate new agricultural as well as industrial development which, however, will also require other major investments, an allocation of benefits might be more useful.

Where the transport facility enlarges the market for commodities previously produced, the economic benefit consists of the difference in

[8] The net value of output and the vehicle operating savings for generated traffic are, of course, not additive.

value of the commodity in the old and the new market, minus the new costs of transport. For example, the price of a commodity in the old market may be 10 cents; in a second market it is 20 cents, but because transport costs are 12 cents, shipment to this market is uneconomic. Assuming a transport improvement that cuts transport costs in half, to 6 cents, the commodity can be delivered to the second market for 16 cents and there be sold for 20 cents. The benefit from the new investment (assuming resources before and after the change are fully employed) would be 4 cents. Account must be taken of the fact that the increased supply may affect prices in both markets; if so, the benefit is usually valued at prices prevailing after the transport improvement is completed.[9]

What can be done in practice to measure the net value of increased production or of wider markets differs from case to case. For example, in the Sarawak illustration given above, detailed studies were made by various experts of the supply of coal, the costs of production and transport, and probable market prices. The problems are usually much more difficult for agricultural development because its success depends on the willingness and ability of a large number of people and the development potential of large areas. In the Sarawak case, the likely agricultural output as a result of the highway could be estimated within a satisfactory margin of error since only two commodities were involved and experience from previous transport improvements on land with a similar agricultural potential could serve as a reasonable guide on probable future output and the other investments needed to achieve it.

This is an area where only very little research has so far been done. But it is clear that if the main purpose of a transport facility is to stimulate economic development, greater efforts must be made to measure this benefit—efforts similar to those now made for an irrigation scheme, for example. And if the economic development can be achieved only if the transport improvement is supplemented by such measures as other investments, extension service to farmers, land reform, etc., then these other measures become an essential condition of the project. This, too, has been recognized in the field of irrigation, but unfortunately not yet fully in transport.

[9] For passenger traffic, this benefit, i.e. the difference between staying at home and traveling, minus the transport costs, can usually not be measured in monetary terms.

Comparing Costs and Benefits

Once costs and benefits have been measured in monetary terms to the full extent meaningful, the results can be put into at least three different forms: the rate of return on the investment, the benefit-cost ratio, or the pay-back period. A great deal has been written about these alternatives, so that the discussion here is limited to a few salient points.

There is unfortunately no uniformity in the application of these forms. In some benefit-cost ratios, for example, gross costs are compared with gross benefits, while in others, some costs are first deducted from the benefits; this can affect the ratio very substantially. Sometimes—and more correctly—it is the difference between benefits and costs which is used. In the case of rate of return calculations, the benefits are sometimes measured against the investment costs (with or without allowance for depreciation), or sometimes by the internal rate of return. It is essential to know exactly what formula is used if the final result is to be correctly interpreted.

While the basic ingredients—the value of the costs and benefits—are the same regardless of the final form in which they are expressed, the usefulness of the various forms is different, depending on the purpose. A short pay-back period is important where the future is unusually uncertain, where better investment opportunities are likely to arise soon, or where funds are not available on a long-term basis. These considerations are much more important for private businesses than for governments. Also, the fact that the benefits of an investment are large in the beginning may give no indication of what they are over the life of the investment, so that this method is a particularly poor one for comparing investments having a different time stream of benefits. Furthermore, there are superior techniques for incorporating uncertainty into investment analysis.

Discounting benefits and costs by the opportunity cost of capital is theoretically the best way of comparing different projects. The most important disadvantage of this approach is that a particular interest rate must be chosen for discounting. In practice, the interest rate mistakenly selected is frequently the one being paid, which may or

may not have any relation to the opportunity cost of capital in the country. Unfortunately, the opportunity cost of capital is frequently not known or can be estimated only with a considerable margin of error. This is particularly crucial since the discount rate chosen is one of the major determinants of the benefit-cost comparison.

This disadvantage can be minimized somewhat by expressing benefits and costs in terms of the internal rate of return on the investment, i.e. the rate which equalizes discounted costs and benefits. In this case, the opportunity cost of capital becomes important only in the marginal cases where the internal rate of return is not clearly above or below the area within which the opportunity cost of capital may be estimated to be. For example, it would be virtually certain that an investment in Japan with a rate of return of 12 percent is justified, since the opportunity cost of capital is less, probably between 6 and 10. But even where the two rates may be relatively close, the internal rate of return formula has the advantage of focusing directly on the crucial question: how the particular investment compares with other investment opportunities. The benefit-cost ratio tends to hide this crucial point in assuming a certain interest rate.

On the other hand, the internal rate of return formula also has its disadvantages. While, as a practical matter, it usually leads to a correct choice of projects, it may sometimes be misleading in comparing projects having different lives and different time streams of benefits. In practice, however, transportation nearly always involves long-term investments and the time streams of benefits do not tend to vary drastically. Even where they do, the margin of error involved in an internal rate of return calculation may be less than discounting by the opportunity cost of capital, which is usually known only within a wide range. Also, where a project is compared not with a direct alternative but with investment opportunities in general, the internal rate is generally a perfectly satisfactory formula.

Another disadvantage of the internal rate of return is that the answer may be ambiguous in that more than one rate may equalize costs and benefits. In practice this is rare in the case of transport projects since the costs are predominantly incurred in the early stages and the benefits arise later, in which case the solution would be unique.

Finally, the rate of return formula has the practical advantage that

economists, financial experts, and many businessmen have some concept of what an interest rate is, so that a rate of return is probably more meaningful to many audiences than a benefit-cost ratio. On balance, therefore, the internal rate of return on the investment is usually, but not invariably, the most satisfactory form in which to express benefits and costs of transportation projects in the less developed countries.

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Transport Sector Programs

Hans A. Adler

[Preparation of a transport sector program can be a useful effort but is not necessarily so. Review of recent transport surveys indicates that the costs of preparing a ten-year program are generally less than one fifth of one percent of the investments. If $200,000 can be saved in an investment program of $100 million, the survey is already justified, and the potential benefits are usually much larger. But there is little merit in preparing a transport study if the government is unable to carry out the measures it shows will be needed.]

The preparation of programs for the transportation sector of developing countries is an infant industry which has been growing rapidly in recent years. The World Bank is probably the organization most actively engaged in administering transport surveys, having participated in about 35 such surveys from 1964 to 1969. Other transportation surveys are being undertaken with the assistance of the industrial countries and other international agencies; in few instances are developing countries attempting surveys without outside assistance.

The impetus for these surveys comes primarily from three sources. First, there is an increasing recognition that macro-economic planning is not enough and that it urgently needs the support of detailed analyses of individual projects. Project analysis alone, however, is frequently not sufficient because in the transportation sector there tends to be a close interrelationship among individual projects;

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for example, the effectiveness of a port investment may depend on rail and road connections; the justification for a road improvement may depend on parallel or feeder roads. The function of the sector program is, therefore, to identify promising projects, to relate them properly to one another, to determine their priorities, and to relate all projects to the macro-economic plan.

A second reason for transport surveys arises because the transportation systems of most countries are severely distorted due to historical circumstances. Probably the single most important factor is the collapse of the monopoly which railways had for almost a century and the consequent painful adjustments of the railways to vigorous competition by road transport. A third and more mundane reason for the increase in the number of transport sector surveys in developing countries is the insistence on them by foreign governments and international organizations providing financial assistance.

The preparation of transport programs is particularly important because in developing countries a transport infrastructure is usually a prerequisite--though by no means a guarantee--of economic growth. In addition, transport requirements tend to grow at a higher rate than national income in the early stages of development. In a dozen Asian countries for example, the annual increase in rail and road traffic in the 1950s ranged from about 6 to 20 percent, while national income was growing at 2 to 5 percent. The ratio of capital to output is high for transport especially in its early stages. Investments in transportation often account for a large part of public investment, frequently 15 to 30 percent. A significant part of these investments in developing countries involves foreign exchange expenditures, often 40-60 percent and sometimes 75 percent. A new investment's operating costs also tend to include continuing foreign exchange expenditures on spare parts, maintenance equipment, tires and fuel.

Transport sector planning is also important, especially in developing countries, because governments own or control nearly all transport facilities. Railways, roads, ports, inland waterways, airfields and airlines tend to be exclusively public investments and the major private investments, such as motor vehicles, are usually controlled by production licenses, import restrictions and foreign exchange controls. Governments generally have the instruments to ensure that the program can be carried out. On the other hand, transportation is exposed to the threat of political interference, which could make planning based on economic criteria a wasted effort. Sound economic analysis may be helpful against political pressures.

Conditions for a Transport Survey

Three important conditions should be met before a transport survey is undertaken. The first relates to an understanding of the broad

transport policies which a government plans to pursue. The uneconomic use of government-owned transportation facilities for defense, political and social purposes is sometimes so extensive that the World Bank has on occasion agreed to participate in transport surveys only after reaching an understanding with the government on the broad transport policies to be followed. This is most important for the operation of railways because the collapse of their former monopoly position has created special difficulties for them and because they are particularly subject to governmental interferences. Will the railway be permitted to dismiss redundant workers and eliminate uneconomic lines and stations? Will new lines be constructed only if detailed studies indicate that the lines are economically justified? Will rates and fares be sufficient to cover at least the marginal costs of transporting each commodity and the full costs of carrying the traffic as a whole? A transportation study of Argentina, for example, found that of a total railway network of about 43,000 km, about 14,000 km of lines were uneconomic and should be abandoned, that an additional 5,000 km needed further study with an eye to possible later abandonment, and that the labor force could be reduced by 30,000-40,000, or 15-20 percent. It is no use to study these problems if for political or other reasons the government is not in a position to do anything about them.

A second condition is the recognition by the government concerned that planning is not a one-shot affair but a continuous process. Too many transport programs have been prepared by international consultants who visited a country for several months or even a year, and left nothing behind but a well-bound report. Such a report may help attract foreign lending and may even stimulate a new awareness of certain problems and their solutions, but however sound the program may be, its preparation is hardly worth the effort unless it can serve as an effective "kick-off" to continuous planning, increasingly undertaken by local experts themselves without foreign assistance.

If the survey is to have lasting value, every effort should be made to train local experts to staff a permanent planning organization. One of the best ways to do this is to create a counterpart organization, so that each of the foreign technicians works with at least one local counterpart. This provides effective, on-the-spot training. It also creates a local team of experts familiar with the program and the reasons for its recommendations, and able to assist in its implementation and modification. In any case, counterparts can help the foreign experts who are usually less familiar than they with the particular conditions of the country, the background of problems, the sources of information and the details of government organization. The participation of local counterparts in the preparation of the program should be supplemented with continuing—but

decreasing—assistance by foreign advisors for several years thereafter, and with the training of local experts abroad.

Brazil provides an example of an effective transport planning organization. Brazil had neglected transport planning for many years and found itself by 1964 in a situation in which an inefficient and costly transport system, with large deficits, was contributing materially to runaway inflation and balance-of-payments difficulties and was undermining the country's agricultural and industrial development. The government called upon the World Bank for assistance; terms of reference for the studies were drawn up and international consultants were selected. In the meantime, the government made vigorous efforts to recruit Brazilian counterparts. A separate agency was set up for this purpose, and about 80 Brazilian counterparts were selected. They worked full time with the foreign experts on the transport studies, and as a result Brazil has a core of transport experts who will be able to continue transport planning with progressively less foreign assistance. However, this successful effort was essentially a crash program to meet a crisis situation.

The third condition for a successful survey is that transport plans must be tied in with realistic planning for area and sector development—discussed below.

Scope of Program

The scope of transport programs can vary widely. The most typical—and generally the most desirable—program covers a country's entire transport system, including all modes of transport. An exception is urban transportation which has its own unique problems and is to a considerable extent separable from the intercity and rural transport network. Nevertheless, urban transport must be considered for total vehicle requirements, and to the extent that it affects intercity traffic, e.g., where urban congestion interferes with adequate access to a port, or where bypasses are needed.

Some programs are less broad. In India and Brazil, for example, the size of the country and the complexity of the transport system made it impractical to prepare programs which would cover the entire country at once. These countries were, therefore, divided into regions, with the idea of ultimately building up a country-wide program from the regional ones. Some programs do not cover all modes; a program for Argentina, for example, excluded aviation, and one for Honduras was limited to roads. This is usually undesirable. Many transport programs do not include, at least in detail, feeder roads for agricultural projects or those intended to open up new land for development. In these cases roads are a joint cost with other investments, and the realization of benefits depends

not only on the roads but also on these investments. The planning of feeder roads is, therefore, handled more effectively in agricultural surveys than in transport surveys, though transport programs frequently include financial allowances for such roads.

Some studies cover more than one country. A transport survey of Central America in 1965 included five countries, and several studies in Africa are also on a multi-national basis. This is important where major traffic flows go beyond the border of one country, such as those of landlocked countries like Chad and Bolivia.

Basic Steps

The preparation of a transport program can be divided into five distinct, though interrelated, steps. 1) Identify the basic goals which are being sought. 2) Prepare an inventory of existing transport facilities, their condition and utilization. 3) Forecast traffic and its distribution to each mode of transport. 4) Examine transport policies and operations to determine what improvements can make it possible to carry future traffic at minimum cost. 5) Prepare a detailed program identifying new investments and their priorities. Each step will be discussed separately below.

Objectives of the Program

Since transportation is a service designed to connect production and population centers with each other or with consumption centers, transportation cannot be said to have a separate objective independent of a country's developmental goals. A country's general strategy for economic development dictates the appropriate transport strategy, though the former must, of course, take into account transport costs as one of the relevant factors. Within this broader context, the objective of transport planning is to ensure that the traffic will be carried at the lowest cost to the economy.

It is one of the facts of transport life that governments use transport services extensively to subsidize a variety of social, political and defense objectives through rates and fares below cost. In some countries, all railway passenger traffic is subsidized while in others specific groups such as the military, school children, government officials, priests or commuters pay especially low fares. Aviation tends to be subsidized to promote a country's international prestige. While some of these subsidies are the result of conscious government decisions, many are quite inadvertent because costs are not known or because of a general reluctance to raise tariffs.

There may, indeed, be a limited role for subsidies to transportation. For example, new transport systems may deserve support as

a form of infant industry, as in the case of aviation in its early stage. There may also be instances where the promotion of transport per se is a legitimate goal, as where a country's social and political integration can be promoted in this way. On the other hand, a government can hardly have a legitimate interest in promoting the less efficient transport alternatives. Moreover, even if the social, political and defense objectives deserve government support, subsidized transportation is a particularly inefficient method for achieving them.

The subsidy usually has to be financed by charging prices higher than costs for other transport services; this was possible for the railways when they still had a monopoly position but has become increasingly less feasible with the growth of road transport. Passenger subsidies are frequently financed by charging higher rates for freight—either for bulk commodities, whose transportation is essential for the country's industrial growth, or for general cargo, whose shift to road transport is thus needlessly accelerated. (In the Soviet Union profits on passenger services have helped to subsidize freight traffic, in sharp contrast to the practice in most countries.) Transport subsidies tend, in effect, to support indiscriminately a multitude of diverse activities ranging from business functions, vacations and social visits to religious pilgrimages; these hardly deserve equal government support and, if openly avowed, would rarely receive it. Transport subsidies distort the location of new industries or population, and discourage existing industries from moving to more economic locations. It is sometimes argued that keeping transport prices low, regardless of cost, helps to reduce inflation; this may be valid in the very short run but it merely increases government deficits, which are at least as inflationary as higher transport prices.

Instead of using the transport system as a subsidy device, it would be much more efficient to have the responsible government agencies finance the subsidy directly through their own budgets, either by supporting the ultimate objective directly or by buying the transport service at commercial rates. If, for example, a government deems it desirable to promote the production of iron ore, direct payments to producers are more efficient than hidden transport subsidies. It is not surprising that many of these objectives look much less important to the interested government agencies when they have to finance and justify them directly in their own budgets than when they can impose the costs on others.

Transport Inventory

Most developing countries do not have adequate, up-to-date and readily accessible information about their transport system. The preparation of an inventory of available facilities, and of their condition and utilization is essential even though it is a time-consuming job.

The inventory should cover not only the physical facilities, but should also indicate the degree of their utilization, the volume and composition of traffic flows, the costs of transport and the related tariffs, the financial situation of transport enterprises, and the government's transport policies. Such an inventory can be prepared most readily for railways and other transport entities which are operated on commercial lines and have appropriate accounting and statistical systems. Most railways have at least some information on their facilities and rolling stock (including type, condition and utilization), on traffic carried, on overall costs and tariffs, and on their financial condition. However, in the case of many railways the data are incomplete; few railways, for example, have sufficient information on the origin and destination of much of their traffic, or on traffic by individual lines, on the cost of carrying different types of traffic (commodities as well as passengers) by individual lines, on the replacement cost of assets at present values, and on maintenance costs of various equipment. In addition, the available data are all too often inaccurate. For aviation, ports and ocean shipping, the situation is similar to railways, but reliable information on inland shipping and roads and road transport is even rarer. Most countries have a general idea of the length of their road network and how much of it is paved, but few have an inventory which describes the condition of the roads, their width, grades, curvature, capacity and traffic, all of which are necessary for intelligent planning. Similarly, it is essential to have an inventory of the motor vehicle fleet by type, capacity, age, operating costs, etc.

The collection of road traffic information is unusually complex. Many developing countries have begun only recently to make traffic counts, and these are generally available for only one or two past years, for a few days during the year and at a few locations which may not be representative. A proper traffic inventory should at least provide information on major commodities and passengers carried, their origin and destination, the type of vehicle, its capacity and load factor. Because traffic may vary widely during the day, the week and the seasons of the year, it is necessary to get hourly and daily traffic data, as well as enough information on seasonal variations to make reasonable estimates of annual traffic. Only after the existing traffic pattern has been established is it possible to estimate future traffic.

Forecasting Traffic

Since future traffic depends on developments in the industrial, agricultural, mining and other sectors of the economy, and on population developments, traffic forecasts can be no better than forecasts of developments in these areas. It is not sufficient to estimate output in macro-economic or sectoral terms. Roads, railway lines

and ports are fixed at definite locations, and it is necessary to estimate not merely future production and consumption but also its specific location. The best time for a transport survey is when planning is also going on for other sectors.

In general transport forecasts and plans should be limited to about ten years—five years in detail and an additional five years in less detail. Macro-economic planning should, of course, have a longer horizon and beyond the ten-year period might well include expenditures under projects previously started, projects which were reviewed for the ten-year program but found to be premature, and global estimates of transport requirements on a macro-economic basis.

After estimates have been made of future production and consumption, these must be translated into traffic. This is generally done on the basis of past relationships between output and consumption and traffic requirements, with adjustments for foreseeable future changes, such as a possible decline in the railway's share of certain traffic, changes in relative costs, etc. Recently attempts have been made to build transportation models, which are an expression of the mathematical relationships between the magnitude of traffic-generating factors and the volume of the resulting traffic. Unfortunately, the factors are frequently complex and the construction of the model difficult and time-consuming. For example, an initial model for coal transportation in the Eastern Region of India was able to explain only about one half of the actual coal traffic. It became necessary to proceed with the more standard techniques of reliance on past traffic trends adjusted for specific new developments in sight. Nevertheless, such models can be useful tools and they will no doubt be used increasingly in the future.

The final step is to estimate the division of traffic among the various transport modes. In principle, the traffic should be allocated to the particular mode which can carry it at lowest cost. In this connection, three special problems deserve mention. First, determining costs is frequently difficult because of inadequate data and because the relevant costs are those to the economy, which may differ from private, financial costs. Second, traffic will in practice not move via the low cost carrier if the rates charged do not reflect transport costs. This is frequently the case, especially for railways, where rates take into account the value of the commodity and tend to be uniform among different lines in spite of cost differences. User charges for roads and ports also rarely reflect costs properly. The transport survey should indicate the resultant distortions and recommend the steps needed to eliminate them.

A third difficult arises from the fact that there are important qualitative differences between the various transport modes. Road

transport, for example, provides a door-to-door service, usually with substantial savings in time compared to railway service, greater frequency and reliability, lower breakage and losses, quicker settlement of claims and other similar advantages. This is particularly important for general cargo and accounts for a major part of the trend to road transport, even though the direct transport costs by road may in fact be higher than rail costs. It is important to keep in mind that the ultimate aim is not lowest transport cost but lowest cost for the delivered goods; these two are not always the same. The neglect of these total distribution costs in some surveys accounts for unduly optimistic forecasts for rail and coastal shipping potentials and underestimates for road transport.

Fortunately a number of practical considerations make long-term traffic forecasting more manageable than it might appear at first sight. First, a major part of the traffic of many railways and ports consists mainly of only a few bulk commodities, such as coal, ores and grain, so that the analysis can be largely limited to these. Second, much of the future traffic, especially in the short and medium term, is traffic which exists already, and basic patterns in the location of industry, agriculture and population do not tend to change drastically overnight. Third, many transport investments are relatively lumpy. A port berth might be justified for 80,000 tons of general cargo per year but might also handle efficiently 150,000 tons, so that a precise estimate of whether the traffic will be 80,000 or 125,000 tons may not be needed; for bulk cargo, the range might be as much as 300,000 to 1 million tons or even more. Similarly, a paved two-lane road may handle as many as 5,000 vehicles per day, so that estimates of 3,000 or 4,000 vehicles may still lead to the same investment.

Fourth, in many cases the forecast need only be made until the time when traffic reaches the project's capacity, provided it can be assumed that traffic will not decline thereafter; this is frequently the case, especially for roads. Fifth, because future benefits are discounted by opportunity costs of capital, which in developing countries tend to be as high as 10 or 12 percent, the correctness of forecasts in the more distant future is substantially less important than it would be at lower discount rates. Finally, because transport, and especially road transport, is nearly always very dynamic in developing countries, an overestimate of traffic might be made up a short time later, so that the cost of the mistake would be less than if the estimated traffic level were never reached. From this point of view, investments in railway lines tend to be much riskier because traffic for most railways has been growing less rapidly than for roads, while the life of railway track and equipment tends to be very long.

Transport Policies and Operations

Many transport programs neglect to make a thorough review of transport policies and operations to ensure the efficient utilization of existing investments and to minimize the need for new ones. This is particularly important for developing countries in view of their serious shortage of capital, the large requirements for transport investments and the heavy foreign exchange component of these investments. Some of the most important policies which a transport survey should examine include:

a. The rationality of the criteria used in deciding on new investments. Few countries base transport investments on the systematic application of cost-benefit techniques; where such studies are made they tend to have such deficiencies as the use of low financial interest rates instead of the higher economic (opportunity) cost of capital, the failure to take into account alternative road transport when building a new railway line, or vice versa, chronic underestimation of costs, and innumerable others.

b. The relationship of tariffs to costs. An efficient allocation of funds to transportation compared to other sectors, and an optimum distribution of traffic among competing transport modes, require that rates and fares reflect the costs of the principal categories of traffic handled—not only for the network as a whole but also by individual line. The survey should, therefore, identify tariffs above and below costs of major traffic categories, the resultant distortions in traffic and investments, and whether adequate freedom exists in fixing and adjusting tariffs. Because the charges for public transport in many developing countries are frequently below cost, transport unfortunately tends to be a serious drain on public savings. Much can be learned from Soviet practice, where the railways make substantial contributions to the government budget in addition to financing the expansion of railway capacity.

c. The adequacy of user charges. In most developing countries, governments do not charge the users of roads, ports, airports, etc., adequately for the cost of these services through fuel taxes, license fees, tolls or other charges. In most Latin American countries, for example, the users of roads pay for less than half of road costs. This is likely to lead to distortions between different transport modes, overinvestment in transport as a whole, inefficient location of new industries, and an undue burden on the tax system and on public savings.

d. The nature of the regulatory system. The transport survey should also review governmental policies on the regulation of trucking and bus services, including licensing, route and distance

restrictions, limitations on rates and fares, weight limits, and other controls, as well as their enforcement. Many developing countries have inherited regulatory systems developed in Europe and the United States to protect railway monopolies or to meet the special problems of the depression of the 1930s.

e. Other policies which should be reviewed include: 1) whether taxes, including import duties, are neutral among the various transport modes; 2) whether the government discriminates in the availability and terms of financing among the modes; 3) whether the government tries to allocate traffic directly to a specific mode; 4) whether the government controls the production or imports of vehicles, spare parts, etc., in a way which discriminates against a particular mode; and 5) whether the government imposes any special responsibility on a particular mode without adequate compensation.

Because governments can develop and administer their transport policies only when properly organized to do so, a transport survey must also review the institutional arrangements. It must ask whether a central transport organization exists at all, and if so analyze the scope of its authority, its staff, and whether adequate statistics are available, so that policies can be established and applied intelligently.

The opportunities for minimizing the need for new investments by operational improvements are usually very extensive, especially for railways and ports, but also for roads. Such improvements relate to all phases of operations: from the better utilization of rolling stock and other equipment to the better maintenance of roads, better labor practices, modern accounting and statistical systems, and appropriate organizational arrangements and administrative procedures.

For example, the Brazilian Federal Railways had intended to spend about $80 million on rolling stock during a recent three-year period. This investment had been based on a traffic forecast and assumed more or less the prevailing operational practices. However, a review of these practices indicated that productivity could be drastically increased. Twenty-five percent of the diesel locomotives were out of use when better maintenance facilities could have reduced this to less than 10 percent; the utilization of serviceable diesels was only about 70 percent, as against the 85 percent common in other countries; the average turn-around time of freight cars was about 13 days, when 8 days would have been a reasonable goal; the average speed of most trains was less than 14 miles per hour, when better operations in stations and yards, better track conditions and signalling equipment might have increased this to perhaps 20 miles; because of the seasonal nature of agricultural production, the Railways had considerable excess capacity in the off seasons, even though more silos and other storage facilities might have

reduced the extremes of seasonal transport requirements; and trains were generally short because station platforms and marshalling yards had never been enlarged. What the Railways really needed was not large new investments in rolling stock but measures to improve the utilization of existing stock. It was estimated that with such improvements it would be possible to reduce rolling stock requirements by about $50 million, though it was, of course, necessary to increase other investments.

The operational problems of many ports are especially acute. At some berths of the port of Calcutta, for example, wheat is unloaded by bagging it on board ship, unloading it, and then emptying the bags in order to transport the wheat by rail in bulk. As a result the unloading rate per day is about 1,000 tons per ship, compared to 4,000-6,000 tons at other Indian ports using mechanical unloading facilities.

Organizational and administrative arrangements are also frequently unsatisfactory. Many railways do not have adequate authority over day-to-day operations; highway departments may be saddled with responsibility for other public works; the various port activities, such as pilotage, tug assistance, loading and unloading, customs, storage and inland transport are often not properly integrated.

The Investment Program

Once future traffic patterns have been estimated and the opportunities for policy and operational improvements have been taken into account, the next step is to decide on the new investments needed to carry the traffic efficiently. It is useful to divide investments into three basic types: investments needed to increase capacity, those to replace old equipment with similar but new equipment, and those necessary for modernization—for new and different equipment.

In the United States, for example, the history of railway investments can be divided into three stages. In the initial period up to the end of the 19th century, most of the investments were to increase track and other capacity; thereafter, until World War I, investment in rolling stock became more important. After 1920, railway passenger traffic declined drastically, freight traffic increased only modestly, and the railway network was reduced by almost 40,000 miles so that net investments did not increase significantly despite modernization. In the early period, large indivisible investments were made, which were only gradually completed; once the basic network existed, output was free to expand with relatively little additional investment. This pattern of investments is relevant for developing countries. In Argentina and Brazil, for example, hardly any

new investments are needed to increase railway capacity; investments are only required for replacement and modernization. The Indian Railways, on the other hand, still require large increases in capacity and, within their limited resources, have to give lower priority to modernization.

In road construction, too, the first investments are to create capacity, but after a basic network exists the major effort consists of improving it. Paving a gravel road is a form of modernization, but also increases capacity. As for road vehicles, the initial effort must be to create a minimum fleet. In the early stages of the growth of the fleet, replacement tends to be only a small part of total investments in vehicles because they are used for long periods—in India, for example, as much as 20 years. Such long periods may partly be explained by the high capital costs, while maintenance costs are relatively low due to the large labor component. As these relationships change, vehicles are replaced earlier and replacement becomes an increasing proportion of total investment.

Investments to expand capacity are most directly related to increases in freight and passenger traffic, so these can be translated readily into rolling stock requirements, additional port berths, or aircraft. Because of fluctuations in demand, such as those caused by seasonal variations in agricultural output, there is inevitably excess capacity during some parts of the year. However, if demand is larger than forecast and if capacity cannot be quickly expanded, there is the danger that transport may become a bottleneck to economic growth. To calculate the proper level of reserve capacity requires a delicate balancing of the extra costs involved and the costs of not being able to carry some freight at all and thus slowing down economic development. The problem of excess capacity is perhaps less serious for road transport because of the greater flexibility of the vehicle fleet and the fact that most roads in developing countries operate far below physical capacity.

The proper timing for replacement of equipment depends primarily on two types of factors: first, the capital costs of new equipment minus the scrap value of old equipment, and the relative costs of maintaining them, which tend to increase with age; and second, obsolescence, i.e., the availability of new equipment incorporating technological improvements. The best timing of replacement investments is by no means the same for different countries. The labor component of maintaining freight cars, for example, is substantially greater than of producing new cars. In countries with low wages and a high cost of capital, replacement should take place later than in more developed countries. This is, in fact, what happens. For example, a study of the optimum age for replacing freight cars in India indicates that it is somewhere between 40 and 45 years; a

similar analysis for New Zealand indicates it to be no more than 35 years.

The third type of investment is for modernization of facilities or equipment which have become obsolete because of technological improvements or other radical changes. For example, in the replacement of steam locomotives, the relevant comparison is no longer between the capital and operating costs of new and old steam engines, but with the costs of diesel or electric locomotives. In the case of roads, modernization is dictated by considerations such as large increases in traffic volume beyond road capacity, the use of heavier or bigger trucks, and higher speeds. Port facilities might become obsolescent because of the use of larger ships or a shift to container shipments of general cargo.

Once the investments needed to increase capacity, to replace old equipment and to modernize have been identified, the next step is to determine priorities among them. This involves generalized cost-benefit comparisons: at first these must be based on relatively rough, general estimates, but they should be refined at a later stage when feasibility studies of individual projects are undertaken. At the level of the transport sector program it is not possible to make detailed forecasts for each individual road section, and forecasts must, therefore, be limited to such broad categories as short- and long-distance freight and passenger traffic, by major types of road. Similarly, it is sufficient to use general criteria for unit benefits, such as the reduction in vehicle operating costs when gravel roads are paved, or the value of the time of ships which is saved when port congestion is reduced. For railways, it is sufficient to focus on the half dozen major commodities and to use more generalized assumptions for estimating general cargo traffic.

Priorities should be determined not only for each transport mode, but also among modes; most transport programs are deficient in this respect. There are two special problems in establishing priorities. Comparisons are difficult when the quality of service varies widely as it does between rail and road. Secondly, while techniques for calculating the benefits of cost-reducing investments are reasonably satisfactory, the benefits of capacity expansion to handle more traffic are difficult to calculate because they involve estimating the net value of the new output.

Determining the proper overall size of the transport program requires, in principle, a comparison of the marginal transport investments with those in other sectors, such as education, agriculture or even defense. Economics at this stage has not developed adequately the tools for each intersector comparisons. In theory, all transport investments are justified with a rate of return higher

than the country's opportunity cost of capital, but in practice programs based on this criterion have generally been larger than seemed justified for other reasons. There may be a number of reasons for this, such as failure to use proper estimates of real costs for capital, labor and foreign exchange, the chronic underestimation of costs, institutional rigidities which prevent the free flow of funds into transport or a particular mode, or the failure to work out project interrelationships, with resultant overcapacity. There are, also, technical limitations in that many highway departments, for example, are inadequately staffed for the efficient planning and execution of road works, so that sharp increases in investments cannot be undertaken quickly.

The transport program should indicate not only the physical investments needed, their costs, priority and timing, but also how the program should be financed. There are essentially three major sources of finance: charges on the users of transport services (whether earmarked or not), revenues from general taxation and domestic borrowing, and foreign aid. The first requires, for example, a forecast of railway revenues and expenditures to indicate to what extent the railway will be able to finance its investments from depreciation reserves and profits; if such internal sources are inadequate it may be appropriate to increase tariffs. Similarly, the level of road user charges, e.g., gasoline taxes, or port charges will have to be examined to determine possible financing from these sources. The foreign exchange costs of the investment program need to be determined because foreign lending is frequently restricted to the financing of imports. While the amount of foreign assistance is only to a limited extent within the control of developing countries, the distribution of investment financing between the government budget and the transport users is. In most countries a much greater emphasis can and should be placed on financing through adequate user charges.

[Condensed from "Preparing Transport Sector Programs," Sector and Project Planning in Transportation. Washington (D. C.): International Bank for Reconstruction and Development, 1967, World Bank Staff Occasional Papers Number Four, pp. 3-31. NOTE: The Annex to this document provides an outline of "Terms of Reference for a Transport Survey." Requests for reproduction should be made to the World Bank.]

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