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TO- AIDTO CIRCULAR XA- 2402

DATE SENT
2/22/68

FROM - AID/WASHINGTON

SUBJECT - Suggested Economic Rate of Return Methodology in Capital Project Analyses

REFERENCE -

The purpose of this airgram is to suggest the most appropriate methodology in presenting and calculating the economic rate of return for capital projects in both the design of scopes of services for feasibility studies financed by AID and the preparation of [illegible] A summary of the major suggestions is listed below. The rationale for the adoption of the analytical techniques suggested herein and technical comments as to the use of these techniques are included in the sections following the summary list.

SUMMARY OF SUGGESTIONS

1. The annual cash flow system of presenting and organizing the basic information on costs and benefits should be utilized.

2. National economic profitability is the most suitable measure of the economic justification for project selection by AID. Whenever relevant, shadow or accounting prices for the more significant elements in the project analysis (e.g., foreign exchange and labor costs) should be incorporated in this calculation.

3. The internal rate of return (IRR) and the net present value (NPV) method of discounting the annual cash flows can be utilized interchangeably in many of the profitability appraisals. The results of the IRR discounting method will necessarily be related or compared to some approximation of the opportunity cost of capital in order to provide a criterion for investment decisions. The NPV discounting method will directly utilize the estimated opportunity cost of capital in the calculations of net present value.

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4. In comparing project alternatives that are mutually exclusive, the NPV discounting method is preferred to the IRR discounting method.

5. When project alternatives are included in the analysis and the length of life of the projects differ, serious consideration should be given to placing the alternatives on an equal time duration basis.

6. The usual assumption as to the relative constancy of costs and returns over the life of the capital project, if adopted, should be explicitly stated and justification for this procedure discussed in detail in the project report.

7. Sensitivity testing of critical variables is an intrinsic part of project appraisal.

INTRODUCTION

As mentioned in NESA CIRCULAR XA 2121, dated March 9, 1967, the economic sections of Feasibility Studies, Economic and Technical Soundness Analysis, Capital Projects, M.O. 1221.2 (including Supplement No. 1, M.O. 1221.3) are in the process of revision. Preliminary drafts of various chapters have been prepared by PPC/SMAD and distributed for comments. NESA CIRCULAR XA-2121 provided the USAIDs with revised guidelines in regard to highway transportation projects. In early December 1967, NESA/CDF forwarded to various USAID offices in the NESA region and distributed in AID/W copies of a final report entitled, "Economic and Technical Soundness Analysis of Electric Power Projects Submitted for Capital Financing," prepared by Dr. H. F. Jones under contract to NESA. It is anticipated that this final report, as revised to reflect comments received, will either be recommended to A.I.D. for agency-wide adoption or used by this region as a temporary replacement for the relevant chapters in the existing Feasibility Manual until such time as a new manual has been approved.

It is unlikely that any final revised feasibility manual or series of manuals on specific types of capital projects will be completed in the near future. The purpose of this CIRCULAR AIRGRAM is to provide USAIDs, in this interim period, with guidance in one specific area of capital project analysis, the calculation of the economic rate of return on capital projects. It is NESA/CDF's belief that this subject is inadequately covered and discussed in the existing Feasibility Manual. The system of analysis presented herein should be incorporated, whenever applicable, in the scopes of services for feasibility studies financed by A.I.D. and in the preparation of loan papers for capital projects.

The guidelines presented in this CIRCULAR AIRGRAM should provide a greater degree of uniformity in the economic rate of return calculations included in loan papers and AID-financed feasibility studies. It is

anticipated that revisions and expansions of the contents of this CIRCULAR AIRGRAM will be made until such time as the revised Feasibility Manual has been completed. Comments from USAIDs on the contents of this CIRCULAR AIRGRAM or suggestions as to xx related topics that might be covered in future circular airgrams are invited.

CASH FLOW SYSTEM OF ANALYSIS

In appraising the profitability of capital projects, NESA/CDF suggests that the cash flow system of analysis be adopted as the basic method of organizing the economic information directly relevant to the proposed investment. In the cash flow system, the significant element is the timing of the estimated or projected receipts (benefits) and disbursements (costs) related to the project. It is suggested that the time period used in presenting the cash flow information be annual.

The major advantage of the cash flow system over the more traditional analytical methods is that it provides a time-phased estimate of the pattern of receipts and expenditures over the assumed lifetime of the project. In any investment decision, a primary concern is not the net difference between the receipts and expenditures over the assumed lifetime of the project but the distribution over time of this relationship. Assuming, for example, that total investment outlays and total net receipts are identical and the construction (or pre-production) periods and the project life are the same, the appropriate choice between two alternative capital projects would be determined by the distribution over time of the net cash flow (that is, receipts minus expenditures). The capital project with the higher net cash flow during the earlier operating period would most likely be the project chosen for financing and implementation. The primary rationale for such an investment decision is the assumption that the value (cost) of one dollar received (expended) in Year 1 exceeds the value (cost) of one dollar to be received (expended) at some future date.

The cash flow system is defined as the incremental cash receipts and expenditures solely attributable to the commencement of the capital project. Expenditures are the sum of the following items: capital outlays, such as the investment in fixed assets, the initial level of working capital plus changes in this initial level, and any renewal or replacement of fixed assets; and non-capital outlays, such as operating, maintenance, overhead, selling and other current costs of the project. The differentiation between capital and non-capital outlays is irrelevant to the analysis. In the analysis, both are considered as cash outlays and involve the use of resources in the time period in which they are projected to occur.

Receipts consist of the projected cash income to be earned by the project. For most industrial projects, the cash flow income will be based on projected sales, not necessarily on actual receipts. The working capital cash outlays

in any given annual period are measured by the difference as between annual periods in the total value of the inventory on hand, including finished products, work-in-progress, raw materials and spare parts. The outlay may be negative (if inventory is reduced) and thus in effect an addition to receipts.

This definition of working capital differs from that adopted in calculating financial rates of return. Financial analysts normally define working capital to include the difference between current assets (cash, inventories and accounts receivable, etc.) and current liabilities. This definition reflects an effort to adjust the sales projections in the cash flow analysis for leads and lags in payments and receipts. In economic terms, working capital items, such as cash, accounts receivable and accounts payable, are financial instruments, and are not an actual use of resources. The use of the cash flow system in economic analysis is only concerned with the actual resource allocation projected to occur in any given time period, at which time it is recorded.

Interest payments are excluded from the cash flow. The interest factor is taken into consideration in the discounting procedures discussed in the next section. Interest during construction is excluded, as well, assuming that the analysis begins in Year 1, (the year in which the initial incremental expenditures are incurred).

Non-cash charges, such as depreciation on fixed assets, are likewise excluded from the cash flow analysis. Repayments of loans and payments of dividends are also excluded, since the discounting procedures discussed below reflect net returns to the project <u>after</u> recovery of the invested capital.

The annual periods used in the cash flow analysis should commence when initial expenditures are incurred in the pre-production or construction period and conclude in the last period (of the assumed length of life of the capital project), at which time salvage or market values are assigned to the fixed assets and working capital remaining in the project.

## INTERNAL RATE OF RETURN (IRR) AND NET PRESENT VALUE (NPV)

The preceding discussion provided some general guidelines in organizing the pertinent incremental cash flows relative to a capital project. The next step is to determine the most useful discounting procedure that will convert future values of net cash flows to present values. There are two general methods of accomplishing this task. One method is to apply various discount rates to the cash flows until the net cash flow equals or approximates a zero value. The discount rate that equalizes the present value of the payments and receipts of the capital project is the <u>internal rate of return</u> (IRR) of that capital project. Once this calculation is completed and the IRR estimated, this result would be compared to some minimum attractive return or opportunity cost of capital (to be discussed later), to determine whether

the capital project should be accepted or rejected. The second method is the net present value (NPV) method. It assumes the discount rate (or opportunity cost of capital) to be applied to the cash flows and selects a capital project for implementation if the net present value is positive (e.g., the present value of cash inflows exceeds the present value of cash outlays). In those cases in which the results of the NPV calculation are zero, then the IRR and the opportunity cost of capital are identical.

For the majority of project evaluations undertaken by A.I.D., either method of discounting cash flow will be acceptable, subject to the special considerations discussed below. The additional calculating work that may be involved in the IRR method is relatively minor and insignificant when compared with the volume of details required to construct the undiscounted cash flows. The choice of one or the other discounting method is a function mainly of the type of project being appraised and of whether project alternatives or comparisons are part of the project analysis. For example, if the project appraisal consists of a private sector industrial project, the results of the IRR method--a percentage return--provide a more comprehensible and simple interpretation of the economic rate of return that the project might earn. Using the NPV method for that type of project does not result in an equally understandable interpretation, since its results--a dollar amount--are significant only when compared to the investment (or at least the initial investment) outlay.

The NPV method may be particularly useful when the comparisons are made between mutually exclusive capital projects that have similar objectives or consist of variations within a basic project. For example, the comparison might be between alternative road widths in a highway construction project. The capital outlays and other costs for each alternative are likely to differ as well as the benefits attributable to each alternative. Using the NPV discounting method, the basis for choosing the most economic alternative is reasonably straightforward; the alternative with the largest net present value at the given discount rate is the preferred investment. The NPV method is also the more convenient discounting method to use in the least cost selection of alternatives providing identical benefits. This latter method presumes that some determination has been or will be made that the capital project is economic when relating benefits to costs.

It is suggested by NESA/CDF that in any comparisons of capital project alternatives using the IRR discounting method that the duration of the time period of the analysis be equal. Although the NPV method theoretically does not require similar treatment as to time equivalency in the project analysis, NESA/CDF suggests that the equating of time periods also be given serious consideration when the NPV discounting method is adopted. The adoption of time equivalency may be significant for capital projects in which the alternatives under consideration have significantly different lengths of life and capital intensities. This would be particularly important, for example, in the comparison of hydroelectric, oil-fired and diesel alternatives of

generating electric power, since their lives vary significantly. Time equivalency, when related to the longer-lived capital project, tends to focus attention and analysis on the broader aspects of the capital project and toward a more comprehensive "system analysis" approach that may provide additional, useful analytical insights.

NATIONAL ECONOMIC PROFITABILITY

One basic criterion in project selection is the economic impact of a capital project in terms of national economic profitability. National economic profitability measures the rate of return earned by the project by discounting the flow of social returns (receipts) and social costs (expenditures) either by the IRR method or by the NPV method. The difference in the results of the two methods are no different than those mentioned previously. If the IRR method results in a rate of return equal or exceeding some acceptable opportunity cost of capital, the project decision is favorable. If the NPV method results in a positive net present social value, the project decision is favorable.

The underlying basic information used in the calculation of national economic profitability is different from that used in calculating the ~~fim~~ financial rate of return to a private firm or company. Taxes paid are costs to the private firm; subsidies received directly or indirectly are additions to income. To the economy, taxes paid by an operating firm to the government or subsidies received by the firm are not considered costs or returns. They reflect income transfers between the project and the government, not actual resources used in the project. Similarly, the private firm accepts the market prices for both its products and input costs as basic operating data. To the economy, these gross returns and costs may not reflect economic values. The cash flows attributable to a capital project when calculating a financial rate of return might therefore have to be re-valued and recomputed to derive the social return and social costs used in calculating national economic profitability.

National economic profitability, as mentioned above, deals with different concepts of benefits and costs than those included in calculating financial rates of return, and these concepts have different levels of economic measurement. The following table outlines the general market combinations that will ~~[illegible]~~ affect the valuation of output and costs of the capital project and the computation of economic rate of return calculations by project analysts:

| Valuation of Output and Costs | Category A | Category B |
|---|---|---|
| | Type of Output | |
| CASE I -- Market Prices | | |
| CASE II - Shadow Prices | DOMESTIC (Items traditionally not entering international trade) | FOREIGN TRADE (Exports and import replacements and international trade items) |

For Case I, in which market prices represent social values, annual capital social costs are the capital outlays defined previously, less the customs duties and similar taxes, if any, on imported investment goods required for the project. Non-capital social costs are identical with the definition used in the previous cash flows discussion except for customs duties, etc., on any imported ~~x~~material inputs. Customs duties are excluded from the concept of social costs since they represent income transfers (between the payer and the government) and not resource costs.

Income taxes and other taxes included in the cost structure should also be identified and excluded like customs duties. For some types of projects in which domestic cost estimates appear to be significantly higher than the c.i.f. price of similar imported items, the possible distortion introduced into domestic costs by the tax pattern may be particularly important. NESA/CDF suggests that project analysts give this analytical aspect special attention, particularly in cases of import substitutes.

~~Examples~~ External economies or diseconomies attributable to the capital project are added to or subtracted from the cash flow outlays. For some capital projects, the identification and quantification of certain external relationships may be feasible and worth undertaking, and could affect the final project design; e.g., the valuation of agricultural crop losses directly associated with the production of sulfuric acid could be a critical element in site location, The identification of these external relationships is not usually the major obstacle in the analysis of these external factors; rather the quantification of the identified external relationships is the primary problem. Where project analysts have identified these external relationships and assigned monetary values, it is important that the basis for the quantification be clearly explained in the project report.

The measurement of the gross social return element in Case I can logically be divided into two major categories. Category A assumes that if the output of the capital project is neither an exportable item, a direct import ~~xxxx~~ replacement, nor an item that normally enters international trade, the proper measure of the gross social return is the estimated free competitive domestic market price of the output of the capital project. Category B assumes

that the planned output of the capital project ~~xxxxx~~ either will be exported, will replace imports, or will add to current output a new item that normally does enter international trade but is not being imported or exported at the present time.

For Category B, assuming that the output of the capital project is considered as an import replacement, the proper measure of the gross social return of the capital project would not be the domestic market price of the output of the capital project, but the cost (excluding customs duties) of importing an equivalent amount of the item. In this particular type of Category B project, the measurement of net social returns, as defined previously, would be the annual total value of the equivalent imports less the annual cash flow outlays of the capital project. Exportable goods produced by a capital project would be valued at the estimated f.o.b. export market price and not at the price received by the producer as reduced by export taxes or increased by export incentives. The use of one of the Category B methods of measuring gross social returns will require project analysts to include detailed product identifications, information on world market price trends for the product, c.i.f. costs to the port of entry for imported items or f.o.b. prices for exported items and, if applicable, estimates of internal transport costs to the site of the project if it will produce import replacements. NESA/CDF is aware of the difficulties in obtaining, and the pitfalls involved in properly interpreting, prices and trends for many items entering international trade, but this analytical technique is a necessary element in capital projects analysis.

For Category A (domestic-oriented output), the analysis may be somewhat simpler to make. The gross social returns can be measured by the competitive market value of the annual output of the capital project, adjusted where relevant for any external diseconomies or economies. Category A, as mentioned previously, includes capital projects that are domestically-oriented in output and competition. The valuation of the output at competitive market prices of industrial projects should include excise taxes, unless such a tax is levied to offset various external diseconomies attributed to the project. Although Category A industrial projects in some LDCs undoubtedly contain elements of monopoly pricing and profits, there appears to be no convenient method of handling this economic distortion in the project analysis.

The prevalent situation for practically all of the countries in the NESA region in which A.I.D. makes project loans is likely to fit Case II (shadow-prices) rather than Case I (market prices). In those countries, the official foreign exchange rates tend to over-value the local currency and, in some instances, wage or labor costs may tend to value these factor inputs above what they might receive in a more competitive market for labor. In order to properly measure social returns under the conditions of Case II, the project analyst must substitute an imputed or substitute value for these distorted market values. These imputed values are normally labeled shadow

prices since, although expressed in monetary terms, they do not reflect the reality of current market arrangements. The imputed values may, of course, vary over the life of a project.

Case II, like Case I, may be divided into Category A and Category B projects. In Category A, since the output of the capital project is considered as domestic-oriented, the valuation of gross social return at the domestic market price would not require revision from the Case I situation unless monopoly elements are considered significant. In the valuation of the social cost, the matter is somewhat different, since many domestically-oriented capital projects may contain significant inputs of direct and indirect foreign exchange expenditures (see discussion below) in both capital and non-capital outlays. A re-evaluation of the total foreign exchange component of the domestically-oriented capital project will likely indicate that the measurement of project costs at the official exchange rate had been underestimated. On the other hand, the domestic labor costs included in the project analysis (both in construction costs and operations) may be overstated because the market wage rates used to compute labor costs do not reflect real costs to the economy in terms of any alternative use of the labor input in the capital project.

Shadow prices in Category A project analysis are particularly significant when making the economic choice between the alternative production techniques available to attain similar objectives. A capital-labor factor relationship in which the foreign exchange component of the capital investment was relatively large might appear to be an efficient use of resources at the official exchange rate for foreign currency and at the market labor cost. At some given shadow price for both foreign exchange and domestic labor, this efficiency relationship could look drastically different and might suggest a better way for the national economy to produce the output (assuming technological factors are not of over-riding significance).

The impact of shadow prices for foreign exchange on Category B capital projects would be greater since both the social returns and social costs are directly affected. The social return would be valued at the import costs or export values previously discussed, adjusted to reflect the shadow exchange rate for foreign currency. The calculation of social costs would be affected in the same manner as discussed under Category A.

The direct foreign exchange components of the annual cost stream, since they are usually readily identifiable as direct imports, are not necessarily the most serious problem in valuation in Case II (Categories A and B). Many capital projects contain significant elements of indirect foreign exchange outlays that are not readily identifiable, nor in some instances, when identified, amenable to quantification. The indirect foreign exchange component of proposed capital projects has been generally ignored in NESA's capital project analyses. For example, the capital project under review may plan to purchase various raw material inputs from a local firm. These raw material

inputs are usually reflected in project reports exclusively as local currency costs. In actual fact, such local raw materials may contain significant amounts of foreign exchange expenditures. The local supplier may have to use foreign exchange in order to produce and supply the projected materials required by the capital project under examination. Numerous other examples can be provided to illustrate the ways in which indirect foreign exchange costs are relevant to the analysis.

Although NESA/CDF has used foreign exchange shadow prices in the analysis of several recent capital projects, the basis for the values assigned to the foreign exchange was not the result of any concerted or extensive research effort. The numbers adopted in many cases were obtained from both A.I.D. and non-A.I.D. sponsored studies that either required up-dating or were limited in certain theoretical aspects. NESA/CDF adopted these foreign exchange shadow prices because even these approximations were considered to be superior for project analyses to the official foreign exchange rates.

We would appreciate information from USAIDs on any current or contemplated research program to derive estimates of shaow prices for foreign exchange and labor costs and also the indirect foreign exchange components of capital projects. Comments from USAIDs on the value or direction of research efforts in this area would be appreciated.

OPPORTUNITY COST OF CAPITAL

The opportunity cost of capital is the most appropriate investment criteria by which either to discount the annual flow of net social returns (social returns less social costs) and calculate net present value or to measure whether the results of the IRR calculation provide an acceptable rate of return on the capital project. In economic terms the opportunity cost of capital concept adopted herein is measured by the net social returns that might have been earned if the economic resources had been allocated to an alternative capital project. The opportunity cost of capital definition is inherent in all economic decisions and assumes the existence of economic alternatives to any given capital project.

Literature on economic evaluation is replete with discussions as to both theoretical and empirical bases for selecting the opportunity cost of capital. NESA/CDF suggests that USAIDs adopt as the measure of the opportunity cost of capital for all capital projects, public and private, the expected or actual marginal productivity of capital investments in the private sector of the economy. The marginal productivity of capital investments in the private sector would, however, be adjusted to reflect the social returns previously discussed in the national economic profitability section (e.g., the opportunity cost of capital would be the return on private investment before, not after, taxes).

NESA/CDF is aware that this suggestion is far from providing a precise criterion for investment decision-making given the wide diversity in capital projects reviewed by this Agency. Risk factors vary by type of project and the guideline suggested herein does not provide for differential risk factors. The basic statistical information from which measures of the social marginal productivity of capital in the private sector are likely to be obtained relate to average returns from capital projects of varying age. Our primary concern is with marginal returns of new capital projects and the variability of the rate of return criterion in the future. The statistical information will also be incomplete as to sector coverage (probably mainly larger industrial operations) and deficient in basic data (accounting or financial concepts rather than economic data).

In spite of these deficiencies, the opportunity cost of capital based on the marginal productivity of capital in the private sector is still considered by NESA/CDF as a better guide to decision-making than other measures available or proposed. As a practical matter, for most of the project analyses in the NESA region, the annual discount rate or minimum acceptable return adopted for project evaluations will not be in the 4 percent to 6 percent range used many times in the past, but in the 10 percent to 20 percent range.

The 10 percent to 20 percent rate of return range suggested would necessarily vary by country in the NESA region. NESA/CDF cannot indicate precisely what specific opportunity cost of capital reflects an accurate evaluation for any specific type of project at a given time in one country. We are not aware of any past or current research efforts that could provide such precise information. NESA/CDF does have limited knowledge of past research efforts giving rough estimates of opportunity costs of capital in some NESA countries. USAID comments and information as to any current or contemplated research on the subject, whether in the Mission or by other parties, would be appreciated. Along with shadow prices and indirect foreign exchange costs mentioned previously, NESA/CDF is interested in encouraging operationally useful economic research to obtain better guidelines than presently available.

RELATIVE CONSTANCY OF RETURNS AND COSTS

In the past, most capital project analyses have tended to assume that the relationship between returns and costs will remain constant over the lifetime of the project after some plateau or point of full capacity utilization has been reached. Such an assumption was probably predicated both on the assumption that this relationship was a reasonable approximation of future events and on the requirement to simplify the analytical procedures.

In the future, NESA/CDF suggests that this assumption, if used in the analysis, be explicitly stated and the basis for the adoption clarified. For some of the LDCs, such an assumption may be plausible and for shorter-

lived projects not a significant element in the analysis. For others, it will tend to provide a biased project evaluation and overlook detailed analysis of economic problems intrinsic to the investment decision. Particular attention should be directed to the movement of real wages which, in the past, for many LDCs have not been readily offset by increases in labor productivity or price increases.

Project analysts should keep this aspect of project preparation and evaluation in mind in developing or reviewing the cash flow analysis presented for the capital project. An explicit justification of the methodology adopted can provide additional useful insight and understanding of the structure of the capital project.

SENSITIVITY TESTING

Sensitivity testing by varying the critical variables in the project analysis and interpreting the results is an intrinsic element in project analysis. Even if current cost information was xxxxx considered accurate and the market demand and price projections were the result of a logical and technically expert approach, some form of sensitivity testing is necessary. Project results are determined by future events containing elements of uncertainty that are not entirely susceptible of analysis. For many of the capital projects submitted to A.I.D. for possible financing, there are likely to be doubts as to accuracy of the current information even when the feasibility study underlying the loan application, after careful review, is considered to be of high professional quality. Whatever the source of information, some form of sensitivity testing is useful.

As mentioned above, the primary emphasis in any sensitivity test should be the critical variables. These will vary from project to project, but usually include construction cost estimates, sales volume (which depends on market demand, distribution capability and production performance) or unit sales price and significant elements of operating costs (e.g., fuel cost for an electric power plant). The choice of the critical variable is not the major impediment to good sensitivity testing; the primary obstacle is the range of values or probabilities which the project analyst can assign to the critical variable. One popular method is to assign values to the critical variables and label these as optimistic, conservative and pessimistic. If feasible, such classifications should be accompanied by xxxxx some effort to place probability factors in the various categories. If categories are used, then the considered judgment of the project analyst as to the probability of this event happening might be added to the analysis. The personnel reviewing or analyzing feasibility studies and preparing loan papers should have the benefit of some quantified judgment by the project analyst on such probability factors.

BRIEF BIBLIOGRAPHY LIST OF RELEVANT PUBLICATIONS

There are numerous books, monographs and articles dealing with the cash flow system of analysis, net present value, the internal rate of return, opportunity cost of capital, and other subjects discussed in this airgram. The following brief list may be of assistance to personnel in USAIDs who may desire further detail on some of the subjects discussed.

The Capital Budgeting System
by H. Bierman, Jr. and S. Smidt
(The MacMillan Company, New York, 1966).

Optimal Investment Decision: Rules for Action and Criteria for Choice
by Pierre Massé
(Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1962).

A Critical Survey of Project Planning
by J. L. Tryon and F. E. Cookson
(Center for Development Planning, National Planning Association, March 1966). A monograph prepared under research contract to AID (revision of M-8406).

The Economic Choice between Hydroelectric and Thermal Power Development
by H. G. Van der Tak (World Bank Staff Occasional Paper Number One, IBRD, published by the Johns Hopkins Press, 1966).

Water Supply, Economics, Technology and Policy
J. Hirshleifer, J. C. De Haven and J. W. Milliman
(The University of Chicago Press, 1960).

Preparation and Appraisal of Transport Projects
by Clell G. Harral
Transport Research Program, The Brookings Institution
Washington, D. C., October 1965 (an AID-financed research program).

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