SOME THOUGHTS ON FEASIBILITY STUDIES

Occasioned by the Appraisal of Road Projects in Thailand

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This article is a discussion of problems experienced by economists and engineers during more than 100 road project appraisal studies in the Far East in 1966/67. The studies had certain special features, but in general conformed to the pattern of road feasibility studies followed by consultants all over the world. The terms of reference for the studies were drafted by the Transportation Division of the International Bank for Reconstruction and Development.

In most countries 10 to 30 per cent of public expenditure is on roads. Road project appraisals therefore represent an important field of application for applied economics. Our discussion is not about the theory of the subject, but about techniques. The central theme, so far as there is one, is how very difficult it is to handle actual cases in this field to a standard of correctness which is intellectually tolerable.

THE BACKGROUND

Thailand, with a population of 30 million and an area of over half a million square kilometers, has 10,300 kms. of main and secondary highways; just over half are concrete or asphalted roads, the rest unpaved, mostly laterite roads. The network of maintained provincial roads is about 6,200 kms. The majority of these are laterite roads or worse. Lower down the scale there are at least 15,000 kms. of identifiable local village roads getting little, if any, maintenance from the local authorities. With the exception of main and secondary roads, the greater part of the unpaved roads become intermittently unsuitable for ordinary four-wheel motor vehicles during the five to seven months of the monsoon. In addition, there are municipal roads and a fairly extensive network of irrigation bund roads; and in recent years American aid agencies have financed the construction of security roads in sensitive areas along the Laotian and Cambodian borders.

There are some 3,600 kms. of railway routes connecting the regional centres with Bangkok. Inland waterways are of major importance. The larger rivers and canals in the central flood plain are navigable by the typical three-to-five-ton river craft all the year round. In the rainy season, when minor streams and canals become full and much of the central plain is under water, all but paved roads become difficult to negotiate and transport in the countryside is largely by boats, ranging from small dug-outs to the barge trains steaming up and down the Chao Phraya.

The average annual income is £50 per head. Vehicle ownership is 12 per 1,000 inhabitants. Economic growth is fast. In the last eight years national income has been increasing by over 7 per cent a year, and the target for the next few years is over 8 per cent. Vehicle registrations and traffic on the main roads have been increasing on average by 20 per cent a year. Since 1960 there has been a tremendous expansion in motor-cycle ownership. The foundation of economic growth is the sound balance of payments, based mainly on the agricultural sector, though rubber and tin and foreign aid have also contributed. In part, however, the boom – and especially the froth visible in the fashion boutiques, swimming pools, night clubs, luxury hotels and restaurants of Bangkok – is generated by the Vietnam conflict, and to that extent the foundations of Thailand's remarkable growth are less secure.

The network of main and secondary highways is being extended and improved in line with general economic development. Under a current £145 million programme some 7,600 kms. of main and secondary routes are being constructed or improved to all-weather standard. The amount of paved road increased from 2,000 kms. in 1956 to 6,000 kms. in 1966, and will be well over 8,000 kms. by 1971. The budget allocations for this year and next year are about £30 million a year, compared with £5 million a year from 1960 to 1965. This crash programme for main and secondary highways is expected to be completed in 1971.

With the gradual phasing out of this programme, more funds will become available for tertiary feeder roads, which have hitherto been rather neglected. In anticipation of this shift in emphasis from main and secondary to tertiary roads, the Department of Highways commissioned a firm of consultants to examine the country's feeder road needs and to identify worth-while projects for a long-term feeder road programme.

THE APPROACH

The preparation of the feeder road programme requires answers to the question: how much should be spent on the programme as a whole, and on which projects, in order of priority?

The first part of the question – how much to spend on the programme – raises wider issues. How much should be spent on roads altogether, and on transport, as compared with other sectors? Indeed, what proportion of the national income should be allocated to capital construction? These wider issues are unavoidable in any planning exercise, however limited the scope. Logically, the feeder road programme should be determined simultaneously by the merit of the individual road projects on the one hand, and by the needs of other public investment and national economic planning on the other.

The study was not, however, conceived in such a wide context. The approach was laid down by the World Bank, which in the main follows the methods and principles of project appraisal evolved over the years by U.S.A. federal agencies. In this approach, the appraisal of a project is a self-contained operation: macroeconomic processes and planning form the background of project appraisal, but do not enter into it. Thus we were not asked to determine the feeder road programme as part of a general transport study, or to construct a macroeconomic model. At the same time

no firm budgetary limit was laid down. The central planning body and the department of highways admittedly had views on the subject, but these were pragmatic and flexible views, and the planning authority expected to obtain a further indication of the investment needs in this sub-sector from the results of the study.

In spite of these limitations, it was still profitable to examine possible projects one by one, short-listing promising candidates in order of priority. A family may not know how much it will be able to spend on clothing next year, or how much it will be able to spend altogether, but it can still examine and evaluate its various clothing requirements, and in the process the clothing budget itself begins to take shape.

The narrow conception of the study as a practical planning job at Highway Department level nevertheless contained the germs of a misunderstanding. Exclusion of the wider economic setting, and indeed of any general economic research, did not make the economic side of the study any less complex and taxing. The main weakness in the concept was the understatement of the economic aspects. Shut out at the front door, the macroeconomic waters seeped in through the back door as soon as the appraisal of individual projects began.

In practical terms, the team was understaffed on the economic side. Engineers and non-engineers had parity in the team; but of the three key expatriate members two were engineers and one an economist. It is not uncommon for economists to be outnumbered on feasibility teams, although the correct proportion at this stage of project evaluation is more likely to be two economists to one engineer.

Practical Constraints and Guidelines

From what has been said so far, it is evident that the consultant's task in Thailand was not to prepare the best programme, but to prepare a reasonable feeder road programme, in place of no programme at all. The Department of Highways was soon to enter on unfamiliar ground – the allocation of funds for the construction and improvement of feeder roads. Without well-formed ideas on priorities, it would be defenceless against pressures from all sides.

The size of the programme was not predefined, and the question of how many projects to examine and to select was in principle left open. In practice it was necessary, and not too difficult, to guess at the amounts likely to become available for feeder roads. Given an average cost of £13,700 per kilometer, and an average expenditure per kilometer of £1,350 to cover five years of maintenance, the total programme was expected to be of the order of 1,200 kms. There was little doubt that 1,200 kms. of worthwhile projects could be found in a country the size of Thailand, but it was clearly desirable not to waste the consultant's time on unpromising schemes. From over 15,000 kms. of identifiable routes, tracks and new alignments, the Department of Highways itself pre-selected 2,525 kms. of *prima facie* promising projects to form the subject of the study. Further roads could be added if insufficient good projects were identified from among the 2,525 kms. This would depend, of course, on the test of minimum worthiness adopted by the consultants, a subject to which we shall return presently. In the event 62 roads, with a total length of 1,288 kms. and estimated construction/improvement cost of £18 million, were identified and ranked in order of priority.

Twenty people worked full time for one year on the project: 5 economists, 5 agriculturists and 10 engineers. Three of the 20 people were provided by the con-

sultant; the rest were Thai personnel. The main difficulty in practice arose on the economic side. The job is not easily defined and delegated in the form of precise instructions. The economist, like the engineer, knows what he is looking for, though this may require some explaining, but he can never be quite sure in what form the vital piece of information will be available in particular cases. There are always supplementary questions to be asked, and much depends on the initiative and experience of the field worker. The skills of applied economic research cannot be easily transplanted to a less advanced economic environment. The expatriate engineers, on the other hand, found no problem in delegating much of their field work to their Thai colleagues.

Ranking of Projects

The main object of the study was to identify good projects, *i.e.*, projects with discounted benefits exceeding discounted costs. Candidate projects were appraised on the assumption that they would be carried out in the same year (1969) and that their economic life would be 15 years. For a few large projects, construction was assumed to be spread over 2 years. Projects showing a positive net present value were worth carrying out and, it seemed, could also be afforded: their total construction and cumulative 5-year maintenance costs happened to agree well with the initial budget estimate.

The budget estimate was, however, only a tentative figure, and the most obvious explanation of the requirement that good projects should also be arranged in order of priority was that there might not be enough funds to carry out the whole programme. For the purpose of ranking good projects when funds may become scarce it is necessary to use the benefit-cost ratio, or a similar criterion relating benefits to the scarce resource, if the largest net present value is to be obtained with whatever funds are forthcoming.[1] The World Bank prefers the internal rate of return method. We decided against it, mainly because of the additional arithmetic involved in trying to find the rate of discount at which benefits and costs are equal. It also seemed preferable to settle at the outset, and as part of the study, what constituted the critical rate of interest. The undiscounted data were, however, printed *in extenso* to facilitate re-calculation according to some other method or with a different discount rate.

Construction and maintenance costs are very closely related. Moreover, lending agencies, after some discouraging experiences, are anxious that new investments should not exceed the financial capacity of developing countries to maintain new roads in years to come. Construction and cumulative maintenance costs appear, therefore, in the denominator. So should – with a minus sign – savings in maintenance costs expected to result from the project.

Two other comments may be appropriate at this point. As will be mentioned later, projects were appraised on standards of construction and maintenance defined as those likely to maximise benefits. Benefit-cost ratios would not be improved or maintained by reducing the scale of projects. When funds are scarce highway authorities are indeed tempted to make funds stretch further by lowering construc-

[1]When projects vary in size, as in this case, a list of priorities according to benefit-cost ratios is likely to diverge widely from one based on net present values.

tion and maintenance standards. On our definition of projects nothing would be gained by transferring funds from project to project by this means.

Where the budgetary constraint exists, as often happens, merely in the form of a threat that expenditure may be cut by some indeterminate amount, the highway authority cannot do better than to carry out first the projects with high benefit-cost ratios, working its way down the list of priorities as long as funds last. But if the budgetary limit were reliably determined the question of priorities would present itself in a different form. Confident of its funds, the highway authority would have nothing to learn from our crude list of priorities. Instead it might wish to know at what time during the programme period to carry out each project in order to maximise the return on the £18 million investment programme as a whole. If we are certain that our resources are sufficient to buy both A and B within a budget period, we may maximise our satisfaction by buying B first, although A would rank higher and would be bought first if there were any doubt about our ability to buy both. The determination of priorities in this sense would presuppose a division of the programme into discrete phases, say 5 annual periods, and the appraisal of each project on the basis of its 5 possible starting years. A programming procedure would then be needed to determine, subject to various constraints about annual budget allocations or the desired geographical pattern of investments, the programme giving maximum return on the investment as a whole.

If the assumption that projects were to be implemented simultaneously at the beginning of the programme period had been relaxed, the ranking order would have changed here and there, but the general order of priorities would have remained recognizably the same. In one case the cost of the road could be substantially reduced by combining construction with the building of an irrigation canal in 1971. The benefits of the project would also mainly arise after irrigation. Appraising this project, as we did, on the basis of construction in 1971 instead of 1969 gave it a significantly higher rank and a better chance of being carried out by 1971. Some care is required in the handling of the DCF arithmetic in such cases. The gain of postponing capital expenditure may be considerable, especially if a high discount rate is used. The logic of the "with" – "without" project comparison requires full weight to be given also to all the benefits foregone by deferment.

The Interest Rate

In normal circumstances, when funds are allocated between alternative employments, the guiding light should be some form of the concept of equality of return on the margin. But the concept is too elusive and of little practical value. The opportunity cost of capital is a more tangible entity, and we looked at the structure of actual rates, which ranged from between 7 and 15 per cent per annum for relatively secure commercial and industrial credit and loan capital to over 2 per cent per month for doubtfully secured speculative credit. In Thailand the preference for consumption and money now is clearly strong, but is largely due to the pull of speculative investment, to the lack of a proper capital market and to the scarcity of sound long-term investment opportunities. One of the incidental objects of planned development is to remedy this. We thought that an economic return of 12 per cent was the sort of figure the national planning body in Thailand would or should have in mind as the minimum for projects such as ours. The World Bank, which was to

provide loan finance at 6½ per cent for some of the recommended projects, would have looked with disfavour at a rate of less than 10 per cent. A rate of 12 per cent meant heavy discounting of future benefits – by a factor of 0.183 in the 15th year. The choice of discount rate was not in fact critical. The priorities were not particularly sensitive to interest rates.

MINIMUM TOTAL TRANSPORT COST

The task of the consultant was to rank 124 road projects. Each presented several construction/betterment possibilities. Should a dirt track be evaluated on the basis of an initial construction to gravel standard, followed by an improvement to a bitumen surface in year X, or on the basis of an immediate construction of a sealed or a paved road? To make valid comparisons between projects, each project was evaluated on the basis of the programme likely to give the lowest present value for initial construction costs together with any subsequent improvement, plus road maintenance and road user costs taken over the 15-year period. It was desirable in arriving at the least cost definition of a project to keep to a minimum the amount of trial and error calculation. The engineers, too, wanted to know on what basis a project was going to be evaluated before they examined the line of the road and made the necessary measurements and quantity estimates.

In the determination of minimum total cost, present and expected future traffic are the key variables; and we were looking for a formula to give the minimum total cost as soon as traffic projections were available. Since the growth of traffic would be dependent on the project itself and on adjacent road projects, including other feeder roads, a certain amount of revision was required. The feedback effect of traffic was not, however, as serious as might be supposed. In many cases the estimated generated traffic was not large enough to call for a revision of the initial least-cost solution.

Road maintenance costs were pre-calculated as a function of construction standard and traffic. They were defined as the costs necessary to keep the road in an unchanging condition. For each construction standard they were a simple rising function of traffic. The engineers however, protested, that the assumption of unchanging quality could not be satisfied beyond a certain traffic density, at which maintenance costs would reach their practicable maximum. It was decided to make this concession to reality, although it made the road user cost function a little more complicated.

Road user costs were expressed as a function of construction standard and the volume of traffic. The volume of traffic would affect congestion, which would affect vehicle speeds and hence road user costs; the volume of traffic would also affect the condition of the road, and hence vehicle operating costs.

The effect of traffic on the condition of the road was generally found to be the more immediate and more important problem, especially on the lower grade roads with which we were mainly concerned. Although such roads might also become congested, the effect of congestion on speed and user costs was much less important than the effect of traffic on the quality of the road.

Minimum total cost formulae were worked out on different assumptions about

initial traffic and traffic growth. Three construction standards were considered adequate for the conditions encountered:

A. Construction of a road 6 meters wide with a 20 cm. soil aggregate surface.
B. Construction of a prime coat and single surface treatment road, with a 5 meter wide pavement and 1½ meter shoulders, wheel load of 10,000 lbs. and annual average daily traffic of 200 to 750.
C. Construction as (B) above, but with a 5 cm. penetration macadam surface and annual average daily traffic of 200 to 1,500.

The problem was further simplified by the assumption that vehicle operating costs on road (B) and (C) would be the same within the specified traffic volumes. Guideline solutions were then obtained by working out a few representative cases in which the initial traffic volumes were specified and the annual rate of growth was assumed to be typical, *i.e.*, 12 per cent initially, decreasing to 4.5 per cent in the 15th year, giving 7 per cent average. The resulting guideline solutions are briefly summarised in the following Table.

Guideline Solutions

Initial Traffic (pcu's per day)	*Traffic after 15 years (pcu's per day)*	*Construction*
0–200	$\leqq$ 250	A
0–200	$>$ 250 $<$ 750	A initially but change to B to be considered when traffic exceeds 250 pcu's per day. If savings during rest of period justify improvement to B, construct initially to B/C geometric standard.
0–200	$>$ 750	A initially, but to B/C standard and change to C at 250 pcu's per day. Construct to C initially if 250 pcu's is reached in the first seven years.
200–750	$<$ 750	B
200–750	$>$ 750	C, but to secondary highway geometric standard if traffic reaches 750 pcu's in the first seven years.

User Cost Savings

After a project had been defined, its evaluation followed familiar lines. Nevertheless the carrying out of 124 project appraisals revealed some dark corners of the benefit/cost calculus.

Although the study was mainly concerned with rural roads of low traffic volume, the savings in road user costs were the decisive element in the justification of most projects, and the validity of the conclusions hinged largely on the quality of the data on road user costs. It was therefore important that the estimates of user costs on different types of road should be in correct relation to one another. In so far as we were concerned with priorities, this was more important than the correctness of the data in a cardinal sense.

Not much information was available about road user costs in Thailand. The data

published by Jan de Weille[2] proved useful; but a difficulty arose from the fact that his costs are expressed as a function of vehicle speed. How could one determine the average speed of vehicles on our 124 roads? It could not be done properly by direct measurement. But the main determinants of vehicle speed were the physical characteristics of the roads, not the traffic volumes. It seemed, therefore, more logical and more practical to express road user cost savings as a function of the physical characteristics of the roads and to estimate road user costs in particular cases by direct inspection of the roads in question. In order to obtain a reasonably accurate measure it was desirable to classify the relevant physical features of roads in more detail than in Jan de Weille, and in particular to include the quality of the riding surface.

A matrix of road user costs was designed in which the main variables were:

(a) the type of road – paved or sealed, laterite or gravel and earth;
(b) the condition of the surface – good, medium or poor;
(c) the gradient – level, rolling or hilly.

Other relevant characteristics, such as excessive curvature and narrow bridges, were also taken into account. There were no major problems in classifying roads segment by segment according to these characteristics. Vehicle operating costs on a road in its existing and improved states, and the savings due to the improvement, were then easily calculated from the matrix.

In adopting this approach the consultants were much influenced by *Modern Highway Planning Methodology*, by Professor Tillo E. Kuhn and Mahir Barutcu, prepared in 1966 for the State Planning Organisation of Turkey and the O.E.C.D. The cost data themselves were often conversions of Kuhn's data, cross-checked with data collected in Africa by Bonney and Stevens.[3]

The main problem in classifying roads and estimating costs was caused by the seasonal changes in the condition and quality of the roads. There was a corresponding problem in estimating traffic, for traffic data were not, and rarely are, collected often enough to assess seasonal variations. During and after the rainy season, up to the time when the district engineer may do his post-monsoon repairs, the surface of a laterite or an earth road might be classified as poor; in the dry season it might pass as good or medium. On rural roads there were also considerable seasonal variations in traffic. Given time, one might have inspected and classified the roads and taken traffic counts more frequently, so that weighted annual user costs could be calculated.

NORMAL TRAFFIC

The estimation of road user savings is, on the face of it, straightforward by comparison with the assessment of induced benefits; yet on closer inspection it bristles with problems.

The recipe used by consultants and recommended by the World Bank is simple enough: estimate normal traffic growth without the project on the existing road, assuming normal maintenance; then apply the operating cost rate (net of tax) on the existing and the improved road to this normal traffic growth; then extend, subtract, discount and sum to obtain the present value of the savings by normal traffic.

[2]Jan de Weille: *Quantification of Road User Savings*. I.B.R.D. & I.D.A., December 1965.
[3]*Road Research Laboratory Notes*, March 1964 and February 1965.

The problems of forecasting vehicle ownership and traffic volumes are formidable in a developing country, where growth curve analysis and the use of econometric and gravity models are almost wholly unfeasible. In Thailand, sophisticated forecasting was severely restricted by the recent origin and exceptionally fast development of motor traffic; by the feedback from road building to traffic, due to the large construction programme in recent years (a problem to which self-justifying forecasts may have contributed); by the impact of decisions by foreign manufacturers to assemble or manufacture vehicles in Thailand; and by the dubious nature of some of the data collecting processes.

The limited data available suggested average annual increases in registered motor vehicles of 15 per cent during 1955–1964, the largest increase being close to 20 per cent in 1959–1962. Traffic counts on the main roads indicated average annual increases of around 20 per cent in the last 4 years, with considerably less than this on rural roads.

Estimates of normal traffic growth on individual feeder roads were made by embarrassingly crude methods, based on the expected growth of the local economy and population and the expected trend of motorisation and vehicle ownership in the country as a whole.

Deduced Traffic

Normal traffic forecasts sometimes indicated that in the not too distant future traffic would exceed the level which the road was capable of carrying. Even with maximum maintenance, further increases in traffic would cause the road to deteriorate. User costs would rise. Although the mechanism of the process may be open to discussion, most economists would agree that there is a tendency for demand to fall off, or for the growth of demand to be restrained, when costs and prices rise. In some road feasibility studies, perhaps in the majority of them, the issue is avoided. Normal traffic is admittedly represented as growing at a decreasing rate, but not for this reason; despite the flattening in the growth curve, traffic is forecast to reach proportions which the roads could not possibly carry. In some studies user costs are fixed throughout, and that clearly is wrong; in others they are permitted to rise, but without effect on demand, and that too is wrong. In our study we decided to have two curves of normal traffic growth, one showing what the traffic would be if the road remained in its present condition, and one lower, corresponding to the deteriorating condition of the road.

The point at which the two growth curves divide and the subsequent course of the sub-normal curve depend on the rigidity of established transport arrangements, *i.e.* on the elasticities of demand and supply and the availability of substitutes and alternatives. To what extent would merchants, transport operators, farmers and users of transport be prepared to absorb higher costs? The answer depends on the alternatives open to them: alternative uses of the vehicles, alternative forms of transport on the same road (*e.g.* motor-cycles are used instead of four-wheel vehicles when roads become unsuitable for cars and trucks), and above all the availability of substitute routes and alternative means of transport.

The availability of substitute routes and means of transport was most important. If there were none and the area was largely dependent on the one route, producers and transport users would tend to absorb the increased cost. There might well be an

effect of income redistribution against the producers, the reverse of the observed improvement in the farmers' position *vis a vis* the merchants when roads were improved. Initially, production, sales, purchases, travelling habits and general transport arrangements would tend to show little response. For a time traffic might even continue along the same line of normal growth, whereas in a more flexible situation there would be some deceleration in the rate of growth. Sooner or later, however, the reaction would come. Some of the merchants would stop sending their trucks, and bus operators would reduce their services or move elsewhere. The economic development of the area would be unfavourably affected, possibly in a dramatic way. Traffic on the road might ultimately decline in conjunction with, and as the result of, decelerated economic growth. In the course of field work the focus was, therefore, on the availability and cost of transport on substitute routes and other transport facilities.

The savings in road user costs due to a road improvement were calculated on the assumption that in the absence of the improvement traffic would grow at the lower, subnormal rate. No attempt was made to evaluate, in terms of road user savings, the benefits of a project accruing to deduced traffic, *i.e.* to the difference between normal and subnormal traffic. Instead, these benefits were evaluated in terms of induced or indirect economic benefits, or, to put it another way, of induced economic losses from not carrying out the project.

The other form of substitution, between different means of transport on the same road, is a special case of traffic diversion; this also caused problems. A feature of traffic in Thailand, away from the main roads and urban centres, is the exceptionally fast increase in motorcycles in recent years. This has been due to various factors. As rural incomes increase, the motorcycle, as the cheapest form of motorised transport, is a step up from the bullock cart. On rural roads and tracks, the motorcycle is often the only practicable form of all-weather motorised transport.

Induced Traffic

One of the peculiarities of feasibility studies is that so much effort should be expended on forecasting the effects of projects and so little on checking the validity of the forecasts afterwards. Induced traffic, *i.e.* the effect of projects on traffic, is a case in point. It is estimated beforehand but rarely observed afterwards.

People usually do not travel or transport goods as an end in itself, but only to further some other economic or social acitivity. Therefore, when a road has been improved, any increase in traffic above normal growth should be explicable in terms of the activities generated by the project. In rural Thailand the purely social content of passenger travel was not likely to be large. At any rate it would probably be related to the economic activities of which output, real income and population may serve as indices. The relationship between these variables and traffic is unlikely to be simple. In Thailand it was found that personal travel and so-called small parcel traffic – such as taking a pig to a neighbouring village – were a more important constituent of traffic than evacuation of produce and imports of materials and manufactured goods.

A few experiments were carried out under favourable conditions. In some cases, the road studied was the only one serving a well-defined area; there was no through traffic, and the information on population and output was reasonably accurate.

Production consisted largely of a few agricultural commodities such as rice, beans, kenaf and corn, and it was not difficult to estimate the amount of agricultural produce requring transport by road. Before the results of traffic counts were available, estimates were made of the traffic on various assumptions about personal traffic. The assumptions, in terms of the number of journeys of a certain length per family per month, were converted into vehicle units, given data and assumptions about average loads. Adding calculated produce, import and personal traffic, we obtained good agreement with the traffic counts.

INDUCED BENEFITS

The purpose of estimating induced traffic was to forecast total traffic on the improved road, so that the right standard of construction could be determined and maintenance costs estimated. Induced traffic is, however, also often used as a measure of benefits. The argument is based on the concept of consumers' surplus. The price which the additional users pay is less than that which they would have been prepared to pay. This surplus is theoretically available to compensate those made worse off by the project. It is generally estimated at half the rate of savings attributable to normal traffic.

The willingness to compensate, as measured by the consumers' surplus, accounts for induced benefits provided that (a) prices equal marginal costs, (b) the scale of projects is too small to affect prices in general, and (c) no individual person benefits or loses by another's consumption.

Consumers' surplus as a yardstick of induced benefits is recognised by the World Bank and generally used by consultants. But prices do not equal marginal costs, and projects, especially in developing countries, are often large enough to affect prices and the general equilibrium. Moreover, since the setting and the object of projects in developing countries is planned growth, the evaluation of project benefits in terms of static partial equilibrium analysis seems inappropriate.

The World Bank appears to acknowledge much of this, but is not prepared to discard consumers' surplus. It merely admits that consumers' surplus is an insufficient measure of induced benefit, and consultants are encouraged to take into account the wider economic repercussions of projects as well. It is recommended that this should be done by estimating the additional net output attributable to the project from a comparison of hypothetical situations "with" and "without" project. The advice that both consumers' surplus and induced net output should be counted as project benefits is not easy to interpret, for consumers' surplus and net induced output are alternative rather than complementary ways of measuring the same effect. Feeling that the assumptions necessary to make the former approach valid were too restrictive, we attempted to account for induced benefits solely in terms of net generated output.

Induced benefits are often too important to be left out of the reckoning; one may, therefore, try to identify them and value them explicitly. This is an admirable ambition, but the virtual impossibility of achieving it with tolerable accuracy is not always appreciated. Some very strange figures are sometimes produced, which only a very uncritical person could accept as credible estimates of induced benefits.

Although in the end the consultants found little cause for satisfaction in their quantification of induced benefits (which constituted around 30 per cent of total benefits), at first sight one or two circumstances seemed to be in their favour.

In the majority of cases the areas served by the roads were almost entirely rural, agriculture making by far the largest contribution to output and income. The consultants concentrated, therefore, on the effect of road projects on local agricultural output. How would agricultural output develop if the project was carried out, and how would it develop without it?

An increase in transport efficiency will widen the market for local farm products and make them more competitive in existing markets; it will thus encourage output. The increase in output will depend (a) on the importance of the reduction in transport costs in relation to total costs, (b) on the supply of the factors required to bring about the extra output, *e.g.* the scope for increased agricultural productivity and the availability of land, labour, fertilizers, etc., and (c) on the elasticity of demand for the products in question.

The essence of the problem of estimating induced benefits is that to answer questions (b) and (c) presupposes knowledge of the expected or planned balance of demand and supply in the economy: of sectoral inputs and outputs and the associated shadow prices. In theory, the two questions are answerable in the context of a general macroeconomic model – which, it has already been mentioned, was lacking. The practical possibility of filling these blanks will increase as we improve our knowledge about what actually happens after roads are built. That knowledge too is as yet not very extensive. In Thailand the team was assisted by Professor Jones's study of the consequences of the Friendship Highway[4] and by Bonney's work on the relationship between road building and economic and social development in Sabah.[5] A comparison of a 10-year-old map with recent aerial photography of parts of Thailand carried out by F.A.O., checked on the ground with reference to road building in the last 10 years, yielded some useful clues.

Assessing the Scope for Development

No matter how large the improvement in transport, the effect on output will be nil if there is no further scope for increased agricultural productivity, or if the supply of one key factor of production is inelastic.

In Thailand it was found that there was usually scope for both increased productivity and more extensive cultivation. The main lesson derived from this part of the study was that in areas where the basic scientific work had been done – agricultural and soil fertility studies, soil surveys and maps – one could make good progress. One could conduct field enquiries and arrive at a reasonable assessment of the potential. In areas where such work had not been done, one could do very little, and it would not have made much difference if there had been twice as many agriculturists on the staff. The scientific groundwork is essential and takes a very long time. It cannot be undertaken within the normal time and budgetary limits of a project feasibility study.

All potentially cultivable land was marked on maps after examination of topography and soil characteristics. The proportion of this land considered presently

[4]J. H. Jones, *Economic Benefits from Development Roads in Thailand.* SEATO Graduate Schoo,l 1964.
[5]R. S. P. Bonney, *R.R.L. Notes* 519, 520, 648.

cultivable was defined according to its distance from a road. The area of land already cultivated was ascertained from agricultural statistics and by field work, and hence the scope for more extensive cultivation was discovered. Some extension would occur in any case. Any remaining cultivable land was a measure of the scope for accelerated extension of cultivation under more favourable conditions, such as improved transport. The process seemed logical, but at each step there were ample opportunities for error.

In the appraisal of improvement projects it was generally found that the scope for more extensive cultivation was not large. The scope for induced benefits would, therefore, rest chiefly on induced increases in agricultural productivity. Thailand produces a substantial surplus of rice and other agricultural produce for export; but by comparison with some other Far Eastern Countries, notably Taiwan and Java, agriculture in Thailand is not as intensive and efficient as it might be. Productivity might be much increased by fertilizers, by better seeds and better farming practices, and especially by double cropping and a change from a shifting pattern of cultivation to permanent farming.

Improved transport, we found, could play an important part in accelerating the growth of agricultural productivity. The net effect could often be very much greater than the improvement in transport efficiency might lead one to suppose, because the dissemination of information and experience, which is aided by better transport, is a big factor in productivity. The road project can act as a catalyst of far more important changes.

Agricultrual productivity in Thailand has been increasing by 2 to 2½ per cent a year, with considerable variations from area to area. Published studies and direct observations by our agriculturists were used to define attainable levels of productivity in each area, in the present state of knowledge. The gap between actual and attainable producitivity defined the scope for improvement. Given further advances in agricultural technology, the scope for improvement would be greater than this. To measure the increase in the rate of growth of agricultural productivity is, of course, very difficult. There was therefore a tendency to underestimate it. This sort of problem is common to all feasibility studies: the benefits which are most difficult to quantify, and which may consequently be quantified on a conservative basis, or not at all, may well be the most important ones. The aggregate effect of such understatements may be quite serious.

Labour Costs and Development

The brief prepared by the World Bank specified that additions to agricultural output should be valued "net", *i.e.* after subtracting all costs of producing that output except the cost of labour. It would have been artificial and arbitary to distinguish between labour costs and farmers' gain in rural Thailand. It was also an advantage to define the benefit as value added, *i.e.* as gross output less inter-industry expenses, depreciation and indirect taxes. This put it on the same basis as the National Account's Net Domestic Product at factor cost and constant prices, and made it readily comparable with savings in road user costs. Moreover, when a road project opened up a fertile area or encouraged agriculture in a semi-developed area, the economic opportunity cost of labour in Thailand would be very small. For the situation was one of basic agricultural underemployment, of farm plots too small to

sustain the family, with a high propensity for labour to migrate freely to other areas. The chances were, in fact, that the immigrants to the new area, far from ceasing to produce rice elsewhere, were previously eating somebody else's rice or preventing somebody else from producing rice more efficiently. The cost might be negative.

This treatment of labour was qualified in one respect. There would be a time lag between settlement and first production in the new area. The land development period could be up to 5 or 6 years in the case of plantation crops. Although virgin areas are generally resettled after the harvest and immigrants bring some provision with them, this might not be enough, and the time lag might act as an impediment to development. Accordingly, the government in its resettlement projects makes a grant to see the settlers through the initial period. Since the expenditure is in the nature of a non-recurring development cost, and might in fact include such items as the cost of hiring a tractor to clear tree stumps, it was treated as a complementary investment cost.

The Value of Developed Land

Projects were evaluated over 15 years. Bridges and earthworks have a longer life than that, so an allowance was made for their residual value at the end of the 15 years. Provided that the natural fertility of land was not exhausted, which it would not be if farming practices were sound, should not the value of developed land be treated in the same way as bridges and earthworks? If the area was promising, the market value of developed land 15 years from now, discounted at a high rate and even without assuming a long-term relative increase in land prices, might well exceed the cost of development. But we hesitated to value developed land on this basis, and regarded the lower historical cost of land development as equal to its residual value.

Demand Factors

Even in a situation of relative scarcity it is quite possible to produce the wrong type or quality of product. In some areas there were doubts about cassava, and in Southern Thailand there were serious doubts about rubber. Both products are mainly grown for export. The provision of access to areas suitable chiefly for rubber plantations was not by itself a guarantee of success. The introduction of alternative crops would be the critical development factor.

In a less accentuated form the same question arose in practically every case: how to allow not only for the uncertainties of demand itself but also for misjudgement, error and folly on the part of the farmers, merchants and others concerned? In parts of Thailand, to which access is difficult, the emphasis is for that reason on agricultural produce of high value and low bulk, such as sesame or castor seed. Melons are grown with a view to selling the seeds, not the melon. These areas – unlike the central plain, where the population is concentrated – do not often produce enough rice for local needs, because topography, soil or climate is unfavourable. The areas are dependent on exchange and transport. Improved transport and communications will open up the possibility of growing bulkier agricultural cash crops such as corn, cotton and wheat. Will the change in the pattern of cultivation be successful? Will the farmers respond in the right way to the opportunities? In Thailand a special case arises in the remote hills in the north and north west, where poppy is grown

with exemplary efficiency. Alternative crops which would produce income as high as that earned from opium have not yet been found.

One of the important assumptions in the analysis was that there would be the normal government measures and social restraints which were needed to enable the potential development to take place. In some cases the analysis could include a full statement of any special conditions and qualifications of the forecast accelerated growth. In others it was evident that to build or improve the road would not by itself make much difference: some other investment or project was required as well.

Complementary Investments and Related Problems

In most parts of Thailand water shortage or flooding is as important as transport in restricting the level of agricultural production. Whilst neither irrigation nor better roads alone would have made much difference, combined they made all the difference. The investments need to be evaluated as a single project. However, this was a road study, not a general rural development study. The whole economy can, no doubt, be subsumed under transport, but this is not a practical approach. On the contrary, when an irrigation or similar sectoral project was already in the planning stage, the construction or improvement of roads for produce evacuation and other rural purposes generally formed part of the sectoral project. This is a common and reasonable practice, provided the sectoral project roads, which are eventually liable to become the responsibility of the Highway Department in any case, are properly integrated with the highway network. The Planning Division of the Highway Department, and the Feeder Road team too, could not do their job properly unless they were kept informed and consulted at an early stage about the road schemes of other departments. We found interdepartmental co-ordination far from perfect. One of the roads on the list of improvement projects, for example, led from a main road to a district town which, together with the surrounding area and sections of the road itself, was due to be submerged in the near future by an irrigation reservoir. When the engineers visited the road the population had already been rehoused by the Ministry of the Interior, which also planned to construct new access roads. In making these plans the Ministry overlooked the existence of an already completed Irrigation Department road, and the Highway Department did not know about either. Finally, the Land Office prepared a report stating that the resettlement area, which the Ministry of the Interior selected without a soil survey, was largely unsuitable for agriculture, a conclusion confirmed by the rapid exodus of the resettled population.

The Feeder Road Team, in order to gain information about other government agencies' projects and their transport implications, revived an existing interdepartmental feeder road committee, through which other branches of government were also informed about the location of our roads and invited to comment upon them. Thus the feasibility consultant must be prepared not only to advise on but to modify and to set up administrative machinery, in order that he can carry out his work and that the results of his work may continue to bear fruit when he is gone.

Secondary Output Effects

Apart from the immediate effect of greater transport efficiency on output and productivity, were there any more indirect economic pluses and minuses to be

taken into account in the calculus of pleasures and pains? Clearly there were. One of these has already been touched on: the opportunity cost of the labour required to produce induced output. The consultants were assured that any transfer of labour to the developing area would have no unfavourable repercussions on output elsewhere in the economy, because labour was abundant and the opportunity cost of labour, of the types involved, was small enough to be ignored. In general, however, it was necessary to consider whether output was "net", or whether the envisaged increases in induced output would be large enough to have an effect on the price of factors of production – labour, land, capital, fertilizers, etc. For an increase in the price of factors of production might result in the curtailment of output in marginal lines elsewhere in the economy. If the yardstick was output, any such unfavourable side effects should be subtracted from the estimated induced output to arrive at the total net effect on output. Negative output adjustments might also arise on the demand side, if induced output was large enough to affect the price of the produce.

The legitimate presence of these side effects in feasibility analyses cannot be disputed. They may be left out of account because the project is judged to be too small to have an effect on price, or less convincingly because the effect is so diffuse that it is impossible to identify it, let alone to quantify it.

The feasibility economist, evaluating individual projects from an investor's or a banker's point of view, as it were, on a microeconomic scale, may also be deterred by some rather treacherous ground in the side-effects area. If net induced output is a benefit, on what grounds do we exclude the multiplier and accelerator effects of the road investment itself? In a country with a serious problem of rural underemployment, this aspect of projects clearly required consideration. The road could be built by more or less labour-intensive methods. In a languishing rural economy, the investment-induced purchasing power might be necessary if the improvements in transport efficiency were to bear fruit. The central planning body would unavoidably consider these wider repercussions.

Of particular concern were the consequences of the additional agricultural income: it was impossible to overlook that a portion of the additional agricultural income would be spent, perhaps to a large extent within the area of the project to start with, and that this was likely to have a significant effect on the output of goods and services in other sectors, even if our project was relatively small. Even in a primarily agricultural country such as Thailand, the share of agriculture in the total domestic product is only about 35 per cent and is declining. Although in our areas about 80 per cent of the population were principally employed in agriculture, the per capita incomes of the remaining 20 per cent were about three times higher on the average. If agriculture flourished, the other sectors would also flousish. Farmers would build new sheds and stores and they would drink more Ovaltine.

In Thailand, as in many other developing countries, there were other reasons why the secondary income effects on non-agricultural sectors should not be lightly treated. The country makes its living by exporting a range of agricultural produce. The ability to import capital goods and manufactures depends on this. In the current economic thinking of the central planning body, agricultural incomes also control the progress of industrialisation. It is thought that the market for Thai manufactures outside Thailand is not large, and the urban market inside Thailand is also not large. Demand in the towns is for sophisticated goods which the Thais cannot produce in

competition with Japanese, American or Australian imports. The main market for Thai manufactures is in the countryside. Land, one might say, is the source of all value. In this respect it was also felt that the direct effect of rural transport projects on agricultural output might easily be overshadowed by the effect of better transport on the balance of economic power between producers and middlemen, and by the resulting redistribution of income from middlemen to farmers and its further economic consequences. In Thailand, as in most other developing countries, the farmer often subsists in a state of virtually complete dependence on the merchant, to whom he usually owes money. Poor roads and isolation play an important part in perpetuating this state of affairs. When roads are improved, the farmer has the opportunity of becoming better informed about prices and market conditions. Competition between merchants strengthens his position when the farm becomes more accessible. When rural roads were improved farmers would, if need be, take their produce to the market themselves by motor-cycle. It seemed probable that the farmers would appropriate not just the whole of the saving in transport costs but some of the merchants' profit. In the broader context of the economy such a redistribution of income would be a development favouring growth.

ECONOMIC CONSEQUENCES OF SOCIAL CHANGE

There is a tendency, it has been said, to give prominence in project appraisals to certain types of benefits for no other reason than that there exists a reasonably satisfactory method of measurement. The benefits may, in fact, be relatively unimportant. The indirect economic effects of an increase in induced output were considered in the previous section. There are other benefits not taken into account because they are not economic. On closer inspection they may be found to have economic consequences.

Certain parts of Thailand are virtually isolated. The basis of the village economy is subsistence farming. Money is hardly used at all. In a roadless village there are boys of 14 who have never seen a motor car. There is something rather absurd in evaluating the effect of a road on such areas in terms of induced output. The road project is in effect a social change project, and the thing to look at first is the upheaval in environment caused by the road. In less extreme cases we were strongly impressed by the serious social, psychological and, in politically unsettled areas, security obstacles to economic progress in isolated areas, where transport is slow, unreliable and at times impossible. Doctors, teachers and other professional people will not go to live and work in such areas, despite bonuses paid by the government. The low level of services and amenities in turn deters qualified and more enterprising people from living and working in such areas. These indirect economic effects cannot be successfully embraced in the quantitative framework. They should not for that reason be omitted. An important place should, therefore, be reserved in feasibility studies for conventional argument. The ratio or percentage figure at the end of the report is only a part of the study, possibly not the most important one.

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