OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

D000048
-53

Distr.
LIMITED

ID/WG.11/1
22 January 1969

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Workshop on Industrial
Project Formulation and Evaluation

[illegible] OF PROJECT FORMULATION AND EVALUATION 1/

1/ The views and opinions expressed in these papers are those of the consultants and do not necessarily reflect the views of the secretariat of UNIDO. This paper is not to be reproduced or quoted without the permission of the United Nations Industrial Development Organization.

id.69-227

Contents

[redacted]

These papers are being circulated at this time to [redacted]'s technical assistance experts in the field of planning and project evaluation, to national planning institutes and to national and regional small training institutes and universities for comments on their methodological approach and practical applicability. It is hoped that they will be carefully studied and commented on so that [redacted] will be better able to direct its future efforts in this field into the most productive and useful lines of action to meet the needs of present and future professionals whose job it is to evaluate and recommend new projects for government approval, licensing and/or financing.

The papers are so organized as to present a unified work. They are divided into five sections which will form the core of the Basic Documents of Project Formulation and Evaluation. It should be noted that they are not intended to be a step-by-step procedural manual on the science of project formulation and evaluation but rather to present the methodology on which the procedural manual will be based.

Section 1 presents a critique of commercial profitability analysis. After introducing the concept and describing a number of practical methods for its calculation, it discusses the reasons which make complete reliance on commercial profitability analysis inadequate. It then introduces the basic concepts of national economic profitability analysis.

Section 2 relates the qualitative criteria of a government's national plan to quantitative criteria which can then be incorporated into the methodology of individual project evaluations. It focuses its attention on five major criteria - increasing present consumption, increasing growth rate, increasing self-reliance, increasing employment and increasing the equitable distribution of income.

Section 3 introduces the techniques for evaluating the contribution of a project to each of these objectives described in the preceding section. Special emphasis is placed on the aggregate consumption objective, both current and future, and on the redistribution objective.

Section 5 introduces the concept of shadow prices as a methodology for reconciling the various objectives through a system of optimal parameters which will reflect the government's policy goals in quantitative terms.

Section 7 introduces the concept of sensitivity analysis as a methodology for determining which of the decision variables will most critically affect the outcome of the project. The results of this sensitivity analysis will allow project evaluators to determine which of the numerous variables should be subject to the closest scrutiny for their reliability and accurateness.

D00049

[redacted]

[redacted]

by

[redacted]
Indian Statistical Institute
India

[redacted]

I INTRODUCTION

In almost all developing countries the national government plays an important role in formulating and evaluating industrial projects. While the mix of public and private sector investment in industry varies from one country to another, the crucial role played by government authorities is a common feature everywhere. Either by direct investment in public sector enterprises, or by indirect controls on private investment (taxes, subsidies and the rationing of scarce investment resources) the government is generally in a position to guide the pattern of industrial investment in the country.

Together with this authority goes the responsibility of government to pursue policies that are in the national interest. Industrial projects must be formulated and evaluated in such a way as to single out for investment those projects and project variants that contribute most to the objectives of the nation. Whether it is considering an undertaking of its own, or an investment proposed by a private agency, the government requires a methodology by which to compare and to evaluate alternative projects in terms of their contribution to national objectives. This paper addresses itself to the basic principles which must underlie such a methodology.

A private firm, faced with a choice among alternative projects competing for its investible funds, typically applies the yardstick of commercial profitability to determine its investment policy. It seeks to invest in such a way as to maximize a measure of the profits accruing to the firm, where the exercise must be carried out in terms of readily identifiable market prices. It is sometimes suggested that the government should apply a similar criterion to discriminate among projects over which it has some control. Hence the demand that public sector enterprises should "pay for themselves" or "make a reasonable profit", i.e. that they should be subjected to the same kind of market tests that private enterprises face.

In the pages to follow, it will be argued that the criterion of commercial profitability is in fact completely inadequate for government evaluation of industrial projects. Commercial profitability is of relevance only for an understanding of the behaviour of private sector enterprises. Whenever the government wishes to predict the behaviour of private firms over which it does not exercise any direct control, it will be useful to combine the commercial profitability of a given investment project from the point of view of the firm. When it comes to

an evaluation of the project, however, a different criterion is required which derives from the point of view of the nation as a whole. Thus commercial profitability may be regarded as a potentially useful tool for positive analysis, but as an inadequate basis for normative judgement.

To pursue the issues raised above, we require first an understanding of what is meant by commercial profitability. Part II of the paper introduces the concept of commercial profitability and discusses a number of ways in which it is measured in practice. Part III takes a critical look at commercial profitability as a basis for evaluating industrial projects, and discusses the reasons for which it must be regarded as inadequate. In Part IV, the concept of "national economic profitability" is introduced as an alternative to commercial profitability. Part IV concludes with a brief discussion of some of the basic principles of social benefit-cost analysis: the evaluation of projects according to the criterion of national economic profitability.

II THE MEASUREMENT OF COMMERCIAL PROFITABILITY

The commercial profitability of a project is a measure of the excess of the total money receipts over the total money expenditures associated with the project. It is of interest to a private firm precisely because the money receipts represent the benefits accruing to the firm and the money expenditures constitute the costs incurred by the firm. The greater the excess of money receipts over expenditures, the more profitable is the project from the commercial point of view of the firm.

The measurement of the commercial profitability of a project begins with a complete, time-wise description of its physical composition. On the basis of the relevant engineering studies and designs, the quantities of inputs and outputs of goods and services that make up the production process must be projected for every year of the expected project lifetime. The second step in the procedure is to attach money values to each of the physical inputs and outputs at each point in time. On the basis of demand and cost studies, the relevant prices must be projected into the future and multiplied by the corresponding inputs and outputs to yield money estimates of expenditures and receipts in each year.

The last, and conceptually the most difficult, step in the assessment of commercial profitability is to calculate a single measure of profitability on the basis of the given time streams of expenditures and receipts. It is easy enough to measure the excess of receipts over expenditures in any single year, but how can the profits of different years - sometimes positive, sometimes negative - be combined into a unique measure of over-all profitability? The problem of choosing an appropriate intertemporal criterion has long troubled investment analysts and project evaluators, and there is still no general agreement about the best technique. In the paragraphs to follow, we shall discuss and compare a number of alternative intertemporal criteria that have been suggested and used in practice.

The pay-back (or recoupment) period

One of the simplest measures of commercial profitability - often used in business practice precisely because of its simplicity - is the pay-back (or recoupment) period. It is defined as the number of years that it takes for the expected stream of net earnings (receipts minus expenditures) to pay back the initial capital outlay of a project. If we let K denote the initial capital

outlay, B_t the gross benefits (total receipts) in year t, and O_t the operating costs (current expenditures, excluding any allowance for depreciation) in year t, we may define the pay-back period as T^* years, where

$$\sum_{t=1}^{T^*} (B_t - O_t) = K \qquad (1)$$

According to this criterion, the smaller is T^*, the better is the project, for the faster one recovers one's initial investment expenditure. The criterion may be used to rank a set of projects from which a limited number may be chosen according to the size of the investment budget.

Apart from its simplicity - which may justify its use for limited screening purposes - this criterion has little to recommend it. It fails to take into account any benefits and costs that occur after the recoupment of the initial capital outlay, and is therefore unable to discriminate among projects with different lifetimes. Even within the recoupment period it takes no account of the timing of benefits and costs, and is therefore unable to distinguish between projects with different time patterns of inputs and outputs. Finally, the treatment of the initial capital outlay K is ambiguous unless all of the investment takes place within a reasonably short period of time.

Discounted cash flow and present value

All of the more sophisticated measures of commercial profitability involve - directly or indirectly - the notion of time discounting. To compare the receipts and expenditures - i.e. the cash flows - associated with a project at different points in time, a rate of discount is introduced which measures the annual rate at which the value of a current dollar declines. The process of time discounting is simply the process of compound interest in reverse. At an interest rate of 10%, a dollar this year becomes $1.10 next year and $1.21 the year after; at a discount rate of 10%, $1.21 two years hence is worth $1.10 next year or one dollar this year. To calculate the present value of any cash flow t years hence, we must therefore divide the value of the cash flow by the value of one compounded at the given discount rate for a period of t years.

The present value of a given project is defined simply as the sum of the values of all present and future net cash inflows (money receipts minus money expenditures), each discounted back to the present at a given rate of discount. Denoting the total receipts associated with the project in year t by B_t (benefits),

and denoting the total expenditures in each year t by C_t (costs), and assuming a project lifetime of T years, we may express the present value of the project at the discount rate i as:

$$PV(i) = \sum_{t=1}^{T} \frac{B_t - C_t}{(1+i)^t} \qquad (2)$$

Note that in this definition, capital expenditures and current operating expenditures (exclusive of any depreciation allowance) are treated equally: both are included in C_t.

Provided that a suitable value can be found for the discount rate i, the present value criterion has much to recommend it as a measure of commercial profitability. It is easy to understand and easy to apply, and it takes directly into account the fundamental principle of intertemporal evaluation: that benefits and costs are of differing value depending upon the time at which they occur. An additional advantage is that - in contrast to the alternative criteria discussed below - the present value criterion reflects the volume rather than the rate of profit associated with a project. This may be an important consideration in comparing mutually exclusive projects or project variants.

The one potential drawback of the present value criterion is the requirement of a magnitude - the rate of discount - which cannot be estimated from project data alone. The rate of discount used for discounting cash flows is usually identified with some market rate of interest, or historical rate of return (see below) based on the experience of the investing firm. Under any circumstances, these rates may be difficult to identify in a satisfactory way. Furthermore, except in certain special circumstances discussed in greater detail at the end of Part II, neither a rate of interest nor a rate of return may be the appropriate figure for the rate of discount. For these reasons, a measure of commercial profitability that is independent of any external magnitude often has greater appeal.

The internal rate of return

Perhaps the most common measure of commercial profitability is the internal rate of return (sometimes called the "yield", or simply the "profitability" of a project). It is defined quite simply as that rate of discount which makes the present value of the project equal to zero. Using the

same algebraic symbols as above, we may equate, the internal rate of return with ρ, where

$$PV(\rho) = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+\rho)^t} = 0 \qquad (3)$$

The advantage of the internal rate of return - vis-à-vis the present value measure - is precisely that it can be calculated directly from project data (the time streams of receipts B_t and expenditure C_t) without any appeal to an externally given rate of discount.

The disadvantages of the internal rate of return are several. In the first place - except for a simplified case discussed below - it is difficult to compute. No simple analytical method exists for solving equation (3); instead, a tedious trial and error method is required in which different values of ρ are substituted into the equation until one approaches the value which drives the present value to zero. Secondly, the solution to equation (3) is not necessarily unique; if the time stream of net benefits $(B_t - C_t)$ changes sign more than once over the lifetime of the project, it is possible - even if unlikely - that more than one value of ρ will drive the present value to zero. Finally, the internal rate of return does not convey any information about the size of a project; when choosing between two mutually exclusive alternatives, one might well prefer a big project with greater absolute benefits but a lower rate of return to a smaller project with a higher rate of return.

When the time pattern of inputs and outputs of a project conforms to a very simple model, a simpler and more familiar expression of profitability may be used for the internal rate of return. In particular, if the entire capital outlay - denoted by K - is made in an initial year 0, and if in the subsequent years 1 through T there are constant annual flows of gross benefits (total receipts) at a rate $\bar{B}$ and operating costs (current expenditures, exclusive of depreciation allowance) at a rate $\bar{O}$, then we may define the equivalent annual rate of return $\bar{\rho}$ as:

$$\bar{\rho} = \frac{\bar{B} - \bar{O} - \bar{D}}{K} = \frac{\bar{B} - \bar{O}}{K} - d_{rT} \qquad (4)$$

where $\bar{D}$ is the annual allowance for depreciation, and d_{rT} is the corresponding

equivalent annual rate of depreciation as a fraction of the initial capital outlay K. If depreciation is calculated according to the "sinking-fund" rule (so that the annual amount $\bar{D}$ is such that, if invested at an interest rate r, it would provide a total fund of K at the end of T years), then - as shown in the Appendix - we may write:

$$d_{rT} = \frac{r}{(1+r)^T - 1} \qquad (5)$$

The straight line depreciation rule corresponds to the limiting case when r = 0:

$$d_{0T} = \frac{1}{T} \qquad (6)$$

It is proved in the Appendix that $\bar{\rho}$ is precisely equal to the internal rate of return ρ for a project of this simple form, provided that depreciation is calculated according to the sinking-fund rule with $r=\bar{\rho}$.

Benefit-cost ratios

Another measure of profitability - used especially for public sector projects - is the benefit-cost ratio. It is very closely related to the present value measure, making use of the same time streams of benefits (B_t) and of costs (C_t), as well as of an externally provided rate of discount i. Using the same symbols as before we may define the benefit-cost ratio of a given project - evaluated at the discount rate i - as

$$\beta(i) = \sum_{t=0}^{T} \frac{B_t}{(1+i)^t} \Big/ \sum_{t=0}^{T} \frac{C_t}{(1+i)^t} \qquad (7)$$

The benefit-cost ratio has had a great appeal to government agencies as a method of ranking alternative projects, although it combines the only drawback of the present value measure (dependence on an externally provided discount rate) with one of the disadvantages of the internal rate of return (failure to convey information about the size of a project).

An alternative method of calculating the benefit-cost ratio is often used when the time pattern of inputs and outputs of a project corresponds to the simple model described in the special case of the internal rate of return. With initial capital outlay K and annual flows of benefits and current costs $\bar{B}$ and $\bar{O}$ from year 1 to year T, we may write the equivalent annual benefit-cost ratio as

$$\bar{\beta}(r) = \frac{\bar{B}}{\bar{O} + \bar{I} + \bar{D}} = \frac{\bar{B}}{\bar{O} + (r+d_{rT})K} \qquad (8)$$

where $\bar{I}$ is the annual interest charge on funds committed to the initial capital

outlay K, $\bar{D}$ is the annual allowance for depreciation, and r and d_{rT} are the corresponding rates of interest and depreciation. It is proved in the Appendix that $\bar{\beta}(r)$ corresponds precisely to the generalized benefit-cost ratio $\beta(i)$ when the rate of discount i is set equal to r and the rate of depreciation d_{rT} is calculated according to the sinking-fund rule.

The choice of an appropriate intertemporal criterion

A numerical measure of commercial profitability is required to impose a preference ordering on a set of alternative projects, that is, to rank the projects according to their desirability. This is essential in choosing among mutually exclusive projects, or among different variants of the same project. But in addition to ranking projects, an investor must decide how many projects to undertake, how much to invest. One project may be superior to another, but if neither are "profitable" it will not pay to invest in either one. Thus what is required in addition to a procedure for ranking is a decision rule for accepting or rejecting a project, whatever its rank. Such a decision rule usually takes the form of a cut-off point: if the numerical measure of profitability is greater than the cut-off value, accept the project; otherwise, reject it.

Apart from the crude pay-back period, three alternative methods of measuring commercial profitability were discussed above. present value, the rate of return, and the benefit-cost ratio. The usual decision rules associated with the three measures are as follows: accept a project (1) if its present value PV(i), at a given discount rate i, is greater than zero; (2) if its rate of return ρ is greater than a given minimum acceptable rate ρ^M; (3) if its benefit-cost ratio $\beta(i)$, at a given discount rate i, is greater than one. Although the use of ρ for ranking purposes calls for no magnitude external to the project, its use in a decision rule requires a cut-off point ρ^M to be defined from outside. If we identify both of the externally given magnitudes i and ρ^M - as they are often identified - with a single market rate of interest r, then all three measures of commercial profitability lead to identical decision rules. The identity of these rules follows directly from the definitional equations (2), (3) and (7).

When it comes to the ranking of projects, there is no such harmony among the three measures. It is easy to show that the orderings of a set of projects generated by the present value criterion, the internal rate of return, and the

benefit-cost ratio need not - and generally will not - be the same. A large project may have a relatively high present value but a relatively low rate of return and a low benefit-cost ratio. A project with low capital costs but high annual receipts and operating expenditures may have a relatively high rate of return but low benefit-cost ratio. Furthermore, the orderings yielded by the present value and benefit-cost ratio criteria depend on the assumed rate of discount and may well change as the rate of discount changes. Projects with quick returns are favoured by high discount rates, and projects with longer gestation lags are favoured by low rates. In sum, the choice of intertemporal criterion is clearly crucial to the outcome of most investment decisions involving the ranking of alternative projects or project variants.

Which of the alternative measures of commercial profitability is the most appropriate, and how should it be applied? To answer this question in a theoretically satisfactory manner, we must go back to the underlying logic of intertemporal evaluation. Every project generates a time stream of money receipts and money expenditures; by subtracting the latter from the former, we arrive at a single time stream of net cash inflows. The problem confronting the evaluator is how to combine these annual net inflow figures into a single, over-all criterion. One possible solution that might suggest itself is simply to add all of the annual figures together. But this is obviously inappropriate, since the value of the cash to the investing firm is different at different points of time. What is really required is to attach to net inflows at each point in time a weight that reflects the value of a dollar of cash inflow at that particular time. If we denote the net cash inflow of a project in year t as N_t and the value to the firm of a dollar in year t as w_t, then the appropriate measure of the over-all profitability of the project is

$$P = \sum_{t=0}^{T} w_t N_t \qquad (9)$$

The key to such a measure of profitability is of course the evaluation of the time weights w_t. We have rejected the notion that they are equal; what we would find more plausible is that - from the point of view of any private firm - the value of a dollar should decrease over time. A dollar this year is worth more than a dollar next year, and a dollar next year is worth more than a dollar the year after. This notion is embodied in the procedure of time discounting. A glance at equation (2) shows that the effect of discounting at a rate i

is to attach to net cash inflows in each year t a weight equal to

$$w_t = \frac{1}{(1+i)^t} \qquad (10)$$

From equation (10) it follows that

$$i = \frac{w_t - w_{t-1}}{w_{t+1}} \qquad (11)$$

Thus the rate of discount i is equal to the annual per-unit rate of decline of the time weights w_t. The usual assumption of a constant rate of discount i in the evaluation of present value implies that the annual rate at which the value to the firm of a dollar of cash inflow declines is constant.

Under what circumstances would the present value criterion with a constant rate of discount i be appropriate? Only if there is reason to believe that the value of a dollar of cash inflow actually does decline at an annual rate i. In particular, when a firm can borrow or lend as much as it wishes at a fixed rate of interest r, then the firm should use the present value criterion with a discount rate i=r. Because the firm can always trade a dollar this year for (1+r) dollars next year, or vice versa, the present value of a current dollar from the point of view of the firm actually does decline at the annual rate r. With unlimited access to a capital market, the profit maximizing firm should undertake all mutually compatible projects with positive present value at the given rate of interest r; the total size of the investment outlay will depend only on the availability of such profitable projects. To choose between mutually exclusive projects, the firm should choose the one ranking highest in present value.

The situation of unlimited access to borrowed funds at a given rate of interest is - unhappily for project evaluators - seldom the rule. Most firms have limited possibilities of raising capital, and face budget constraints on investible funds. When the firm cannot borrow and lend at will, market rates no longer reflect the annual rate at which the present value of a dollar to the firm declines. To preserve the logic of intertemporal evaluation, a different method is required to arrive at the appropriate time weights. Unfortunately, there is no longer any simple and objective procedure for determining these weights, and there is certainly no guarantee that the appropriate weights will be such as to imply a constant rate of discount.

A theoretically satisfactory approach to the problem of project choice under budget constraints can be developed only by setting up a comprehensive, multiperiod model of constrained profit maximization. Such a model would include (1) a maximal function incorporating the subjective time preference of the owners of the firm for dividends declared from profits; (2) a set of activities describing the alternative projects available to the firm; and (3) a set of constraints describing the time-wise budget and other limitations on the operations of the firm. From the over-all solution to such a programming model would emerge the appropriate time weights w_t for evaluating any new project according to the present value criterion, as well as a set of accounting prices reflecting the true value to the firm of various constrained resources (such as investible funds in a given time period).

The very magnitude and complexity of the task required to provide a theoretically satisfactory solution to the problem of project evaluation explains why less accurate and less sophisticated measures of commercial profitability are widely used. The difficulty of deriving the appropriate time weights - or the appropriate rate of discount - to use with the present value criterion under budget constraints leads to a variety of substitute measures. As noted earlier, the present value criterion (as well as the benefit-cost ratio) is often used with rates of discount equal to some market rate of interest, or some notion of a marginally acceptable rate of return. Neither of these alternatives can be justified except under very limiting conditions, but it is difficult to judge in a given situation whether the inaccuracy will be serious or negligible. Even less justifiable - but perhaps more common - is the use of the rate of return criterion to rank projects, and the selection of as many projects from the top of the list as will exhaust the available funds. In sum, the measurement of commercial profitability - like most aspects of business practice - is far from being an exact science, and there is still a great deal of room for legitimate controversy and a great deal of scope for improvement.

III THE LIMITATIONS OF COMMERCIAL PROFITABILITY

In the introduction to this paper it was stated categorically that commercial profitability is completely inadequate for government evaluation of industrial projects. Why is this so? What should prevent the government from using precisely the same methodology to evaluate its own projects as private investors use to evaluate theirs? The fundamental reason is that, whereas the private investor seeks to evaluate the effect of a project on the welfare of his own firm, the government - representing the nation as a whole - should be concerned with the welfare of all the people under its rule.

As soon as one departs from the interest of a single private firm to consider what is best for society as a whole, one enters into the domain of political science and ethics. The manner in which a society determines what is in the collective national interest, and the sense in which the government gives expression to the national will, are issues that go beyond the scope of this paper. Whatever the particular form of government, however, and whatever the nature of the decision-making machinery, we can distinguish between the private interest of an individual and the "social welfare" of the community of individuals. We assume that it is the national government - as the duly constituted political authority - which determines and articulates the interests of the community as a whole.

Commercial profitability could be used by government authorities to measure the value of a project only if the commercial profits of the project - as viewed by a private investor - coincided with the net benefits of the project to society as a whole. This would be true only under a set of very limiting conditions. First, the money expenditures associated with the project would have to reflect all of the costs incurred by society in connexion with the project, and the money receipts from the project would have to measure all of the benefits to society arising from the project. Second, the intertemporal criterion used for private evaluation would have to be relevant also for the community as a whole, i.e. the (explicit or implicit) time weights associated with benefits and costs at different points in time would have to reflect the relative value of net benefits to the whole community at each point in time.

These conditions are indeed extremely limiting. At each of the three stages of private project evaluation (see part II), the conditions are likely to be violated. In the listing of physical inputs and outputs at each point in time, a private firm considers only those items which affect the firm itself. The government must (in principle) take into account all of the items which affect any agent of the economy. In the valuation of the physical inputs and outputs which constitute the project, the private firm applies market prices reflecting the costs and benefits to the firm itself. As a reflection of the costs and benefits to society as a whole, however, these market prices may be completely irrelevant, and - in some cases - they may not even exist. Finally, to compare receipts and expenditures occurring at different points in time, the private investor will look for a measure reflecting the changing value of a dollar to the firm over time; there is no reason to believe that the value of a dollar to society changes in the same way as it does to an individual firm.

In brief, the profits of a private firm are likely to differ from the net benefits to society both in respect to coverage (the inputs and outputs included in the evaluation) and in respect to valuation (the price attached to the inputs and outputs, currently and intertemporally). In the remaining pages of Part III, the nature of - and the reasons for - these differences will be spelled out in greater detail. These differences are so widespread - particularly in economies in the early stages of industrialization - that commercial profitability loses its relevance for the evaluation of industrial projects. This conclusion should not really be very surprising. All governments find themselves pursuing policies inconsistent with a strictly commercial point of view, and few people would seriously suggest that commercial profitability is always the best measure of social welfare.

Inadequacy of coverage

An analysis of the commercial profitability of a project fails to take into account any benefits and costs accruing to economic agents other than the enterprise which undertakes the project (except in so far as these are translated into receipts and expenditures for the enterprise itself). At the same time, the commercial profitability calculus sometimes includes receipts or expenditures associated with the project which have no counterpart as benefits or costs to any economic agent. These discrepancies of coverage arise in a variety of different circumstances.

A glance at the accounts of a private firm suggests several such discrepancies. When a firm pays taxes to the government, they are naturally treated as an item of expenditure; when it receives a subsidy for its output, it enters as a receipt. Such taxes and subsidies involve no real movement of resources, but only a transfer of money between two economic agents (the government and the firm). From the point of view of society as a whole, therefore, there are no corresponding costs and benefits. In the same way, a private firm incurs a cost in maintaining liquid balances as working capital, yet this involves no sacrifice of real resources and therefore no cost to society. And any payment that an individual firm makes to insure itself against the risk of failure may be largely superfluous from a social point of view, since the pooling of risks to many firms and undertakings reduces greatly the over-all risk to society.

Apart from such discrepancies between private and social coverage which are largely of an accounting nature, there is an important class of social benefits and costs - known as "external economies and diseconomies" - which tend to be omitted from the commercial profitability calculus. An external economy (diseconomy) exists when the economic activity of one individual or enterprise results in a gain (loss) of welfare by another individual or enterprise. The external economies and diseconomies arising from a given project are rarely translated into money receipts or expenditures for the agency undertaking the project. This point can be illustrated with reference to a number of examples typical of industrial projects.

Most industrial undertakings call for a substantial supply of labour with the skill and the experience to carry out a variety of complicated tasks. Often such labour is not readily available and must therefore be trained as part of the undertaking itself. The costs of training are incurred by the enterprise, and the corresponding benefits are also captured so long as the locally trained labour is employed by the enterprise. But when the trained labourers leave to find work elsewhere (on or before the termination of the project), they have the advantage of newly acquired skills and experience which represents a real social gain that does not accrue to the enterprise in the form of money receipts. Labour training and skill formation are often important external economies of industrial projects in a country where skilled labour is in short supply.

Examples of external diseconomies are also readily found in industrial projects. The pollution of water by the discharge of waste material and the fouling of air with heavy smoke are common features of many industries. Such by-products of industrialization involve an obvious social cost, sometimes they are controlled by state regulations, but rarely are they translated into costs for the enterprise.

Another class of external economies is associated with projects that are large in relation to the economy of the area where they are located, or in relation to the over all demand and supply of particular goods and services. A new industrial project in an economically backward area may stimulate economic activity in such a way as to lead to benefits for a wide range of people and/or firms not directly connected to the project. The expansion of demand for products used by the project may promote more efficient production and higher profits in supplying industries; and the expansion in supply of the output of the project may lower the price at which it is available in the market, and thereby confer benefits on all consumers greater than any corresponding losses by producers. The fact that many of the above mentioned external economies and diseconomies may be difficult to quantify and to measure does not reduce their significance in divorcing social welfare from commercial profitability.

Inadequacy of valuation

If we assume for the moment that the methodology of commercial profitability could be so modified as to take into account all of the relevant inputs and outputs and only the relevant inputs and outputs from the social point of view, we must still ask whether market prices are appropriate for the measurement of these inputs and outputs. How do we know when a price is appropriate? A price is supposed to indicate the value of a unit of the good or service to which it is attached, in terms of some standard monetary unit of account. The more valuable is a good - i.e. the greater the gains that result from having it, or the greater the losses involved in doing without it - the higher the price that should be attached to that good.

The key to the determination of an appropriate price is a criterion of welfare with which to measure the gains and losses associated with the addition and subtraction of different goods and services. Indeed, a price is nothing but a measure of the contribution to welfare of an extra unit of the good or service

to which it is attached. For a private firm seeking to maximize profits, the relevant welfare criterion is precisely the level of money profits accruing to the firm. The loss in welfare associated with the use of an input is simply the money cost of purchasing the input, and the gain in welfare associated with the production of an output is the money receipt obtained by selling the output. Thus the appropriate prices for the calculation of commercial profitability are precisely the market prices of purchase and sale.

In the case of government evaluation of industrial projects, however, we require a criterion of social rather than private welfare. Just as the private firm seeks to maximize its own profits, the government should attempt to maximize the social welfare of the nation as a whole. In order to do so, it must use prices which reflect the marginal contribution to social welfare of each good and service. The price of a project input should reflect the loss to the rest of society in giving up that input, and the price of a project output should reflect the gain to the rest of society in obtaining another unit of that output.

Is there any reason to believe that market prices can play the dual role of measuring marginal contributions both to private and to social welfare? Economists have shown that, under certain very limiting conditions, the use of market prices and the maximization of commercial profits will lead to a maximization of social welfare in the sense of a "Pareto optimum". A Pareto optimum is a situation in which no one person can be made better off without reducing the welfare of another person. To say that market prices will lead to a Pareto optimum is to imply the following: any project that yields positive profits when its inputs and outputs are evaluated at market prices will result in a new situation where some people could attain higher levels of individual welfare and nobody would suffer losses of welfare. It is this conclusion which leads many people to identify commercial profitability with social desirability.

The conditions under which the conclusion is valid are the assumptions that underlie the economist's model of a competitive market economy, from which the result is derived. It is assumed that all markets function perfectly: there are many buyers and many sellers, prices are determined by the free play of supply and demand, and no individual buyer or seller can influence prices

through his own behaviour. It is also assumed that nature is such as to give rise to no external economies or diseconomies, nor to any kinds of interdependence among producers and consumers.

Unfortunately for project evaluators, the competitive model cannot legitimately be used to justify the application of market prices in project evaluation. The problems are twofold. In the first place, the criterion of Pareto optimality reflects much too limited a concept of social welfare to serve as a basic standard of valuation. Secondly, the assumptions which underlie the competitive model are so often violated in the real world that little confidence can be placed in any conclusions derived from it.

The criterion of Pareto optimality

Pareto optimality is not so much a criterion of optimality as a criterion of efficiency. A situation in which no one person can gain in welfare without another person losing is certainly not to be preferred to a situation in which there are still gains to be had for some without losses for others. In the latter case there are unexploited opportunities going to waste: there is inefficiency. But if Pareto optimality is a necessary condition for a social optimum, it cannot be regarded as sufficient. There are an infinity of alternative situations consistent with Pareto optimality among which the criterion does not distinguish.

In particular, the criterion of Pareto optimality has nothing to say about the distribution of income. The gains of the rich are not distinguished from the gains of the poor, for no distinction is made between individuals. As a result, the use of market prices in project evaluation would be as likely to channel benefits to those who have as to those who have not. This neutrality of Pareto optimality vis-à-vis income distribution runs counter to the professed objective of most nations to reduce the extent of income inequality. Although it is arguable to what extent this objective should be reflected in the formulation and evaluation of individual projects, there are few governments that would be prepared to ignore the distributional consequences of their undertakings.

Apart from the redistribution of income, these are other possible social objectives which are ignored by the purely efficiency-oriented criterion of Pareto optimality: the expansion of employment opportunities in an economy

characterized by structural unemployment, the achievement of self-sufficiency in a country heavily dependent on foreign aid; the provision of basic public services, such as education and medical facilities, that would not pay for themselves in free markets. In all of these cases, a government might well be prepared - in the interest of the nation as a whole - to sacrifice some potential gains in individual welfare levels in order to make a contribution to other social objectives. Yet the market prices that would emerge under the best of circumstances in a perfectly competitive model would attach no value to any other objective than a net increase in the self-evaluated welfare of some individuals irrespective of who the gainers are.

The assumptions of the competitive model

Even if additions to individual welfare levels - irrespective of who the gainers are, and irrespective of any other objectives - were the only relevant goal to guide the evaluation of projects, market prices would still fail to play the role assigned to them in the competitive model. The key assumption of perfectly functioning markets is much too ambitious a requirement. Both because of inherent market inadequacies, and because of institutional market imperfections, market prices tend to lose their normative significance and can therefore not be used to measure gains and losses to society as a whole.

There are certain kinds of economic phenomena which by their very nature preclude the proper functioning of a market. In such cases, we may speak of the inherent inadequacy of the free market system. For example, external economies and diseconomies - discussed earlier under the heading of coverage - often give rise to benefits and costs that are not captured by the market mechanism. Whenever my welfare depends on the activity of someone else, but I cannot be made to pay for the benefits I enjoy or I am not compensated for the inconvenience I suffer, then the market system does not function properly.

There are many examples of goods and services that reflect external economies through interdependence of consumption. As the owner of a telephone, I stand to benefit (up to a point!) the greater is the number of other subscribers. As a participant in a public health programme - or even as a non-participant living in the same area - my welfare increases with the number of other people involved in the scheme. Yet in neither case do I pay as an

individual consumer for the extra benefits arising from the consumption of others. The examples cited earlier of air and water pollution, and of labour skill formation, reflect externalities due to the dependence of one man's welfare upon the productive activities of others. Here again the associated benefits and costs are not captured by the market mechanism.

In the case of certain goods and services that are jointly consumed by many individuals, more consumption for one man does not necessarily imply less consumption for another. My use of a road or a bridge, except for minor wear and tear, and apart from any overcrowding, does not reduce the benefits that others may derive from it. My listening to a radio programme in no way prevents anyone else from tuning and enjoying the same programme. Such goods and services are labelled "public goods" because they cannot be privately consumed like oranges or haircuts. The chief characteristic of public goods is that the marginal (extra) cost of providing for additional consumption is zero, so that nobody should be prevented from consuming more if he derives any positive benefit from it. Yet such a policy would also call for charging a price of zero, with which the initial costs of production could not be covered. Thus there is no market price that would lead to a social optimum in such circumstances, and the public sector is usually called upon to rescue public goods from the inadequately functioning free market.

Another common phenomenon which violates the assumptions of the competitive model is that of "increasing returns to scale". The technological characteristics of many goods and services are such that the cost per unit of output falls markedly as the scale of production increases. Steel mills, electric power plants, and many other heavy industries show significantly increasing returns to scale. Under such circumstances, it is advantageous both for a private firm and for society as a whole to produce in large scale units. But the very existence of large scale units is inconsistent with the competitive requirement that there be large numbers of relatively small buyers and sellers in each market. Large-scale production leads to situations of monopoly (a single seller) or oligopoly (a few sellers) where firms can influence market prices by their own actions, and thereby prevent these prices from serving social rather than private ends.

Perhaps the single market which one would expect on a priori grounds to be inherently the most inadequate is the capital market. It is from the capital market that the intertemporal prices so crucial to project evaluation must emerge, as summarized in the form of the market rate of interest. Apart from the institutional difficulties of introducing perfect competition into capital markets - due to increasing returns, lack of knowledge and communication etc. - there is strong reason to believe that even a perfectly functioning capital market may be inadequate to register society's collective intertemporal preferences. This is because collective intertemporal preferences may well differ from individual preferences expressed in markets through private, atomistic decisions. I may be willing to save for the future if others will do likewise, but unless everyone is compelled to save together for the future, I may not be interested in postponing my consumption alone. Because of such considerations, the total flow of savings resulting from competitive market decisions may not be socially optimal. Society as a collective whole may attach a higher value to savings than does the free market.

All of the cases discussed thus far lead to difficulties with the competitive model that are not just institutional - a matter of empirical fact - but that are inherent in the social and economic situation - a matter of logical necessity. The inability of the competitive model to deal with external economies and diseconomies, public goods, increasing returns, and collective decisions will lead to market failure whatever the nature of the market institutions. Thus both in less developed and in advanced economies, in poor and in rich countries, one finds the public sector playing a major role in the areas of economic activity where these phenomena are important. But market failure is by no means limited to such phenomena. Especially in the less developed economies, there are many kinds of institutional market imperfections which also serve to inhibit the smooth functioning of the market system.

In order to function smoothly, markets require large numbers of buyers and sellers, a high degree of knowledge, a steady flow of information, considerable mobility of labour and of resources, and freedom from various restrictive regulations and practices. Such conditions can by their very nature be attained only after a considerable period of economic development. In the early stages of industrialization, there are rarely more than a few producers of any given industrial product. A relatively uneducated population and a relatively

undeveloped system of transport and communications contribute to a lack of information and mobility. The traditional social structure, the concentration of power in the hands of privileged groups, and the predominant authority of the government are often factors which tend to subordinate the role of the free market in a poor country.

The result of such tendencies can be observed in a wide variety of different markets. Domestic goods prices are distorted by monopoly exploitation, by speculation on the part of traders, by governmental price control on various commodities, by tariff protection against foreign goods, and by other instances of private and public interference with the market mechanism. Capital markets in particular suffer from monopoly elements, from widespread ignorance, and from arbitrary government regulation, with the result that interest rates may vary from as low as 3 per cent for governmental agencies to as high as 40 per cent for peasant farmers. Under such circumstances it is very difficult to argue that market rates of interest have any significance for project evaluation, or that the flow of savings in the economy is optimal in any sense.

Labour markets in developing economies often display a peculiar form of structural disequilibrium. On the one hand, many densely populated countries suffer from high rates of total and partial unemployment. This leads to a surplus of unskilled labour and occasionally even of skilled labour both in rural and in urban areas. On the other hand because of the political power of the employed, and the reluctance or inability of the unemployed to bid down wages - wage rates in the organized sectors of the economy remain substantially higher than the value of the output produced by a marginal labourer elsewhere in the economy. As a result, the market wage rate faced by an industrial employer does not reflect the actual cost to society of hiring an extra man.

Another market which is typically imperfect in a newly industrializing economy is the foreign exchange market. Because of the sharply increasing import demand typical of the early stages of industrialization, or because of an excessive degree of domestic price inflation due to rising development expenditures, many developing countries face great pressure on their balance of payments. The result is often an over valued exchange rate which must be defended by tight governmental control of imports and special incentives for exports. Under such circumstances, the official rate of exchange for foreign

currency understates the real value of the foreign currency to the economy - as measured by the gains associated with an extra unit of imports, or the losses associated with the diversion of domestic resources into an extra unit of exports.

Thus, the failure of the market system in developing economies is due as much to institutional market imperfections as to inherent weaknesses in the operation of markets. Such institutional imperfections tend to justify a wider role for the public sector in developing economies than in economies with more highly developed market institutions. For the same reason, they call for a more thorough understanding of the limitations of commercial profitability.

IV THE CONCEPT OF NATIONAL ECONOMIC PROFITABILITY

If commercial profitability must be dismissed as an inadequate criterion for the formulation and evaluation of industrial projects, what can replace it? What kind of analysis can be applied by government authorities to select those projects and project variants that best serve the interests of the nation as a whole? The lengthy discussion in Part III on what is wrong with commercial profitability may indirectly serve to suggest the principles upon which an alternative and more appropriate methodology should be based. To distinguish it from commercial profitability, we shall call the alternative criterion 'national economic profitability'. The formulation and evaluation of projects according to the criterion of national economic profitability rather than commercial profitability is generally called 'social benefit cost analysis'.

The basic principle of social benefit cost analysis is to evaluate the net effect of a project on the welfare of society as a whole rather than on the welfare of a single individual, enterprise or agency. The form of a social benefit-cost analysis is no different than the form of a private commercial profitability analysis. First, all of the inputs and outputs associated with a given project must be recorded. Secondly, prices must be attached to these inputs and outputs to translate the physical quantities into comparable value terms. And finally, intertemporal weights must be attached to the net value of the project in each year of its operation so as to reduce the time stream of values to a single over all measure of profitability.

A social benefit cost analysis differs from a corresponding private profitability analysis only in its coverage of inputs and outputs and in its valuation of those inputs and outputs, i.e. in the two broad areas in which the methodology of commercial profitability was found wanting. In a social benefit-cost analysis we must interpret the inputs and outputs of a project to mean <u>all</u> of the costs and benefits associated with a project, whomsoever they affect. And we must use a standard of value to measure these costs and benefits that reflects their impact on the over-all social welfare rather than on anyone's private profits. The most difficult and the most important part of any social benefit cost analysis is the determination of the prices used to measure benefits and costs, currently and intertemporally. A detailed discussion of the issues and the methodology will follow in subsequent papers. But a few general principles may be introduced here.

First of all, a clear statement of national objectives is required to give content to the notion of national economic profitability. Secondly, there must be an evaluation of the relative importance attached by society as a whole to contributions to different objectives - under different circumstances, and at different points in time. Without such information, it is impossible to give meaningful content to the concept of social welfare. And without a working concept of social welfare, there can be no meaningful prices - for a price is simply a measure of the contribution to (social) welfare of an extra unit of the good or service to which it is attached.

Once a basis has been established for comparing contributions to different objectives, and for evaluating contributions at different points in time, the problem of pricing may be reduced to the measurement of benefits and costs with respect to each separate objective at each distinct point in time. Where market prices exist, they may serve as a point of departure for measuring benefits and costs. But wherever there is reason to believe that a given market price fails to reflect the real benefits or costs to society - because of market inadequacy, market imperfection, or any kind of market failure - the market price must be systematically corrected or altogether replaced in an effort to move towards a more appropriate social measure.

The methodology of social benefit-cost analysis is not easy to apply - and it may sometimes appear impossibly difficult. But this does not argue against the validity of the approach, nor does it strengthen the case for commercial profitability. An industrializing economy is an extremely complex phenomenon, and one would hardly expect the optimal formulation and evaluation of industrial projects to admit of simple rules of decision-making.

Appendix

In this brief appendix we spell out some of the algebra that underlies the discussion of rates of return and benefit cost ratios on pages 20-22 of the text. It will be helpful first to consider the following expression:

$$V_{rT} = \sum_{t=1}^{T} \left[\frac{1}{(1+r)^t}\right] \qquad (A\text{-}1)$$

V_{rT} represents the present value of a constant flow of one unit discounted at a rate r over T periods. Since this expression is embedded in a number of different financial magnitudes, we seek to convert it first into a simpler algebraic form.

Making use of the following standard identity:

$$\sum_{t=0}^{\infty} a^t = \frac{1}{1-a} \qquad (0 < a < 1) \qquad (A\text{-}2)$$

We may write:

$$\sum_{t=0}^{\infty} \left[\frac{1}{1+r}\right]^t = \frac{1}{1-\left[\frac{1}{1+r}\right]} = \frac{1+r}{r} \qquad (A\text{-}3)$$

Therefore:

$$\sum_{t=1}^{\infty} \left[\frac{1}{1+r}\right]^t = \sum_{t=0}^{\infty} \left[\frac{1}{1+r}\right]^t - 1 = \frac{1+r}{r} - 1 = \frac{1}{r} \qquad (A\text{-}4)$$

$$\sum_{t=T+1}^{\infty} \left[\frac{1}{1+r}\right]^t = \left[\frac{1}{1+r}\right]^T \sum_{t=1}^{\infty} \left[\frac{1}{1+r}\right]^t \qquad (A\text{-}5)$$

$$= \left[\frac{1}{1+r}\right]^T \left[\frac{1}{r}\right] = \frac{1}{r(1+r)^T}$$

And we may now write:

$$V_{rT} = \sum_{t=1}^{T} \left[\frac{1}{(1+r)^t}\right] = \sum_{t=1}^{\infty} \left[\frac{1}{1+r}\right]^t - \sum_{t=T+1}^{\infty} \left[\frac{1}{1+r}\right]^t \qquad (A\text{-}6)$$

$$= \frac{1}{r} - \frac{1}{r\,(1+r)^T} = \frac{(1+r)^T - 1}{r\,(1+r)^T}$$

$$= \boxed{\frac{1 - (1+r)^{-T}}{r}}$$

Now we may proceed to derive the expression given in equation (5) of the text for the rate of depreciation d_{rT} according to the sinking fund rule. We want to determine the fraction $\bar{D}/K$, where $\bar{D}$ is the constant annual amount which must be invested at an interest rate of r per annum to provide a total fund at K at the end of T years. An amount $\bar{D}$ invested in year t will provide a total of $\bar{D}(1+r)^{T-t}$ by year T. Thus we require:

$$K = \sum_{t=1}^{T} \bar{D}\ (1+r)^{T-t} \qquad (A\text{-}7)$$

$$= \bar{D}\ (1+r)^T \sum_{t=1}^{T} (1+r)^{-t}$$

$$= \bar{D}\ (1+r)^T\ V_{rT}$$

$$= \bar{D} \left[\frac{(1+r)^T - 1}{r}\right]$$

Solving for d_{rT}, we get:

$$d_{rT} = \bar{D}/K \qquad (A\text{-}8)$$

$$= \boxed{\frac{r}{(1+r)^T - 1}}$$

Q.E.D.

To proceed further, we introduce a new term a_{rT} which is defined simply as the sum of the rate of depreciation d_{rT} (calculated according to the sinking fund rule) and the rate of interest r:

$$a_{rT} = d_{rT} + r \qquad (A-9)$$

Expressing d_{rT} directly in terms of r and T, we may rewrite a_{rT} as follows:

$$a_{rT} = \frac{r}{(1+r)^T - 1} + r \qquad (A-10)$$

$$= \frac{r + r\left[(1+r)^T - 1\right]}{(1+r)^T - 1}$$

$$= \frac{r(1+r)^T}{(1+r)^T - 1}$$

$$= \frac{r}{1 - (1+r)^{-T}}$$

$$= \boxed{\frac{1}{V_{rT}}}$$

We are now in a position to prove the assertions made on pages 14 and 15 of the text. We consider a project whose time pattern of inputs and outputs conforms to the following simple model:

1) a single capital outlay $\bar{K}$ in year 0,
2) a constant annual flow of benefits $\bar{B}$ from year 1 through year T,
3) a constant annual flow of operating costs $\bar{O}$ from year 1 through year T.

First we shall prove that the equivalent annual benefit-cost ratio $\bar{\beta}(r)$ defined in equation (8) of the text as

$$\bar{\beta}(r) = \frac{\bar{B}}{\bar{O} + \bar{I} + \bar{D}} = \frac{\bar{B}}{\bar{O} + (r+d_{rT})K} \qquad (A\text{-}11)$$

corresponds precisely to the benefit-cost ratio $\beta(i)$ defined in equation (7), using a discount rate i=r:

$$\beta(r) = \sum_{t=0}^{T} \frac{B_t}{(1+r)^t} \Bigg/ \sum_{t=0}^{T} \frac{C_t}{(1+r)^t} \qquad (A\text{-}12)$$

In order to do this, we need only substitute the constants K, $\bar{B}$ and $\bar{O}$ into equation (A-12):

$$\beta(r) \sum_{t=1}^{T} \frac{\bar{B}}{(1+r)^t} \Bigg/ \left[K + \sum_{t=1}^{T} \frac{\bar{O}}{(1+r)^t} \right] \qquad (A\text{-}13)$$

$$= \frac{\bar{B}\left[\sum_{t=1}^{T} \frac{1}{(1+r)^t}\right]}{K + \bar{O} \sum_{t=1}^{T}\left[\frac{1}{(1+r)^t}\right]}$$

$$= \frac{V_{rT}\,\bar{B}}{V_{rT}\,\bar{O} + K}$$

$$= \frac{\bar{B}}{\bar{O} + a_{rT}K}$$

$$= \frac{\bar{B}}{\bar{O} + (r+d_{rT})K}$$

$$= \bar{\beta}(r)$$

Q.E.D.

Now we wish also to prove that given $r=\bar{\rho}$ in the calculation of d_{rT} - the annual rate of return $\ddot{\rho}$ defined in equation (4) of the text as

$$\ddot{\rho} = \frac{\bar{B} - \bar{O} - \bar{D}}{K} = \frac{\bar{B} - \bar{O}}{K} - d_{\rho T} \qquad (A-14)$$

corresponds precisely to the internal rate of return ρ defined in equation (3):

$$PV(\rho) = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+\rho)^t} = 0 \qquad (A-15)$$

We begin by substituting the constants K, $\bar{B}$ and $\bar{O}$ into equation (A-15):

$$PV(\rho) = -K + \sum_{t=1}^{T} \frac{\bar{B} - \bar{O}}{(1+\rho)^t} \qquad (A-16)$$

$$= -K + (\bar{B} - \bar{O}) \left[\sum_{t=1}^{T} \frac{1}{(1+\rho)^t} \right]$$

$$= -K + V_{\rho T} \left[\bar{B} - \bar{O} \right]$$

$$= V_{\rho T} \left[\bar{B} - \bar{O} - a_{\rho T} K \right]$$

$$= V_{\rho T} \left[\bar{B} - \bar{O} - (\rho + d_{\rho T}) K \right]$$

Now we try out the rate $\ddot{\rho}$ for ρ, and - using the definition of $\bar{\rho}$ in equation (A-14) - we can show that this results in a present value $PV(\ddot{\rho})$ equal to zero:

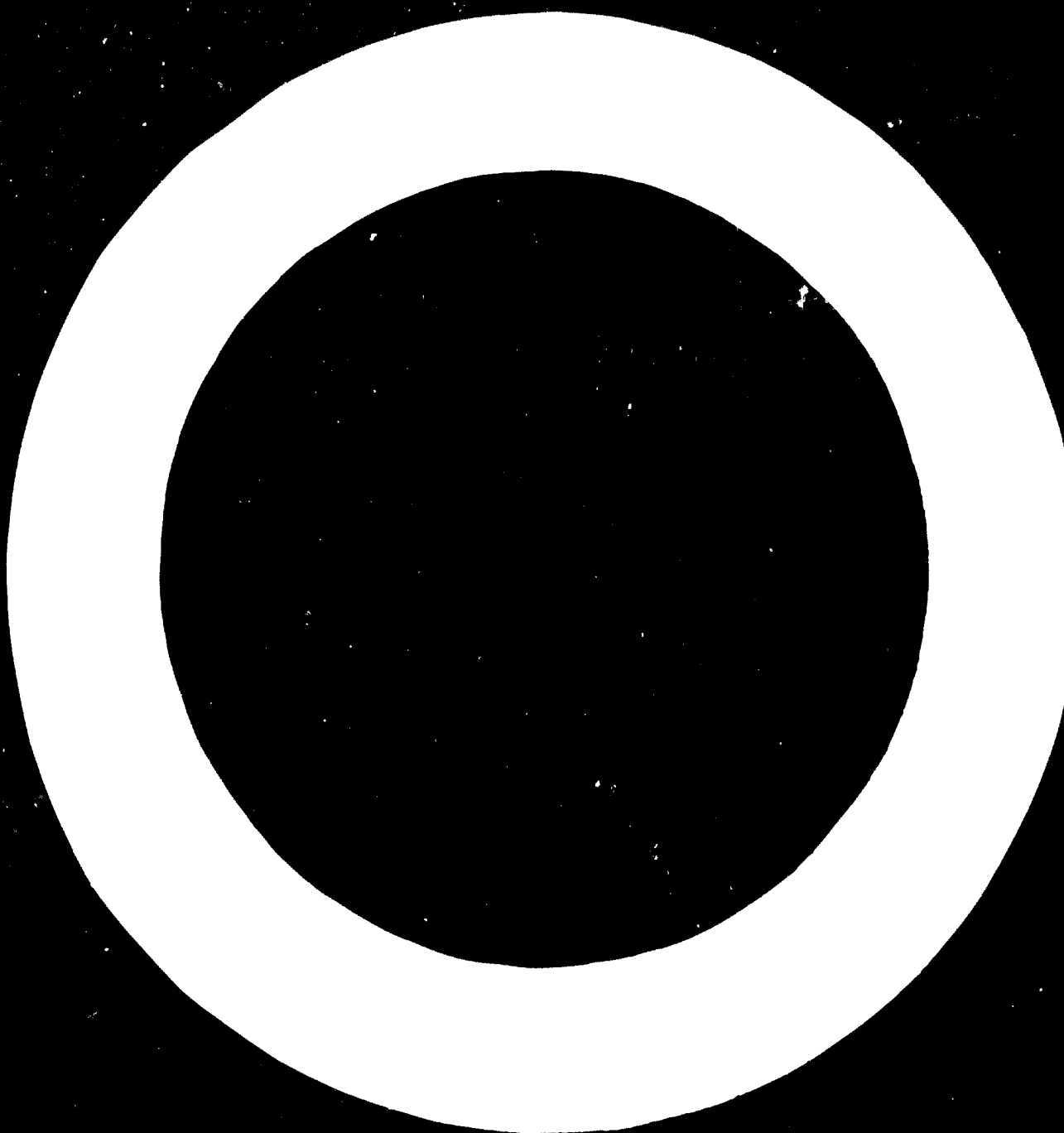
$$PV(\ddot{\rho}) = V_{\rho T} \left[\bar{B} - O - (\rho + d_{\rho t}) K \right] \qquad (A-17)$$

$$= V_{\rho T} \left[\bar{B} - \bar{O} - \left(\frac{\bar{B} - \bar{O}}{K} - d_{\rho T} + d_{\rho T} \right) K \right]$$

$$= V_{\rho T} \left[0 \right]$$

$$= 0$$

Q.E.D.



D00050

THE REFLECTION OF THE GOVERNMENT'S OBJECTIVES IN THE CALCULATION OF NATIONAL ECONOMIC PROFITABILITY

by

Stephen A. Marglin

Contents

The study "Commercial Profitability and National Economic Profitability" discussed both techniques for calculating commercial profitability and reasons why commercial profitability is an inadequate and misleading criterion for project formulation and evaluation in the public sector. That study also indicated that criteria for evaluating a project's contribution to the economic welfare of the nation, its "national economic profitability", properly depend on the objectives projects are supposed to serve and the relative importance accorded each objective. This study discusses these objectives and spells out a method for reflecting these objectives in the conglomerate "national economic profitability".

The principal objectives: aggregate consumption and redistribution

"The better life" that is the goal of the developing nations has many components, and few would measure progress towards this goal in economic terms alone. But even fewer would deny the importance of increasing the material standard of living in countries where the majority of individuals have less to spend on food, shelter, and clothing than the average expenditure on alcoholic beverages and tobacco in the United States of America.

This suggests that aggregate consumption, contributions to total consumption, will be an important objective of public investment in most developing countries. Of course, aggregate consumption is a composite: how do we add apples and oranges, or apples today and apples tomorrow? The first question is easier to answer than the second: in aggregating the various components of consumption, we use the relative valuations that consumers themselves place on different goods and services, as reflected in their willingness to pay for them. Sometimes willingness to pay is easy to measure, as when the public investment adds marginally to the supplies of goods and services distributed through competitive markets, in this case the market price indicates what people are willing to pay for a marginal unit of the good rather than go without, for this is what they do pay rather than go without. Other times willingness to pay is exceedingly difficult to measure, as when public investment adds non-marginal increments to the supplies of goods and services traded in competitive markets, or when public investment adds to the supply of rationed goods, or when public investment adds to the supply of producers' goods, or

when public investment adds to the supply of goods and services that are distributed outside the market mechanism. The problems of benefit measurement in such cases are discussed in the study "The Measurement of Benefits and Costs" and here we need only take note of the problem. Its magnitude, we may also note, is not trivial. Take, for example, the last case. Suppose a proposal to begin television broadcasting is to be analysed in terms of its contribution to aggregate consumption. To estimate the valuation consumers place on television programmes is a task from which most analysts would shrink in even the most advanced countries, let alone in the developing countries, when the relevant data could not even be amassed, much less analysed. Fortunately not all situations in which market prices break down as indicates of consumers' valuations are as hopeless as the television example. In many cases willingness to pay can be imputed to consumers when they don't actually pay as much as they are willing.

It may strike some as odd that consumers' valuations form the basis of adding disparate items into a single index of aggregate consumption. For this would seem to suggest that if consumers place the same marginal valuation on a package of cigarettes that they place on a performance of classical dance, the government ought to attach equal priorities to marginal increments of the two, notwithstanding the deliterious effects on health of the first and the cultural enrichment provided by the second.

Actually, reliance on consumers' valuation to measure aggregate consumption suggests no such thing, for it is diametrically opposed to the intention of this series of studies to suggest that aggregate consumption is the sole objective of public investment and contributions thereto the sole test of an investment's national economic profitability. Nevertheless, consumers' valuations are important in general, it seems sensible to consider rejection of consumers' valuations as the result of additional social objectives and to reserve the term "aggregate consumption" to measure the value of consumption as consumers see it. In general - though not always - these additional objectives will be relatively unimportant in the analysis of industrial and agricultural projects. In any event we shall postpone further discussions of "merit-wants" such as cultural enrichment to a later point in this study.

We have left an important question outstanding: how to compare the value of apples today and apples tomorrow. It might seem that if we aggregate apples today and oranges today according to consumers' valuations, we ought to rely on the relative values consumers place on apples today and apples tomorrow in aggregating consumption over time. If consumers are willing to borrow at an annual rate of interest of 10 per cent to increase their present consumption, the implication is that they place 10 per cent more value on consumption this year than on consumption next year. Plausible as this sounds, there are many good reasons for rejecting the intertemporal valuations revealed by consumers than in borrowing or saving decisions when we aggregate consumption over time. These reasons are discussed in the "The Social Rate of Return and the Social Rate of Discount" and it would be needless duplication to repeat the arguments here. Suffice it to say that in the methodology outlined in this series of studies the relative weights to be placed on consumption at different times in determining the contribution to aggregate consumption of any proposed project reflect value judgements on the part of the government.

Formally we can write the contribution to aggregate consumption from a hypothetical project as a weighted sum

$$W_0 B_0 + W_1 B_1 + \ldots + W_t B_t \ldots, \qquad (1)$$

where B_t is the contribution to aggregate consumption in year t and W_t is the relative weight attached to marginal contributions to that year's consumption. The greater the value of expression (1), the greater the project's contribution to aggregate consumption weighted according to its marginal value at different times. If one is asked to choose among two or more variants of a proposed project, and the criterion of choice is solely aggregate consumption, the variant for which the value of expression (1) is highest is the preferred one.

Normally we fix W_0, the weight on present consumption, at unity; present consumption thus becomes the unit of account, the standard of reference against which we compare all other benefits and costs. Generally we expect marginal additions to consumption to be less valuable as the economy becomes richer.

The rate at which the weight falls over time is called the social rate of discount. It is defined by the formula:

$$i_t = \frac{W_t - W_{t+1}}{W_{t+1}}$$

Customarily we assume that i_t is constant over time largely through ignorance, since there is no logical reason why it should be expected to remain constant. This assumption permits us to drop the subscript from i and to write W_t in the form

$$W_t = \frac{1}{(1+i)^t} \quad . \qquad (2)$$

Thus expression (1) becomes

$$B_0 + \frac{B_1}{1+i} + \ldots + \frac{B_t}{(1+i)^t} + \ldots, \qquad (3)$$

or in more compact notation,

$$\sum_{t=0}^{\infty} \frac{B_t}{(1+i)^t} \quad , \qquad (4)$$

which readers of the comparison study "Commercial Profitability and National Economic Profitability" will recognize as the present value (at the discount rate i) of the stream of contributions to aggregate consumption. This measure of a project's contribution to the aggregate consumption bears a formal resemblance to the measure of commercial profitability proposed there. But the formal nature of the resemblance should be emphasized. In general we should expect neither that the annual contributions to aggregate consumption equal the cash flow from the project nor that the social rate of discount equals the private rate of discount.

The aggregate consumption objective makes no distinction among the recipients of benefits or the bearers of costs. A rich man's consumption counts as much as a poor man's. Given the concern with mitigating inequalities professed by most of the developing countries, disregard of the distribution of benefits and costs can be justified only if it is assumed that the desired distribution of consumption is to be achieved independently of the mix of public investment. Otherwise a government that means what it says

when it professes a concern for mitigating inequalities should be prepared to sacrifice some potential aggregate consumption realizable from public projects in order to improve its distribution.

To assume that the desired distribution of consumption is to be achieved independently of projects is, however, to place undue reliance on fiscal policy -- taxes and subsidies -- and on the pricing policies used in the distribution of the outputs of public enterprise. In the first place tax systems in most developing countries are relatively weak. Political, institutional and administrative obstacles prevent taxation of the rich to the point necessary to substantially reduce consumption inequalities. And the other side of the coin is the widespread objection to increasing the consumption of the poor by direct subsidies. Critics of subsidies ranging from conservative to radical in their politics argue that the enhancement of self-respect that accompanies active participation in the process of increasing one's standard of living is worth some sacrifice of aggregate consumption even if direct subsidies would be less costly.

Moreover, the taxes that are feasible, as distinct from the lump sum taxes fashionable in theoretical discussions of economic welfare but practicable only in a revolutionary context, in general lead to some losses of aggregate consumption; feasible taxes invariably modify the structure of incentives that is consistent with maximization of aggregate consumption. An excise tax of 100 per cent on tobacco products, for example, means under competitive conditions, that the market price (inclusive of tax) is double the marginal cost of cigarettes. Since individuals are willing to pay twice as much for an extra package of cigarettes than it costs the economy, aggregate consumption is less than would be possible in the absence of the excise tax.

The use of pricing policies to redistribute consumption may also reduce aggregate consumption. If rationing of food grains places equal amounts of wheat in the hands of a poor man, who would be willing to pay $0.20 for the marginal kilogram he receives and a rich man who would be willing to pay $0.40 for an additional kilo, the aggregate value of the two men's consumption could be increased by transferring wheat from the poorer one to the richer.

Lest more be read into this exposition of the effects of taxes and rationing than is intended, it should be emphasized that it is incorrect to infer the suggestion that taxes and rationing should be abolished. Rather the point is that such intervention in an otherwise competitive system entails a cost in terms of aggregate consumption insofar as they are effective. The cost may be well worth bearing in view of governmental objectives other than increasing aggregate consumption and the constraints that limit the government's choice of tools for carrying out these objectives. A further point is that other tools for reducing consumption inequalities - specifically, the mix of public sector projects - should not be rejected out of hand. Indeed, the view underlying this set of studies is that often appropriate choices with respect to location, capital-intensity and related aspects of public projects, as well as with respect to the distribution of their outputs are relatively effective in accomplishing the goal of income redistribution. Only a careful analysis of the cost of redistribution in terms of aggregate consumption foregone will tell whether, in any specific instance, the redistribution game is worth the aggregate consumption candle.[1/]

But before we examine the problem of comparing contributions to the redistribution objective with contributions to the aggregate consumption objective, we must define a measure of redistribution. Actually, the only difficulty lies in the definition of the group to whom it is desired to redistribute consumption. In principle, we might consider every individual or family a separate 'group', for the social value of extra consumption may be different for each individual. Of course this is obviously impractical, first, because we would never hope to calculate the distribution of benefits and costs so finely, and secondly because we could never hope to determine the social value of marginal consumption individual by individual, or family by family.

1/ We need not consider those cases where the two objectives are complementary rather than conflicting. In such cases one can have the best of both worlds.

Clearly some compromise between theoretical rigour and operational feasibility is required, and necessarily the compromise will lie relatively far in the direction of the second pole. One possibility is to draw a "poverty line" at, say, the tenth or twenty fifth percentile of the population ranked in terms of consumption. That is, the poorest 10 or 25 per cent of the population would be singled out as the group to whom income is to be redistributed; within this group all would be treated equally. (Conceivably the richest 5 or 10 per cent of the population might be designated a separate group from the middle class, a separate group from whom it is relatively desirable to take away income). Alternatively classification might be on a regional basis, the poorest regions (in terms of per capita consumption) being treated as "groups" to whom redistribution is desired. The drawback with regional classification is that it precludes consideration of the distribution of benefits and costs within the region, it is possible that the rich in a poor region will be the beneficiaries of the redistribution of consumption. Thus the regional classification makes sense only if one has confidence that benefits and costs in poor regions will at least be distributed uniformly among the population.

Once the groups have been defined, the remaining conceptual problems of measuring redistribution benefits and costs are easily solved. Within each group equal weight is attached to all members and whenever specific goods and services are provided, the measure of consumption gains and losses are the valuations the groups' members themselves place on the goods and services, as indicated by their willingness to pay. (The difficulties of aggregating a diverse basket of consumption goods by weighting each component by willingness to pay have been discussed in connexion with the aggregate consumption objectives; no more need be said here.) Whenever redistribution takes the form of general purchasing power (for example, wages) rather than specific goods and services, the monetary magnitude of the group's income can be taken as the measure of the benefits to the group. The implicit assumption underlying the use of the money value of the transfer as the measure of redistribution is that the income of the group is entirely spent by its recipients on a large number of goods and services each of whose market price reflects marginal willingness to pay. Costs borne by members of the group are treated symmetrically with benefits.

Thus, in addition to a project's contribution to aggregate consumption in year t, B_t, we must identify its contribution to the consumption of those groups to whom it is desired to redistribute consumption. Let us label these contributions R_{t1}, ...R_{tn}, the second subscript identifying the group. This done, we can now turn to the problem of comparing redistribution and consumption gains, a problem not unlike the problem of comparing the worth of an apple with the worth of an orange.

Aggregating contributions to different objectives

Recall that we want to compare contributions to different objectives with a view to deciding whether or not in any specific instance aggregate consumption should be sacrificed to redistribution goals. And if so, how much. The most straightforward way of resolving this question is to define the contribution to national economic profitability in any year as a weighted sum of contributions to aggregate consumption and the contribution to the consumption of the specific group 1, ..., n, deemed to merit special consideration. The weight on aggregate consumption is conveniently fixed at unity so that the weight on the consumption of group j, which we shall denote by V_{tj} is the <u>premium</u> the government places on the consumption of groups j in year t relative to aggregate consumption in the same year. Thus in year t, the contribution to national economic profitability is measured by

$$B_t + V_{t1} R_{t1} + \ldots + V_{tn} R_{tn} \qquad (5)$$

If, for simplicity, we assume temporarily that there is only one group ("the poor") singled out for redistribution, expression (5) becomes

$$B_t + V_t R_t \qquad (6)$$

there being no need of a second subscript on V_t and R_t.

Multiplying the contribution to the consumption of the poor by the premium the government places on this group's consumption relative to the consumption of the population at large permits us to add the gains in terms of redistribution to the gains in terms of aggregate consumption; the two measures of economic welfare are rendered comparable by the imposition of relative weights. If a change in the design or operation of project would transfer one dollar from the population at large to the poor and if the government puts a premium of V_t dollars per dollar on the consumption of the group, then the

economic consequences of this transfer are held to be as desirable as an alternative change which would increase the consumption of the population at large (but not the consumption of the poor) by V_t dollars. And this is exactly what expression (6) says: The first change would leave B_t the same as before, but increase R_t by one dollar, and the value of expression (6) would rise by V_t dollars. The second change would add V_t dollars to B_t and leave R_t unchanged, which again would increase the value of expression (6) by V_t dollars. Of course, a change in design or operation that increased the consumption of the poor without reducing anybody else's consumption would increase national income profitability by $(1+V_t)$ dollars, for both B_t and R_t would rise by one dollar.

(If we revert momentarily to expression (5), which permits us to deal with more than one group, then we can introduce the possibility of negative as well as positive V_{tj}'s. A negative V_{tj} indicates that group j's consumption has a lower social value at the margin than the consumption of the population at large. A group like the richest 5 or 10 per cent of the population might be accorded a negative premium. V_t equal to -1 would indicate that net contributions to the consumption of the group have no social value whatsoever since the increase in the magnitude of B_t is exactly offset by the increase in the magnitude of R_{tj} when the latter term is multiplied by -1 before adding it to B_t.)

It remains to aggregate the contributions to national economic profitability at different times into a scalar measure of a project's social worth. The imposition of the premium V_t on the consumption of the poor before adding it to the contribution to aggregate consumption means that expression (6) measures the contribution to the two objectives in year t in units of aggregate consumption in year t. Hence the procedure for weighting aggregate consumption at different times elaborated earlier can be applied here. Under the assumption that the time weight falls at a constant rate, the over all measure of national economic profitability becomes the present value of the annual contributions measured by expression (6):

$$\sum_{t=0}^{\infty} \frac{B_t + V_t R_t}{(1+i)^t} \quad . \qquad (7)$$

Expression (7) is the test of whether changes in project formulation that improve the distribution of income at the expense of aggregate consumption (or vice versa) are worthwhile in view of the value judgements reflected in the V_t's: any change that increases the magnitude of expression (7) is desirable, any change that decreases its magnitude is undesirable. When a list of mutually exclusive variants is under scrutiny, the variant for which the value of expression (7) is maximized is the preferred one.

This sketch of a procedure for aggregating contributions to different objectives leaves unanswered the question of fixing the weights on the consumption of the poor at different times. The task can be reduced in magnitude by the simplifying assumption that the weight on consumption of the poor relative to aggregate consumption does not change for a specified number of years. After this period distribution of income is assumed to be sufficiently satisfactory to eliminate the premium entirely. With this assumption judgements are required only on two numbers: the length of time T over which the need for redistribution is expected to last, and the magnitude of the weight V between the present and year T. Expression (7) becomes

$$\sum_{t=0}^{\infty} \frac{B_t}{(1+i)^t} + V \sum_{t=0}^{T} \frac{R_t}{(1+i)^t} \qquad (8)$$

Judgements on V and T ought to reflect both forecasts or plans for the economy's development as well as basic social values of the political leadership. Ideally these judgements would emerge from the process of choice of a pattern of development by a political leadership from a set of alternatives prepared by technicians. But for some time to come this seems an unrealizable ideal for most, if not all, countries - advanced as well as backward. Neither the tools for analysing the data nor the data are sufficient for technicians to provide a set of alternative patterns of development, and in most countries technicians are woefully lacking both in quantity and quality. Moreover the political process appears to discourage rather than encourage the systematic, explicit decision-making by the leadership that our idealized scheme invisions.

Until such time as a reasonable facsimile of the scheme suggested above becomes feasible, the following procedure is recommended.

Technicians responsible for formulating project plans should treat V and T (or V's and T's in case there is more than one group deemed to merit special consideration) as unknowns of the problem. Values of these parameters that make significant differences in the design or operation of projects should be identified, and a set of project variants prepared that are optimal in different ranges of parameter values. An extensive discussion of the general techniques involved in this procedure is presented in the companion study on "sensitivity analysis." Here the procedure is outlined in the briefest form possible by means of a simple example.

Suppose that for T = 20 a proposed irrigation system would optimally - optimality being reflected by maximization of expression (2) - provide water for a larger number of poor "subsistence" farmers for values of V above 0.3 and would provide water for a small number of larger "commercial" farmers for values of V below 0.5. Suppose further that for T = 30 the critical value of V is 0.4, and for T = 10, the critical value of V is 0.8. Then the two variants of the irrigation scheme should be presented to the responsible decision-maker (for example, the Minister of Irrigation, the Minister of Finance, or the Cabinet) with an explanation of the implications for V and T of the choice of one alternative over the other. This procedure will not only sharpen the issues involved in the choice of one variant over another, it will provide data which can later serve as the basis for fixing the values of V and T to be used for formulation of other projects.

Other objectives

The discussion of the aggregate assumption objective defined the basis for adding up different goods and services in terms of the relative valuations of the consumers themselves: their willingness to pay reflected in market prices (for goods and services that are distributed through a competitive market mechanism) or imputed. The basis for aggregating different goods and services under the redistribution objective is also consumers' valuations. The difference between aggregate consumption and redistribution objectives lies not in the procedure for adding up goods and services, but in the weights attached to the totals.

But governments may not be content to accept "consumers' sovereignty", as reliance on consumers' valuations is generally called. Consumers' valuations, after all, are only partly based on inherent wants; custom and fashion also play a great role. Many governments may wish their own valuations of the relative importance of different goods and services to influence the composition of public investment programmes. For example, in societies in which custom militates against spending money to educate girls, many government leaders would prefer to impose their own judgements about the desirability of expanding educational opportunities for girls than to let decisions be guided by the valuations revealed by traditional parents in the market place (or, what is more likely, by the valuations imputed to them). Similarly, in the allocation of medical services, many governments have indicated that they are not guided only by consumers' valuations, but by other considerations as well.

We call goods and services elevated by the government above the test of consumers' valuations 'merit wants'. The objectives served by providing these goods and services are called collectively "merit-want objectives". In principle, the technique for reflecting merit want objectives in the calculus of national economic profitability is straightforward. The premium the government places on marginal increments to the fulfilment of a merit want, over and above the valuation placed on the good or service by consumers, multiplies the quantity of the good provided, whereupon the product is added into the measure of national economic profitability. The premium is defined relative to aggregate consumption, so that it measures the amount of aggregate consumption the government is willing to give up to change the aggregate consumption mix by adding one dollar's worth of the merit want and subtracting one dollar's worth of some other good, 'worth' being measured in terms of consumers' valuations. Formally, if M_t is the premium the government places on a merit want in year t, and Q_t is the quantity of the good provided in the year t, the measure of the project's contribution to national economic profitability in year t becomes

$$B_t + V_t R_t + M_t Q_t \qquad (9)$$

in place of formula (6). Contributions to merit-want objectives are aggregated over time the same way as the contribution to the other two objectives.

Of course, the difficulty with this procedure is identical to the difficulty of implementing the redistribution objectives: fixing the premium relative to aggregate consumption. Probably the difficulty is temporarily best resolved in the same way too: a sensitivity analysis with respect to the magnitude of the premium, in the manner outlined in connexion with the redistribution objective and elaborated in the study of sensitivity analysis. The problems posed by merit want objectives are in any event less severe in industrial and agricultural project formulation and evaluation than in other areas of development typically, merit wants are most important in education and health programmes, and these enter into most industrial and agricultural projects in only an ancillary manner.

It may come as a surprise (as well as a relief!) to read that this concludes the discussion of how to reflect objectives in calculations of national economic profitability. A surprise because nothing has been said about such widely cited objectives as increasing the rate of economic growth, reducing unemployment, improving the balance of trade, or increasing the rate of saving.

In fact all these objectives are reflected one way or another. The social rate of discount reflects the relative value of future and present consumption, and, as the study "The Social Rate of Return and The Social Rate of Discount" makes clear, the magnitude of the social rate of discount is related to the rate of growth. The reduction of unemployment is in our view valued primarily as a means of increasing the incomes of one of the poorest groups in society, those without jobs. Thus the income redistribution objective captures most of the social goal intended by the reduction of unemployment.

The goal of improving the balance of trade does not directly affect the calculation of national income profitability, but it does indirectly. Earnings and costs of foreign exchange are generally worth more than their value at the official rate of exchange in terms of the aggregate consumptions a unit of foreign exchange will buy. For this reason foreign exchange earnings must be evaluated in terms of a "shadow" price that reflects the premium foreign exchange commands over and above the official exchange rate. The technique for evaluating foreign exchange earnings is elaborated in the study "The Measurement of Benefits and Costs", and the technique for measuring the shadow price of foreign exchange is elaborated in the study "Shadow Prices: Foreign

Exchange, Savings, and Labour". Here we need only point out that the scarcity of foreign exchange, which determines the magnitude of its shadow price, will depend on how great the pressure to improve the balance of trade is. Normally, the more foreign exchange available, the lower will be its shadow price. Thus the goal of improving the balance of trade is indirectly reflected in the computation of aggregate consumption benefits and costs.

Similarly, the goal of increasing the rate of saving is reflected indirectly rather than directly. This goal is important when constraints limit the government's ability to mobilize savings. As with foreign exchange, the measure of value of a unit of saving is the aggregate consumption it makes possible, specifically the sum of future contributions to aggregate assumption from a unit of saving, weighted by the relative values of consumption at different times. The goal of increasing the rate of saving makes sense when the value of saving as defined above, that is its shadow price, exceeds the nominal price of one. In this case a correct accounting of aggregate consumption benefits and costs includes effects on the rate of saving induced by a project evaluated at the shadow price of savings as elaborated in the study on measurement of benefits and costs.

The truth of the matter is that the line we have drawn between objectives and indirect effects on objectives is somewhat arbitrary. We could have defined separate objectives of improving the balance of trade and increasing the rate of saving. In this case the shadow price of foreign exchange and savings would become relative weights, like the V's and M's. However, the link between these objectives and aggregate consumption seems to us sufficiently close that it is neater and clearer to include effects on the balance of payments and savings within the aggregate consumption objective. The shadow prices of these composite goods can, as the study "Shadow Prices: Foreign Exchange, Savings, and Labour" indicates, be calculated without the introduction of any new value judgements, which distinguishes them from the weights on redistribution and merit-want objectives.

Summary

The major objectives reflected in the concept of national economic profitability are aggregate consumption and redistribution. Contributions to aggregate consumption are defined by the valuation consumers themselves place on the goods and services provided to them as reflected in their willingness to pay for the goods and services they consume. Willingness to pay is in turn reflected by market prices whenever small increments of goods and services are distributed directly to consumers through a competitive market mechanism, but willingness to pay must be imputed to consumers otherwise. Redistribution benefits are measured by the contribution to the consumption of the members of specific groups deemed to merit special consideration. If the benefits provided such groups take the form of general purchasing power (for example, wages), then the monetary magnitude of the group's income is the measure of the benefit it receives. If benefits take the form of specific goods and services, the willingness to pay of members of the group for the goods and services provided them is the measure of benefits. Costs borne by the group are treated symmetrically.

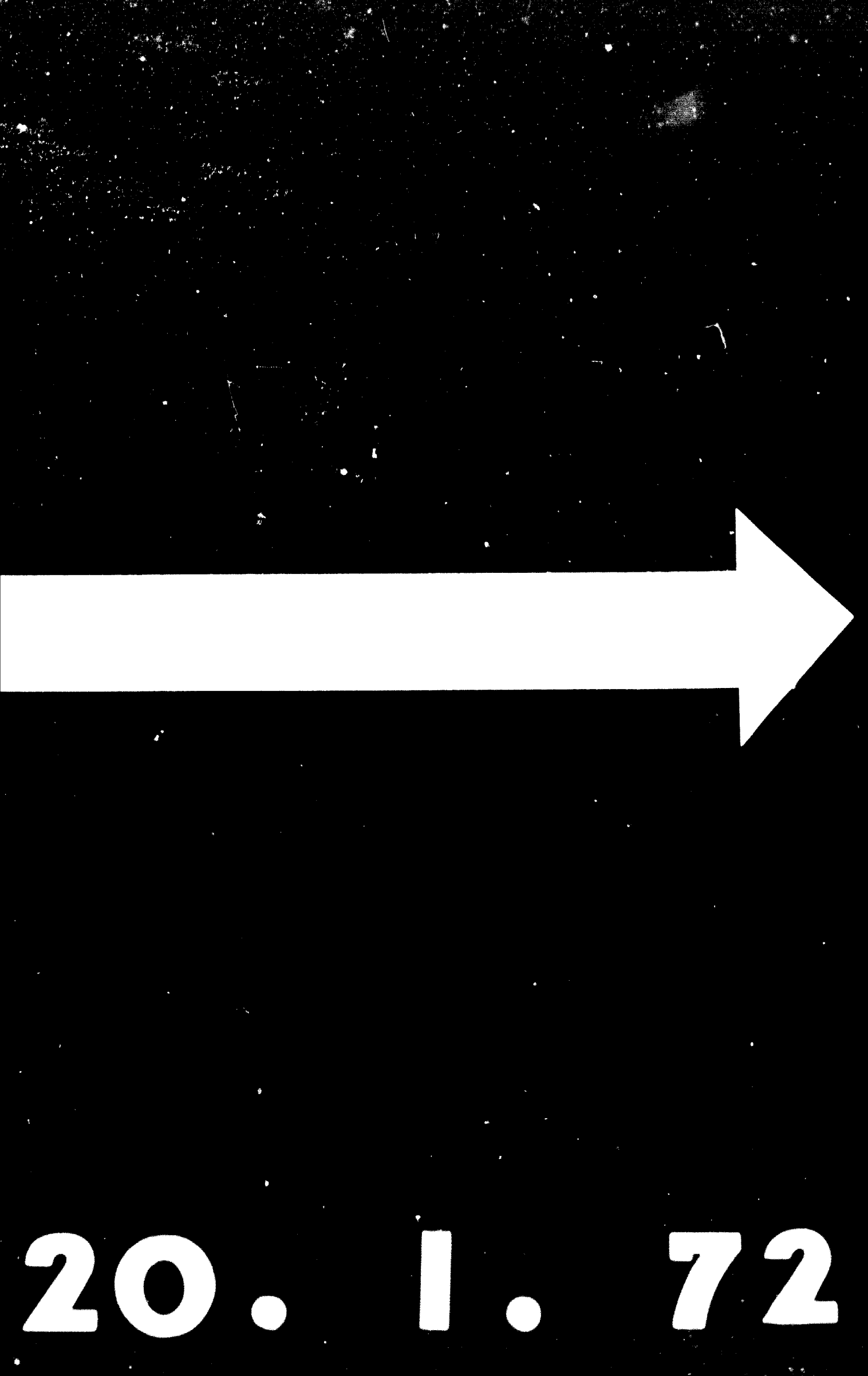
Aggregate consumption benefits (and costs) and redistribution benefits (and costs) cannot be directly added to determine national economic profitability any more than apples and oranges can be added to determine the value of the fruit. Just as prices make apples and oranges comparable in terms of money, so do relative weights on aggregate consumption and redistribution make these composites comparable in terms of national economic profitability. The unit of account is normally aggregate consumption, so that the weight on aggregate consumption is fixed at one and the weight on redistribution benefits to a particular group is the premium placed by the government on the group's consumption relative to consumption of the population at large.

In addition, benefits and costs occurring at different times can be added together only if weighted by their relative values. If present benefits and costs are taken as the unit of account in this aggregation process, and if the weight on benefits and costs is assumed to decline over time at a constant percentage rate, the weighted sum of present and future benefits and costs becomes the <u>present value</u> of the stream. The rate at which the weight on benefits and costs falls is called the <u>social rate of discount</u>. The present value of benefits and costs is the recommended measure of a project's national economic profitability.

Goods and services for which the government rejects consumers' valuations are treated separately under the heading of "merit-want" objectives. The weights attached to the quantities of merit want goods and services are the premiums attached by the government to their values over and above the value placed on these goods and services by consumers. (Their value in terms of willingness to pay is already included in calculations of aggregate consumption and redistribution.)

Other objectives, such as increasing employment, improving the balance of payments, and increasing the rate of saving are reflected indirectly in the aggregate consumption and redistribution objectives. The methods by which these objectives are reflected are outlined in this study and detailed in the consumption studies, "Measurement of Benefits and Costs" and "Shadow Prices; Foreign Exchange, Savings, and Labour".

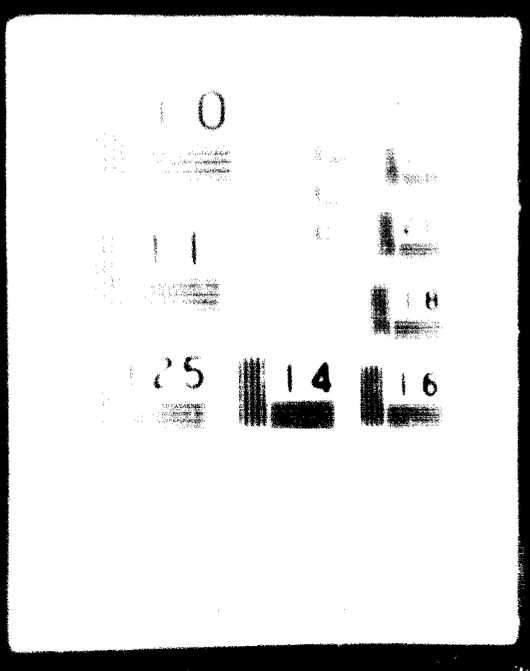
The chief difficulty of our scheme for reflecting objectives in calculations of national economic profitability, apart from the measurement of benefits and costs, lies in fixing the relative weights on different objectives. In the absence of adequate instructions by the political leadership, it is recommended that the weights be considered as unknowns of the project formulation problem and that critical magnitudes of weights (that is, magnitudes that change the project's design or operation) be identified by the formulators. This will not only help those who must choose among the alternative variants of a project to understand the consequences of their choice, it will also provide the data on which systematic discussions and decisions on the fixing of weights for later projects can turn.


20. 1. 72

2 OF 3

DO

0048 - 53



D00051

THE MEASUREMENT OF BENEFITS AND COSTS

by

Thomas E. Weisskopf
Indian Statistical Institute
India

Contents

List of diagrams

I [illegible]

The methodology of social benefit-cost analysis, as suggested in the preceding papers, begins with the specification of a set of national objectives. These objectives give expression to the social and economic goals of the nation; they are intended to guide all public decision-making not only at the level of project formulation and evaluation, but in all areas of economic policy as well. In an earlier paper, a variety of typical national goals were [illegible] of economic development. The alternative objectives emerging from the discussion include the following: (1) increasing the aggregate consumption of the nation, irrespective of who the consumers are; (2) redistributing consumption from one more favoured group of consumers to another less fortunate group; (3) reducing involuntary unemployment and (4) promoting self-sufficiency [illegible] (5) promoting certain goods or services described as "merits wants" to which the consumer attaches greater social value than individual consumers.

By their very nature, the above objectives are in mutual conflict. There may be projects or policy measures which will contribute to some or all of the alternative objectives. But, beyond a certain point, it will be possible to increase the contribution to one objective only by reducing the contribution to some other objective. Thus, in the formulation and evaluation of projects, a procedure is required for comparing the importance of alternative objectives. In the same way that contributions to alternative objectives may come into conflict, contributions to a single objective at different points in time are likely to conflict. More consumption now means less consumption later, and a decision must be made regarding the relative importance of present as against future contributions to any single objective.

The problem of reconciling multiple objectives, and the problem of reconciling multiple time periods, are important enough in social benefit-cost analysis to warrant detailed discussion in other papers. This paper focusses on the problem of measuring contributions to a single objective at a given point in time. A benefit is simply a positive contribution, and a cost is a negative contribution, towards the achievement of a particular objective. As this definition suggests, the concept of a benefit or a

cost - can emerge only in terms of a particular objective, and the measurement of benefits and costs must be carried out separately for each relevant objective.

Of the five alternative objectives cited above, the first two may be singled out as the most significant for industrial project formulation and evaluation. It has already been pointed out in the preceding paper that the objective of reducing unemployment often mainly reflects a desire to increase the welfare of the unemployed - a desire which is more appropriately encountered under one or both of the first two objectives. The objective of promoting self sufficiency may well amount simply to the desire to rectify deficits on the balance of payments, which is really a matter of efficient resource allocation in the interest of promoting higher consumption levels. And the objective of providing "merit wants" is probably significant for most government programmes with a social welfare orientation, but it is not likely to loom large in connection with industrial projects.

On the other hand, the improvement of the national standard of living - achieved by raising the level of aggregate consumption - and the reduction of inequality brought about by redistributing consumption - are objectives that are and should be very much in evidence in the formulation and evaluation of industrial projects. For this very practical reason, the present paper will concentrate exclusively on the measurement of benefits and costs with respect to the "aggregate consumption" and the "redistribution" objectives.

Apart from the distinction between objectives, a distinction between "direct" and "indirect" benefits and costs is often made in the literature on benefit-cost analysis. Such a distinction is really rather arbitrary, for there is often a whole spectrum of benefits and costs differing only in the degree of "directness" or "indirectness". Rather than attempt to draw an arbitrary line, in this paper we shall describe as "indirect" only a particular class of benefits and costs that may arise, not because of the form of a project, but because of the economic conditions in the nation as a whole. This class of benefits and costs must be considered when the rate of saving and investment in the economy is less than the desired rate. Under such circumstances, the effect of a given project on the current rate of saving and investment may lead (indirectly) to future benefits or costs that must not be ignored.

In the pages to follow, the discussion is divided into three parts. First, in Part II, we discuss the measurement of current benefits and costs with respect to the aggregate consumption objective. In Part III, we take up the measurement of the special class of indirect future benefits and costs with respect to the aggregate consumption objective. Finally, we conclude in Part IV with a discussion of benefits and costs with respect to the alternative redistribution objective.

II [illegible]

In the measurement [illegible] with respect to any objective, two stages [illegible] are involved. First, the benefit or cost should be [illegible] what is it exactly that the economy gains or loses as a result of the project? Secondly, the benefit or cost must be measured according to a criterion reflecting the corresponding [illegible] project is or negative in the objective in question. Although the basic principles involved in the analysis are the same for all kinds of benefits and costs, it will be convenient to divide the discussion into different stages. First we will take up the measurement of benefits and later the measurement of costs. In each case we will first discuss general principles and then go on to illustrate them with specific examples of different types of benefits and costs.

A. The measurement of benefits

The basic principle involved in calculating the aggregate consumption benefits of a project is to measure the consumers' "willingness to pay" for the "net output" of the project. By the "net output" of the project, we mean the goods and services made available to the economy by the project which would not have been available in the absence of the project. If the goods and services physically produced by the project add to the supply of those goods and services available in the economy, then they may appropriately be regarded as the net output for the purposes of our analysis. However, if the goods and services produced by the project do not add to the supply available in the economy - if instead they substitute for an alternative source of supply, leaving the total supply constant - then the net output of the project is really reflected by the resources released from the alternative source of supply. The net effect of the project on the economy - which is what we seek to measure in evaluating the project - is to add to the availability of those goods and services that were previously used up as inputs in supplying from an alternative source an amount of goods and services as outputs equivalent to that produced by the project.

The distinction drawn above is fundamental to the identification of benefits. In every instance one must ascertain whether the physical output of a project adds to supply or substitutes for supply. In the first

case, we identify the net output of the project as the actual physical output, and we proceed to measure the corresponding project benefits according to consumer willingness to pay for the goods and services produced. In technical terms, we may say that the relevant margin for measurement is the demand margin: the value of the benefits depends on the demand for additional goods and services.

In the second case, we identify the net output of the project as the resources previously used in the alternative source of supply of the same amount of physical output. In this case, we may say that the relevant margin for measurement is the supply margin: the value of the benefits depends on the saving in the alternative costs of supply of the goods and services. Here we measure the corresponding project benefits according to consumer willingness to pay for the goods and services released - or saved - by the project.

Whether the project benefits occur on the demand or on the supply margin, we have stated that the criterion of measurement with respect to the aggregate consumption objective is the consumers' willingness to pay". This criterion reflects the benevolence of the aggregate consumption objective on consumer sovereignty, and the neutrality of the objective with respect to different consumers. In effect, we are saying that, irrespective of the distribution of income - no matter who has the money - and irrespective of the nature of any individual's sovereign desires, we will measure the (aggregate consumption) benefits of a good or service according to the maximum amount that some individual would be prepared to pay for it. The reasoning is that he would be willing to pay up to an amount such that the satisfaction he gets from the good or service is equivalent to the satisfaction he sacrifices by parting with the money. Thus we can measure the benefit of the good or service as represented by the satisfaction derived from it in terms of a common monetary standard of value.

Once the project benefits have been identified, the problem is to find a suitable measure of consumer willingness to pay for the relevant net output. Here it is useful to distinguish several categories of net output. On the one hand, the net output may consist of final consumer goods for domestic consumption. This can occur only when the project itself produces consumer goods, and these represent an addition to the supply available to the economy.

Alternatively, the relevant net output may consist of intermediate producer goods which are either produced by the project, resulting in an increase in domestic availability, or which are released by the project from an alternative source of supply, resulting also in a net increase in their availability to the domestic economy. Finally, we must consider the important case when the relevant net output of the project consists of foreign exchange. This will be the case when the project output is exported, directly or indirectly, or when it substitutes for imports, directly or indirectly. It is also possible that part of the net output of a project be labour or land, if these primary resources are released from an alternative source of supply. Since labour and land figure most more conspicuously as project inputs, a fuller account of their measurement will be deferred until the next section on the measurement of costs. The same comments apply mutatis mutandis to the measurement of benefits and costs. Benefits in this case are simply costs that are saved.

[illegible]

Suppose that the project under consideration is a sugar manufacturing plant, which will sell sugar on the domestic market for home consumption. This sugar will neither substitute for imported sugar, nor for any alternative domestic sugar production, but it will simply add to the supplies available on the domestic market. It is expected that the sugar will sell for 3 rupees a kilo.

What is the best measure of consumer willingness to pay for the sugar? The first measure that suggests itself is the market price itself. For when a consumer pays a given price for a good, the satisfaction he derives from that good must be at least as great as the sacrifice he makes in cash. In other words, his willingness to pay must be at least as great as the market price of the good, or else he would not engage in the transaction. Under certain conditions, it can also be shown that consumer willingness to pay cannot be greater than the market price. Then we can be sure that the consumer willingness to pay - and hence the appropriate value to attach to the sugar - is precisely equal to its market price.

The conditions which guarantee that consumer willingness to pay for the project sugar does not exceed its market price are threefold: (1) that the sugar is freely available to any potential customer willing to pay the

market price; (2) that no consumer is in a position to exercise "monopsony" power, i.e. to influence through his own purchases the market price level; and (3) that the addition to the total supply of sugar brought about by the project is not large enough to change the market price.

Conditions (1) and (2) are the conditions of competitive buying. Wherever buying is competitive, we may be sure that the price paid by each consumer for his last kilo of sugar reflects precisely the extent of his satisfaction from that kilo, and therefore also his willingness to pay for it. For if his willingness to pay exceeded the market price, he would buy more sugar at that price - provided that he was free to do so, and that his own purchases would not push up the price. Indeed, he would continue to buy more sugar up to the point where his willingness to pay for an extra kilo would be brought down to the market price. This argument holds irrespective of whether the sugar is taxed or subsidized, and irrespective of whether the sellers - as distinct from the buyers - are in a position to influence through their actions the market price level (thereby exercising "monopoly" power). All that is required is that the conditions of purchase be competitive.

Condition (3) is also required to ensure that the anticipated market price of the project sugar reflects the willingness to pay for all of the additional kilos of sugar supplied by the project. If the willingness to pay for an extra kilo - as reflected by the market price - is the same both before and after the project takes effect, then we can be sure that no consumer of the additional output was willing to pay any more than the market price for it.

If any one of the three conditions noted above is not satisfied, then we can no longer say that consumer willingness to pay is limited to the market price. Suppose, for example, that the project output of sugar is large enough relative to the total supply so that the market price is expected to fall from a previously prevailing level of 3 rupees to 2 rupees a kilo. Before the plant begins to operate, consumer willingness to pay for the last kilo of sugar is 3 rupees; when the plant begins production, consumer willingness to pay for the last unit falls to 2 rupees. Under these circumstances, neither the old nor the new price is an adequate measure of consumer willingness to pay for a unit of the project output.

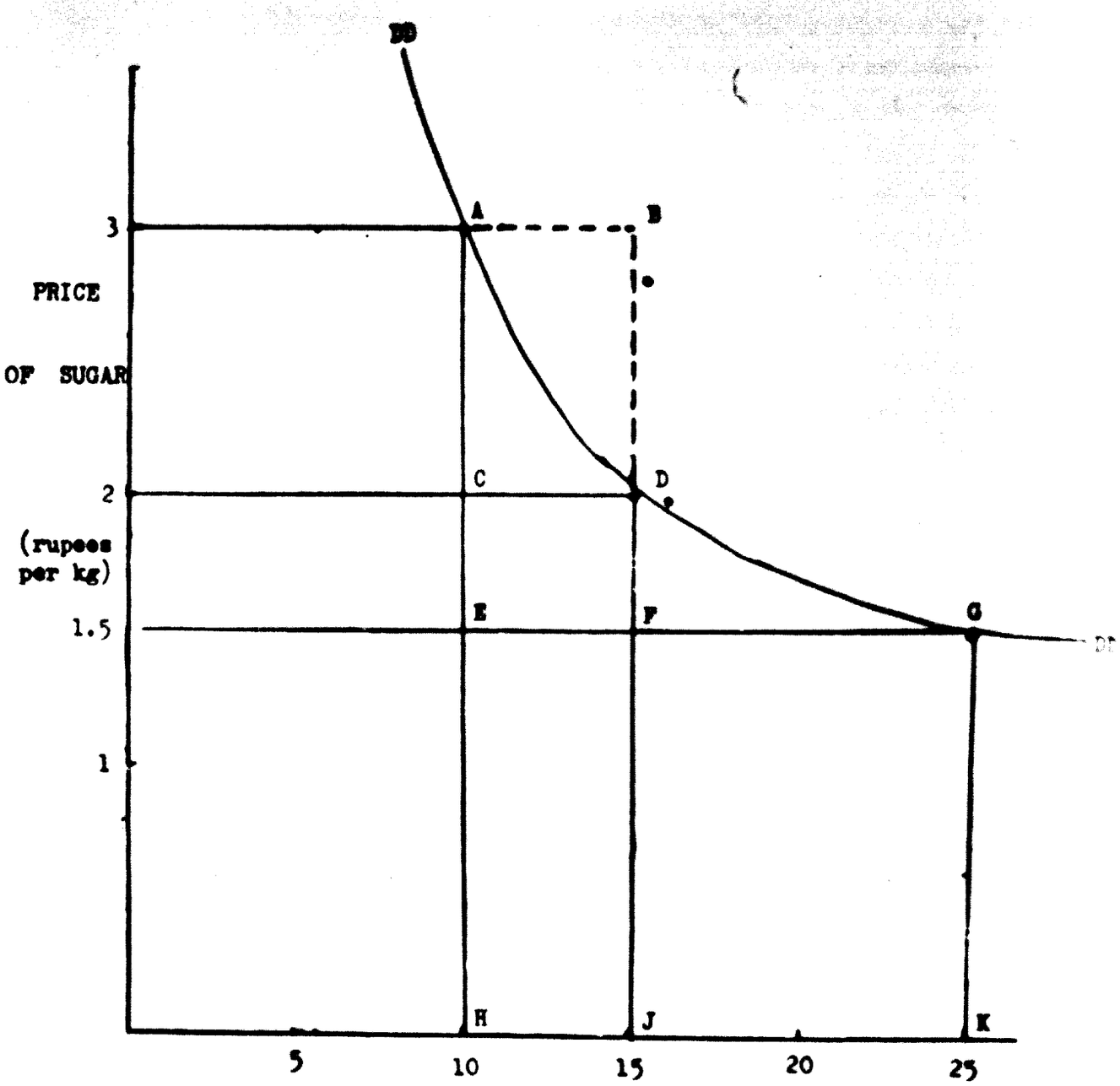
This situation can be illustrated with reference to diagram 1. DD is a demand curve indicating the total annual demand for sugar (on the horizontal axis) at a range of possible prices (on the vertical axis). Suppose that the current annual production and supply of sugar is 10 million kilos; the demand curve shows that the market will just be cleared at a price of 3 rupees a kilo, and this is the price which would prevail in a free market. If our projected sugar plant would produce another 5 million kilos a year, bringing the total annual supply to 15 million kilos, we observe from the demand curve that the new market-clearing price would fall to 2 rupees a kilo. The consumer willingness to pay for an extra kilo of sugar is measured by the height of the demand curve at a given supply level; it is precisely equal to the corresponding market-clearing price. Inspection of the diagram will show that the correct measure of total consumer willingness to pay for the new sugar plant output is neither the actual market payment of 2 rupees per kilo times 5 million kilos (represented by the area CDJH), nor the old market price of 3 rupees per kilo times 5 million kilos (the area ABJH). Instead, the correct measure is the area ADJH under the demand curve between the old and the new supply levels. The excess ACD of consumer willingness to pay over the actual market payments (CDJH) for the project sugar is labelled the "consumers' surplus".

Now let us suppose that the second condition is violated: sugar is not freely bought and sold on the domestic market, but it is rationed according to a quota system. The need for rationing arises only if the sugar is being sold at a price lower than required to bring the demand into equality with the supply. For example, in diagram 1, with the current rate of supply of sugar equal to 10 million kilos a year, suppose that the government decides to fix the price of sugar at 1.5 rupees a kilo in order to benefit low income consumers. This is well below the market clearing price of 3 rupees a kilo, and it would call forth an annual demand of 25 million kilos. Since this demand cannot be satisfied at existing rates of supply, the government is obliged to devise a scheme for rationing the 10 million kilos among the many would-be buyers.

Clearly, under such circumstances, the current market price of 1.5 rupees a kilo is no guide to consumer willingness to pay for additional sugar. Whenever a product is rationed, one can only be sure that its ration price <u>understates</u> consumer willingness to pay. In our example, the actual

Diagram 1

The demand for sugar



willingness to pay for an additional 5 million kilos of sugar is, of course, still the area ADJH, which is substantially greater than the area KFJH which would be obtained by multipyling the price of 1.5 rupees per kilo by 5 million kilos.

The same argument clearly also applies when the size of the project in question is not large enough to affect the price at which the output could be sold in a free market. The ration price is always less than the consumer willingness to pay, whether or not the latter is precisely equal to the potential market-clearing price. This potential market-clearing price should not be confused with the price that may prevail in a secondary "black" market, which can result from an illicit resale of rationed commodities. The "black" market price is a function of the limited demand and supply that finds its way into illegal transactions, and it cannot be assumed to be representative of a corresponding free market.

In summary, if the output of a project is not freely available to consumers at a given market price, or if it is large enough to result in a change in the corresponding price, the measurement of consumer willingness to pay requires an investigation into the shape of the demand curve for the product. This is of course a more difficult task than simply applying a market price, but it cannot be avoided if a realistic appraisal of the project is to be made. An even more difficult task arises when the output of the project is not purchased at all on the market, so that there is not even a first approximation in the form of a market price. Part of the consumer good output of a project may involve educational or medical facilities, housing or welfare programmes, which often carry no meaningful market price. To evaluate such benefits of public investment is a challenging task, but the problems that arise will not be considered in any more detail here for they are unlikely to figure prominently in the formulation and evaluation of most industrial projects.

Producer goods

Let us consider now a project in which the relevant net output involves a producer good such as steel, which may be used either as an intermediate good or a capital good in the production of other goods. For convenience, we shall assume that the project itself is designed to turn out a million

tons of steel and adds the same amount to over-all domestic supplies. The same kind of analysis, however, would apply if the project output merely substitutes for an alternative source of supply, and steel is among the resources thereby saved and increased in net domestic availability.

When the relevant net output of a project is used in the production of other goods and services, the principle of measurement according to consumer willingness to pay still applies. The only difference is that the ultimate increase in consumption made possible by the increased availability of the producer good may be many stages of production removed from the project output, and this tends to make the problem of measurement more complex. Thus the extra steel made available by the projected steel plant may be used to fabricate bicycles that will be sold directly to final consumers; it may be used to build rails that will enable the railways to provide both final and intermediate transportation services; it may be used to fabricate machines that will turn out both consumer goods and more producer goods. The value of the steel from the point of view of the aggregate consumption objective is the willingness to pay of the final consumers for all of the ultimate consumption attributable to the steel.

As a first approximation, the willingness to pay for the steel of the producers who purchase it may be taken as a measure of their value to the ultimate consumers. As in the case of consumer goods, there are certain conditions under which the market price actually paid by the producers reflects their true willingness to pay. These conditions include first of all the three mentioned earlier: that (1) anyone can purchase as much steel as he wants at the prevailing market price; (2) the purchasers of steel do not exercise any monopsony power; and (3) the augmented supply of steel does not bring about a change in its market price. In addition, it is also necessary that (4) the purchasers of steel do not exercise any monopoly power in the markets where they sell their product. This fourth condition did not apply in the case of purchasers of consumer goods, for by definition consumer goods are not resold in other markets. But a producer who can command a higher price for his bicycles if he limits his production will make monopoly profits, and his willingness to pay for steel will exceed what he actually pays by the amount of monopoly profits he can make.

Thus if the additional steel made available by the project is not bought under competitive conditions, if the product for which it is used is not sold under competitive conditions, or if the price of steel is lowered by the extra supply due to the project, then the (future) market price of steel will understate the purchasers' willingness to pay. In such cases it may be necessary to look into the demand conditions for steel just as one would examine the demand curve for sugar, with the difference that the demand for steel is a "derived" demand rather than a demand based directly on consumer preferences.

In certain instances it may be possible to measure indirectly the willingness to pay of purchasers of producers' goods by calculating the net profit which the producer realizes on the purchased input. For example, if the market for steel is hopelessly uncompetitive, we may still estimate the willingness of a given producer to pay for steel by calculating the residual remaining after deducting from the sales value of the producers' output the costs of all inputs other than steel. This residual is a measure of how much the producer would be willing to pay in order to get the steel: if he paid more, he would make losses, and if he paid less, he would make profits on his enterprise.

So far we have tacitly assumed that the willingness to pay for the steel of the producer who purchases it is in fact the appropriate measure of its ultimate consumption value. This assumption is valid only if the same four conditions listed above apply to all the markets between the purchaser of steel and the ultimate consumer of the steel-based final good or service. In other words, there must be no departures from competition in the further processing of the project steel, and the increased supply of steel due to the project must not be significant enough to lower any prices further along the line.

If there are monopoly or monopsony elements in the further processing of the project output, or if the relevant markets are subject to rationing or other interference with free market exchange, then the immediate purchaser of the project output does not capture the full consumption benefits of that output when he resells it after processing. The price he receives is artifically lowered from what it would be under competitive conditions, and hence his willingness to pay for project output

is also reduced. In principle, to measure the full value of project benefits, the immediate purchaser's willingness to pay must be supplemented by the excess in subsequent purchasers' willingness to pay over and above their actual payments. Exactly the same rule holds when - under competitive conditions - the increment in the supply of the good produced by the project results in a lower price of that good in processed form at a later stage. The aggregate consumption benefits include not only the immediate purchaser's willingness to pay, but also the extra benefits enjoyed further along the line by those people whose willingness to pay for the processed good exceeds its market price. These extra benefits correspond exactly to the "consumers' surplus" defined earlier.

Foreign exchange

In developing and newly industrializing economies, it happens frequently that the ultimate net impact of a project is not on the domestic availability of goods and services, but on the market for foreign exchange. This is obviously the case when the project involves the production of goods for increasing exports: the net effect of the project is to increase the supply of foreign exchange available to the economy rather than the availability of any particular good or service. The same is true when the project involves the production of goods that will substitute for imports: provided these goods can be expected actually to replace previous imports, rather than augment total supplies, the net effect is to release a sum of foreign exchange equivalent in value to the foreign exchange cost of the previous imports. Exports and imports substitution may also be promoted indirectly if a project releases goods from an alternative source of supply, and these goods are then used to increase exports or save on imports. In either case, the relevent net output is foreign exchange to the extent that exports are increased or imports decreased.

It is sometimes argued that when a project provides goods of a kind that were previously imported, the net output of the project should be treated as foreign exchange irrespective of whether the goods are actually used to replace imports, or whether they simply add to the total supply on the domestic market. This argument can be analysed with reference to diagram 2. Let DD represent the demand curve - and the willingness

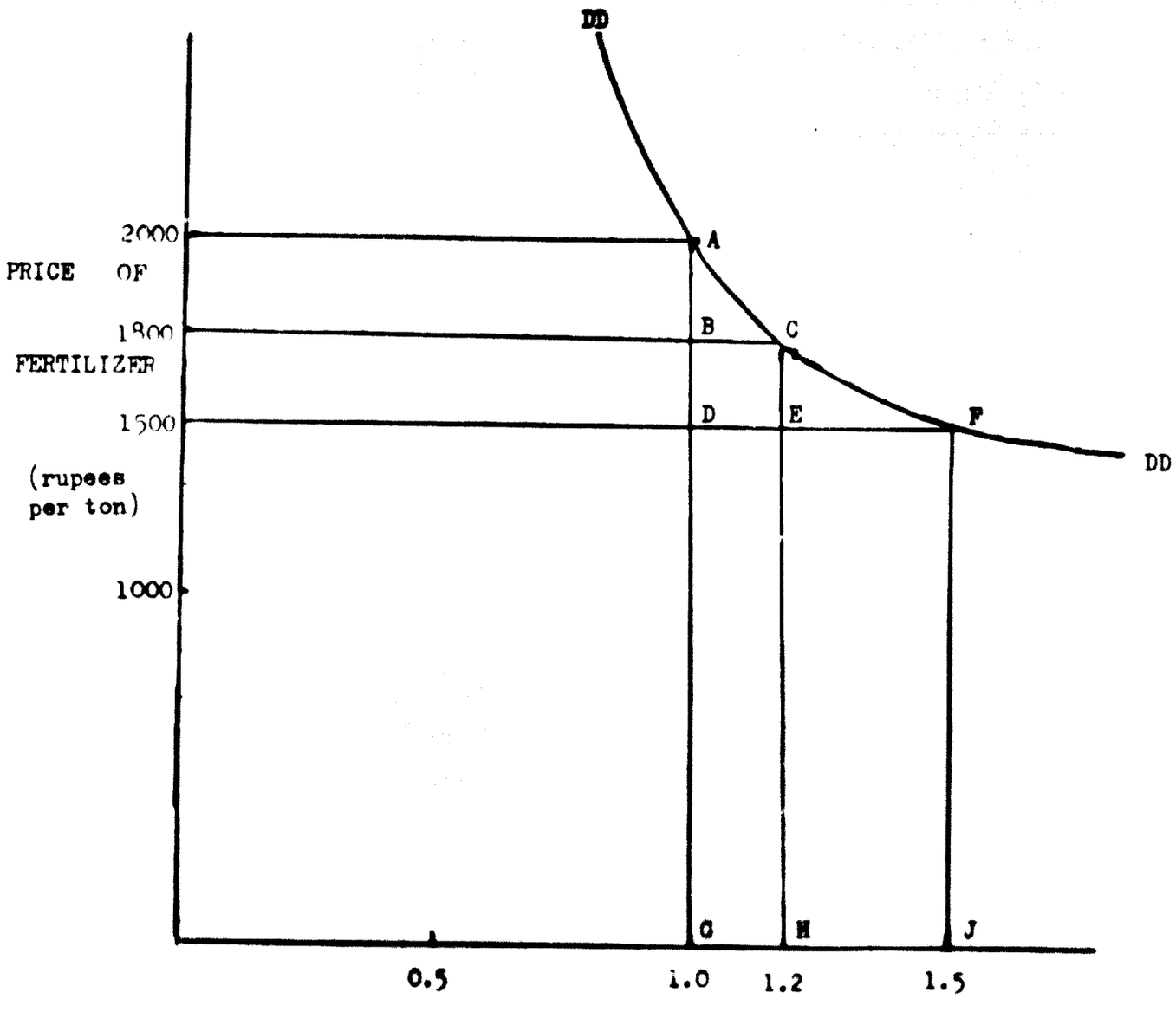
to pay - for nitrogenous fertilizer on the domestic market, with the price of the fertilizer measured on the vertical axis and the quantity demanded on the horizontal axis. Suppose that the current fertilizer supply consists of 1 million tons (nitrogen content), of which half is produced domestically and half is imported. The foreign exchange cost of the imported fertilizer is the equivalent of 1,500 rupees per ton, but the domestic production cost is higher. To project the domestic manufacturers, the government applies an import tariff amounting to 500 rupees per ton, and all of the fertilizer is sold at the market-clearing price of 2,000 rupees per ton.

A new plant is now proposed to manufacture 200,000 additional tons of nitrogen. If this is added to domestic supplies, it can be seen from diagram 2 that the market-clearing price will fall to 1,800 rupees per ton. If it substitutes for previously imported supplies, the price will of course remain at 2,000 rupees per ton. Now if the total supply of fertilizer to the domestic market is held constant when the project goes into operation, the net effect of the project will be to substitute for 200,000 tons of previously imported fertilizer, and the net output of the project will be the 300 million rupees (1,500 rupees per ton times 200,000 tons) worth of foreign exchange that is saved (corresponding to the area DEHG).

If the effect of the project is to increase the total supply of fertilizer from 1.0 to 1.2 million tons of nitrogen, then according to the principle of willingness to pay, the benefits of the project should be measured as the area ACHG under the demand curve between the supply levels of 1.0 and 1.2 million tons. The argument to the contrary suggests that, even under these circumstances, the benefits should be measured as the area DEHG, because the government could capture the additional benefits ACED in any event simply by increasing imports by 200,000 tons. Benefits which could be obtained by a mere change in import policy, so the argument goes, should not be attributed to any particular project. So long as the government can reap benefits by increasing imports (which it can do by importing up to the point where the total supply of fertilizer reaches 1.5 million tons), it should be advised to do so. Once the import level has become optimal, it should then consider whether a new domestic plant is justified - and the import substituting criterion will then lead to a measure of benefits at the foreign exchange saving value of 1,500 rupees per ton.

Diagram 2

The demand for nitrogenous fertiliser



The above argument is perfectly valid - provided the government can and does raise imports to the optimal level when advised to do so. It is certainly proper to recommend that it improve its import policy, and to measure the net benefits attributable to increased imports by the area between the demand curve and the foreign exchange cost curve. But if, for good or bad reasons, the government does not in fact change its import policy - if imports of fertilizer in this case are actually kept constant at a level of 500,000 tons - then it is quite misleading to pretend that the government is pursuing an optimal trade policy. The issue is really an empirical one, to be decided on the merits of each case. If the government does pursue an optimal trade policy, or can be persuaded to do so, then this should be taken into account. But if the government seems to be acting otherwise, the evaluation of project benefits must proceed on the basis of what is most likely to happen.

Having established in any particular case that foreign exchange is the relevant net output of a project, it is still necessary to find a measure of the value of foreign exchange. For up to now we have been measuring all benefits in terms of domestic currency, while foreign exchange as an output is expressed in some foreign currency. The principle to be applied is the same as with any material output - we must determine what is the willingness to pay (in terms of domestic currency) for the extra foreign currency made available by a given project.

As a first approximation, we may again consider the market price as a measure of willingness to pay. The market price of any given foreign currency is nothing but the official rate of exchange between that currency and the domestic currency. If this market price is to be appropriate, the same conditions listed earlier in the case of producers' goods must apply to foreign currencies - which are purchased not by final consumers but by intermediate traders or producers. Condition (3) is in fact likely to be satisfied in most foreign exchange markets: the changes in supply due to individual projects will be negligible in comparison to the total supply of foreign exchange. If in addition the foreign exchange market - and all related markets - are perfectly competitive, so that foreign currency can be bought and sold without limit at the official exchange rate, then the domestic willingness to pay is presumably accurately reflected by the domestic currency equivalent at the official rate.

In fact, however, it is much more common to find in developing economies a strictly controlled foreign exchange market, where the supply of foreign exchange is rationed in one way or another over the much greater demand that arises at official rates of exchange. Under these circumstances, the official market rates quite clearly understate the domestic willingness to pay for foreign currencies and it becomes necessary to estimate by other means the true aggregate consumption value - expressed in domestic currency - of a unit of foreign currency.

If we assume for the moment that all foreign currencies may be exchanged among themselves at an official set of exchange rates, then the problem of valuing foreign currencies reduces to finding a single price for a common unit of foreign exchange. We first convert all foreign currency values into their domestic currency equivalents, using the official rates of exchange. Then we have only to ask: what is the domestic willingness to pay for an amount of foreign exchange officially equivalent to a unit of domestic currency? The required number we call "the shadow price of foreign exchange".

Because of the importance of the foreign exchange impact of most projects in developing countries, the estimation of a shadow price of foreign exchange is of great significance for social benefit-cost analysis. It should be noted, however, that if all foreign currencies are not freely convertible among themselves, the shadow price of foreign exchange will not be unique. For each non-convertible currency, a distinct shadow price will have to be evaluated reflecting domestic willingness to pay for that currency, and the currency must be kept separate in the accounting of foreign exchange benefits and costs. The shadow price(s) of foreign exchange can be grouped with a series of critical parameters which describe conditions relating to the economy as a whole, rather than characteristics of a particular project or set of projects. These parameters we shall call "national parameters", and a discussion of their estimation will be deferred to a later paper.

B The measurement of costs

The basic principle to be applied in calculating **costs with respect to any objective is that** costs are simply equivalent to **benefits foregone.** As in the case of aggregate consumption benefits, we measure aggregate consumption costs according to the criterion of consumer willingness to pay. We have seen that the benefits of a project consist of its "net output", defined as the goods and services made available to the economy which would not have been available in the absence of the project. By the same token, the costs of a project consist of its "net input", which may be defined as the goods and services withdrawn from the rest of the economy that would not have been withdrawn in the absence of the project.

As in the case of measuring benefits, the first step in measuring costs is to identify correctly the relevant net input to the project. Here again we must distinguish between alternative possibilities. On the one hand, the use of various physical inputs on a project may result in a decline in the total availability of those inputs exactly equal to their consumption by the project. To the extent that this is true, the net input to the project consists of the actual physical inputs. On the other hand, it is possible that in response to the demand made by the project for these inputs, their supply is correspondingly increased in the rest of the economy. In that event, there may be no change in the total availability of the goods and services actually used as inputs to the project. The net input to the project will then consist of those goods and services whose availability to the rest of the economy is reduced because they are used up in producing inputs for the project. In effect, we include within the scope of the project any ancillary production which takes place only because of the demands raised by the project.

In every case, the problem is to identify what goods and services suffer a net decline in availability because of the existence of the project. The distinction drawn earlier between the demand and the supply margin may be carried over from benefits to costs. If the actual physical inputs to the project suffer a decline in total availability, we must look to the demand for these goods and services by other potential purchasers in order to measure their aggregate consumption costs. Here the relevant margin for measurement is the demand margin. If, on the other hand, the

project requirement of inputs is met by increased supply from other sources, we are concerned with the supply margin. Given the variety of inputs that are required by any single project, it is most likely that some inputs will have to be measured on the demand margin and others on the supply margin.

Once the project costs have been properly identified, the problem of finding a suitable measure of willingness to pay is precisely the same as in the measurement of benefits. Consumer goods will of course not figure as relevant project inputs, but producers' goods and foreign exchange are typically important net inputs. In addition, we must consider the two primary factor inputs which are not produced: land and labour. In the following pages, we consider separately the special problems that arise in connexion with each category of project input.

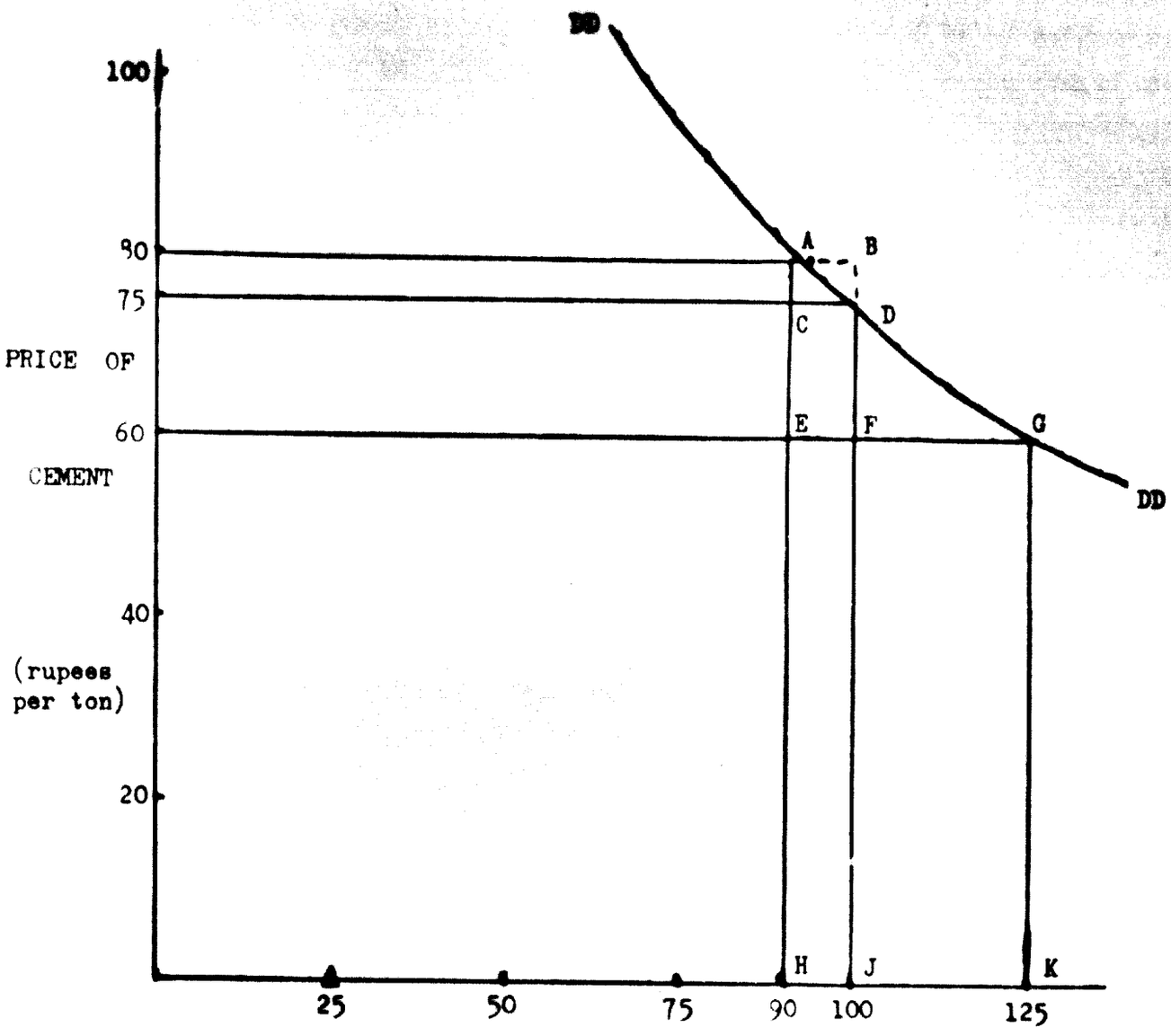
Producers' goods

Let us suppose that the project in question involves the construction of a large concrete-fill dam. One of the important inputs is cement, whose aggregate consumption cost we seek to measure. If the total availability of cement to the rest of the economy is reduced by the amount of cement used on the project, we seek to evaluate the willingness to pay for the cement which is no longer available. The calculation is very closely related to the measurement of the aggregate consumption benefits due to an increase in the availability of cement, say, as a result of a new project for manufacturing cement.

Producer willingness to pay for the cement is the first approximation to its aggregate consumption benefits (if the availability is increased) or costs (if the availability is decreased). In order for the market price of cement to serve as an appropriate measure of producer willingness to pay, the same four conditions noted earlier in the discussion of producers' goods benefits must apply. Under perfectly competitive conditions, the market price reflects producer willingness to pay - provided that the demand by the project for cement is not so great as to push up its market price. In such an event, producer willingness to pay is understated by the original - lower - market price, and overstated by the future - higher - market price. This situation is represented in diagram 3.

Diagram 3

The demand for cement



Before the dam is begun, let the annual rate of supply of cement be 100,000 tons, and suppose that it sells at a market-clearing price of 75 rupees per ton. If the annual demand raised by the dam is 10,000 tons, and if no additional supplies of cement are forthcoming in response to the construction of the dam, the supply available to the rest of the economy is reduced to 90,000 tons. This more limited supply clears the market at the higher price of 80 rupees per ton. The willingness to pay for the 10,000 tons of cement used by the dam is clearly neither the new market price of 80 rupees times 10,000 tons (the area ABJH) nor the old market price of 75 rupees times 10,000 tons (the area CDJH); it is precisely equal to the area ADJH under the demand curve. The correct measure involves the addition of the "consumers' surplus" ACD, enjoyed by the previous purchasers of the last 10,000 tons of cement, to the value of the cement obtained by using the original market price.

If the cement were rationed, or if the cement purchasers exercised any monopoly or monopsony power in the relevant markets, the market price of cement would understate the willingness of purchasers to pay for it, and a more careful study of the demand conditions would be required. In this event, one could attempt to measure producer willingness to pay according to the net profits realized on cement - as suggested earlier in the case of the steel output. The same qualifications raised earlier with respect to the markets for the further processing of the steel output apply equally in the case of the cement input. In principle, the aggregate consumption costs involve not only the immediate would-be purchaser's willingness to pay, but also the excess of willingness to pay over actual payment for all purchasers further along the line.

Suppose now that - rather than cutting into the existing supplies of cement - the project gives rise to additional supplies in the same amount as required. Under these circumstances, the market price of cement does not change - but it is also irrelevant. For now we must evaluate the input cost corresponding to the cement in terms of the cost of supply, i.e. the cost of the resources used in producing cement. The principles involved here are the same as above, only one stage further removed from the dam construction project.

Let us assume that a careful evaluation of the cost of producing cement leads to an assessment of 60 rupees per ton. The difference between the 60 rupees' cost of production and the 75 rupees' sales price may, for example, be due to a government excise tax. We should now value the aggregate consumption cost of the cement at 60 rupees per ton, which, multiplied by the 10,000 tons used on the project, leads to an over-all cost of 600,000 rupees (the area EFJH). This is of course substantially less than the cost measured at the demand margin (the area ADJH), when it was assumed that the over-all supply of cement was not expanded in response to the project.

It is sometimes argued that even if the supply of cement can be and is expanded at a real cost (viz. 60 rupees per ton) lower than the willingness to pay for it (viz. 75-80 rupees per ton), it is the latter figure that is relevant for the benefit-cost analysis. The point here is akin to the one raised earlier in connexion with import substitution. It is argued that benefits in the amount of ADFE can be obtained in any event by expanding cement production independently of the dam project, so that these benefits should not be implicitly attributed to the dam project by lowering the cement input costs from ADJH to EFJH.

Once again, the argument is valid if <u>in fact</u> there will be an independent investment in cement expansion. Such an investment would reap net benefits equal to the area between the demand curve and the 60-rupee cost curve, and these net benefits would be positive up to a total supply of 125,000 tons of cement. Certainly the government should be advised to take up such a project, if there are no other good reasons for doing without it. But unless and until the production of cement is actually expanded by an independent project, it is wrong to pretend that it is. The evaluation of the dam project must proceed on the basis of the most likely occurrences, which need not necessarily turn out to be the optimal ones.

<u>Foreign exchange</u>

Cases in which foreign exchange proves to be the relevant net input to a project are far more common than one might initially suspect. To begin with, directly imported inputs on current or capital account are likely to involve a net drain of foreign exchange equivalent to the foreign exchange cost of the inputs. As long as the availability of these particular inputs to the rest

of the economy is not affected, it is the availability of foreign exchange in general that is reduced by the project, and the relevant net input is precisely the foreign exchange used up.

There are only two relatively unlikely circumstances under which the foreign exchange used for directly imported inputs on a project would not be obtained at the expense of the availability of foreign exchange to the rest of the economy. First, if there is a fixed quota of imports of a product used as a project input, then the result of using such imported products for the project is to reduce the availability of the product to the rest of the economy. In this event, the effective net input is not foreign exchange but the product itself, and its cost should be measured in terms of willingness to pay for that product in particular rather than foreign exchange in general. Secondly, it may happen that a project draws not from free foreign exchange for its imported inputs, but that instead it uses a foreign exchange loan or grant which is tied exclusively to the project. If the loan or grant made to this one project in no way reduces the chances of additional loans or grants to other projects - nor the total availability of foreign economic assistance - then the imported input results in no immediate drain on the supply of foreign exchange available to the economy. In the case of a grant, the imported input is costless; in the case of a loan, the relevant costs must be determined according to the loan repayment obligations - for it is only when those repayments are made that there will have to be a diversion of foreign exchange away from other uses.

Apart from directly imported inputs, foreign exchange may appear as the relevant net input in a variety of indirect ways. Suppose, for example, that rubber is to be used as an input to a projected tire-manufacturing plant in a country that produces large quantities of rubber for export. It is possible that the project demand for rubber would lead to additional rubber production, in which case the rubber input should be valued at its cost of production. It is also possible that the project would draw rubber away from other domestic uses, in which case the rubber input should be measured according to the other purchasers' willingness to pay for it. But perhaps the most likely result of the project demand would be to direct rubber away from the export market, where most of it was previously going. In this event,

what the economy loses is the foreign exchange that would have been earned by the exportable product, and the relevant net input is simply foreign exchange.

The same kind of situation may arise with respect to import substitutes. Let us consider the same tire plant in a different country in which there are no rubber plantations, but a domestic synthetic rubber plant has begun to substitute for some previously imported rubber. If the tire plant uses domestic synthetic rubber as an input, it may appear that there is no drain on foreign exchange. However, unless the supply of rubber to other domestic users is curtailed, the net effect of the project will be to raise the requirements of rubber in the economy as a whole. And unless there is idle capacity in the synthetic rubber plant, or a new plant is installed right away, the only source from which the additional requirements can be raised is the world market. Once again, the relevant net input would turn out to be foreign exchange.

This line of reasoning may be carried even further. Any input whose supply is increased in response to a project must be valued according to the resources used up in its production. If these resources include foreign exchange - via directly imported inputs, via exportables, or via import substitutes - then to that extent the relevant net input consists of foreign exchange. Whenever the measurement of an input takes place on the supply margin, according to production costs rather than immediate willingness to pay for the input, foreign exchange is likely to figure among the relevant net inputs.

Once the relevant foreign exchange inputs to a project have been identified, it remains only to measure them according to the principal of willingness to pay. Here the procedure becomes identical to the measurement of foreign exchange benefits, and the earlier discussion of benefits can be carried over entirely to costs. As noted already, unless the market for foreign exchange is sufficiently competitive for one to accept the official rates of exchange as measures of willingness to pay for foreign currencies, one must introduce one (or more) shadow price(s) of foreign exchange to value the domestic currency equivalent of the foreign exchange inputs. The estimation of the shadow price(s) of foreign exchange is discussed in a subsequent paper.

Labour

No production process can take place without the input of labour. From manual workers to highly skilled operatives, from errand boys to top executives, labour of different grades and in different proportions figures prominently in the cost accounting of any major enterprise. In order to identify the relevant net input to a project which corresponds to the hiring of (the services of) any given man, one must as usual ask the question: what does the rest of the economy ultimately lose when this man joins the project? To begin with, what productive resources - human or material - decline in availability as a result of the input of labour to a project?

The immediate effect of engaging a man's services on a project is to deprive the rest of the economy of those services. Unlike steel, cement, or (indirectly) foreign exchange, the supply of human beings cannot be increased by judicious investment in response to the demand of any particular project. Here - and elsewhere - it is important to distinguish between unskilled and skilled labour. Unskilled labour is defined to represent only the most primary labour, of a kind that can be supplied by a man without any special education or training. Skilled labour is defined to include all of the different grades of labour which involve some degree of education or training above the minimum established in the society. The supply of unskilled labour cannot be varied in the short-run; it is a function of long-run demographic trends. The supply of skilled labour of any given type, however, can be increased (at the expense of the supply of less skilled labour) by suitable investment in education and training. Such investment represents what is often called "human capital formation".

It is often the case that a project requiring certain specialized services includes a training programme to upgrade the quality of part or all of the labour force. Just like the costs of housing, transport, welfare etc., which may also fall within the scope of the project, the costs of a training programme must be reckoned as net inputs to the project. (Note that the net benefits of housing etc. - to the extent that they are not reflected in the direct project output - must be reckoned as part of the over-all net output of the project.) Irrespective of the amount of training a man may get on the project itself, his cost as an input to the project depends on his skill at the time of joining the project, for that is what the rest of the economy is deprived of.

When an unskilled labourer is hired for work on a project, the availability of unskilled labour to the rest of the economy declines, and the relevant net input for a given year is one man-year of unskilled labour services. When a skilled labourer joins a project, a man-year of labour services of that particular skill represents the relevant net input - unless, in response to the requirements of the project, training programmes elsewhere in the economy are stepped up so as to prevent the net availability of this kind of skilled labour from declining. In the latter event, we must look at the supply margin for skilled labour: the relevant net input to the project becomes the inputs required for the training programme to turn out more skilled labour, including the input of an equivalent amount of labour at a lower skill level. Thus whatever the nature of the case, the use of labour on a project involves a decline in the availability of the same amount of labour - although not necessarily of the same skill - to the rest of the economy.

Having identified the relevant labour component of the inputs to a project, it remains to determine the ultimate consumer willingness to pay for a unit of labour services of each particular kind. Once again, if the necessary conditions involving competitive markets and relatively small changes in supply can be assumed to hold, then the market price - or wage rate - of a particular grade of labour may be taken as an appropriate measure of willingness to pay. In many developing countries, however, such a guideline will be of little practical value, for labour markets tend to be notoriously uncompetitive. It was observed already in an earlier paper that in countries with a large population relative to the endowment of other resources, a significant degree of disguised and/or overt unemployment of labour may coexist with a positive market wage. The reasons for which a positive wage might be paid under such circumstances are varied, but they generally reflect institutional constraints - such as the political power of employed labour, a minimum wage concern on the part of the government, or the existence of alternative family or social forms of subsistence income for the unemployed.

To the extent that labour services are drawn (directly or indirectly) from previously unemployed labour, the net loss of productive services to the rest of the economy is clearly nil - even if a conventionally determined

positive market wage must be paid. Thus under the conditions of a "labour surplus", the appropriate cost of labour inputs (sometimes called "the shadow price of labour") may be zero. Before proceeding to evaluate all labour costs at a price of zero, however, one must heed several words of caution. First, it is essential to distinguish carefully between the different types of labour. While the real cost of unskilled labour may well be zero - if the jobs in question can be adequately filled at all times by labourers otherwise unemployed - the same is not necessarily true of skilled labour. It is more than likely that where population is in surplus, skills are in short supply - with the result that the willingness to pay for skilled labour may not only be greater than zero, but perhaps even greater than the market wage.

A second consideration to be borne in mind is the regional dimension of labour supply. Even if there is a labour surplus in the economy as a whole, it may well be unevenly distributed between regions, and - in particular - between urban and rural areas. If the project in question is located in an area where the immediate supply of surplus labour does not match the project demand for unskilled workers, then the net cost to the economy of bringing in unemployed labour from elsewhere must include the costs of transfer. These costs include not only the immediate costs of transportation - which are not likely to be high - but the extra cost of providing basic social amenities to the workers on the project site which they would not have required in their original location. Such expenses must typically be incurred when an industrial project draws unskilled labour from rural into urban areas, where the real cost of essential public services is likely to be higher. If these transfer costs are incurred by the project, they can be considered separately as project net input. But to the extent that they are borne by the labourers, they must be included in the over-all social cost of labour input.

A final word of caution on the cost of labour applies even when the costs of skills and of transfer may be ignored. The payment of a market wage of 150 rupees a month to an unskilled worker (whose cost is measured at zero because he is otherwise idle) results in a transfer of income from the government or private employer to the worker in the amount of 150 rupees each month. If the government or the private employer has a greater

propensity to invest out of his income than the worker, and if the ultimate consumption value of funds invested exceeds the corresponding value of immediate consumption, then there will be a net loss to society arising from the transfer. Taking this argument into account, the "shadow price of labour" should be positive rather than zero. This final correction involves precisely the category of "indirect" benefits and costs which we have decided to postpone to Part III of the paper, it will therefore be ignored in the present discussion of "direct" aggregate consumption costs. The reader is referred to a subsequent paper for a more detailed treatment of the whole concept of the 'shadow price of labour'.

Land

Land as an input is naturally associated with every project requiring a site, but especially in the case of industrial projects it is likely to form a negligible fraction of total costs. For that reason, no elaborate discussion is called for here. As a factor of production which is by definition in constant supply, land as an input must always be measured on the demand margin. When land is used up by the project, that land is denied to the rest of the economy and cannot be substituted for from any other source of supply. The appropriate measure of the cost of land as an input is the ultimate consumer willingness to pay for the aggregate consumption benefits made possible by the use of the land.

Where land markets are competitive, and where the project demand for land does not appreciably bid up its price, the market price of land (or the market rental rate) may be taken as a measure of the willingness of purchasers to pay for the land (or its use). Just as in the case of producers' goods, this willingness to pay on the part of purchasers may in turn be used to measure the aggregate consumption cost of the land so long as the further markets between the land and the ultimate consumption goods satisfy the same conditions. If the land required by a project has no other potential use, then the market-clearing price of the land is zero, and irrespective of the actual cost that must be paid for it, the land must be measured at zero cost as an input to the project. If the land does have an alternative use, but if the market price does not provide an appropriate measure of its value, then it may be possible to measure the cost of the land by the net benefits which are foregone because the land can no longer be devoted to the alternative use.

III THE AGGREGATE CONSUMPTION OBJECTIVE: INDIRECT FUTURE BENEFITS AND COSTS

In our discussion of direct aggregate consumption benefits and costs, we have so far been tacitly assuming that all benefits and costs of a project result in corresponding gains and losses of present consumption. To measure each project benefit and cost, we have applied the criterion of the willingness to pay by the consumer for the additional consumption made possible by the good or service in question. We should now recognize, however, that a man who benefits from a project may respond to his improved position not by increasing his present consumption, but by increasing his savings. And a man who incurs costs on a project may respond not by cutting down on his consumption, but by reducing his savings. Such changes in savings may be translated into changes in investment, which in turn will have consequences for future production, consumption and savings. To the extent that a project influences current investment rather than current consumption, it will provide not direct current consumption benefits but indirect future consumption benefits.

So long as the value of the indirect future consumption benefits due to a unit of funds devoted to investment is equal to the value of the direct current consumption benefits due to a unit of funds devoted to consumption, it makes no difference to our social benefit-cost analysis whether benefits (or costs) are consumed or saved and invested. If, however, the future benefits due to investment exceed the corresponding present benefits due to consumption, then the rate of saving and investment in the economy is less than the socially optimal rate, and society gains in the long run by any increase in savings and investment at the expense of consumption. When such a situation obtains, it becomes essential to evaluate the overall effect of a project on the mix of consumption and investment in the economy, for every year in which the project is in operation. It is also necessary to estimate the ultimate aggregate consumption benefits due to a unit of current investment, so as to make these comparable with the benefits due to a unit of current consumption.

One may well ask, at this point, why any individual project should be expected to help in attaining an optimal rate of saving and investment for the economy as a whole. After all, is not the rate of saving and investment a macro-economic problem that should be resolved by an appropriate fiscal and monetary policy? The answer is that if in fact a government is in a position

to achieve its desired rate of saving and investment via fiscal and monetary measures, then there is no reason to confront the problem at the project level, and no need to inquire into the use of benefits realized or foregone on account of any individual project. If there are no constraints on the fiscal powers of the finance minister, there should be no indirect future benefits and costs attributable to a particular project.

If, on the other hand, the government is not in a position to achieve its desired rate of saving and investment via fiscal and monetary policy - or if there are significant costs associated with the required policy measures - then it becomes perfectly legitimate to use individual projects as another instrument to achieve the same goals. The fact that almost all developing countries are striving for higher rates of saving and investment than currently obtained is a convincing argument for the need to consider the saving and investment implications of individual projects. In most of these countries, political and institutional constraints limit the ability of finance ministers to raise rates of saving and investment to their desired level.

Once this proposition is accepted, we must first of all inquire into the effect of project benefits and costs on the rate of investment in the economy, and then evaluate the indirect benefits or costs due to any change in the rate of investment. During the period of project construction, resources are drawn away from the rest of the economy and funds to pay for these resources must be raised at the expense of the rest of the economy. How much of the sacrifice made by the rest of the economy is a sacrifice of consumption, and how much is a sacrifice of investment? Later, during the period of project operation, benefits are returned to various sectors of the economy, in the form of goods and services or cash flows. How much of the gains made by these sectors of the economy result in increased consumption, and how much result in increased investment?

There are at least two ways of approaching the issue that might suggest themselves. On the one hand, one might link the consumption-investment effect of the project to the technological nature of the goods and services that are used as inputs or produced as outputs. Thus if an investment good is diverted from elsewhere in the economy to be used in project construction, this would be regarded as a sacrifice of investment. Similarly, if the project benefits are associated with the production of an investment good, this would be

regarded as a gain of investment. And the converse would hold for consumption goods. The alternative approach would link the consumption-investment effect of the project to the expenditure patterns of the groups who gain and lose by the project. Thus if the project construction costs are ultimately paid for by group A, the fraction representing a sacrifice of investment is given by the marginal propensity to save of group A, and the fraction representing a sacrifice of consumption is given by their marginal propensity to consume. Similarly, if the beneficiaries of the project are group B, the division of the gains between consumption and investment is determined according to the marginal propensities to consume and to save of group B.

The choice between the two approaches should depend upon one's judgment about the factors that limit investment in the economy. The first approach is appropriate to a situation in which the effective constraint on investment is the supply of certain investment goods. In this case, the net effect of the project on the supply of these goods is what determines its effect on the over-all consumption-investment mix in the economy; any other good or service should be regarded as a consumption good for the purposes of the evaluation. The second approach is appropriate to a situation in which the effective constraint on investment is the availability of savings. Under these circumstances, any required investment good can be obtained - through domestic or international transformation - by a sacrifice in consumption. It should be noted that one approach may be preferable in some years, and the second approach in other years. In particular, the supply of certain investment goods may be regarded as relatively inelastic for the immediate future, but more elastic in the long run, so that the first approach would apply initially and the second approach later.

The most plausible example of binding supply constraint on investment would probably be the case of an economy dependent upon imported capital goods for investment, where essentially all available foreign exchange is already being directed into investment in one form or another, and where the opportunities for increasing foreign exchange earnings are sharply limited by an inelastic world demand for the country's exports. Under circumstances such as these, there would still be a substantial fraction of investment inputs not subject to a supply constraint. Hence the amount of investment foregone by

by using up a unit of foreign exchange (the constrained input) - or the amount of investment made possible by earning or saving a unit of foreign exchange - would actually be a multiple of the consumption value of that unit of foreign exchange. Thus to assess the quantitative effect of project input or output on the over-all consumption-investment mix of the economy, according to the first approach, it is necessary to evaluate in each year of the project the net claim on the constrained input(s), and to multiply this net claim by the reciprocal of the fraction of total investment which - on the average - consists of the constrained input(s).

When the effective constraint on investment is demand rather than supply, the second approach is called for. It then becomes relevant to inquire into the distribution of project benefits and costs among different economic groups or sectors, and to examine the savings behaviour of each. The net gain to a particular group or sector is equal to the value of the net aggregate consumption benefits which it receives, minus the value of any net cash payments which it has to make. Thus the evaluation of the ultimate distributional effects of a project must take into account both the initial distributional effect of the aggregate consumption benefits and costs, and the further redistributive effects of the cash flows brought about by the project.

From the conceptual point of view, it is desirable to distinguish the immediate impact of the project benefits and costs from the accompanying monetary transfers, for the two may not correspond. The first step in assessing the distributional effects of a project is to associate an immediate gainer and loser with each aggregate consumption benefit and cost. Thus when a government agency undertakes the construction and operation of a project, it diverts resources away from use elsewhere in the economy, to the extent that these resources are drawn from the private sector, the private sector as a whole sustains the immediate cost, and to the extent that the resources come from government stocks, the government is the immediate loser. If the project output is made available to a given set of consumers, these consumers enjoy the corresponding immediate benefits.

The ultimate loss of the private sector depends on the extent to which it is compensated for the resources it gives up, and the ultimate gain of the consumers depends on the amount which they are required to pay for their benefits. Thus, the second step in assessing the distributional effects of a project

is to distinguish and examine all of the cash flows to which it gives rise. If the government increases taxes in direct response to the project, there is a transfer from the taxed public to the government coffers which increases government gains and increases public losses by exactly the same amount - the aggregate consumption value of the cash flow. If the government finances its outlays by borrowing, there is a transfer from lenders to government in the initial stage, and a series of transfers from government to lenders in a later stage when the loan is being repaid. If the consumers of the project output must pay for that output, there is a transfer of cash and hence consumption benefits - from the consumers to the producers of the output in the amount of the actual cash payments. Three basic points should be emphasized: (1) cash flows must only be considered if they would not have arisen in the absence of the project; (2) for every cash flow the benefits and costs sustained by the parties involved are necessarily equal; and (3) the sum of the net benefits (gains minus losses) to each group must add up to the net direct aggregate consumption benefits of the project as a whole.

Following this approach, let $B^D(t)$ be the direct aggregate consumption benefits of a given project in year t, let $C^D(t)$ be the direct aggregate consumption costs, and let $\Delta B^D(t)$ be the corresponding net benefits:

$$\Delta B^D(t) = B^D(t) - C^D(t) \qquad (1)$$

We now distinguish N different groups or sectors affected by the project: n = 1, ..., N. For example, one group might consist of wage-earners (n = 1), a second group of profit-earners (n = 2), and a third group might be represented by the government sector (n = 3). The classification of groups ought to be made according to their consumption and savings behaviour, as far as available data will permit. We now denote the direct costs, direct benefits, and direct net benefits realized by each group on account of the project by $B_n(t)$, $C_n(t)$ and $\Delta B_n(t)$, so that

$$\Delta B_n(t) = B_n(t) - C_n(t) \quad n = 1, \ldots, N \qquad (2)$$

and, since the groups include everyone affected by the project,

$$\sum_{n=1}^{N} B_n(t) = B^D(t) \qquad (3)$$

$$\sum_{n=1}^{N} C_n(t) = C^D(t) \tag{4}$$

$$\sum_{n=1}^{N} \Delta B_n(t) = \Delta B^D(t) \tag{5}$$

Now let the marginal propensity to save (out of net benefits or their cash equivalent) be $s_n(t)$ for group n in year t. Then the net increase in saving on the part of group n in year t, as a result of the project, is

$$\Delta S_n(t) = s_n(t) \quad \Delta B_n(t) \qquad n = 1, \ldots, N \tag{6}$$

and the corresponding net increase in consumption is

$$\Delta C_n(t) = \left[1 - s_n(t)\right] \quad \Delta B_n(t) \qquad n = 1, \ldots, N \tag{7}$$

The over-all net contribution of the project to investment and to consumption in year t may be obtained by summing the net increases due to each group:

$$\Delta I_t = \sum_{n=1}^{N} \Delta S_n(t) \tag{8}$$

$$\Delta C_t = \sum_{n=1}^{N} \Delta C_n(t) \tag{9}$$

Since we are dealing with benefits net of costs, any of the magnitudes ΔI_t, ΔC_t, $\Delta S_n(t)$ and $\Delta C_n(t)$ may be negative as well as positive. Summing equations (6) and (7) over all groups, and using equations (5), (8), and (9), we can show that

$$\Delta B^D(t) = \Delta C_t + \Delta I_t \tag{10}$$

In other words, the net direct aggregate consumption benefits of a project in year t can be divided into two components representing the net increase in consumption and the net increase in investment, respectively.

Having established the effect of the project on the mix of consumption and investment in the economy in each year, it remains to evaluate the indirect future net benefits attributable to the presumed excess social value of investment over consumption. In order to do this, we require a measure of the value of a unit of current investment relative to the value of a unit of current consumption. This measure we shall call "the shadow price of investment". Like the shadow price of foreign exchange, the shadow price of investment is one of

of those critical national parameters which describe conditions relating to the economy as a whole, rather than characteristics of particular projects. Because of its importance for the evaluation of all projects, the estimation of the shadow price of investment will be discussed in detail in a subsequent peper.

It should first be noted that unlike the shadow price of foreign exchange - the shadow price of investment may not be unique. In fact, it is shown in the paper referred to above that if different groups in the economy have different propensities to save, and/or if the returns to the investment from the savings of different groups are different, then we cannot associate a unique shadow price of investment with all of the net investment generated by a project in a given year. Instead of a global shadow price of investment $p^k(t)$ to attach to the over-all net change $\Delta I(t)$ in year t, we require a separate shadow price $p^k_n(t)$ to be applied to the net change in investment $\Delta I_n(t)$ due to each group n in that year.

If we are unable to distinguish among the savings behaviour of different groups in the economy, then we must accept a single global shadow price of investment $p^k(t)$ based on some average propensity to save and rate of return to investment. In this event, the evaluation of indirect future net aggregate consumption benefits involves simply the multiplication of the net change in investment brought about by the project in year t by the excess in the social value of investment over the social value of consumption. Thus the indirect net benefits come to

$$B^I(t) = \left[p^k(t) - 1\right] \Delta I(t) \qquad (11)$$

and (using equation (10)) the total direct and indirect net aggregate consumption benefits of the project in year t amount to

$$\Delta B^T(t) = \Delta B^D(t) + \Delta B^I(t) - \Delta C(t) + p^k(t)\, \Delta I(t) \qquad (12)$$

Assuming that we are in a position to distinguish among different groups in the economy, the measurement of indirect net benefits must proceed separately group by group. Thus the net change in investment in year t due to group n must be multiplied by the excess of the social value of investment from that group over the social value of consumption:

$$B^I_n(t) = \left[p^k_n(t) - 1\right] \Delta S_n(t) \qquad (13)$$

where group investment is equated with group savings. The indirect net benefits from the project as a whole are then obtained by summing over the separate groups:

$$\Delta B^I(t) = \sum_{n=1}^{N} \left[p_n^k(t) - 1 \right] \Delta S_n(t) \qquad (14)$$

The total direct and indirect net aggregate consumption benefits in year t may now be written (using equations (8), (9), and (10)) as:

$$\Delta B^T(t) = \Delta B^D(t) + \Delta B^I(t) = \sum_{n=1}^{N} \left[\Delta C_n(t) + p_n^k(t)\, \Delta S_n(t) \right] \qquad (15)$$

If we define the "social value" $v_n(t)$ of a unit of net benefits to group n in year t according to the proportion in which the group divides its net benefits between consumption and saving, and the social value of each part, we get:

$$v_n(t) = \left[(1 - s_n(t)) \times 1 + s_n(t) \times p_n^k(t) \right] \qquad (16)$$

Substituting equations (6), (7) and (16) into equation (15), we arrive at an alternative way of looking at the total net aggregate consumption benefits of a project in year t:

$$\Delta B^T(t) = \sum_{n=1}^{N} v_n(t)\, \Delta B_n(t) \qquad (17)$$

The total net benefits can be expressed simply as the sum of the net benefits realized by each group multiplied by the social value of benefits to that group.

From equation (16), it can be seen that the numerical value of $v_n(t)$ varies between 1 and $p_n^k(t)$. For a group which consumes all of its marginal income (which might be approximately true of wage-earners), $s_n(t) = 0$ and $v_n(t) = 1$. For a group which saves all of its marginal income (the government?), $s_n(t) = 1$ and $v_n(t) = p_n^k(t)$. Clearly, any transfer from a group with a relatively high social value of net benefits to a group with a relatively low value results in indirect future costs. This point lies behind the argument cited earlier for a positive shadow price of unskilled labour even when it is otherwise idle. Whenever a positive market wage is paid by an employer to a previously unemployed worker, there is a money transfer from a group with a higher $v_n(t)$ to a lower $v_n(t)$. The result is an indirect future cost equal to the difference in the values of the $v_n(t)$ times the cash amount of the transfer.

IV THE REDISTRIBUTION OBJECTIVE

In the discussion of "direct" aggregate consumption benefits and costs in Part II of this paper, we consistently used the criterion of willingness to pay to measure project benefits and costs. As noted earlier, this criterion is completely neutral with respect to the wealth, the nature, or the habits of the person who enjoys the benefits or incurs the costs. As long as someone was willing to pay for another unit of a good or service, that good or service was valued according to his willingness to pay. No questions were asked about the value of a given good or service to society as a whole as distinct from its value to the individual.

In Part III of the paper, we took into consideration one respect in which the immediate willingness to pay of an individual consumer may fail to reflect the value of a good or service to society as a whole. When the value of the future consumption made possible by saving and investing a unit of benefits exceeds the value of the present consumption of that unit, then we cannot be satisfied with immediate willingness to pay as a measure of benefits and costs, and we must inquire also into the distribution of project benefits and costs between consumption and investment. We seek to correct the valuation of those net benefits which result in increases in investment in such a way as to take into account the "social value" of the investment relative to consumption.

What is meant by the "social value" of investment? The social value of a unit of investment - measured by the "shadow price of investment" - is simply the present value of the future consumption made possible by a unit of investment, evaluated according to the principle of consumer willingness to pay for that consumption. In other words, the use of a shadow price (or several shadow prices) of investment to calculate indirect future consumption benefits is required to account for future benefits on the same willingness to-pay basis as present consumption benefits. For this reason, we speak of indirect aggregate consumption benefits: there is no departure from the principle of willingness to pay, but it is necessary to adjust immediate willingness to pay wherever it fails to reflect the ultimate willingness to pay for present and future benefits on a comparable basis.

In this Part IV of the paper, we go on to consider another important respect in which the immediate willingness to pay of an individual consumer

fails to reflect benefits and costs to society as a whole. This time we depart from the objective of increasing aggregate consumption - present or future - and consider instead the possible social objective of redistributing income from more favoured to less favoured groups within the society. This objective involves a clear rejection of the principle of willingness to pay irrespective of the individual, and requires instead that a distinction be made between different groups enjoying different levels of well-being. As long as we wish to redistribute income (in the form of net benefits) from one group to another, we cannot be indifferent as to who are the gainers and who are the losers from a project.

In connexion with the redistribution objective, the same question raised earlier in the context of savings and investment may be posed: why must redistributive goals be achieved via individual projects? Should not the government seek to bring about the desired distribution of income by means of taxes, transfers and other instruments of national fiscal policy, and let projects be judged on the basis of their contribution to aggregate consumption alone? Once again, the answer is an empirical one. To the extent that it can use other means of redistributing incomes without great cost, any government is well advised to do so. But in actual practice, political and institutional constraints are likely to limit the ability of most governments to redistribute income via fiscal measures, and even then the costs associated with such measures may not be negligible. The result is that a good social benefit-cost analysis cannot afford to ignore either the savings or the redistribution effects of individual projects.

Turning now to the measurement of project benefits and costs with respect to the redistribution objective, we must consider the sense in which the objective is to be understood. On the one hand, the government may wish to redistribute income between groups defined according to their income level, e.g. from high-income groups to low-income groups. On the other hand, the government may wish to redistribute income between groups defined according to their place of residence, e.g. from residents of a prosperous region to residents of a backward region. The second case is slightly more complicated than the first, because a project may itself bring about some net immigration into the area in which it is located and thereby increase the size of the group defined as residents of that region.

As discussed in an earlier paper on the reconciliation of multiple objectives, a government may give expression to its redistributional objectives by attaching some extra positive weight to the net benefits accruing to the more deserving group(s) and/or by attaching some extra negative weight to the net benefits accruing to the less deserving group(s). The choice of a numerical value - positive or negative - for the weight associated with any given group is beyond the scope of this paper. Here we are concerned only with the measurement of the amount of net benefits realized by any particular group singled out for special treatment.

A redistribution benefit (or cost) must be defined with respect to the particular group in question: it is nothing but an aggregate consumption benefit (or cost) that accrues to that group. Thus the measurement of redistribution benefits and costs involves exactly the same principles used in Part III to determine the ultimate allocation of project benefits and costs among different economic groups or sectors. The redistribution benefits to a group are equal to the immediate aggregate consumption benefits it receives minus any off setting payments made to other groups, and the redistribution costs to the group are equal to the immediate aggregate consumption costs it incurs minus any compensating receipts from other groups. To measure the net redistribution benefits realized by a particular group, we must examine all of the aggregate consumption benefits and costs - direct and indirect - of a project, as well as all of the accompanying cash transfers, and determine to what extent each item affects the group in question.

Let us consider first the redistributive effect of the direct aggregate consumption benefits of a project. Whether the net output of the project consists of the very goods and services which it produces, or of goods and services which it releases from alternative sources of supply, the immediate beneficiaries may be identified as the persons who make use of the additional supply, and whose willingness to pay for it measures the corresponding direct aggregate consumption benefits. To the extent that the immediate beneficiaries must pay for their use of the project net output, their redistributional gains are reduced and those of the group receiving the payment are increased. Depending upon the associated cash transfers, the direct aggregate consumption benefits of a project may be spread over a number of different groups other than the immediate beneficiaries.

Suppose, for example, that we are considering a multi-purpose water project which will add to the availability both of irrigation water and power. The immediate beneficiaries of the project are the farmers who receive water for their fields and the domestic and industrial electricity consumers who make use of the additional power. Thus in the first instance the farmers as a group gain aggregate consumption benefits equivalent to their willingness to pay for the water, and the power consumers gain benefits equal to their willingness to pay for the electricity. However, both the water and power consumers will have to pay something for their benefits; irrigation and power charges will be levied by the government authority operating the project. The payments for these charges represent cash transfers back to the government, and these add up to the share of total benefits captured by the government. Typically, the irrigation and power charges will amount to less than the original willingness to pay for the water and electricity, so that the farmers and the power consumers still emerge with net redistribution benefits in their favour.

Suppose now that the net output of the project consists of foreign exchange: who is the immediate beneficiary? This depends upon the way in which foreign exchange is allocated in the economy. The immediate beneficiaries will be those persons - in the public or private sector - who are able to use the extra foreign exchange for marginal increases in imports. Whether these importers realize any net redistributive benefits depends on how much they have to pay for the foreign exchange they use for importing. If the foreign exchange is auctioned off in a free market, the importer may part with domestic currency equivalent to his full willingness to pay. If the foreign exchange is allocated via some quota system, the importer may buy his foreign exchange at an officially determined rate substantially less than his willingness to pay - in which case he receives net redistribution benefits. The rest of the direct aggregate consumption benefits may be returned in the form of domestic currency to the enterprise which operates the foreign exchange earning or saving project.

The analysis of the redistributive effect of the direct aggregate consumption costs of a project is similar to that of the benefits. The net input to a project may be associated at first with the persons who forego the use of the good or service whose supply is reduced, and whose willingness to pay

for it measures the corresponding direct aggregate consumption costs. To the extent that those who give up the goods and services are compensated by others, or reduce their own payments to others, the cost is shifted to other groups. Via such cash transfers, the ultimate costs may be borne by groups quite distant from those who are most immediately affected by the project. Let us consider some examples.

When a worker is withdrawn from employment elsewhere in the economy to work on a public project, the cost is usually passed on to the government employer. A private sector employer loses one man but saves his wage and -- assuming the wage reflected the employer's willingness to pay for a marginal worker -- comes out even. The worker himself changes employers but presumably gets the same wage as before, and thus realizes no net gain. But the government employer pays a wage which would not be paid in the absence of the project, and therefore suffers a redistribution loss. It should be noted that although the income group to which the worker belongs is unaffected by his new job, the regional group may well be affected. If the worker came from a different region to work on the public project, the region into which he has immigrated gains redistributional benefits equal to his earnings, and the region which he left loses the same amount.

Suppose now that the worker in question was unemployed before getting a job with the project. (The same argument would hold if he held a job earlier, but his previous position was filled by an otherwise unemployed man.) In this case there may be no direct aggregate consumption costs to the economy when the man is put to work on the project. As before, the government suffers a redistribution loss in the amount of the wage it pays. However, in this case there is also a redistribution gain in the same amount which accrues to the worker. The direct aggregage consumption cost is zero, but because of the cash transfer there is both a redistribution gain and a redistribution loss among the two groups affected. From the point of view of redistribution among regional groups, there is now a net gain to the project region as before, but no net loss to any other region.

When the net input to a project consists of a material good withdrawn from alternative use elsewhere in the economy, the cost is generally passed on to the government in the same way as for employed labour. A private sector firm loses the input but saves the costs with which it would have been purchased,

and - except for any excess of willingness to pay over purchase cost - comes out even. The government, on the other hand, pays for an input it would not otherwise have bought and suffers a redistribution loss. Unlike the case of labour inputs, there are no redistribution effects here involving income or regional groups other than the government except to the extent that discrepancies arise between willingness to pay and actual market payments.

The same is true for inputs of foreign exchange. When such inputs are used on public projects in a given region rather than elsewhere in the economy, there are non-governmental income or regional group gains and losses only to the extent that actual payments for foreign exchange differ from willingness to pay. As noted earlier, this may well be the case when foreign exchange is rationed. When a government licenses foreign currency to private firms who are allowed to pay for it at the official (undervalued) rate, these firms are in effect receiving a government subsidy. If the government subsequently embarks on a public project and cuts down on the foreign exchange available to the private sector in order to allocate it to the project, there is a loss to the group and region of the marginal private sector firm which foregoes its implicit subsidy. If the government makes any of this foreign exchange available to private firms or individuals in the project region, there is a corresponding group and regional gain in the amount of the accompanying implicit subsidy.

Thus far we have assumed that the input costs of a public project will be paid by the government. They may also be passed on in part or in full to the tax-paying or the lending public, in which case new cash flows arise with redistributional implications. To the extent that taxation is increased, there are net losses to each income and regional group that pays the taxes. In the case of borrowing, there is redistribution against the lenders at the initial stage and in their favour when the loan is repaid.

In the case of <u>indirect</u> future aggregate consumption benefits and costs, we must also determine to what extent a particular group may be affected. Once the net <u>direct</u> aggregate consumption benefits to a group have been determined according to the principles outlined above, the corresponding net <u>indirect</u> benefits may be calculated by applying a formula akin to equation (13) of Part III. Given the marginal propensity to save of the group in question,

we first determine the amount which would be saved out of the direct net benefits accruing to the group. This amount must then be multiplied by the excess of the relevant shadow price of investment over unity in order to determine the amount by which the value of the future consumption benefits stemming from the savings exceeds the present value of the savings. The resultant net indirect (redistribution) benefits accruing to the group must then be modified by any associated cash transfers away from the group (e.g. by government taxation of investment income).

After the ultimate net redistributional impact of a project on any given group has been calculated as outlined above, there remains one further adjustment which is of importance primarily in the case of regional group redistribution. Whether the net benefits accruing to a particular region are consumed or invested, a part of them will be respent within that same region. To the extent that they result in a net transfer of wage or profit income from elsewhere in the economy to the project region, they will result in a new round of benefits to the region. For example, the expenditure arising from incomes earned on the project may draw small business and ancillary services into the area. The income of these enterprises is now earned in the project region and contributes to the redistribution of benefits in its favour. Such a chain of "indirect" benefits can in principle continue indefinitely, with the benefits on each successive round progressively declining.

If r represents the marginal proportion of the "direct" net redistributional benefits R^D which - when respent - results in additional net benefits to the region, then the value of the "indirect" net redistributional benefits R^I can be expressed as:

$$R^I = rR^D + r(rR^D) + r(r^2R^D) + \ldots. \qquad (18)$$
$$= R^D (r + r^2 + r^3 + \ldots)$$

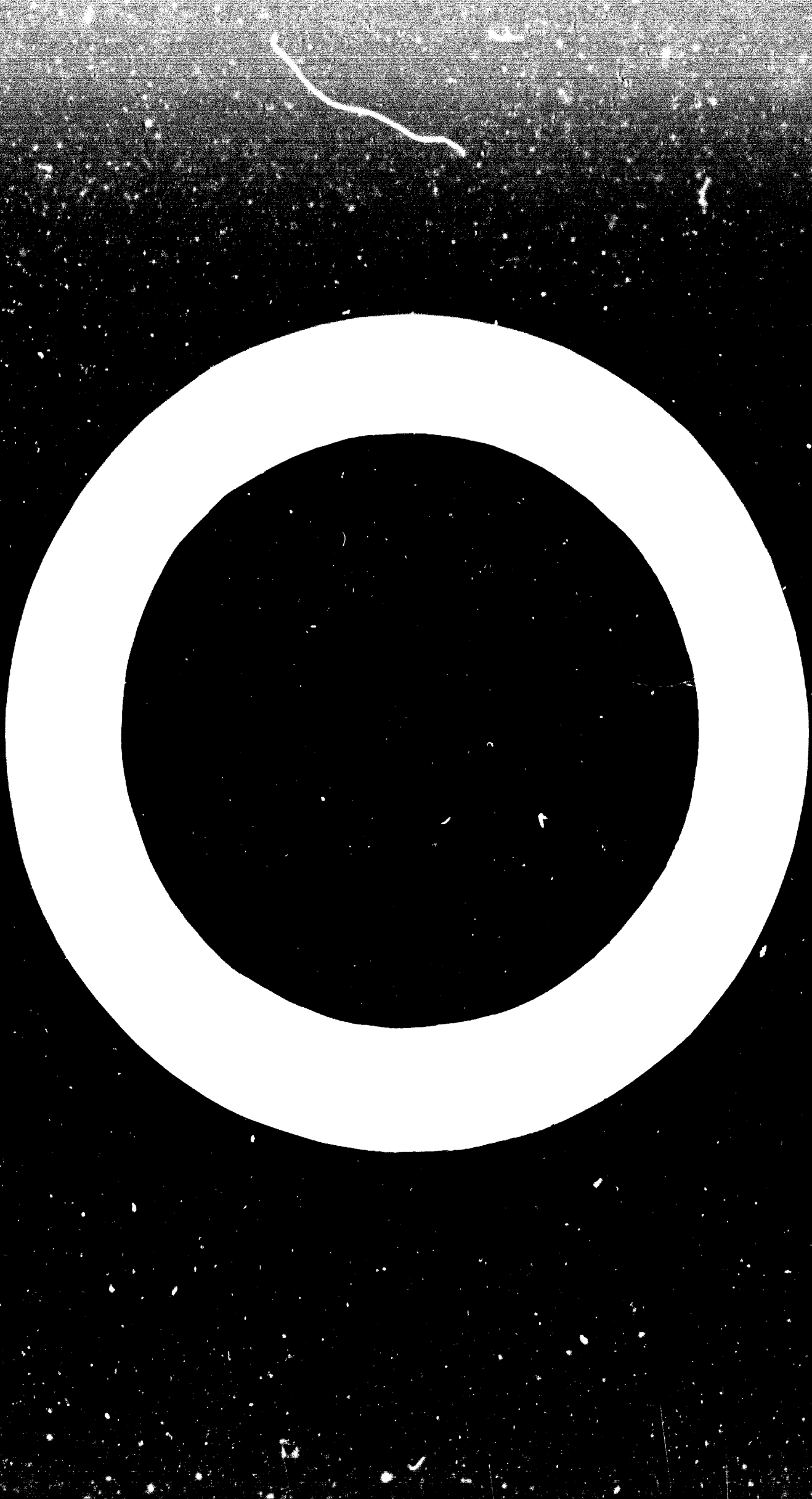
and the total net redistributional benefits R^T to the region is given by:

$$R^T = R^D + R^I \qquad (19)$$
$$= R^D (1 + r + r^2 + r^3 + \ldots)$$
$$= R^D \left[\frac{1}{1 - r} \right]$$

The expression $\left[\frac{1}{1-r}\right]$ is called the "regional income multiplier". It is applied to the "direct" net redistributional benefits $R^D(t)$ in a given year t to yield the total net redistributional benefits $R^T(t)$ to a particular region in that year. The use of equation (19) for the regional income multiplier is subject to one qualification: the successive rounds of benefits rR^D, r^2R^D, r^3R^D etc. actually occur only after an interval of time, whereas the formula assumes that they all take place instantaneously. To be precise, one ought to distinguish the successive rounds of benefits according to the time at which they occur. In practice, however, the calculations are likely to be sufficiently rough so that no such careful distinctions will be called for.

In the case of redistribution among groups defined according to income class, the counterpart to the regional income multiplier is a "class income multiplier" based upon respent benefits which return in future rounds to the same group. It would appear highly unlikely, however, that such a phenomenon could be significant enough either to warrant or to make possible its inclusion in the redistribution calculus. Thus for all practical purposes, we may dispense with any such adjustment of the net redistribution benefits accruing to particular income groups.

In retrospect, one might raise the question why no multiplier effect is applicable to aggregate consumption benefits for the entire economy. These benefits, too, are respent in successive rounds, and might be considered income-creating for the economy as a whole. The objection is that unless there are idle resources to be activated in such a process, no additional net national income can be created. With resources fully employed, it is possible to shift income from one region to another (whence the regional multiplier effect) but not to add to national income in any given year. On the other hand, if there are idle resources which can be activated in response to a given project -- and not otherwise -- then any additional income generated on this account should be credited as aggregate consumption benefits to the project.



D00052

SHADOW PRICES: FOREIGN EXCHANGE, SAVINGS AND LABOUR

by

Stephen A. Marglin

It has been seen in earlier studies that a correct accounting of the national economic profitability of a project often requires planners to utilise shadow prices in place of the market prices of specific goods and services produced or consumed by a project; thus in the study "Measurement of Benefits and Costs" principles for formulating shadow prices of specific goods and services were discussed. It has also been seen that shadow prices must be used for evaluting aggregate or composite goods, and in this study we take up the problem of deriving shadow prices for two aggregates, foreign exchange and savings. Then we shall use the shadow price of savings to derive a shadow wage for unskilled labour in situation of "labour surplus".

Foreign exhange

Introduction

The goal of benefit: cost analysis is to translate as many of the consequences of a project, bad as well as good, into a common unit of account, so that alternative investment tactics can be compared from a social point of view: the unit of account that seems most natural, and the one that we have chosen in this set of studies, is aggregate consumption, as measured by the willingness to pay of individuals for the goods and services they consume. What we are investigating in this section is the value of foreign exchange in terms of aggregate consumption; to a first approximation, at least, we are asking how much consumers would be willing to pay for an additional unit of foreign exchange.

The "Introduction to Economics for Industrial Project Formulation and Evaluation" explains the relationship between willingness to pay, market prices, and consumers' satisfaction. Here only a reminder is needed that in the absence of rationing, market prices reflect the willingness to pay for marginal amounts of different goods and services. Thus if individuals were free to buy as much foreign exchange as they liked at the official rate of exchange and to import what they pleased free of taxes, the shadow price of foreign exchange would be unity. The official exchange rate would then be a market price reflecting a willingness to pay one rupee for the goods that can be purchased with the official equivalent of one rupee in dollars, pounds, or francs. This is to say that individuals would be willing to give one rupee's worth of domestic goods (worth being measured at domestic market prices) for one rupee's worth of imported goods.

The fact is that in many, perhaps most, developing economies foreign exchange is not freely available at the official rate of exchange. Nor are private economic agents free to import whatever they choose free of taxes. Rather, most governments seek to control the composition of imports. The rule is that foreign exchange is not only taxed but also rationed, formally or informally.

The question of whether foreign exchange ought to be rationed rather than distributed through the market mechanism is a strategic one beyond the scope of this study. Suffice it to say that the question cannot be divorced from other issues of development strategy. As the study "Commerical Profitability and National Profitability" pointed out, the scarcity of foreign exchange arises in the first place because the official rate of exchange has been inherited from an earlier, usually colonial, era in which it equilibrated the balance of payments without the need for rationing of foreign exchange because of the very lack of emphasis on economic development characterizing that era. But the post-colonial emphasis on economic development has resulted in new import demands, as well as in inflation at home that has often had adverse effects on exports. Governments of developing economies have been forced to choose between (1) rationing limited amounts of foreign exchange available to them and (2) changing the official exchange rate so that it adjusts demand to supply.

We take no position on this choice. But we do wish to register a warning against naive appeals to classical or neoclassical economic liberalism that enjoin devaluation and market allocation of foreign exchange as the only reasonable solution to the problems posed by an over-valued currency. Certainly the virtues of market allocation demonstrated by models of perfect competition from which the problems of externalities, market imperfections, and achieving a just distribution of income are absent have limited relevance to economies in which these are major problems. The presumption in favour of the market that pervades Western economic thought has no justification in resolving the question of how to allocate foreign exchange.

In situations where, for better or worse, foreign exchange is rationed and imports taxed, the very existence of rationing and duties signifies that the marginal willingness to pay for foreign exchange exceeds its value at the official exchange rate; if this were not the case, there would be no need to ration or tax the available supply. By what percentage does the willingness to pay for foreign

exchange exceed its value at the official exchange rate? This is another way of asking what the shadow price of foreign exchange is.

A one-commodity example

Suppose, to take a simple (albeit far-fetched) example, that any extra foreign exchange that becomes available will be used to import French cognac at a at a c.i.f. price of 15 francs (Fr. 15) per bottle. Suppose at the official exchange rate one franc is worth two units of domestic currency, which for definiteness we shall suppose is measured in rupees. Thus at the official exchange rate the domestic cost of a bottle of cognac is 30 rupees (Rs. 30). Suppose further that there are no taxes but that the scarcity of foreign exchange leads in turn to a scarcity of cognac in the domestic market such that the market in the port of entry clears only at a price of Rs 45 per bottle. Thus a small increase in the availability of foreign exchange of, say Fr 150 - Rs. 300 at the offical rate of exchange - would permit the importation of an additional ten bottles of cognac, for which the willingness to pay is Rs. 450. Hence Rs. 300 worth of foreign exchange provides consumption for which the willingness to pay is Rs. 450, which is to say that foreign exchange worth 1 rupee at the official rate has a value of Rs. 1.5 in terms of domestic willingness to pay. In other words the shadow price of foreign exchange, which we shall denote P^F, is Rs. 1.5 per rupee.

Complications

This simple example illustrates the principles of calculating the shadow price of foreign exchange But of course the real world significantly differs from the example: first, the example ignores changes in domestic production triggered by marginal imports, that is substitution of imports for domestic production; second, increments of foreign exchange are not spent only on one commodity; moreover, some of the goods imported may be producers' goods for which there is no direct consumers' willingness to pay; third, the response to added availability of foreign exchange may be in part a reduction in the pressure to export rather than solely an increase in imports; fourth, duties and excise taxes, and the resulting transfers of income between the government and the private sector complicate the problem of evaluating foreign exchange in terms of domestic willingness to pay and c.i.f. prices; finally, imports may be rationed in the domestic market, so that price does not reflect marginal willingness to pay.

Substitution of imports for domestic production

The calculation of shadow price of foreign exchange in the cognac example implicitly assumes that the marginal cognac represents a net addition to the economy's consumption of liquor. But suppose that this is not the case, and that domestic production of brandy falls by one bottle each time an additional bottle of imported cognac becomes available. If for simplicity we assume that domestic brandy is equal in quality and price to imported cognac, then the gain from an additional Rs. 300 of foreign exchange is in reality the extra product that will be produced with the domestic resources that formerly were devoted to the production of ten bottles of brandy. If the marginal cost of domestic brandy is equal to its price of Rs. 45, then reduction of domestic output of brandy by ten bottles makes resources worth Rs. 450 available to the domestic economy. Thus the calculation of the shadow price of foreign exchange is unaffected.

But suppose that the marginal cost of domestic brandy is less than the price because, say, of an excise tax on domestic brandy. In this case the resources released by reducing the domestic output of brandy will have a lower value. For instance, if the excise tax is Rs. 15 per bottle and the marginal cost is Rs. 30, then the resources released by reducing the output of brandy by ten bottles are worth only Rs. 300, which would mean the shadow price of foreign exchange would be Rs. 1.00 per rupee.

We shall in general assume as a first approximation that marginal imports do not substitute for domestic output but rather represent net additions to the goods available to the economy. It would be equivalent to assume substitution of imports for domestic equivalents, with marginal costs of domestic equivalent equal to their respective prices. The one exception to the "no-substitution" assumption occurs in the discussion of capital goods that follows on pp 112-4. Ignoring substitution between imported capital goods and domestic production seems less tenable than ignoring substitution possibilities in other cases.

A two-commodity example

The next complication is relatively easily disposed of. Suppose that in addition to cognac, there is a second import that receives a share of incremental supplies of foreign exchange. Suppose further that the c.i.f. price of this second import is Rs. 10 per unit at the official rate of exchange, and

that the domestic market clearing price is Rs. 20 per unt. Finally suppose that at the margin, one quarter of increments of foreign exchange is allocated to the second import and three quarters to cognac. Thus the domestic willingness to pay for the imports purchasable with, say, Rs. 400, worth[1/] of foreign exchange is

$$\text{Rs. } (45 \times 10 + 20 \times 10) = \text{Rs. } 650$$

The first term in parenthesis is the willingness to pay for the cognac purchased with three quarters of the increment in foreign exchange; at Rs. 10 per bottle (the price at the official exchange rate), Rs. 300 ($= \frac{3}{4} \times$ Rs. 400) covers ten bottles. The remainder of the increment of foreign exchange, Rs. 100 ($= \frac{1}{4} \times$ Rs. 400), covers the purchase of ten units of commodity two, for which the domestic willingness to pay is Rs. 20 per unit; the second term in parenthesis measures the willingness to pay for the portion of foreign exchange allocated to the second import.

Rs. 650 is thus the willingness to pay for Rs. 400 worth of foreign exchange. The shadow price, as the willingness to pay per rupee of foreign exchange, is the ratio Rs. $\frac{650}{400}$ or P^F = Rs. 1.625 per rupee.

One important point ought to be noted. It appears that the value of foreign exchange would be increased by shifting the allocation of foreign exchange from cognac to the second import. Indeed, this is so but the point is relevant only if the allocation of foreign exchange can be regarded as open to choice in the context of project formulation and evaluation. The view underlying the present discussion, however, is that the allocation of marginal increments of foreign exchange is more realistically thought of as a prior decision reflecting preferences and constraints, a decision that ought to be taken as given with respect to project choice. That is, the marginal allocation of foreign exchange is here regarded as a given parameter of the investment decision rather than as a choice variable.

1/ A rupee's "worth" of foreign exchange will always imply valuation at the official rate of exchange unless there is a specific contrary indication.

Generalization to n commodities

Generalization of the principles of determining the shadow price of foreign exchange to the case of an arbitrary number of commodities is straightforward. Let m_i be the fraction of foreign exchange allocated to the i^{th} of n commodities at the margin, and let P_i^D represent the domestic market clearing price (port of entry) reflecting the marginal willingness to pay for the i^{th} import. Finally, let P_i^S represent the c.i.f. price of the i^{th} import. Then $\frac{m_i}{P_i^S}$ measures the quantity of the i^{th} import that will be purchased with a marginal rupee's worth of foreign exchange and $\frac{m_i}{P_i^S} P_i^D$ measures the willingness to pay for the fraction of the rupee devoted to the i^{th} commodity. The shadow price of foreign exchange is the willingness to pay for the goods imported with the entire rupee, which is to say

$$P^F = \frac{m_1}{P_1^S} P_1^D + \ldots + \frac{m_i}{P_i^S} P_i^D + \ldots + \frac{m_n}{P_n^S} P_n^D$$

If we rewrite this formula in the equivalent form

$$P^F = \sum_{i=1}^{n} m_i \frac{P_i^D}{P_i^S} \qquad (1)$$

we see that the shadow price of foreign exchange can be thought of as a weighted average of the ratios of domestic market-clearing prices to c.i.f. prices, the weights, $m_1, \ldots, m_n$ reflecting the content of the marginal import bill.

Naturally we are concerned with the shadow price of foreign exchange in future years as well as in the present. In fact formula (1) can be used for any year provided one has estimates of the marginal import bill and market-clearing and c.i.f. prices of imports in that year. But it should be recognized that the confidence one can have in the estimates of these parameters will generally diminish rapidly as one looks farther and farther into the future.

Producers' goods

The next complication on our list is that producers' goods as well as consumers' goods generally figure in the marginal import bill, indeed producers' goods are often the dominant form of imports in developing countries. Actually,

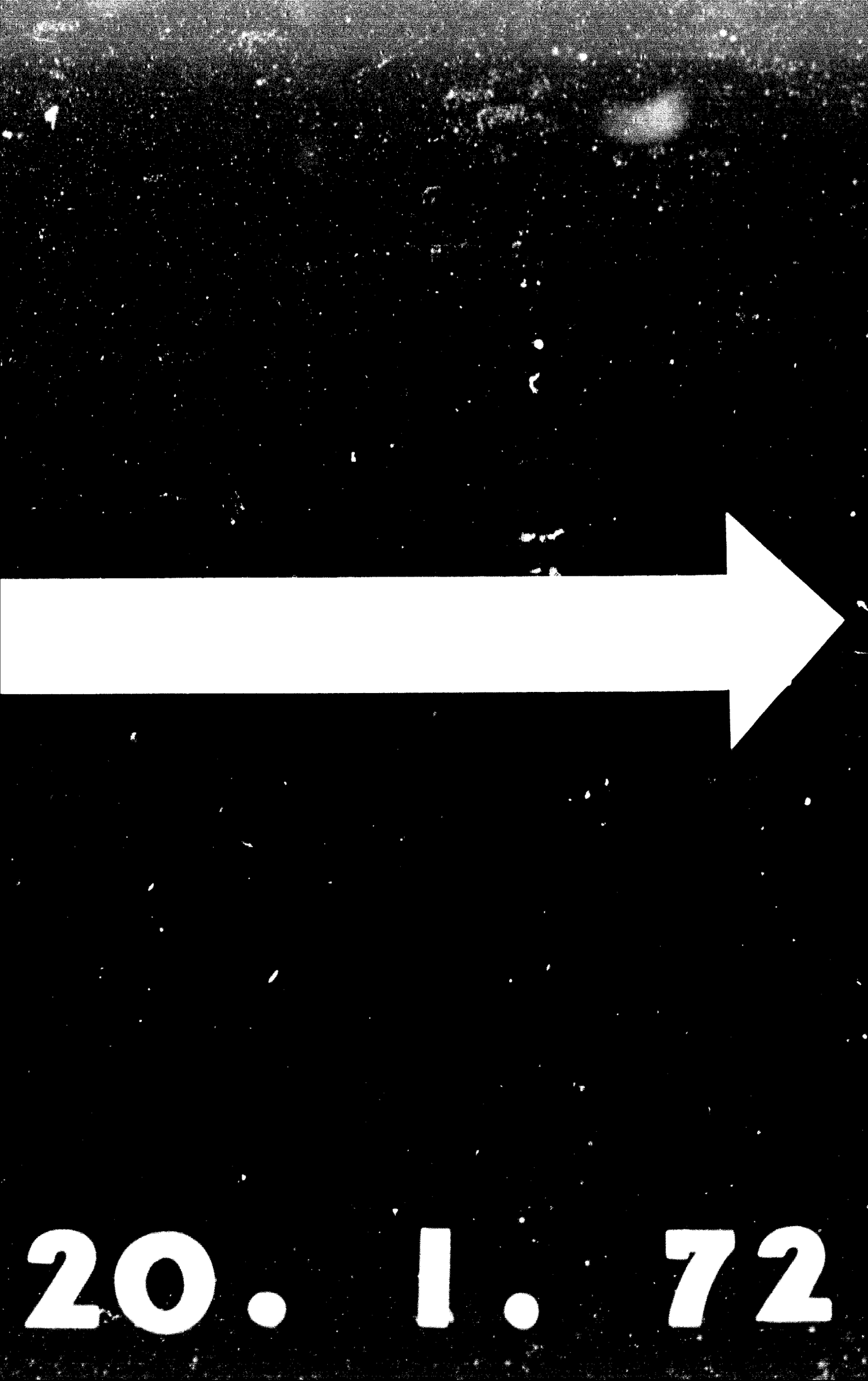
producers' goods are principally of two kinds: intermediates for consumption goods and capital goods. Intermediates pose little difficulty as long as they move through competitive markets as they are transformed into consumption goods. Capital goods also pose no serious problems provided such constraints as limit the choice of the rate of capital formation are political and institutional in nature rather than technological, which is to say that there are constraints on the extent to which the economy can be induced or forced to abstain from consumption, but no constraints on the supply of capital goods.

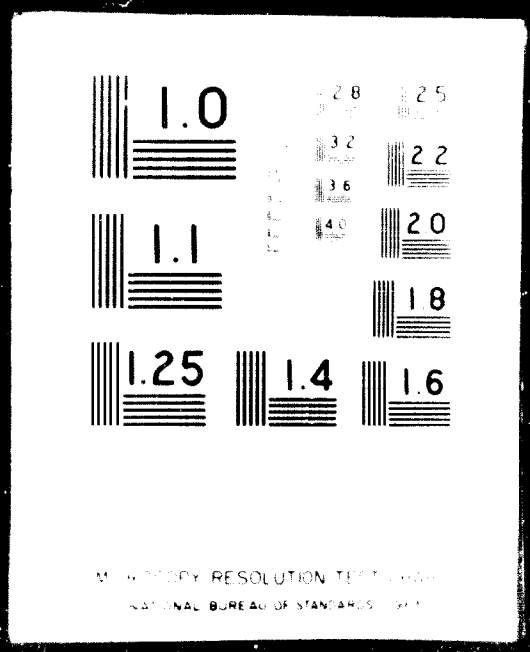
Intermediate consumption goods

As the study "Measurement of Benefits and Costs" showed, under competitive conditions the derived demand for intermediates reflects consumers' willingness to pay for end-products. Thus the formula given earlier in this study can be used without modification. However, the willingness to pay of monopolists and oligopolists for intermediates will not in general fully reflect the willingness to pay of consumers because imperfect competitors tend to take the elasticity of demand for their products into account in deciding how much to produce. This is not to say that any imperfection is enough to vitiate the willingness-to-pay calculus; rather, the extent to which market imperfections matter depends on the extent to which they lead to divergence between marginal costs and prices. This is an empirical question specific to each economy, one that cannot be resolved in an elucidation of general principles.

Capital goods

Capital goods present the same problems as consumption intermediates, and additional ones too. One of the pervasive features of this series of studies is the assumption of constraints on the rate of capital formation. If these constraints are political and institutional alone, then the availability of foreign exchange does not affect the rate of investment. This is not to say there is no link between imports and investment, but rather that the causality works the other way around: the rate of investment together with domestic production possibilities determines the level of imports (and exports). Thus if extra foreign exchange becomes available but political and institutional constraints do not permit an increase in the rate of saving corresponding to the share of capital goods in the marginal import bill, then the marginal imports of capital goods will merely substitute for domestic production. If (1) the resources released domestically from capital formation are devoted to production of consumption goods for the home market (a reasonable assumption in a model in which constraints on investment are not technological in nature), and if


20. 1. 72



(2) relative prices of capital goods and consumption goods in domestic markets reflect domestic marginal rates of transformation (a somewhat heroic assumption in any model), then the domestic prices of imported capital goods can be used as surrogates for the willingness to pay for the consumption goods that owe their existence to the import of capital goods. For in this case the domestic prices of imported capital goods will reflect the extra consumption that resources released from production of capital goods domestically will provide.

This leaves the problem of how to evaluate imported capital goods that do not replace domestic production, that is to say, capital goods whose importation is accompanied by an increase in the rate of investment. To the extent that constraints on the rate of investment are political and institutional, the argument of the previous paragraph applies. In evaluating the foreign exchange allocated to capital goods, we want to know the willingness to pay for the consumption foregone. This can be viewed as the domestic willingness to pay for consumption goods whose production would have to be foregone domestically if capital goods were produced at home rather than imported. The domestic prices of imported capital goods can be used as surrogates for willingness to pay for these consumption goods if it is assumed that relative domestic prices of capital goods and domestically produced consumption goods reflect domestic marginal rates of transformation.

In economies lacking significant capital goods industries the arguments of the previous paragraphs do not apply directly, for the possibility of substitution between domestically produced capital goods and imported ones does not exist. Nevertheless, if we continue to assume that the rate of saving is limited only by political factors, then the absence of a domestic capital goods industry does not pose insurmountable problems to the use of domestic prices of imported capital goods as surrogates for the willingness to pay for foregone consumption. The foregone consumption in this case can be viewed as either (1) the consumer goods and intermediates that could have been imported with the foreign exchange allocated at the margin to capital goods or (2) the exports that could have been diverted to the home market in the absence of marginal imports of capital goods. The use of domestic prices of imported capital goods as surrogates for the willingness to pay for foregone consumption presupposes that domestic prices of imported capital goods and imported consumer goods, imported intermediates, or exports (as the case may be) are proportional to international prices.

It may be that limitations on the rate of saving are technological instead of, or in addition to, political and institutional. For example, suppose the economy's capital goods industries (construction, machine building etc.) are very small or non-existent and that the domestic output of capital goods cannot be augmented by a more labour-intensive use of existing equipment. Suppose also that foreign exchange earnings cannot be increased by reducing domestic consumption of goods traditionally exported because of a low elasticity of demand for the country's traditional exports. If in addition imports of finished and intermediate consumer goods cannot be reduced by reducing domestic consumption, then the limitation on the availability of foreign exchange together with the limitation on the domestic output of capital goods may make it impossible to increase the level of investment - quite independently of political and institutional considerations - unless free supplies of foreign exchange can be increased by means of new non-traditional exports or by means of import substitution. In this case, unlike the ones analysed in previous paragraphs, the level of investment depends on the availability of foreign exchange.

In general, however, the limitation on the rate of investment posed by constraints on the supply of foreign exchange appears to be less important than limitations posed by political and institutional factors. Hence, having taken note of the possibility of the technological constraint on saving in which foreign exchange plays a limiting role, we nevertheless stick to formula (1), which assumes that constraints on the rate of saving are political and institutional.

Exports

The next complication on our list - that marginal increments in the supply of foreign exchange may lead to a reduction of exports as well to increase in imports - is more easily treated than the ones we have dealt with up to now. We can pretend that reductions in exports are increases in imports and evaluate them accordingly. That is, if at the margin the fraction m_j of a rupee's worth of foreign exchange is spent on the j^{th} export (meaning that the exports of the j^{th} commodity are reduced by m_j rupees when the availability of foreign exchange increases by one rupee), and if the domestic willingness for the j^{th} export is P_j^D and the f.o.b. price at the official rate of exchange P_j^S, then the willingness to pay for the fraction

of incremental foreign exchange spent on reducing exports of the j^{th} commodity is

$$m_j \frac{P_j^D}{P_j^S}$$

With this convention, foreign exchange "allocated" to reducing exports can be included in formula (1).

Taxes and transfers

We now come to one of the thorniest questions of evaluating foreign exchange: the treatment of indirect taxes, particularly excise and import duties. Do we include or exclude them in our calculations of the shadow price of foreign exchange? Taxes are excluded from the c.i.f. (or f.o.b.) prices $P_i^S, \ldots, P_n^S$ by the very definition of these prices; and this is as it should be, for these prices are measures of the foreign exchange cost of imports (and exports) at the official rate of exchange. But taxes are included in the market prices $P_i^D, \ldots, P_n^D$, for these prices are measures of consumers' willingness to pay for goods that enter into international trade.

But this is not the end of the story. Suppose the government's ability to tax is constrained by political considerations. Suppose also that the marginal social value of government expenditure is greater than the marginal social value of private expenditure. Then if by virtue of the same political constraints that limit its ability to tax, the government cannot increase the budget deficit, any transfer of income from the private sector to the government that accompanies an increase in the availability of foreign exchange should be taken into account. If τ_i is the sum of indirect taxes levied on the i^{th} good, then

$$\sum_{i=1}^{n} m_i \frac{\tau_i}{P_i^S}$$

represents the increase in the resources at the disposal of the government from the availability of the marginal rupee's worth of foreign exchange. In a project's national profitability accounts, the amount obtained by multiplying expression (2) by the project's net foreign exchange earnings (measured at the official rate of exchange) should be treated as a transfer

from the private sector to the government. Such transfers are analysed in the study "Measurement of Benefits and Costs" and that discussion need not be repeated here.

It should be noted that any profits that accrue to the government by virtue of a monopoly in foreign trade should, like taxes, be treated as a transfer from the private sector to the government. If, for example, the whole difference between the market-clearing price of Rs. 45 per bottle of cognac and the c.i.f. price of Rs. 30 per bottle is the fruit of a government monopoly in the importation of cognac, the effect on the distribution of income between the government and the private sector is the same as if the difference between the two prices is the result of an import duty of Rs. 15 per bottle.[2/]

Rationing

Up to now it has been implicitly assumed that imported goods are distributed through the market mechanism once they enter the country, even though the decision as to what goods to import is not left to the market mechanism. If an import is rationed, then its domestic market price underestimates the willingness to pay for the good. For intermediates the situation is not hopeless, because sometimes the willingness to pay for intermediates can be imputed from the market prices of the goods and services into whose production they enter. If a producer utilizes a single rationed import in the production of a good sold in a competitive market, and if all other inputs are purchased in competitive markets, then the residual surplus which remains after deducting the costs of production (including a normal profit on capital) can be attributed to the rationed import. The willingness to pay for this import is the sum of the rationed price and the average residual surplus per unit of the rationed import.

2/ If the marginal bottle of cognac could be sold on the domestic market only by reducing the price slightly, the loss of profit (or tax revenue) to the government on all the inframarginal bottles of cognac must be taken into account. The marginal revenue (MR_i) revenue to the government, taking into account this loss of revenue, is

$$MR_i = \left(1 + \frac{1}{\varepsilon_i}\right) P_i^D$$

where ε_i is the elasticity of demand with respect to price. Where the elasticity of demand is minus infinity (that is, when the demand schedule is horizontal), the marginal revenue is the same as the market-clearing price.

Unfortunately this method of imputing willingness to pay for rationed imports breaks down if the conditions outlined above are not fulfilled. For instance, if the producer is an oligopolist or monopolist rather than a competitor, then it becomes impossible to separate the surplus earned on the rationed import from the oligopoly or monopoly profit, there is no such thing as a "normal" oligopoly or monopoly profit. Also if there is more than one rationed input, whether of domestic or foreign origin, it is impossible to allocate the surplus between them.

If imported consumer goods are rationed in domestic markets, then it becomes virtually impossible to measure consumers' willingness to pay unless one has unusually good estimates of their demand schedules. The best procedure is probably to eliminate rationed goods from the calculation entirely and adjust the weights $(m_1, \ldots, m_n)$ on the remaining goods so that they add up to unity. If rationed goods are a sufficiently small fraction of the total, this procedure will probably do little harm. On the other hand, if rationing is ubiquitous, then we might well despair altogether of using willingness to pay as a measure of the aggregate consumption value of foreign exchange!

Summary

If the economy is reasonably competitive, then the shadow price of foreign exchange can be written as the weighted average of ratios of domestic market prices at the port of entry to c.i.f. prices computed at the official rate of exchange. Denoting the fraction of the marginal rupee's worth of foreign exchange devoted to the i^{th} commodity by m_i, the domestic market price (port of entry) by P_i^D, and the c.i.f. price at the official rate of exchange by P_i^S, the shadow price of foreign exchange P^F is given by the formula

$$P^F = \sum_{i=1}^{n} m_i \frac{P_i^D}{P_i^S} \quad . \qquad (1)$$

Formula (1) presupposes that, except for capital goods, marginal imports represent net additions of goods (instead of substitution for domestically produced goods). To take care of capital goods, it is supposed that relative prices of consumption and capital goods in domestic markets reflect domestic marginal rates of transformation; this assumption becomes relevant when the fraction of marginal imports devoted to capital goods differs from the marginal rate of saving. Formula (1) also presupposes that the rate of saving

is not constrained by the availability of foreign exchange, which is to say that the domestic capital goods industry, or export industries, or imports of consumer goods are sufficiently elastic that the rate of saving is limited not by a shortage of capital goods but rather by a lack of effective demand. In other words, such constraints as there may be on the rate of saving are political and institutional in nature rather than technological. Moreover, formula (1) presupposes that monopoly, oligopoly, and rationing are not so pervasive that market prices cease to reflect willingness to pay for intermediates as well as final goods and services. Other assumptions required to justify formula (1) are stated in the course of the discussions summarized in this paragraph.

Savings

Introduction

Throughout this series of studies, constraints on the rate of saving have been noted; the consequence of these constraints is that a rupee saved is socially more valuable at the margin than a rupee consumed. Formally, this has meant that criteria for project formulation and evaluations attach a shadow price, P^K, to saving, a shadow price that is normally expected to exceed unity. In this section we shall set out the principles for determining the value of the shadow price of saving.

General principles

Suppose marginal investments in the economy yield a constant, perpetual return of r rupees for each rupee invested now. If the social rate of discount i is also a constant over time, and if the returns from investment are consumed as they become available, then the present value of the aggregate consumption generated by the marginal investment is:

$$\sum_{t=1}^{\infty} \frac{r}{(1+i)^t} = \frac{r}{i} . \qquad (3)$$

This is the value of the marginal unit of investment in terms of present aggregate consumption, which is precisely what is meant by the term "shadow price of investment" or "shadow price of saving". (For present purposes "investment" and "saving" are synonymous.) Thus under the assumption of constant social rates of return and discount and immediate consumption of returns, the shadow price of saving P^K is the ratio of the social rate of return to the social rate of discount:

$$P^K = \frac{r}{i} \qquad (4)$$

In the study "The Social Rate of Return and the Social Rate of Discount" it was observed that, in the absence of constraints, a condition of optimal development is that the social rate of return and the social rate of discount be equal. In this case, therefore, the shadow price of saving is one. But the same study also indicated many reasons for expecting r and i to be different in practice. If the social rate of return exceeds the social rate of discount, the shadow price of investment will exceed one.

Even as a first approximation, however, it is unrealistic to suppose all returns from investment are immediately consumed, as formula (4) assumes. Rather a fraction s will be saved and the remainder (1-s) will be consumed. This means that the original stake of one rupee will not remain constant but instead will grow over time. If we denote the amount accumulated in year t by A_t, then the contribution to aggregate consumption in year t from the original one rupee stake is $(1-s) \times rA_t$. On the assumption that s as well as r and i remains constant over time, P^K, equal to the present value of the stream of consumption, becomes

$$P^K = \sum_{t=1}^{\infty} \frac{(1-s)rA_t}{(1+i)^t}$$

Now to evaluate this expression, we need only write out A_t in terms of s and r. In year 1, A_t is of course one, the original stake. But in year 2, the stake is augmented by reinvestment of sr. Thus in year 2, $A_2 = (1+sr)$. In year 3, the fraction s of year 2's return of rA_2 is added to the stake. So

$$A_3 = A_2 + srA_2 = (1+sr)A_2 = (1+sr)^2.$$

Indeed, the general formula relating the accumulation in year t to the accumulation in the previous year, t-1, is

$$A_t = A_{t-1} + srA_{t-1} = (1+sr)A_{t-1} = (1+sr)^{t-1}.$$

Thus formula (5) becomes

$$P^K = \sum_{t=1}^{\infty} \frac{(1-s)r(1+sr)^{t-1}}{(1+i)^t}. \qquad (5)$$

Rewriting the above in the equivalent form

$$P^K = \frac{(1-s)r}{1+sr} \sum_{t=1}^{\infty} \left(\frac{1+sr}{1+i}\right)^t \qquad (6)$$

we can make use of the standard technique for evaluating perpetual constant streams of returns (see the Appendix to the study "Commerical Profitability and National Profitability"). This gives

$$P^K = \frac{(1-s)r}{i-sr} \quad , \qquad (7)$$

which is to say that the shadow price of saving is the product of the share of consumption in the marginal returns from investment and the social rate of return, $(1-s)r$, divided by the difference between the social rate of discount and the rate at which capital accumulates by virtue of reinvestment, $i-sr$. Formula (7), it should be noted, assumes that the rate of growth of the original stake, sr, is less than the social rate of discount, i. Otherwise, the shadow price of saving, as defined by formula (6), becomes infinite!

Formula (7) can be reached by a different route. Instead of computing the present value of the consumption stream produced directly and indirectly by a present investment of one rupee, we can compute the present value of the sum of the direct contributions to consumption $(1-s)r$, and the direct contribution to investment sr, valuing the second component of returns at the shadow price of savings, P^K. Thus the annual return becomes

$$(1-s)r + P^K sr.$$

If, as we assume as a first approximation, the shadow price of saving is constant over time, the present value of the returns from the original stake is

$$P^K = \sum_{t=1}^{\infty} \frac{(1-s)r + P^K sr}{(1+i)^t}$$

After simplifying the above expression, we obtain

$$P^K = \frac{(1-s)r + P^K sr}{i}$$

If we now solve for P^K, we obtain formula (7)

$$P^K = \frac{(1-s)r}{i-sr} \qquad (7)$$

Non-constant return and saving rates

If any of the relevant parameters - the marginal rate of saving or the social rate of return, (or, for that matter, the social rate of discount) - changes over time the social value of next year's saving relative to next year's consumption will differ from the social value of this year's saving relative to this year's consumption. Formally, the shadow price P^K will change over time. Indeed, one might normally expect that any divergence between r and i will eventually disappear, so that after some date in the future P^K will equal one. If central planners or forecasters can estimate the time at which the values of r and i will converge, or - what amounts to the same thing - if they can directly estimate the time at which the savings constraints will cease to be binding, then the following procedure can be used to estimate the shadow price of savings for each year.

For simplicity, suppose that the social rate of discount remains constant and only the social rate of return and the marginal rate of saving change. Denote the social rate of return in year u by r_u and the marginal rate of saving in year u by s_u. Then the shadow price of saving in year t, which we shall denote by P^K_t, is the present value of aggregate consumption from the marginal rupee of investment in year t:

$$P^K_t = \sum_{u=t+1}^{\infty} \frac{(1-s_u)r_u \left[(1+s_u r_u)\ldots(1+s_{t+1} r_{t+1})\right]}{(1+i)^{u-t}} \qquad (8)$$

This formula is analagous to formula (5), the numerator's first factor $(1-s_u)$ representing the marginal consumption per unit of income in year u, the second factor r_u the income generated by each unit of capital in year u, and the product in square brackets representing the accumulation of capital in year u from an original stake of one rupee.

Formula (8) can be simplified even further by noting that once r_u and i become equal, the present value of all future returns becomes one. That is, if r_u is equal to i for all years after year T, then the shadow price of saving in year T and all later years is one:

$$P^K_T = \sum_{u=T+1}^{\infty} \frac{(1-s_u)r_u \left[(1+s_u r_u)\ldots(1+s_{T-1} r_{T+1})\right]}{(1+i)^{u-T}} = 1$$

Now consider an investment of one rupee at time t. Segregating the consumption generated up to time T from the consumption generated after T, we have

$$P^K_t = \sum_{u=t+1}^{T} \frac{(1-s_u)r_u\left[(1+s_{t+1}r_{t+1})\ldots(1+s_{u-1}r_{u-1})\right]}{(1+i)^{u-t}} +$$

$$\frac{(1+s_Tr_T)\ldots(1+s_{t+1}r_{t+1})}{(1+i)^{T-t}} \sum_{u=T+1}^{\infty} \frac{(1-s_u)r_u\left[(1+s_{t+1}r_{t+1})\ldots(1+s_{T}r_{T})\right]}{(1+i)^{u-T}}$$

The second sum is simply P^K_T, which by assumption is equal to 1. Hence the above formula reduces to

$$P^K_t = \sum_{u=t+1}^{T} \frac{(1-s_u)r_u\left[(1+s_{t+1}r_{t+1})\ldots(1+s_{u-1}r_{u-1})\right]}{(1+i)^{u-t}}$$

$$\ldots + \frac{(1+s_Tr_T)\ldots(1+s_{t+1}r_{t+1})}{(1+i)^{T-t}} \qquad (9)$$

Formula (9) expresses the present price of saving as the sum of "joint products": the first term is the present value in year t of consumption generated up to year T; the second term is the present value of the capital accumulated in year T from one original one rupee investment.

Formula (9) is simpler to compute than formula (8) since it requires answer estimates only for T years rather than for an infinite future. But formula (9) is obviously much more cumbersome to use than formula (7), which uses constant i, r, and s. One compromise that is possible when planners can forecast the time T at which r_u and s_u will converge, but not the exact values of r_u and s_u, is to assume that r and s as well as i retain their current values between now and year T. This compromise assumption reduces formula (9) to

$$P^K_t = \sum_{u=t+1}^{T} \frac{(1-s)r(1+sr)^{u-t-1}}{(1+i)^{u-t}} + \frac{(1+sr)^{T-t}}{(1+i)^{T-t}},$$

and simplifying,

$$P^K_t = \frac{(1-s)r}{i-sr}\left[1-\left(\frac{1+sr}{1+i}\right)^{T-t}\right] + \left(\frac{1+sr}{1+i}\right)^{T-t}. \qquad (10)$$

Examination of formula (10) reveals that if T is relatively large and i exceeds sr, then formula (10) becomes approximately equal to formula (7), at least for small values of t. In other words the assumption of perpetually constant values of r, s and i leads to approximately the same results as the compromise of assuming constant values of these parameters up to the time at which the social rate of return and the social rate of discount converge.

The "labour-surplus" economy

Principles for relating the social rate of discount to the rate of economic growth have been discussed in the study "The Social Rate of Return and the Social Rate of Discount", now to complement that discussion we shall examine the relationship of the social rate of return and the marginal rate of saving to wages and profits in a "labour-surplus" economy, that is, in an economy in which the social rate of return differs from the social rate of discount because the wage rate for unskilled labour differs from its opportunity costs.[3/]

Let the wage rate for unskilled labour be denoted w and let the opportunity cost of unskilled labour the marginal productivity of peasants whose holdings are small, individuals in overcrowded service industries, or, in the limit, totally unemployed individuals - be denoted z.[4/] Assume that unskilled workers consume their entire income and that the only other category of income is profits, of which the fraction a is saved, and the fraction (1-a) is

---

3/ In the present discussion, unskilled labour means labour that comes to a project without special skills. Workers who receive training (on the job or otherwise) are still unskilled in terms of their foregone opportunities, which is the relevant sense of the term for the present purposes.

4/ The obstacles to measuring z should not be lost sight of. Zero may not be a bad first approximation, but it is in general an underestimate. Under-employment rather than unemployment is the typical condition of the "surplus-labour" economy, and the marginal productivity of the under-employed workers is not literally zero even though it might be quite low.

consumed. Suppose that the marginal rate of present investment provides jobs in perpetuity for n workers. Thus, if we denote the private rate of return (that is, the rate of profit earned in perpetuity by the marginal unit of capital) by r, the social rate of return to the marginal rupee of investment is given by the formula

$$[illegible] \qquad (44)$$

Formula (44) says that the difference between the social rate s of return and the private rate of return r is the excess of the wage rate associated with a marginal unit of capital over the alternative productivity of the newly employed workers. The marginal saving rate s is the ratio of savings to the marginal income [illegible]

$$[illegible] \qquad (45)$$

Substituting the right-hand sides of (44) and (45) for s and r in formula (7), we have

$$[illegible]$$

Simplifying,

$$[illegible] \qquad (46)$$

In the above [illegible] wage rates to the opportunity cost of [illegible] the marginal saving-capital ratio is expected to change as capital [illegible] time. In order to give a mathematical expression to the [illegible] of saving [illegible] we assume that the [illegible] with [illegible] approximately [illegible] [illegible]

$$[illegible]$$

The corresponding shadow price of government saving [illegible] is simply

$$[illegible] \qquad (15)$$

Both these formulas are based on the assumption that the marginal consumption [illegible] of governmental [illegible] takes the form of a "public good" whose marginal contribution to aggregate consumption is equal to its marginal cost. Both formulas also assume all parameter values are constant [illegible]. It is possible to relax this assumption, but the formulas for the two shadow prices become even more complicated.)

[illegible]

The formulas for shadow prices derived in the previous section pro- [illegible] for example, in the "[illegible]" [illegible] divergence between the social [illegible] the social rate of [illegible] sufficient [illegible] it is assumed that [illegible] assumed that the [illegible] of the return [illegible] the government is unable to [illegible]

[illegible]

and that the only ties that bind are those (political ones) that limit demand. Thus the form the project's output takes is of no consequence; if the proportion of capital goods in a project's output is inconsistent with the effects on demand that follow from the distribution of the project's income, supplies of capital goods and consumption goods elsewhere in the economy will adjust to bring over-all supplies into the line with over-all demands. This assumption does not rest on the belief that technological constraints never limit the supply of capital goods, but rather on the conviction that technological constraints on the supply of capital goods are unimportant relative to political constraints limiting demand.

Summary

The shadow price of saving (or investment) is the sum of contributions to aggregate consumption over time from a marginal investment of one rupee, weighted by the value of marginal increments in consumption at different times relative to present consumption. The magnitude of this shadow price depends upon the extent to which the social rate of return diverges from the social rate of discount and upon the marginal rate of saving. The shadow price of saving exceeds unity if the social rate of returns exceeds the social rate of discount; this is taken in this series of studies to be the typical case for developing economies on the assumption that institutional and political constraints prevent the government from mobilizing sufficient savings to equate the social rate of return with the social rate of discount.

In the course of the discussion several formulas have been given for the shadow price of saving, reflecting complications such as the nonconstancy of parameter values over time. And in the next-to-last section the general principles for measuring the shadow price of saving have been applied to a "labour-surplus" economy in which the social rate of return differs from the social rate of discount because the wage rate differs from the opportunity cost of labour.

Labour in a 'labour-surplus' economy

Introduction

In the "labour-surplus" economy defined in the course of the discussion of the shadow price of saving, employment of one additional worker directly requires the sacrifice of a unit of aggregate consumption. But the worker is assumed to consume his entire wage w, so his employment increases aggregate

consumption by (w - z) rupees. Moreover the extra wage payment w reduces the income of profit recipients by an equal amount, which reduces consumption by (1-a)w and savings by aw.

In the study "The Measurement of Benefits and Costs" the changes in the saving-consumption mix occasioned by the transfers of income that accompany increased employment were treated as indirect benefits, and the shadow wage of labour was defined as the direct opportunity cost z. This is a straightforward and correct procedure, but sometimes it may be simpler to include these indirect effects in the shadow wage, and here a procedure is spelled out for doing so.

General principles

The procedure actually is very simple. To the direct opportunity cost of labour z, we add the consumption lost by recipients of profits (1-a)w and saving lost by recipients of profit, evaluated at the shadow price of saving, $P^K aw$, then subtract the value of the consumption transferred to the worker, w. Denoting the shadow wage defined to include indirect effects on saving and consumption P^L, we have

$$P^L = z + (1-a)w + P^K aw - w$$

or

$$P^L = z + a(P^K - 1)w. \qquad (16)$$

The shadow wage in a two-sector model

In a more sophisticated model that takes account of the non-uniformity on the rates of savings, profits, and wages, the calculations of the shadow wage naturally become more complicated even though the general principles are the same. If we distinguish between the private and public sector by the same notation as before - subscript 1 for the private sector, subscript 2 for the public sector - then we can derive shadow wages that depend on the assumption we make about the way the expansion of public sector employment is financed.

The simplest case, perhaps, is to assume that any expansion of public sector employment is at the expense of alternative public consumption and public investment in the ratio $(1-a_2) : a_2$. Then by reasoning identical to that underlying formula (16), the shadow wage becomes

$$P^{L2} = z + a_2 (P^{K2} - 1) w_2 \qquad (17)$$

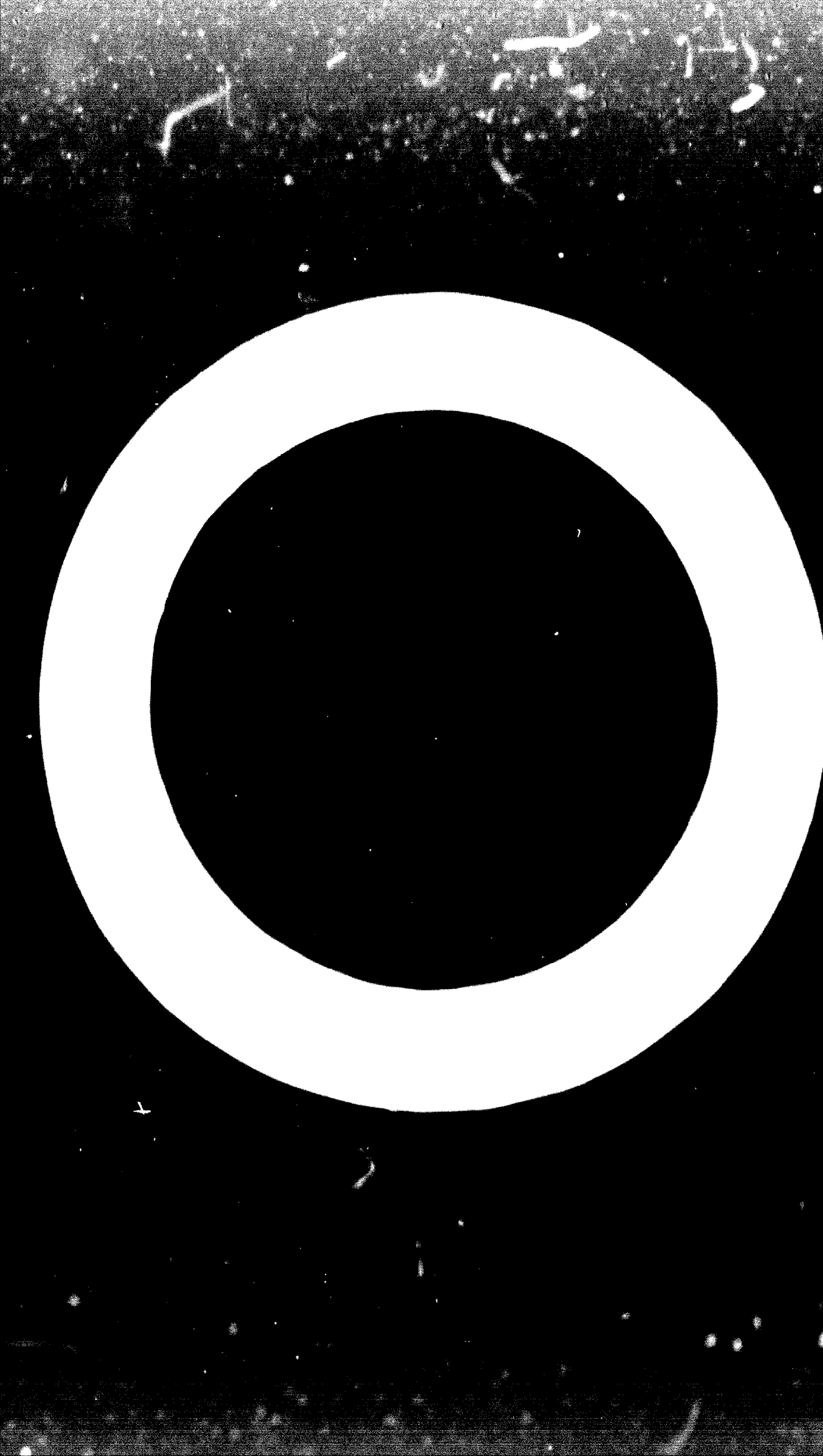
If, on the other hand, expansion of public sector employment is financed by a small increase in taxes on private profits that reduces capitalist consumption and saving in the ratio $(1 - a_1) : a_1$, the shadow wage is approximately

$$p^{L1} = z + a_1 (p^{K1} - 1) w_2 \qquad (18)$$

(This formula holds only in approximation because it does not take account of the increase in the profit tax rate, which affects the value of p^{K1}.) Intermediate assumptions are possible, with results intermediate between formulas (17) and (18).

Summary

Rupee for rupee, wage income provides a smaller contribution to aggregate consumption than private profits or the government's income because workers in general have lower rates of saving than capitalists or the government, and the shadow price of saving in general exceeds one. Thus if one includes the effects on the mix of saving and consumption in the calculation of the cost of expanding public sector employment by one worker, the shadow wage will exceed the direct opportunity cost of employment defined by the alternative marginal productivity of the newly employed worker, z. The amount by which the shadow wage exceeds z is equal to the product of the premium placed on saving over consumption, (p^K-1), multiplied by the reduction in saving accompanying the expansion of employment by one man, aw, where a is the marginal rate of saving of the economic agents whose resources finance the expansion of employment.



D00053

[redacted]

by

[redacted]

Social benefit-cost analysis essentially involves the calculation of the net social worth of a project. As it should be clear to the reader by now, such a calculation can only be made by combining diverse information, not only about the project itself but also about the rest of the economy, into a single measure of the projects' social value. The present value of the project is supposed to provide such a measure.

The various types of information that go into the calculation of such a measure can be divided into three broad categories. The first category consists of the data relating to the performance of the project itself. For example, what technological process is proposed for the project? What facilities are to be constructed? What is the proposed time pattern for the construction of these facilities? What materials and services are required for it and in what sequence? When does the project start giving results? What are the raw materials and services needed to produce those results? For how long and in what time pattern would these outputs be forthcoming? What has to be done to maintain the productive facilities in good working order? At what time, approximately, will the major facilities (plants and equipment) need replacement? Any well formulated project report should provide this information in required details. Obviously, one cannot expect a project report to contain every single item of information in terms of quantitative details. For example, no project report will list all the bolts and nuts of different specifications that the project would need in specific quantities. Some of these items will be included in broad categories measured in terms of their aggregate value, where such valuations will be done usually in terms of the market prices. But a good project report should provide disaggregated information about items, for which the evaluator may need to apply measures of value different from the market prices. Thus, inevitably a project report will contain information about the market prices for its inputs and outputs. The first category of information will consist of data relating to the technology of the project as well as the market prices for the various inputs and outputs of the project.

The second category of information, which a social benefit-cost analyst will need, relates to the method of financing the project and the proposed scheme of distributing its benefits. These are outside the scope of the project engineer's professional competence. Here the social accountant steps in. The questions he has to answer are as follows: How is the project going

to be financed? If it is from the proceeds of additional taxation, what groups in the economy are going to be hurt by the new taxes and how? If it is from market borrowing, what alternative avenues would these borrowed funds have gone into? If it is to be financed from the current surplus of the government, would the funds have gone into alternative investment projects? In short, what would have happened to the expenditures in the economy if the project were not undertaken? Similarly, when the project will start giving benefits, how will these benefits be distributed in the economy? How much will go to create additional consumption for the people? Furthermore, how much of these additional consumption benefits will accrue to certain vulnerable sections of the population, to whose welfare public policy is specially committed? How much of the benefits will be used for new investments and therefore, for the growth of the economy? Any particular good needed for the project must come from somewhere: will it come from alternative users, from new production or from imports? Similarly it is necessary to decide how the outputs of the project will affect the total availabilities in the economy. This is all necessary information, because only when the evaluator can identify the various margins, which the proposed project will affect, can he start working on the problems of valuation.

The third category of information needed for the social benefit-cost analysis consists of information that is not connected with the particular project at all. This is related to the social objectives and the technological and the behavioural relations relevant for the economy as a whole. For example, how much of today's consumption is the society prepared to sacrifice at the margin in order to increase tomorrow's consumption by, say, one unit? What rate of return does a new project expect elsewhere in the economy? How much, in terms of domestic resources, has to be spent to earn one unit of foreign exchange through exports? Or, what is the value of an extra unit of foreign exchange to the society, if it is used in the best possible way? If an extra unit of income is generated in the economy, what fraction of it is expected to be saved? How many aggregate consumption benefits, in the judgement of the society, can be sacrificed in order to provide some given benefits to a certain poor community, whose welfare deserves special attention? Some of these questions can be answered empirically, i.e. with the help of the relevant data regarding the state of the economy. Others involve, in addition, judgements about social values. Obviously, it is outside the scope of a typical project-level worker's competence to answer all these questions. He will need to have these questions answered for him by some competent central authority.

Once he has all these questions answered for him, a project evaluator can proceed to compute the present value of the net benefits of the project, as recommended here. The present value is supposed to provide the best measure of the net social worth of the project. The decision regarding the acceptance or rejection of the project should be based on the magnitude of the present value, so computed. If our decision rule is correct, then this criterion will enable us to arrive at the right decisions about the selection of projects, provided, of course, that all the estimated parameters, on which the criterion is based, are properly and correctly specified. If there is a mistake in the specification of any of these parameters, then the present value will be biased. Consequently, even though the decision rule is theoretically correct, the results obtained by using this decision rule may be vitiated. This is not surprising because any decision rule is only a way of combining empirical evidence and value postulates in order to arrive at a logical conclusion. The "black box" is satisfactory if the right answer comes out when correct information is fed into it. By the same token, when incorrect information is fed into it, an unsatisfactory answer should be expected.

What all this tells us is that the correctness of information is a necessary condition for the success of the social benefit cost analysis technique. But can any project-evaluation be one hundred per cent sure that all the estimates are correct and perfectly certain? The answer to this question is invariably in the negative. The estimates that a project-evaluator will have to work with will be of varying degrees of reliability and certainty. Frequently, he will not even be able to assess how uncertain and unreliable some of the estimates are, even if a satisfactory measure of uncertainty for these estimates could be constructed theoretically. Sometimes, a few of the estimates will be based on guess work, his own or that of some more competent investigators. It will be impossible to assess the accuracy of such guesses. And this will be particularly true for the last category of information needed by the project evaluator, i.e. in the case of the so called central parameters. If there is a central planning authority in the country, engaged in estimating these parameters and handing them down to the project-level workers to make decentralized decision making possible in a consistent manner throughout the economy, then the task of the project-evaluator is relatively easy. He has only provide answers which are consistent with the parameters supplied

by the central authority. But it merely succeeds in shifting the responsibility for errors to the latter. Therefore, the question arises if there is some way of knowing the consequences of certain errors of estimation and judgment before accepting blindly the verdict of the decision rule. This is what sensitivity analysis is all about.

Suppose the project-evaluator is not sure about the reliability or certainty of a parameter he is using for his computation. The parameter may be an estimate connected with the technology of the project, e.g. the expected life of his plants. It may be related to the method of financing the project. Or, it may be some central parameter, like the "shadow exchange rate" or the "social rate of discount". If, for example, his doubt is about the life of the plant which has been estimated to be, say, ten years, he would like to know how crucially his evaluation of the project depends on this estimate of the life of the project. It is perfectly possible that even a fifty per cent deviation on either side from the estimated life of the project will not change his decision about the acceptability of the project (as indicated by the present-value criterion). In other words, if the present value of the project is positive in all the three cases (an expected life of five, ten or fifteen years), then obviously, any reasonable error in the estimation of the life of the plant can be tolerated. If, however, the present value of the project becomes negative as soon as an estimated life of nine years (instead of ten years) is taken for the present value calculation, then a reliable estimate for the life of the plant becomes crucially important for decision taking. In the former case, the present value will be considered "insensitive" to the errors in the estimate of the plant life, while in the latter case it will be considered "sensitive".

It is worth noting in this connexion that such descriptions as "sensitive" and "insensitive" are relative concepts. They are valid only with reference to a certain probable range of errors. Once the project-evaluator makes a judgment about the probable range of errors in the estimation of any parameter, he can compute the present value of the project with respect to different estimates of the parameter within the range. If the present value does not change sign within this range of variation for the parameter, then he is on surer grounds about his decision than if it does. Sensitivity analysis, thus, means a number of recomputations of the present value on the basis of

alternative magnitudes for certain estimated parameters. Theoretically, an infinite set of such recomputations is possible. In practice, a project-evaluator will be interested in carrying out sensitivity analysis with respect to only a few "soft" estimates within certain probable ranges.

All this is generally true. Sensitivity analysis is important, because the decision-maker should guard against the possibility of being misled by imperfect information or 'soft' estimates. But sensitivity analysis is particularly important because in most countries the central planning authority is not so constituted as to fit perfectly into the role assigned to it in our (or a similar) presentation. Therefore, most project evaluation jobs will have to be done with, at best, certain imperfect estimates of the central parameters, like the shadow exchange rate (x_f), shadow wage rate for unskilled workers (x_l), the social rate of discount (i), the marginal social rate of return (r), the social value of the marginal income of a certain depressed group (w) etc. In such a situation, a project evaluator should, as a matter of routine, try to make, instead of one, a whole set of present value calculations with respect to a set of alternative assumptions regarding each of these parameters. If the number of such parameters is large, a reasonable set of such sensitivity calculations can be very large indeed. Three values for each of x_f, x_l, i, r and w will require the computation of 243 present values. It may be useful to take more than three alternatives for some parameters. It may be worthwhile to test the sensitivity of the project with respect to alternative schemes of financing it, alternative technological assumptions about efficiency and plant life etc. But with every extra dimension added to the sensitivity analysis, the demand for calculations increases at a high rate.

However, the mathematical structure of the present value formula is so simple that all the calculations can be done with relative ease. If there is access to an electronic computer, the requirement of sensitivity analysis for every project can be met by a simple computer programme, which will grind out solutions for each project in a matter of seconds or minutes.

Let us write down the present-value formula in algebraic terms. First, the net benefit of the project (positive in the case of benefits and negative in the case of costs) for any particular year should be disaggregated in terms of goods and services to the extent that the market prices need to be replaced by the appropriate shadow prices. Let us assume that only two categories of

goods and services need to be revalued in terms of appropriate shadow prices. There are (a) shadow workers, whose opportunity cost in the economy is not reflected in the market wage rate, and (b) aspects of imports, whose price in terms of the official exchange rate does not reflect the social willingness to pay for the foreign exchange. Let us denote the three categories of net benefits for the period t as follows:

$B_1(t)$ = the net benefits due to the employment of unskilled workers at time t

$B_f(t)$ = the net benefits accruing in terms of foreign exchange at time t

$B_d(t)$ = the remaining net benefits of the project in terms of domestic resources at time t

Secondly, we have to look into the question of the distribution of the net benefits among the different sections of the population. For the sake of simplicity, let us assume that there is only one clearly identifiable group of people, whose welfare merits special attention. Let us call this group "poor". Then let us denote by $B^p(t)$, the benefits accruing to this group. So,

$B^p(t)$ = the net benefits accruing to the "poor" people at time t.

Thirdly, since it is assumed that the society is not satisfied with the volume of domestic savings, which is currently being generated, the instruments of the policy should be aimed towards increasing the rate of savings in the economy. In the selection of projects too, other things being equal, those projects that can be financed out of new savings, i.e. out of reduction in current consumption, or that will distribute benefits in such a fashion as to make higher savings possible in the future should be preferred. In other words, the society does discriminate among projects with the same net benefit streams if the distribution of the benefits between consumption and savings happen to be different. Savings, in this case, are more valuable than consumption. Therefore, it is necessary to bring out separately that part of the net benefit which belongs to the stream of savings in the economy. So,

$B^s(t)$ = the net benefits of the project at time t, which is a net addition to (or a subtraction from) the savings in the economy.

Now, if we define the shadow prices for the different categories of benefits, we can get an aggregate measure of the net benefits for that period. A price

What we have done so far is to evaluate all the benefits of the projects in the period t in terms of the aggregate consumption in that period. If the life of the project extends up to T periods, then our remaining problem is to aggregate the net benefits of the different periods into one single measure. The present value is such an aggregate measure. The social willingness to pay for a unit of consumption in the next period in terms of consumption in this period is reflected in the parameter, i, the social rate of discount. This means that the society is willing to pay one unit of consumption at the margin in any period if it can get, at least, $(1 + i)$ units of extra consumption in the next period. Therefore, the net social worth of the project in terms of present consumption (in our terminology of the 0^{th} period) is given by

$$PV = \sum_{t=0}^{T} \left[B_0(t) + \lambda_1 B_1(t) + \lambda_p B_p(t) + (w-1)B^D(t) + (p-1)B^S(t)\right] \Big/ (1+i)^t$$

$$= \sum_{t=0}^{T} \left[B_0(t) + \lambda_1 B_1(t) + \lambda_p B_p(t) + (w-1)B^D(t) + \frac{\lambda_1 - \lambda_p}{1 - \sigma_p} B^S(t)\right] \Big/ (1+i)^t$$

If we propose to carry out sensitivity analysis with respect to, say, three parameters i, λ_1, λ_p and w then the present value can be expressed as a function of these five parameters: $PV = (i, r, \lambda_1, \lambda_p, w)$. Now given the time series of B_0, B_1, B_p, B^D and B^S for any project, we can programme the present value computations for any parametric variations of the arguments.

So far we have discussed the usefulness of sensitivity analysis essentially from the point of view of the project level worker, who is interested in quantifying and lessening the possibility that his unreliable estimates may lead him to wrong decisions. Sensitivity analysis is also an extremely useful analytical tool for the policy maker who is supposed to provide the project-level workers with the required control parameters. But how does the policy-maker acquire these parameters? It is seldom the case that the central planning authorities have already worked out in detail the implications of all the projects in different strategies of development, and thereby have made a rational choice of the optimum strategy so that even the "shadow prices" would have emerged out of such a comprehensive exercise. But in the absence of such a time-consuming exercise, the policy-maker can get valuable insights into the nature of the basic problem if he conducts a systematic analysis of the behaviour of how the various individual projects confronting him. Sensitivity analysis helps in formulating broadly the structure of an investment project.

For example, a typical investment project in the sector of large-scale industries requires investment expenditures in the first few years without producing outputs. In the case of a typical underdeveloped country, a large part of the investment goods and technical know how will have to be imported at that time. After this "gestation period", the project will start producing a continuous stream of outputs with the help of raw materials and services. At first, there may be some "teething trouble" so that the output may fall short of the rated capacity, but after that period there should be a steady stream of outputs until the time comes for major replacements.[2/] If the industry is essentially an import substituting activity or if the industry is producing for an export market, then a part of the outputs can be counted as foreign exchange benefits. Otherwise, the consumers' willingness to pay for the new supplies will provide the measure of value. Thus, the large industrial projects will have a certain type of rather well-defined structure.

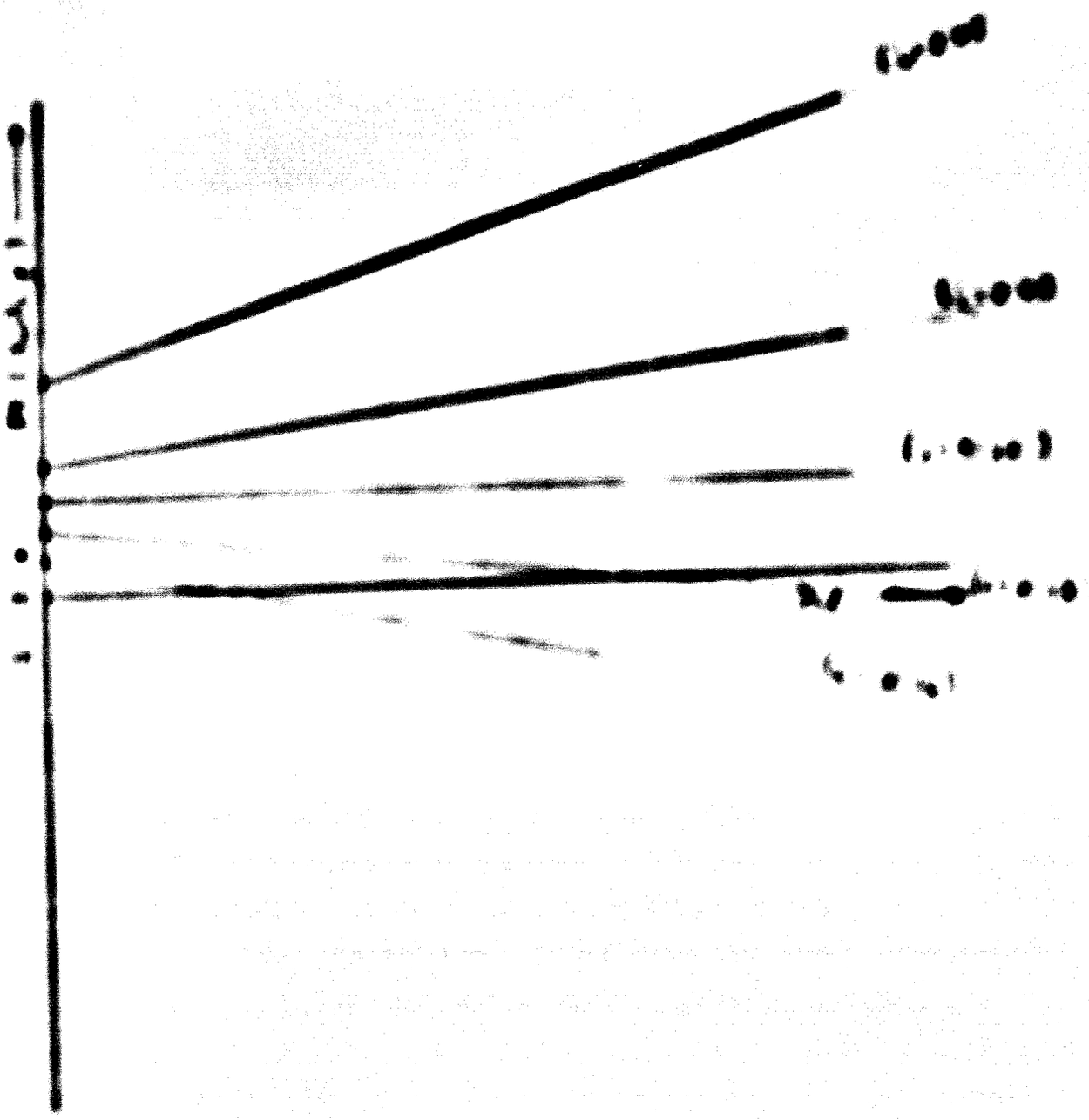
Let us take another example, say, of a big multipurpose river project. Typically, such a project has a longer gestation period, sometimes over seven or eight years. A large part of the expenditures during the period of construction is the wage cost to be paid to the construction workers. Usually, the construction activity in an underdeveloped economy, employs a large number of unskilled workers. The benefits of such a project are irrigation water, electricity, flood control, navigation facilities etc. It is always difficult to measure these benefits directly in terms of the consumers' willingness to pay for the immediate outputs. The pricing and the distribution policies of the government, the measurement of external economies etc., are crucially important in the measurement of the social value of the benefits of such projects. Again, the life of a multipurpose dam is also considerably longer than that of typical industrial equipment. In a similar fashion, we can give examples of certain other types of public investment projects, which have distinctive structures of their own.

2/ Since the present value formula puts less and less weights on the outcomes at more and more distant future, the cost of any inprecise specification at a later date is less than what it is in the near future.

The point of all this is that the sensitivity analysis of a wide assortment of public investment projects will reveal the relative importance of the different parameters for the different classes of projects. In certain cases, the shadow exchange rate may be of crucial importance. In certain other classes of projects, the social rate of discount may be the most sensitive parameter. In a third case, the redistributive objective may be the determining factor, for a very wide range of variations in i or λ_f. An understanding of these differences in precise quantitative terms can be of great help to a policy-maker in estimating the central parameters and in pinpointing the area of further investigations.

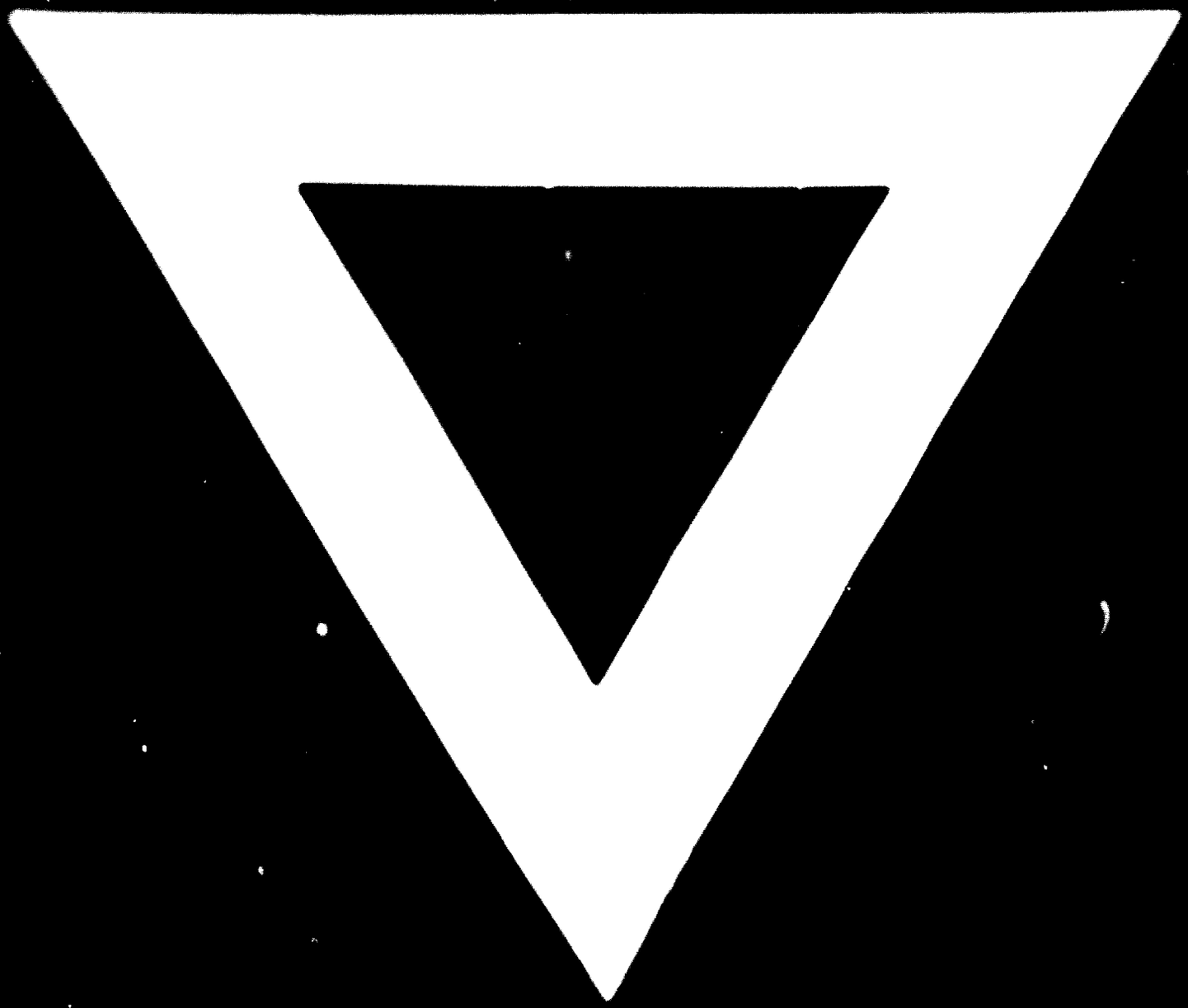
To illustrate the point, let us take the case of the sensitivity analysis of a project with respect to two parameters - the social rate of discount, i and the shadow exchange rate λ_f. From the algebraic expression for the present value formula it is clear that for any given discount rate, the present value is a linear function of the shadow exchange rate. Obviously, the project which is only a user of foreign inputs will look less and less attractive as the shadow exchange rate is increased. Similarly, the project that only produces benefits in foreign exchange will appear more and more attractive the higher the exchange rate. The interesting case is where there is a substantial foreign exchange component in the investment costs and also there are foreign exchange benefits in the later years (see figure 1). In this case, higher exchange rate increases the attractiveness of the project when the social rate of discount is rather low, decreases the attractiveness of the project for higher rates of discount. For certain intermediate values of the social rate of discount, the present value of the project is insensitive to the shadow exchange rate: the project is clearly attractive or unattractive.

For almost all investment projects, where positive benefits start coming only after a period of incurring investment expenditures, the higher the rate of discount, the less attractive does the project look. The projects requiring a longer gestation period can be undertaken only if the social rate of discount is low, because a high rate of discount implies a greater impatience for consumption or a greater reluctance for savings. Moreover, if the social rate of discount (i) is considerably lower than the marginal rate of return on investments (r), then other things being equal the project, which can be financed without substantially reducing investment elsewhere in the economy or which



[redacted]

[redacted]



20. 1. 72