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Choosing Rural Road Investments to Help Reduce Poverty

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Summary. — The paper first critically reviews past and current practices in how rural road investments are selected. An attempt is then made to develop an operational approach that is grounded in a public economics framework in which efficiency and equity concerns are inseparable, information is incomplete in important ways, and resources are limited. A key problem addressed is that a potentially important, though unknown, share of the benefits to the poor from rural roads cannot be measured in monetary terms. The proposed method aims to identify places where poverty, inaccessibility and economic potential are high. The method is illustrated for Vietnam.

Key words — rural roads, poverty, evaluation, Southeast Asia, Vietnam

1. INTRODUCTION

It is widely agreed that the economic appraisal of development projects should help select projects that contribute most to social welfare. The chosen projects should yield larger gains in social welfare than alternatives. Put in such general terms, the objective is clear enough. But its implementation, and particularly how to measure net benefits, are rarely so clear. This paper focuses exclusively on the appraisal and selection of investment projects in the rural roads sector, where the specific objective is taken to be poverty reduction. This is broadly defined to include relevant nonincome dimensions of welfare. How one might go about choosing between road investments is discussed in general terms with some specific illustrations from current work in Vietnam.

A vocal group of rural road enthusiasts has claimed that rural roads result in significant social benefits. Since these are difficult to quantify, they have typically been omitted from conventional appraisal techniques. It is further argued that this has led to longstanding biases against rural road projects and (since the poor are primarily rural) that there are biases against pro-poor investments. As a remedy, special techniques have been devised for evaluating and selecting rural road projects that simply take the eventual flow of important social benefits as given. Unfortunately, there is as yet little convincing empirical evidence that rural roads affect social outcomes beyond what they would have been without the road. Although the argument that high social benefits will ensue is sometimes plausible, the evidence provided in justification is rarely so. Without better evidence, there can be no presumption that such benefits will be high or even positive.

Given the poor quality of what we do know in this area, there appear to be two solutions. The first is to simply halt all rural road construction that does not pass conventional cost–benefit rates of return criteria and wait until unambiguous empirical evidence is available. Past experience does not suggest that this option will be favored. Decisions continue to be made with imperfect knowledge and that is not

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likely to change here. The second option is to improve on what is currently done and come up with a coherent, internally consistent evaluation methodology that explicitly says how much lower a rate of return to measured benefits one is willing to accept, and to test that with subsequent research. The point of this paper is not to decide which solution should be chosen but rather, to try to lay out the foundation for the second. The paper argues that there should be research on two fronts simultaneously. Special efforts need to be directed at measuring the existence and magnitude of the so-called social benefits from rural roads. At the same time, work needs to be done on improving the methods widely used to appraise and select rural road projects in the absence of that evidence.

To this end the paper proposes an alternative approach. The proposal recognizes explicitly that an important problem for some types of public spending, including rural roads, is that there is a potentially sizable share of the benefits that cannot be measured in monetary terms so as to be aggregated consistently with monetary measures of other benefits and costs. But, research should at least be able to provide an assessment for a few selected cases, which can provide a benchmark. There are participatory methods for tapping local information to form judgements of the relative importance of different types of benefits in a specific setting. The proposal tries to use the information available to form a second best appraisal method, taking account of the informational constraints faced in practice.

In the following sections, the paper argues that a change in the transport sector's current approach to rural road investment selection is warranted along the lines described, building on some of the poverty-focused "hybrid" methods found in recent rural road appraisals at the World Bank and elsewhere. The paper first critically reviews the methods typically used for selecting roads, both conventional cost–benefit analysis (Section 2) and the more recent hybrid methods which combine cost–benefit methods for some projects with cost-effectiveness calculations for others (Section 3). Section 4 discusses efforts at quantifying typically excluded benefits. This is followed, in Section 5, by an examination of the relevance of the traditional approach in the context of a poor rural economy, using Vietnam to illustrate the points made. Survey data are used to test the approach's underlying assumptions. The paper then proposes an alternative approach. Section 6 sets out the problem to be solved. Section 7 presents the proposed methodology and Section 8 looks at implementation. The paper ends with some concluding comments.

2. TRADITIONAL COST–BENEFIT ANALYSIS OF ROADS

There is some research on the importance of infrastructure, and in particular road infrastructure, to agricultural output, economic growth and poverty reduction (including Antle, 1983; Binswanger, Khandker, & Rosenzweig, 1993; Fan & Thorat, 1999; Jacoby, 2000; Jalan & Ravallion, 2002). For example, Jalan and Ravallion (2002) found that road density was one of the significant determinants of household-level prospects of escaping poverty in rural China. It is far from clear, however, that existing methods of project appraisal for rural roads will properly reflect the potential benefits to the poor.

Cost–benefit analysis methods for appraising investments in the road infrastructure sector were first developed for roads in more urbanized, high-traffic density areas, drawing on methods from a developed country literature on road appraisal. Traditionally, road investments in World Bank financed projects have been selected based on benefit indicators derived from consumer surplus calculations of road user savings, comprising both of vehicle operating cost savings and journey time savings. Forecasts of traffic demand—reflecting both normal growth in traffic and that generated by the project—are used to derive willingness to pay estimates to proxy project benefits. Over time, the approach has been implemented at different levels of sophistication, anywhere from only considering benefits accruing to motorized four-wheel vehicles to also including gains to nonmotorized traffic and pedestrians based on reduction of travel time savings. In some cases, estimates of the value of agricultural production increases induced by the road investment are also included. [1] The appraisals have generally not made distinctions between beneficiaries from different income or other socioeconomic groups.

A number of criticisms have been leveled at this approach (Gannon & Liu, 1997; Hine, 1982). One is that it tends to bias investments toward richer areas since the demand for traffic and hence, willingness to pay measures, are higher for the rich. Another is that it is appropriate for high, but not for low traffic areas; and relatedly, that it fails to capture some important, but hard to quantify, benefits from road investments. For these reasons, some observers argued that the method led to underinvestment in rural roads and in particular, rural roads serving poorer populations. There are projects that, by conventional cost–benefit analysis based on poorly measured benefit streams, do not have an internal rate of return greater than the critical level (typically set at 12%), yet yield higher social welfare gains than the projects that do pass the test.

In the late 1970s, a number of papers inside the World Bank argued for replacing, or supplementing, consumer surplus measures with producer surplus benefit measures for roads where traffic levels are low (see Beenhakker & Chammari, 1979; Carnemark, Biderman, & Bovet, 1976). The case for a change in focus rested on the induced agricultural developmental impacts of roads not captured by traffic cost savings when traffic is low. Producer surplus estimates aimed to capture gains in agricultural incomes resulting from transport improvements and concomitantly higher farm-gate, and lower input, prices. The aim was to prevent biases caused by sole emphasis on consumer cost savings in predominantly agricultural areas. Complementary agricultural development programs were also emphasized in order to maximize road investment returns (Beenhakker & Chammari, 1979).

Cost–benefit (CB) analysis as currently practiced in the transport sector continues to be riddled with problems in how benefits are measured. Valuing benefits for nonmarket goods for which prices are not known and the consumption of which is subject to quantity constraints is difficult (Cornes, 1995). One problem concerns a lack of agreement on the social welfare function on which these valuation judgments are ultimately based. Conventional CB analysis does not unambiguously answer the question of how much should be spent on rural roads. A fundamental source of the ambiguity has to do with the weights people attach to the multiple objectives of policy. Of course, these problems are not faced by the road and transport sectors alone. These issues are shared throughout public finance and public policy.

The main problems in conventional methods for assessing rural roads relate to alleged systematic exclusion of certain benefits, faulty measurement of the included benefits, and failure to recognize that the assumptions needed to justify ignoring distributional impacts—and so focus solely on efficiency gains—do not hold in practice.

It is claimed that conventional appraisal methods, even when combining consumer and producer surplus, are still likely to result in the underfunding of rural roads. Critics maintain that the techniques omit some key benefits, such as those accruing to individuals and to society from increased attendance to schools, health and other facilities rendered accessible by the road investments. Accompanying distributional benefits are also ignored. Furthermore, there may well be large but omitted risk insurance benefits from linking isolated poorer populations to national transport and communication networks. Quantification of such purported benefits remains largely intractable. These omitted benefits would be of less concern if it could be argued that they are positively correlated with the included benefits. That is not, however, plausible. Rural roads may well have high omitted benefits but low included benefits. Ranking road investment options in terms of observable benefits may be only weakly correlated with the ranking in terms of total benefit. If the alleged social benefits are real, conventional methods are unlikely to be a reliable guide to project selection.

Current methods of estimating the included benefits are also questionable. Both consumer and producer surplus are problematic as currently measured. Typical consumer surplus calculations for roads tend to exclude consumer gains from changes occasioned by the road in nontransport goods prices. Average daily traffic measures frequently used in forecasting benefits are hard to predict. Similarly, producer surplus measures tend to be incomplete and arbitrary in what is included. Why focus solely on farmers and agricultural produced surplus? Impacts on nonfarm employment and other income-earning opportunities are typically not factored in. Producer surplus measures also often rely on the same supply response parameters across regions, on spotty production data and make use of averages across income groups not allowing for household and geographic specific factors that influence marginal benefits (van de Walle & Gunewardena, 2001).

The use of distributional weights to counter biases against poor areas has tended to be frowned upon within the sector (Gannon & Liu, 1997). As Gannon and Liu state

"Economic efficiency is widely accepted as the primary objective of transport sector operations and is used, through CB analysis, to guide project selection and design" (Gannon & Liu, 1997, p. 23). They argue that distributional concerns should be handled at the macro-economic level such as directly through the tax system and, that income distribution decisions are essentially a political responsibility. They also feel that "use of distributional weights is, by and large not appropriate" since they "are subjective, vulnerable to misinterpretation and open to manipulation" (Gannon & Liu, 1997, p. 26).

The argument that the transport sector should be geared to maximize efficiency is based on a first-best model of the economy, whereby one aims for efficiency in production, and redistributive instruments such as the tax system and lump-sum transfers are used to achieve the redistribution objective. There are two problems with this view. First, the objective can be questioned, and second, its implementation is problematic in practice. The key assumption underlying the "maximize efficiency" view is that a complete set of markets exists and that other instruments are available for meeting the equity objective. Then the productive sectors, such as transport, can be left to deal solely with efficiency. Given market failures (including incomplete markets) and limitations on redistributive instruments, the realism of the argument that transport should care solely about efficiency can be questioned. Given that equity is valued, if one cannot establish that there already exist the instruments needed for redistribution, and that markets work well, then focusing solely on efficiency becomes unsupportable.

Second, even if we agree that efficiency is the objective of road investments, benefits must still be measured properly and thoroughly. Otherwise, it is entirely possible that the efficiency objective is not in actual fact being met. If important net social benefits exist, then benefits are typically not being thoroughly measured. Consequently, as discussed above, the measurement of benefits will tend to emphasize benefits to the better off and omit those that favor the poor. It can be argued that the benefits that one cannot measure tend to be those that accrue to the poor, so that achieving the partial efficiency objective may well bias investments against the poor. Thus, in both cases, biases in evaluation practice may go against projects that favor the poor.

3. POVERTY-FOCUSED HYBRID METHODS

Transport sector experts typically do not make decisions about how much of the budget should be allocated to the sector, or even across broad within-sector categories (such as rural versus urban roads). They are presented with a set budget for investment in rural roads, say, and must then choose what road projects to do. This means that there are ways of choosing projects that allow a more comprehensive assessment of the benefits, but do not claim to measure the social rate of return.

A key difference between CB analysis and cost-effectiveness (CE) calculations is that the latter work only in situations where total expenditures for a program are fixed. In such a case, one only needs to decide how to allocate the budget in the best possible way. There is no need to use a consistent metric of benefits that could be the basis for comparisons with other programs or resource uses. Nor is there a need for this benefits indicator to be expressed in monetary units or for it to be comparable with indicators used for other programs. The only requirement is to obtain an outcome indicator per amount spent. It is an indicator specific to the particular program and would not necessarily be of interest to any other program. Thus, although CB and CE both measure the ratio of benefits to cost, the "benefit" units are different. To put the CE indicator in a broader context would require a comparable measure of the social value of the project outcomes.

A number of projects in the World Bank and elsewhere have turned to CE calculations to take account of a broader set of benefits—such as potential health and education benefits—yet get around the problem of putting a monetary value on them. The method is sometimes referred to as multicriteria analysis (Cook & Cook, 1990). It has typically been used when traffic volume is too low (<50 vehicles per day) for conventional consumer surplus measures to make sense, yet, it is strongly believed that there will be important social benefits. In general, a least-cost approach is adopted. A threshold level of costs is arbitrarily designated and project investments costing less are exempt from a conventional CB analysis that aims to maximize efficiency alone. [2] The eligibility of subprojects is then subject to "social criteria" such as poverty indicators meeting some predetermined level. [3] In practice, the "social criteria" are often no more than the number of population in the zone of influence per unit cost. In other cases, potential subprojects are ranked according to indices based on a series of variables deemed to identify needier locations (see, for example, the Zambia project, World Bank, 1997).

If one accepts that the project as a whole must reach some minimum internal rate of return (though recognizing that this is based on a partial measure of benefits) then it is unclear why one would only measure the rate of return for subprojects above some cost level. There is no reason to suppose that the cheaper projects (of which there may be many) would have the same (conventionally measured) rate of return. So there could well be a selection bias in this method. It would be better to estimate the rate of return to a random sample of subprojects.

A further concern about past "hybrid methods" is with the benefits measure, which tends to be crude. For example, *a priori*, there can be no assurance that higher population served per unit cost will translate into higher benefits from a road investment. Given identical numbers of potential beneficiaries, it is conceivable that a higher investment cost due to worse terrain could produce considerably higher benefits, as a result of resolving a worse access problem. Furthermore, it is not always clear why some variable is included in the benefit index, and even why it is weighted positively. For example, lower literacy is often treated in this way. Yet, lower literacy in an area might instead be taken as a positive indicator of need (in effect, a distributional weight) or a negative indicator of benefit, assuming that those among the poor who are literate will have the highest marginal gains from access to a road. A sharper conceptual distinction is needed between the "benefits" and how they are weighted to reflect concerns about distribution.

A final concern is that the process of determining the variables and their weights should more fully exploit the knowledge of local experts and of the poor themselves. Road experts can help on technical matters, but are unlikely to be the best people to make the decisions about what information should be included in making a comprehensive assessment of the social gains, and how that information should be aggregated.

4. ASSESSING THE EXCLUDED BENEFITS FROM RURAL ROADS

Recognizing the possibility that some potentially important benefits arising from rural road provision and rehabilitation are not included by conventional methods of measuring benefits, there have been efforts to quantify social gains and add them to transport cost savings. [4] For example, in attributing education gains it has been assumed that better road access will increase enrollments by an amount derived from mean national rates; previously nonattending children are assumed to complete school, and their life-time earnings predicted based on a comparison of earnings for educated and noneducated individuals nationally. Total additional earnings, appropriately reduced to take account of the costs of education, are then added into the road benefits measure.

Such methods require strong assumptions. Implicitly, road access is treated as the sole constraint to children attending school. Yet, there could be a host of contributing reasons that may in turn, partly explain why that particular road has not previously been built. Demand for schooling could be low as a result of high local poverty and the opportunity cost of children's time. Alternatively, there may be cultural reasons keeping girls away, the returns to education may be perceived to be low, or the quality of the school and teaching may be affecting the schooling decision. Second, it is also a strong assumption that when these children join the labor market, economic conditions will be identical and that current earning differentials will persist.

In attempting to account for these benefits that are difficult to quantify, it is not uncommon for road project appraisals and impact evaluations to draw on socioeconomic indicators across geographic entities (villages, regions), delineated by whether they are serviced by a road, for evidence of such benefits and their magnitude. This is part of the approach intended for the research effort mentioned above within the CB framework (South Asia Region, 1999), but this technique is also used as evidence in CE calculations. As is well known from the evaluation literature, however, drawing policy conclusions from such statistics can be misleading. Table 1 illustrates the potential biases using a simple model in which road placement is endogenous, and based in part on the outcome indicator used for assessing impact. By simply comparing outcomes in villages with roads versus those without, the evaluator can easily conclude that there are large benefits when in fact there are none.

The general point here is that unless road placement is truly random—which seems most

Table 1. *Deceptive assessments of the gains from rural roads*[a]

	Mean incomes in villages with and without a road ($/day/person)		
	Without road ($n = 56$)	With road ($n = 44$)	% increase (t-test)
Case 1: Road yields 20% income gain	1.287	2.413	87% (2.29)
Case 2: Road yields no income gain	1.287	1.976	54% (2.00)

[a] The table shows mean incomes for a group of villages that do not have road access and a group that does. Mean income is much higher for the villages with roads. From such statistics the conclusion is sometimes drawn that the roads generated these large gains—87% increase in mean income for one group of villages and 54% for the other in this particular case.

These numbers were created, however, by a model in which roads generated an income gain of only 20% for case 1, and no gain for case 2. The model's pre-intervention incomes were drawn randomly from log normal distributions. Road placement was determined endogenously, as a function of village income (with 25% weight) and a second independent log-normal random variable (75%). The latter could represent population size, ethnicity, likely votes, historical accident, or any other variable influencing road location by the government. Thus, roads are distributed across villages in terms of a latent variable $z = 0.25y + 0.75x$ where y is log income and x is the other determinant of road placement. The model gave a road only to villages with positive values of z.

Of course, the evaluator does not know the true impact of the roads and is tempted to base an estimate on the observed differences in mean incomes between villages with a road and those without. This yields a large overestimate.

unlikely—simple comparisons of outcome indicators in villages with roads versus without them can be very deceptive. Using such data as evidence of benefits without accounting for the process by which the road came to be built in a specific location may lead to very deceptive policy conclusions and decisions. (Indeed, there is nothing preventing a health project from coming along and replacing the "with and without road" to a "with and without a health intervention," and attributing the same income gains to the health policy.)

5. HOW RELEVANT IS ALL THIS TO POOR RURAL DEVELOPING COUNTRIES?

Many of the aforementioned limitations of conventional rural road investment appraisal and selection apply directly to poor, largely rural developing economies. [5] For one, the assumptions underlying the "maximize efficiency" goal are generally not plausible in such settings. There tend to be few redistributive instruments available to policymakers. Indeed, we look to sectors such as rural infrastructure and roads to help achieve redistributive objectives. In addition, it cannot be assumed that investments in rural roads will automatically be pro-poor. Failure to consider the equity objective alongside the efficiency one will thus bias sectoral investments against poorer areas and poor people.

Consumer and producer surplus as conventionally measured appear to be inadequate measures of expected benefits in these settings. For example, in countries such as Vietnam and the other Asian transition economies, it is particularly difficult to predict how agricultural output will alter, or how traffic levels will develop, given how many factors can begin to change all at once. In many areas, labor and land markets will be newly developing alongside the road investment. Roads have been just one of many constraints to development. Their economic and social benefits will depend on many factors including, for example, whether affordable transport services follow the road investment. We know little about how the rehabilitation of a road link interacted with the other changes in the economy will eventually alter traffic flows and composition, the provision of transport services, agricultural and other sectoral employment, input and output markets. This may well also be true in more static economies—such as in sub-Saharan Africa—where, due to a series of other constraints, effects from the road may not be reflected in traffic levels or agricultural productivity for a long time. On the other hand, the argument that there may be substantial pro-poor gains from rural roads that are difficult to measure and to include in conventional CB analysis could also apply to most of these rural settings. For these reasons, working within the CE framework and attempting to refine it, seems to be the most appropriate, as well as promising, means of tackling rural road appraisal, once the decision to invest in rural roads has been taken.

Assuming that roads bring net benefits, assuring minimum access to all may be pro-poor in countries where the better-off are well-served by past road investments. Further expansion will tend to reach the poor. But, this may not be the case in the poorest countries. Vietnam is a case in point. The country had negligible investment in infrastructure for decades coupled with destructive wars. The road stock remains sparse and in severe disrepair. There has clearly been a tendency to concentrate first on rebuilding higher level networks as opposed to insuring basic access to isolated and poor communes. One would need a very large budget to ensure a level of "minimum access" to all and yet, the benefits from any lesser goal will tend to be captured by better-off areas. One should also consider whether providing road access to isolated, poor communities is in all cases a cost effective use of scarce resources for poverty alleviation. Thus, given an objective of raising living standards in a cost-effective way, and given the fixed nature of most rural transport projects—where the total allotted budget for the project is almost certainly not sufficient for ensuring some defined minimum access to all households—a method is still needed for ranking road projects that takes into account both equity and efficiency.

One response to the above arguments is that we need not worry since inaccessibility is an adequate proxy for poverty in rural developing economies. It is also strongly implied that high-poverty areas have low economic potential. Such convictions underlie the rhetoric and justification for current poverty-focused appraisal approaches to rural road projects—whereby, typically, a budget is set aside for noneconomic or "social" objectives, not subjected to ordinary economic analysis, and projects are chosen so as to maximize the population provided with "basic access" for a cost deemed acceptably low. Under this perspective, the appropriateness of a selection formula that aims to identify places where poverty and economic potential are high and access is low, is open to serious doubts.

This paper argues that if one wants to use a transport intervention to reduce poverty, it is important to worry about all three factors. Among places where benefits will be high, there are both poor and nonpoor places; among poor places there are ones where access is bad and ones where access is already good. Spending on roads will not help the poor much if they already have good access. Alternatively, in some poor and low-access places, the costs may far outweigh the potential benefits from improved access. Other interventions—such as facilitating outmigration—are more cost-effective ways to reduce poverty.

Only data can help resolve these tensions. For example, data can throw light on the argument that the poor are concentrated in areas where access is bad and vice versa. If the empirical evidence supports that view, one variable can be dropped from the formula used to identify appropriate interventions.

A commune-level data base covering 200 of Vietnam's communes in six provinces allows an investigation of these issues. [6] These data were used to create measures of poverty, inaccessibility and economic potential by commune. Poverty is represented by an index that combines the rate of infant mortality, the rate of malnutrition for children under five, and the incidence of hungry households in the commune. [7] Inaccessibility takes into account the existence of passenger and freight transport services, kilometers of commune roads per area, access to different levels of road, railroads, navigable waterways and whether a paved all-weather, or paved sometimes impassable, commune-level road runs through the commune. Economic potential reflects population density, agricultural potential (here represented by irrigated agricultural land per capita), the number of social and economic facilities, human capital (% of children 15 and under who have completed primary school) and number of other development programs. Each of the index components was attributed points reflecting low, medium or high values—determined by the range of the data—for a maximum of 100 points for each index. One can certainly quibble both with the variables included, as well as with how they are aggregated. Yet, the general conclusion was not in the least altered by sensitivity tests changing the combination and aggregation of the variables (including using far fewer variables to construct the inaccessibility and poverty indices in case different components cancel each other out).

The communes were ranked according to each of the three measures. Figure 1 plots the commune rankings by inaccessibility against rankings by poverty; Figure 2 does the same for inaccessibility and economic potential; and Figure 3 does so for economic potential and poverty. As is readily seen, there is very little correlation between any of these rankings.

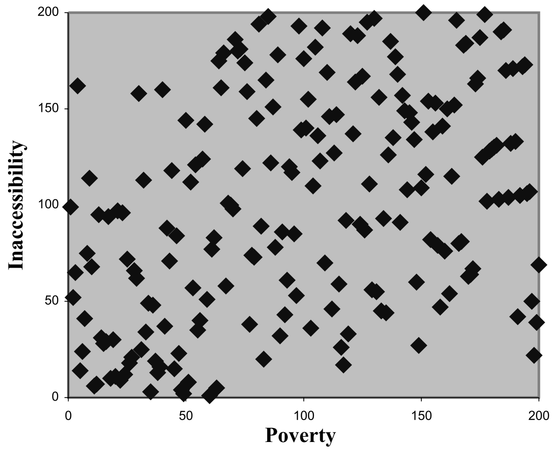

Figure 1. *Communes ranked by inaccessibility and poverty.*

These data clearly show that, in Vietnam at least, one cannot simply reduce the choice to places with either poor access, or high poverty, or economic potential. It will be important to figure out how to combine and weight these factors so as to select the places where roads will have the greatest impact on poverty given the cost. Clearly, there are places where inaccessibility, poverty and economic potential are all high, identified by the northeast quadrant in each figure. Project selection needs to be able to identify the intersection of the three. This is where returns to road investments will be highest. Of course, even among these places further targeting choices will exist but they will matter much less. [8]

6. THE APPRAISAL PROBLEM REVISITED

Let us assume initially that a fixed budget is available for raising living standards through the construction or rehabilitation of rural road links. How should the budget be allocated? In answering this question, one must consider the allocation between regional entities, such as province, district and commune. One must also

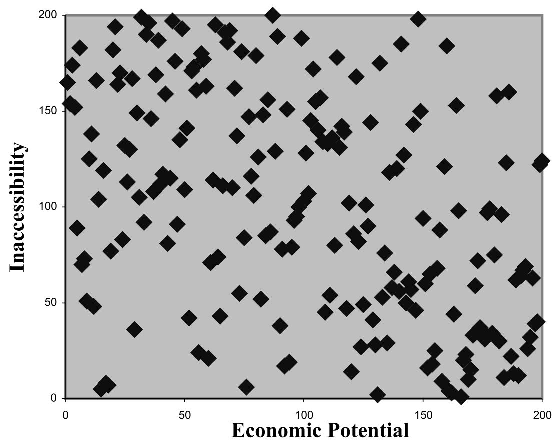

Figure 2. *Communes ranked by inaccessibility and economic potential.*

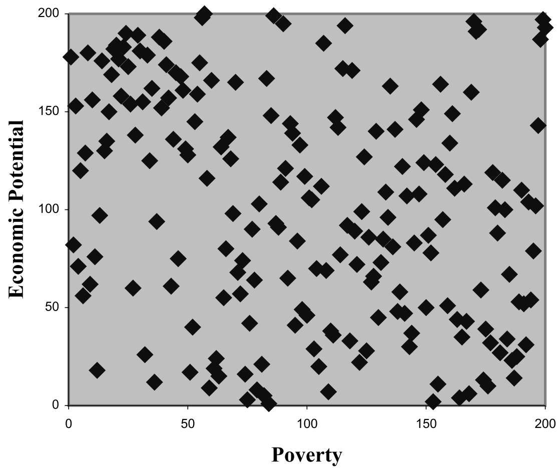

Figure 3. *Communes ranked by economic potential and poverty.*

consider geographical coverage within each of these levels. In making these choices one wants to assure a cost-effective use of resources, given the overall objective of reducing poverty.

A number of issues arise in addressing this appraisal problem. First, how can we measure expected benefits—accounting for factors that can be expected to influence the benefit stream, but also attaching values to each factor to allow a ranking of all potential investment projects? Existing road attributes (e.g., road density in the area), as well as commune and population characteristics (e.g., human resource development; presence of development projects and complementary infrastructure) will clearly influence the social returns from an investment. But they are likely to do so in differing degrees. [9] This suggests that some kind of weighting scheme must be designed to reflect each factor's significance. How are such weights to be determined?

How are distributional goals to be incorporated? All else equal, preference should clearly be given to poorer beneficiaries of the road investments. But how should "poverty" be measured? In practice, data availability and comparability across the potential roads' zones of influence, are likely to be the decisive factor. A further concern relates to what tradeoffs will be accepted between reaching the poor and other objectives, such as traffic volume.

Another question concerns the ability to appraise centrally all potential road links—that could run to tens of thousands—individually. Is it acceptable to rely on a limited number of "representative" road link appraisals and to extrapolate to other areas? Do alternatives to this common solution exist? Finally, there is no guarantee that the initial budget allocation was optimal. Can something be said about whether too much or too little is being allocated to the sector as a whole?

The following section proposes one approach to resolving these issues, within realistic information constraints.

7. THE PROPOSED APPROACH

A total budget C is available for rural road investments. It is assumed that there are many road links that are potential candidates for the project and that C is not sufficient to fund them all. The task of the appraisal is to provide a ranking among these potential links by defining a selection formula that identifies places where poverty, inaccessibility and economic potential are high. Ultimately, we want a ranking formula that can reflect tradeoffs between these variables and still be implementable.

It is assumed that each road link has a set of encompassing communities (*EC*) and that benefits are confined to those communities. Although this is unlikely to be the ideal way to define a road's zone of influence, it reflects a pragmatic attempt to resolve the data collection problem. The approach takes advantage of the fact that data are often, and/or more easily, collected at the community level. For data reasons, too, inequality within the *EC* is ignored—all those within a given *EC* are treated the same way. Road links here refer to any type of road—whether provincial (state), district or commune.

The benefit to a typical user of a proposed link is estimated from data on existing physical infrastructure, human development, economic potential of the region and other factors that may influence the marginal gains from a road investment. One could then calculate total benefit (multiplying by the number of people in the *EC*) and hence the benefit to cost ratio for the link. But, this treats different users in different *EC*s the same way, and so does not reflect equity concerns. Instead, we want to give higher weight to poor users. This is done by attaching a social weight to each *EC*, reflecting how poor residents are on average. Thus a socially weighted benefit–cost ratio is created.

Social welfare (SW) is defined as $\sum S_iB_iN_i$, where S_i is the social (equity) value attached to a typical user of the ith link, taken to be the average person living in its *EC*; B_i denotes the efficiency gain per person for the ith link; and N_i is the number of people in the *EC*s of the ith link. (I will return to the problem of measuring S_i and B_i.) Let C_i denote the total cost of rehabilitating the ith link (cost per unit length times length.)

The problem is then to maximize SW subject to $\sum C_i = C$. To find the best allocation, all potential road links should first be ranked by the benefit-to-cost ratio: $S_iB_iN_i/C_i$. (If $B_i = B$ for all i, then the ranking is simply done by S_iN_i/C_i.) Arbitrary thresholds for different types of roads, or for amounts set aside for the poor, are not required. The same criteria are used for all road links.

If a minimum pecuniary rate of return is also stipulated then this is a further constraint that must be satisfied. If the minimum rate of return condition is not satisfied, then one finds the feasible project composition which achieves that rate of return at maximum SW, or one spends less than the initial budget. If the constraint is satisfied then that suggests a case for expanding the initial budget. It is, however, important that in setting the minimum pecuniary rate of return one takes account of nonpecuniary benefits (see below).

(a) *Benefits and equity weights*

The measure of benefit for the ith road link (B_i) is derived from the values of a series of variables X_i which help to determine the average benefit that can be derived from the road investment within the link's *EC*s. These include attributes of the road and attributes of the people served. Some factors may lessen benefits, some may increase the stream of benefits. Careful thought needs to go into ensuring that relevant variables are accounted for as much as possible. But, what is considered will ultimately depend on what can be measured at the encompassing community level. Certain factors will be of more consequence to the road benefits, as well as to overall project objectives, than others. For example, we may want to put a higher weight on connectivity to the existing network than to the state of the existing road. Hence a system of weights (w_j) needs to be established which reflects the relative importance of each observed variable in X in the determination of eventual benefits. So $B_i = \sum_j w_jX_{ij}$, where $\sum w_j = 1$. For each link i, the weighted values of the Xs are then added up to get a measure of the total expected benefit from the road link. This should then be expressed on a per capita basis.

In a similar fashion, we can postulate that the social weights S_i are a weighted sum of the values taken by a vector of measurable variables Z_i describing the socio-economic conditions in the *EC* of the ith road link. The poorer the average person in an *EC*, the higher the value of S. Thus, $S_i = \sum_k v_kZ_{ik}$, where v_k is the weight attached to the kth factor deemed relevant to the overall social weight, where $\sum v_k = 1$.

An important issue is the scaling of B and S, since this determines the overall importance attached to equity versus efficiency (as measured by the Bs). This is a value judgment. One way to decide the issue is to fix the ratio of the maximum B to the minimum B and similarly for S. B_i can be normalized to vary between 0 and 100, say. Similarly the minimum S (for the least poor *EC*) can be set to zero. The decision on the maximum S (for the poorest *EC*) then determines the relative weight attributed to equity versus efficiency by the formula.

Finally, the resulting measure of benefits is divided by the estimated costs. The costs will vary according to the road type and the planned work. The ratios are then used to rank all road link investment proposals. The first disbursement from the budget goes to the link with the highest benefit–cost ratio. The next goes to the next highest ratio, and so on till the budget is exhausted.

(b) *Nonpecuniary benefits and minimum rates of return*

Given that valuation problems are likely to be worse for certain projects, it cannot be optimal to insist that all projects achieve the same rate of return as required for a public investment with known (measured) benefits. The approach common in current practices in the sector is that a project must either achieve a certain return (constant across all types of projects) or it is taken completely outside the normal evaluation system. This can hardly be the best solution. In reality, for all types of projects we are able to measure some benefits reasonably straightforwardly but not others, and the extent of the valuation problem is no doubt greater for some types of projects than others.

Instead of putting certain projects outside the evaluation process, it may be better to explicitly acknowledge the problem of nonpecuniary returns by setting lower target monetary rates of return for certain types of projects, reflecting our best guess of the value of unmeasured benefits. By this approach, decision makers would have to set benchmark estimates of the magnitude of average nonpecuniary benefits for each type of project; this can be done in the form of the appropriate "discounts" on the pecuniary rate of return. For example, if it is believed that only two-thirds of the benefits are being captured in the existing CB calculations for rural roads and the overall minimum rate of return is 12% (when all benefits are monetary and observed) then the minimum monetary rate of return on rural roads should be 8%.

There will of course be ample scope for debate on how to set these discounts to allow for unmeasured benefits. While some guidance might be found in existing research, there will be considerable uncertainty around any estimate. But it is arguably better to directly confront this problem, and set explicit "best guess" estimates rather than putting important classes of development projects outside the evaluation system, such that we have little or no idea if we are investing too much or too little in these types of projects. Looking ahead, the need to make explicit allowances for nonpecuniary benefits will no doubt stimulate research to provide better information on these benefits in the future. (The current practice provides little encouragement to improve valuation data and methods for the types of projects that are dropped from the set to which a minimum rate of return is applied.) Proper, careful evaluation based on the latest evaluation best practices, that allows for endogenous placement or, where possible, uses experimental methods, could greatly improve our knowledge about these benefits. More explicitly recognizing our lack of knowledge in this area will add impetus toward resolving the issue in a believable way taking proper account of biases such as due to the nonrandomness of program placement (see Table 1). This means setting up focused and rigorous research projects that aim to cover enough project types to provide an idea on various nonpecuniary benefits.

A number of judgments will need to be made to implement the above approach, notably in setting the various weights (including the overall weight on equity versus efficiency). The next section suggests how well-informed judgments, consistent with social values in each setting, might be formed in practice.

8. PUTTING THE APPROACH INTO PRACTICE [10]

The following gives a step by step example of possible implementation in Vietnam. Obviously, it is important to be flexible and allow for institutional and other local constraints in implementation. The approach needs to be piloted, revised after a first cycle and altered in the light of experience. All players must be willing to accept set-up costs including the time necessary for data collection and analysis, as well as for all project proposals to be made.

A fixed budget is available for the rehabilitation of rural road links. All provinces (covered by the project) compete for this budget. This will create incentives for the provinces to come up with efficient cost proposals, within the bounds of the construction standards set by the project. The selection formula's specific variables and their weights are devised by the project team in collaboration with the government, following an extensive consultative process. The idea is to then decentralize the formula to the provinces that will be responsible for making proposals and bid for the money. The steps are as follows:

Step 1. Availability of data at the commune or district level, and consultations with a wide array of data, poverty, rural development and infrastructure specialists in government and academia, allows the Bank and the transport ministry teams to delineate a set of

*X*s—encompassing commune and road characteristics—that must be taken into account in estimating expected efficiency benefits. [11] A potential list of the variables that determine efficiency gains might include the following: road density in area; local human resource development (as measured, say, by percentage of children completing primary school); other (complementary) development projects in area; accessibility to social service facilities; accessibility to other forms of transport (train, waterways); agricultural development potential (as measured, say, by unused land with agricultural potential); current road condition; linkages with the existing road network.

Step 2. Next the scale and key variables determining the imputed social value of the benefits from a link must be determined. Given project objectives, the poverty level is an important characteristic of *EC*s. Ideally, comparable commune-level poverty data would be available centrally. Data often exist at commune or district level but there is currently no system for compiling it nationally. Recent advances in combining census and household-level survey data to estimate poverty levels at very disaggregated regional level are promising in this respect (Minot & Baulch, 2001). In the meantime, one possibility is to rely on the provinces to come up with an internal poverty ranking of all their communes using a reasonable and widely accepted indicator of welfare. This should be done outside the provincial departments of transport, for example, by the Ministry of Labor, Invalids and Social Affairs' provincial office (DOLISA), or the authorities responsible for the provincial implementation of the national "Hunger Elimination and Poverty Reduction" (HEPR) program.

If a single poverty measure does not exist, the ranking can be based on a composite index of available variables (Z) that influence S_i. The content and scale of S_i must be identical across all provinces and command wide acceptance. For example, it might include one or more of the following: infant mortality rates (IMR), average incomes, literacy, share of school-age children attending secondary school, undernutrition, etc. Since such indicators are typically expressed in different units, a different scale must be determined so that the numbers can be added up (note that this applies also to the *X*s). Most communes report such data to the district. The province authorities should then be able to collect the information from each of their districts.

Step 3. To determine the weights on the variables in B and S, and the value of the scale for the poorest EC relative to the least poor, and hence the scaling of equity versus efficiency concerns, a multidisciplinary group of government and nongovernment Vietnamese experts can be set up. The Bank team can design and participate in focus group meetings whence the weights can be defined by consultative process. Separate meetings may be needed for S and B. In the Vietnam context, it would be highly desirable to bring together knowledgeable representatives from the Women's Union, the Farmer's Union, the Commission for Ethnic Minorities and Mountainous Areas, Ministries covering transport, health, education, agriculture and rural development; and academics specializing in ethnic minority and gender issues, health, education, poverty, rural development and transport. By relying on a commission of local experts, it is expected that the measurement of benefits will adequately reflect societal values.

Step 4. A technical assistance team should be provided to each province for a certain amount of time to explain the rules of the game, help make project plans and conduct consultations with communities, and comment on the shelf of possible projects. It will also explain that validation checks will be made.

Step 5. All provinces produce proposals. The methodology is applied to all types of roads. The provinces must carefully weigh the costs of spot repairs, versus rehabilitation, versus full upgrading in making their proposals. The provinces are also required to carry out consultations in the communities of potential subprojects prior to making their bids. This is to ensure responsiveness to local needs and that the views of prospective beneficiaries are taken into account (concerning choices in levels of road upgrade and in setting priorities between subprojects within an intervention area). This should be done with the help of impartial groups, such as the Women's Union (which is active throughout the country) or local branches of national NGOs, that are independent from the provincial department of transport officials and can be trusted to represent the views of local communities. Each province draws up a list of benefits and costs for all road links put forward as potential subprojects. The process should allow for proposals that include more than one road link, and possibly combinations of different levels of road links. For example, a benefit-to-cost ratio calculation could be based on a network of two or more contiguous links where it is persuasively argued that the benefits from one link are considerably higher if the other link is also rehabilitated. The technical team would be responsible for explaining this, ensuring that consultations with communities and all prospective beneficiaries are satisfactorily undertaken and results reflected in the proposals, and for generally extending assistance to the provincial teams. [12]

Step 6. Since the formula is fully decentralized it may be desirable to introduce additional incentives to play according to the rules. Validation of the province assessments of numbers can be made on a random basis. A province that is found to have cheated is punished. Punishment can consist of being thrown out of the game, or face some appropriate penalty such as a tax on its costs.

Step 7. The money is allocated to provinces according to the lists. The first unit of money goes to the highest benefit for cost "subproject," the second to the next, and so on. One potential issue is that of the cross-province funding distribution. It is conceivable that the best projects will be concentrated in a few provinces. If this is a concern, there are a number of ways to prevent this eventuality. It might be specified that the second pot of money must go to a different province from the first, and so forth, to avoid all the money ending up in only a few places. Or it may be decided that each province originally selected to participate must get a minimum of the total, (say 1/60th in the case where 30 provinces are participating). Alternatively, a formula could be determined by which one-half of the entire budget is allocated in proportion to province population size, or population and a provincial index of inaccessibility and poverty, leaving the rest to be allocated according to where the most cost-effective links are proposed. Either way, the money is still allocated according to the lists of rankings. If the minimum allocation has been reached for each province, we stop. If not, then we will need to go back to the list and go through a process whereby the last chosen link is dropped and (unless it is located in the underfunded province) replaced by the link with the highest CB ratio from the underfunded province, and so on.

Step 8. For a representative project within each of the main road types, a conventional internal rate of return calculation is made based on producer and consumer surpluses. This is used to estimate the overall rate of return to the set of subprojects selected up to Step 7. A minimum return that is adjusted for the current "best guess" of the expected nonpecuniary benefit levels is determined. If the average rate of return is at or above the minimum then one stops. If, however, it is below the minimum, then one has to substitute projects that had not previously been included for some that had. Thus substitution should be made so as to assure the least cost in terms of the more comprehensive measure of benefits used in selecting projects. The project with the lowest benefit–cost ratio in the road type category with the lowest rate of return should be dropped and replaced by the project with the highest ratio among those previously rejected. This continues until the minimum rate of return is reached.

9. CONCLUDING COMMENTS

Measuring the benefits of rural roads is fraught with difficulty. Special selection and appraisal criteria for rural roads have evolved that simply assume important social benefits, despite a general lack of rigorous empirical evidence. These are used as justification for abandoning economic analysis when, as is the case in many rural areas of developing countries, traffic levels are too low for conventional consumer surplus measures to make sense. This paper has argued, however, that efforts concurrently need to be made to improve on the methods that are currently being used to apportion budgets on rural road projects. The paper proposes such an improvement. This needs to be backed up by serious research on the impacts of rural roads on living standards, broadly defined.

The approach proposed here builds on a number of past approaches, observations and project experience. The aim has been to focus the discussion back squarely on the objective of poverty reduction, but doing so within a public economics framework in which efficiency and equity concerns are inseparable, information is incomplete in important ways, and resources are limited. The approach tries to avoid the tendency to treat budgets for so-called "social objectives" outside the realm of hard-nosed economic analysis, but also recognizing the constraints faced in practice in implementing rigorous appraisal with limited information.

The advantages of proceeding as outlined in this proposal include that it holds the hope of building capacity, and is participatory; it extracts local information that may not be readily available to the center, and it appears to be feasible through its reliance on the participation of local authorities and residents in the appraisal of subprojects. The method promises to assure that the most effective investments are selected from the point of view of poverty reduction, given both the information and resource constraints.

NOTES

1. Hine (1982) provides a good discussion of the most commonly used methods of estimating benefits.

2. Recent examples include road projects in Peru, Zambia, Andhra Pradesh, and China (World Bank, 1995, 1996, 1997, 1998a, respectively).

3. For example, eligibility under the social criteria for a project in Peru requires that infant mortality rates be over 80, the index of unmet basic needs be above 70% (the index is an area specific composite of sanitation facilities, housing quality, educational attainments, school enrolments, employment and dependency based on census data) and that there be more than 100 beneficiaries per kilometer (World Bank, 1995).

4. A recent example is South Asia Region (1999).

5. For a critique of current methods and a discussion of the broader issues in the China context see Huenemann (2001).

6. See van de Walle (1999) for a description of the data-base—the Survey on Impact of Rural Roads in Vietnam (SIRRV).

7. Hungry households are defined nationally as those with the income per person equivalent of less than 13 kg of rice per month. This is a popular and widely collected statistic in Vietnam.

8. The lack of correlation between inaccessibility and poverty does not, *per se*, throw any doubt on the case for geographic targeting for poverty reduction (Bigman & Fofack, 2000). It does suggest that the aim should be to target high poverty areas, not areas with low accessibility when aiming to reduce poverty. But, those high poverty areas must also have bad access if the policy instrument is to be road or other transport interventions.

9. Numerous studies have remarked on the key role of complementary inputs and mediating variables in explaining the gains from a rural road investment. For example, see Hine (1982) and Cook and Cook (1990).

10. This section elaborates on an actual example from a recent World Bank project (World Bank, 1998b). Some points have been developed further than in the project for expository reasons.

11. A number of variables that help determine the efficiency gains might also enter the equity weights, possibly with the opposite sign! For example, there is evidence of significant complementarities between physical and human infrastructure investments (for example, van de Walle, forthcoming). Thus, it is likely that the marginal benefits from a road project will be higher in areas where education and health status are higher. On the other hand, one might want to favor *EC*s with lower human capital, and hence welfare, with a higher distributional weight.

12. It should be noted that although not a topic of this paper, further local participation of beneficiaries may be crucial to project sustainability, ownership and future maintenance. The latter is often judged to be key to a rural road investment's success.

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