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

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

07521

United Nations
United Nations Industrial Development Organization

Original: English

Training Workshops on Industrial Project Formulation and Evaluation

CID/IPE/TW.5
Restricted Distribution

LECTURES ON SOCIAL COST-BENEFIT ANALYSIS FOR INDUSTRIAL PROJECT FORMULATION AND EVALUATION

Prepared by

DR. THOMAS WEISSKOPF
Indian Statistical Institute
New Delhi, INDIA

PROFESSOR STEPHEN A. MARGLIN
Harvard University
Cambridge, MASSACHUSETTS

PROFESSOR AMARTYA K. SEN
Delhi School of Economics
University of Delhi
Delhi, INDIA

for

United Nations Industrial Development Organisation
UNITED NATIONS

i. 67-067

LECTURES ON INDUSTRIAL PROJECT FORMULATION AND EVALUATION

Table of Contents

Chapter I

INTRODUCTION: REASONS FOR DEPARTING FROM THE CRITERION OF COMMERCIAL PROFITABILITY

National Planning and Project Formulation and Evaluation

In most of the developing countries, if not all, public investment plays a critical role. How are governmental agencies to know which investment alternative to undertake, which to forego or postpone? For example, how much steel to produce, how much to import? How much cloth to produce, and by what techniques?

Many countries answer these questions in part by means of a national economic plan (for example, the Indian Five-Year Plans). But a national economic plan can at best lay out the strategy of development. It necessarily must leave many tactical questions unanswered. A national plan can, for example, suggest the over-all magnitude of investment in irrigation in both financial and physical terms. But the national plan cannot set out the dimensions of individual undertakings, except possibly for the largest projects. The designers of each project must decide how large to build the reservoir and the canal system, how much land to irrigate, which land to irrigate. In addition, they must decide whether to build the dam of concrete or of earth, whether to use labour intensive or capital intensive techniques to move materials, and a host of other questions.

It is these tactical questions that are the province of "benefit-cost" analysis, as the techniques for analyzing public investment decisions at the project level are called. Benefit-cost analysis is not an alternative to economy-wide planning, but a supplement.

Commercial Profitability and Benefit-Cost Analysis

Private enterprise utilizes a form of benefit-cost analysis in deciding which investment to undertake, and in deciding how to design individual projects. Private decisions are guided by commercial profits, profits being the difference between revenues (benefits to the enterprise) and costs. Can a governmental agency use the same simple criterion to guide its decisions? Unfortunately not, for a primary difference between the typical private firm and the governmental agency is (or ought to be) that whereas the benefits that accrue to other economic agents - individuals and firms - are of interest or relevance to the private firm only as a means to its own profits, the provision of benefits to others is important to the government as an end in itself. Constrast the reaction of private and public monopolists to a proposed increase of output that would casue price to fall (or at least would prevent price from rising as much as it would if supply were to remain restricted) because purchasers would not accept the increment in output except at al lower price. The prospective commercial profit of the expansion is reduced by the decline in price that would accompany the augmentation of output. But the loss to the enterprise is balanced by the gain to consumers who would be able to buy at the lower price. It is unreasonable to expect a private enterprise to take consumers' gain into account, but a public enterprise certainly ought to.

This is not to say that the government should be indifferent as to who receives the benefits of public economic activity. An avowed goal of economic policy in most developing countries is the eradication of extreme inequalities, and it is therefore appropriate that greater weight be attached to benefits received by the poor than to benefits received by the rich.

Thus there are at least two dimensions in which commercial profitability is inadequate for public investment decisions: first, commercial profitability fails to take into account benefits (and costs) to economic agents other than the enterprise; second, the distribution of these benefits and costs is ignored.

The Special Case of Perfect Competition and Lump-Sum Transfers

If all economic activity achieved the results of the economist's model of perfect competition, then commercial profitability would be an appropriate guide in all economic-decision-making, public as well as private. The existence of universal perfect competition would guarantee that no gain or loss would accrue to any economic agent other than the public project, so that the **size** of the net gain produced by the project would be largest when commercial profits were largest.

In the perfectly competitive model the most desirable distribution of income is assumed to be achieved by means of taxes and subsidies that do not distort decisions (so called "lump-sum transfers"). However, no government has yet found a way to levey taxes and give subsidies that does not affect economic decision-making. And many governments would be reluctant to use lump-sum transfers even if they were feasible; political opposition to the "dole" reflects a widespread philosophical belief. Without the possibility of lump-sum transfers commercial profitability is not an adequate criterion for the social desirability of public investment even in an economic regime that is otherwise perfectly competitive. The government may wish to sacrifice size of the economic pie to achieve a better slicing, and this would require it to depart from the criterion of commercial profitability.

In fact, commercial profitability is an inadequate criterion for the government not only becasue the absence of lump-sum transfers obliges the government to pursue redistributive goals through its choice of investments. Commercial profitability is an inadequate criterion also becasue perfect competition is a more apt description of the economists model than of the actual environment of economic decisions, especially in the developing countries. Consequently, the income produced by a project is not necessarily maximized when commercial profit is maximized.

This is not the place for a long discussion of the degree to which the competitive model is relevant to public decision-making. Bu a cursory look at some of the reasons why the competitive model is violated in fact can shed light on the problems of formulating public investment criteria. Three important assumptions of the competitive model that are violated in reality are the assumptions about technology, knowledge, and credit.

¶. The technological characteristics of many goods and services prevent competition in their production. Perfect competion requires a large number of firms to be producing each commodity so that each is too small to affect its price. But many industries are characterized by "increasing returns," that is, by a technology which permits the cost per unit of output to fall markedly with the scale of output. Electric energy, steel, and transport are instances of increasing-returns industries. A steel plant of one million tons annual capacity costs less than double the cost of a steel plant of one-half million tons. The existence of increasing returns favours large scale enterprises both from the social and the private point of view. Thus the assumption of large numbers tends to be violated and the tendency is all the more acute in developing countries because of the relatively small size of markets. The tendency to monopoly or oligopoly that results from increasing returns may invite public participation in production and distribution r public regulation of private enterprise. One of the two is necessary because the "invisible hand" of commercial profit no longer serves the national interest as it does under perfect competition; in monopolistic or oligopolistic industries, unlike competitive ones, the decision of the individual firm affects the economic well-being of agents than the firm itself. And these benefits and costs are, as we have already observed, outside the scope of the calculus of commercial profitability.

Closely related to the problem of increasing returns is the problem of "public goods." Public goods is the economist's term for goods (like public health, community radios, defense) that have the property that they are, or can be, consumed jointly by many individuals, without the consumption of one interfering with the consumption by another. Contrast "private goods" like bread and cloth; the more one individual consumes, the less there is available for another. Many goods have both public and private characteristics. A bridge, for example, is a public good up to the point that it becomes crowded; then it become a private good because one man's crossing delays another man.

The definition of a public good is purely technical and does not imply logically that public goods must be in the public sector. But it is intuitively clear that public goods cannot be produced under conditions of perfect competition. It follows that private profit does not reflect the national interest. Consider the decision whether or not to build a bridge. Suppose for simplicity that the bridge will last only one year so that problems of the rates of interest and amortization can be assumed away. Let the cost of the bridge be $1 million. Now suppose that careful studies indicate that the revenue-maximizing toll rate is $1 dollar per crossing, and that 2,000 crossings per day are expected at this price. One year's total revenue in this case would be $750 thousand (2,000 crossing per day x 365 days). The bridge clearly is not desirable from the point of view of commercial profits, and no private entrepreneur would be willing to construct it. Does this mean that the bridge is necessarily undesirable from the government's point of view? No such inference can be drawn. In the first place, as has already been suggested, the government out to be concerned about benefits to other economic agents, in this case, the potential bridge users. Many of these individuals may derive a benefit from the bridge far in excess of the one dollar fee levied on them for corssing. But there is a more subtle problem. The one dollar fee might prevent many poor people (and even rich people for whom the value of a crossing is less than one dollar) from using the bridge, and if their additional utilization would not congest the bridge, a prima facie case exists for letting them do so. Thus the benefits of the bridge would be increased by reducing the fee. Suppose, to take an extreme case, that even if no toll is charged the bridge would not be congested. Then it would be in the national interest to let anybody cross, no matter how little he might be prepared to pay for the privilege. In this case it is clear that the benefits at the zero toll rate, measured by what individuals would be willing to pay (rather than what they might actually be charged), might be greater than the cost of the bridge. Thus a case could be made for constructing the bridge despite the commercial losses.

Note that the conflict between commercial profits and social benefit would still be present even if the one dollar fee would result in 3,000 crossings per day, or a total revenue of $1,095,000 and a profit of $95,000. The argument for decreasing the toll to zero loses non of its force. Provided the additional use of those not willing to pay a fee does not congest the bridge, social benefits are maximized by charging no toll, with the result that the bridge leads to a commercial loss of $1 million dollars per year. Only a scheme of price discrimination that permitted bridge authorities to charge lower prices to those for whom the utility of crossing the bridge is low would unite commercial profits to social benefits. However, the costs of administering discriminatory pricing schemes reduces the attractiveness of this solution to the problem posed by public goods.[1/]

A third way in which technology reduces the efficacy of perfect competition is in the existence of external economies. An external economy or diseconomy exists when the economic activity of one individual increases or decreases the economic gain of another. In the perfectly competitive model, external economies are assumed away. Each individual receives the full value of his contribution to production, and each pays the full cost of the commodities he consumes. Likewise for firms. But in the world, as distinct from the model, external economies and diseconomies are often present. A classic example of an external diseconomy is the smoke nuisance that results from many industrial processes. The discomfort caused to the population at large does not enter into the calculus of commercial profits because the individual enterpriese is not in general obliged to compensate for the damage its smoke causes. But these negative benefits ought to be taken into account in the calculation of social benefits. (They are already reflected to some extent in zoning laws that regulate industrial location).

There is a large literature on the subject of external economies and diseconomies. But at this point we need not concern ouselves with the intricacies of externalities. Suffice it to say that external economies and diseconomices are closely bound up with increasing returns and public goods. Indeed it might be said that every externality is a mixture of public goods and increasing returns. Thus the basic technological reasons why the commercial profits fail to reflect total social benefits are existence of increasing returns and public goods.

Universal availability of knowledge about the techniques of production and quick response to changes in knowledge are another paid of assumptions that are not realized even as a first approximation in most developing conomies. Agriculture is a leading example of a sector in which the availability of knowledge is limited and the response to technological change is slow. Large scale public expenditures on agricultural extension are required, both

1/ For some public goods -- national defense is a leading example -- discriminatory pricing is infeasible even conceptually because of the impossibility of excluding individuals from the benefits of the good.

to spread knowledge of improved techniques and to increase the speed of response of the peasants. These activities may result in benefits to farmer (higher output) and consumer (lower prices) but show no commercial profit.[2/]

The situation in industry differs only in degree. Businessmen may lack knowledge of products, processes, and raw materials outside traditional lines of activity. They may have no means of projecting future demands, especially in countries embarking on an industrialization programme that changes the whole structure of demand. In this case past experience may be of little help in projecting the future, and such projections are one important reason for national planning in mixed enterprise economies.[3/] Moreover, the availability of knowledge, which could be provided by a system of "industrial extension" analagous to agricultural extension, may not be enough. Businessmen may be slow to respond to opportunities radically different from their traditional activities. Private monopoly or oligopoly may result even when the technology could support competitive industry. And in monopolistic or olgopolistic industry there are, as we have observed, benefits and costs to agents other than the firm which necessarily fall outside the calculus of the firm's commercial profits.

Apart from the tendency to monopoly of oligopoly that imperfect knowledge creates, the problem of convincing tradition-bound businessmen to enter new lines of activity may require public enterprise in the early stages in order to point the way, whether or not the government intends a particular industry ultimately to lie in the private sector. The first ventures may not be commercially profitability because of the learning costs, but the benefits of establishing cadres capable of expanding the industry may offset the commercial losses.

Still another reason why the competitive model is not an accurate one for developing economies is that the competitive model requires competitive capital

---

2/ One reason that private enterprise does not undertake enough "extension" simply to sell fertilizers, pesticides, and other inputs, is that the private is unable to recapture all the gains of this activity.

3/ This is a widely cited argument for planning even in industrialized countries, notably in France.

markets. And capital markets are the hardest in which to introduce perfect competition. Increasing returns to scale in financial institutions appears to be one reason for lack of competition, imperfections in the dissemination of knowledge another. Thr result is that undertakings for which large investments are required are in reality open only to a handful of potential entrepreneurs, a situation which is strikingly at odds with the competitive model. The private alternatives are therefore monopoly or oligopoly, with the resulting cleavage between commercial profits and social gains. It should be noted that if imperfections in the capital market are the only bar to competition in the private sector, the industry might be organized along competitive lines within the public sector.[4/]

Summary

Benefit-cost analysis is to national planning what tactics are to strategy: a supplement, not a substitute. Benefit-cost analysis must go beyond a conventional analysis of commercial profitability because the government enterprise, unlike the private firm, is in general concerned with the gains and losses of economic agents other than the enterprise. Not only the total gains and losses to others, but also their distribution is relevant to the government concerned with moving towards a more equal distribution of income. Only if lump-sum subsidies and taxes are economically and politically feasible could the government ignore the distribution of gains and losses to others caused by a public enterprise. In this case any pattern of gains and losses could be offset by counterbalancing taxes and subsidies. Only in the presence of universal perfect competition do commercial profits reflect all the gains and losses produced by an enterprise. But perfect competion does not exist, and there are at least three reasons why the competitive assumption is especially inappropriate to developing economies.

i) technological obstacles; increasing returns; public goods; external economies.

ii) imperfections in the dissemination of knowledge and in responses to knowledge.

iii) imperfections in capital markets that limit the number of entrepreneurs.

4/ But if the breakdown of competition is general, prices of products and raw materials may fail to indicate social values accurately. Hence commercial profits would still be an inadequate guide to decisions for public enterprise even if competitive.

Chapter II

THE OBJECTIVES OF ECONOMIC DEVELOPMENT

The discussion of Chapter I has shown that the practice of maximizing commercial profits at market prices is highly unlikely to lead to the economic activities which are optimal from the point of view of the welfare of the nation as a whole. No such simple rules are available to guide the formulation and evaluation of projects according to the national interest. It becomes necessary then, the substitute for commercial profitability a more thorough method for determining national profitability in the broadest sense.

The first step in any such endeavor must be the examination of what it is that constitutes the national interest. Basic to the formulation and evaluation of any project is the knowledge of what one is trying to achieve -- there can clearly be no evaluation without criteria by which to evaluate. This point may seem too obvious to need any elaboration, but it is stressed here because all too often the methodology suggested for, or used in, project evaluation reflects too narrow a view of the national interest. While statements of multiple national objectives abound, it is rare that more than one of these -- increasing national income -- in incorporated in a consistent manner into the evaluation of a project.

The Panagua Project is a good case in point. A variety of different Calivian Government objectives were noted in Part II of the Project Report, but the numerical benefit-cost calculations were based solely on the contribution of the Project to national income. The importance of other objectives -- notably the economic and social development of the Mendalvan region, and the distribution of benefits to the small farmers of the area -- was evidenced by the fact that the Project was strongly recommended, in spite of the relatively small national income benefits it seemed to provide. It would clearly be preferable to give explicit recognition to the multiple goals of public policy, and to attempt to translate these goals into quantifiable objectives with respect to which benefits and costs could be consistently and comprehensively evaluated.

A great variety of development objectives can be culled from project reports or various national and international statements of policy. Some typical objectives are the following:

1) the increase of national income
2) the increase of domestic consumption
3) the increase of the rate of economic growth
4) the reduction of disparities in income and wealth, among individuals, groups or regions
5) the reduction of unemployment
6) the improvement of the balance of trade
7) the improvement of educational and health standards
8) the promotion of social welfare

The list is not exhaustive, but it does cover the major objectives relevant to project planning which are expressed in one form or another by planners and officials in developing countries. All the the Galivian Government objectives considered in the Panagua Project Report can be interpreted in terms of the above list.

Before proceeding to examine the consequences of a multiplicity of public goals, it will be useful to inquire further into the nature of the objectives listed above. Some of these objectives may appear unclear, and other may be redundant. In the interest of clarity and consistency, it will be helpful to reduce the list to a hard core of distinct and potentially quantifiable objectives.

The first three items in the list are clearly related, and they are also ambiguous. The increase of national income or consumption raises the question -- when? Now or in the future? The rate of economic growth raises the question -- what? Consumption, national income, or something else? Consumption is clearly the basic concept involved: it is desired for its own sake. National income includes both consumption and investment, but investment is desired only for the sake of the future consumption it makes possible. Thus the first three objectives reduce to the promotion of domestic consumption, present <u>and</u> future. The problem raised by having to compare consumption flows in different periods of time will be deferred until later.

Up to this point the discussion has centered on **aggregate** domestic consumption -- the question of its distribution among regions, groups or individuals has not been raised. The fourth objective on the list introduces explicitly the notion of distribution. It is clear that the concept of economic development cannot be divorsed from distributional considerations; in a certain sense, the whole development effort in less developed countries can be regarded as an attempt to reduce the inequalities of income and wealth among nations. By the same token, the development effort within a given country generally seeks to reduce existing inequalities as well as to increase aggregate welfare, or at least to insure that all segments of society share in the gains.

The only question that may arise with respect to distribution is whether it should be considered a separate objective on the project level. Conceding that it is desirable from the national point of view to redistribute income from relatively rich to relatively poor regions or groups of people, one might suggest that this be accomplished on the national level via taxes and subsidies rather than through individual projects. The main objection to this procedure is that in practice there are important political and social constraints which limit the flexibility and scope of government pricing and fiscal policies. Higher prices or taxes affecting privileged groups are often resisted through political or economic pressure, or by appeal to institutionally determined precedent. Lower prices to unfavoured groups, on the other hand, are often very difficult to administer, and cash subsidies may be socially unpalatable. For such reasons it seems unlikely that most governments can expect to achieve their redistributional goals through the use of direct measures alone. It is far more likely that the easiest way for the Galivian Government to help the Mendalvan region in general, and the small farmer in particular, is to give special attention to public projects located in that region which provide new opportunities for small farmers to improve their own circumstances. Thus government planning authorities might well find it necessary to achieve such goals at least in part by incorporating redistributional objectives into their investment criteria.

It should be noted that there are also economic grounds for exchewing reliance on pricing and fiscal policies in the pursuit of distributional goals.

Unless these policies take the form of lump-sum transfers -- which are unlikely except in a revolutionary context -- they result in departures from marginal cost pricing which open the door to misallocation of resources. Thus either method of redistributing income -- direct or indirect -- may have a cost in terms of aggregate consumption, and there is no a priori reason to rule out one or the other.

The fifth listed objective is to reduce unemployment. This objective is subject to several interpretations, and it calls for further clarification. In many developing countries with a large population relative to the endowment of other resources, a significant degree of unemployment -- or underemployment -- of labour coexists with a positive market wage for labour services. It may then be the case that the market wage fails to judge accurately the cost in terms of aggregate consumption of putting to work unemployed labour. Under such circumstances, a reduction in unemployment would represent one aspect of a policy designed to promote the optimal allocation of resources with respect to the objective of increasing aggregate consumption, and it would therefore properly be subsumed under the latter objective.

An alternative reason for emphasizing the reduction of unemployment as a national objective might be the desire to reduce the disparities of income and wealth between the employed and the unemployed. It might well be reasoned that the best way to raise the economic welfare of the unemployed is to give them wage-earning opportunities. However, if this is the case, the objective ought to be labelled "income redistribution" and not "reduction in unemployment," and it falls under the fourth objective on the original list. The only justification for distinguishing a separate employment objective is if the government considers employment a good thing for its own sake -- or, conversely, if it considers idelness (or leisure) to be an evil. In the case of the Panagua Project i. is not clear which interpretation the Galivian Government wishes to make, but it may be presumed that the last interpretation is of secondary important.

The objective of improving the balance of trade suffers from an ambiguity analalogous to that of reducing unemployment. At least two possible interpretation suggest themselves. In many developing countries; just as there is often a so-called "labour surplus", there is likely to be a foreign exchange scarcity. Chronic balance of payments problems, met by exchange controls, import quotas, export subsidies, etc., all point to an undervaluation of foreign currency by the official exchange rate. Even when substantial amounts of external aid are made available, it is often the case that a unit of foreign exchange is worth considerably more to domestic producers and consumers than its official price. In recognition of this fact, any government would be well advised to pay close attention to the balance of payments effects of a given project, and to seek to reduce the net drain on foreign exchange in the economy by increasing exports or reducing imports. The reason for doing this, however, is not that trade deficits are a bad thing per se, but that the optimal allocation of foreign exchange resources with respect to the objective of increasing national consumption possibilities calls for a greater economy of foreign exchange than would be practices at the official exchange rate. As in the case of unemployed labour, the market price fails to judge accurately the consumption opportunity cost of foeign exchange, and the objective of improving the balance of trade may well reflect this fact rather than an independent goal.

A separate trade objective is appropriate only in a situation where the government wishes to promote a greater expansion of exports, and a greater economy of imports, than would be dictated by the most productive allocation of foreign exchange resources with respect to the aggregate consumption objective. From the point of view of aggregate consumption, there is no harm in a trade deficit which is covered by external aid, and it will always be desirable to use whatever aid is available to increase imports without any corresponding increase in exports. Improving the balance of trade as a separate objective can only mean that the government wants to reduce the gap between imports and exports below the total availability of external aid. In other words, the government would willingly turn down a grant of external aid for the sake of policy objectives other than increasing aggreate national consumption. There may well be good political reasons for avoiding a continued dependence on external aid, even if it is available from donor countries. If the often stated goal of attaining "national self-sufficiency" can be given this interpretation, it does represent a distinct trade objective. In evaluating the Panagua Project, it may be assumed that the Galivian Government is not prepared to reject any aid -- present or future -- which might be extended.

The last two objectives on the list -- the improvement of educational and health standards, and the promotion of social welfare -- share the same characteristics and potential ambiguity. In the first place it is generally very difficult to measure achievement with respect to these objectives in terms of money value, for education, public health, etc. are usually placed beyond market tests. Even assuming that their value to the consuming public could be assessed by some indirect method on a standard comparable to marketed goods and services, there remains the possibility that the government -- in the national interest -- may wish to place more weight on contributions to these objectives than would be placed on them qua consumption by consumers buying them in the market place.

The first issue raised is one of measurement and not one of separate goals. The relevant objective is the increase of aggregate consumption, and the problem is to determine the contribution made to this objective according to a valuation based on consumer sovereignty. The difficulties that arise here are akin to - but perhaps more serious than - the difficulties that arise in measuring the value of irrigation systems, bridges, roads, etc. where the actual fees charged do not necessarily reflect the corresponding (marginal) value of consumption or cost of production. The second issue raised, however, concerns a new and distinct objective. When the collective national interest calls for greater emphasis on goods and services such as public education, nutrition, sanitation, etc., than the individual private interest, then the promotion of such "merit wants" should enter as a national objective independent of the increase of (consumer sovereign) aggregate consumption, When the Galivian Government talks of "promoting better housing and sanitary conditions," it is not clear whether they mean simply to provide for the inhabitants the services which they would be willing to purchase as sovereign consumers, or whether the Government wants to attach an additional public merit to these services. In the absence of more detailed information, it is probably reasonable to assume that the former is the case.

The original list of eight objectives may now be recast into a shorter list of five logically distinct categories, of which only the first two have major relevance to the Panagua Project.

1) the increase of aggreage consumption
2) the redistribution of aggregate consumption (by regions, groups or individuals)
3) the reduction of unemployment (per se)
4) the improvement of the balance of trade (per se)
5) the fulfillment of merit wants

Each of these categories applies both to the present and to the future. For every objective, there are actually an infinity of related objectives involved, for there is a logically separate objective corresponding to each future year (or other accepted unit of time).

Faced with such a multiplicity of objectives -- by category and over time -- it is clearly impossible to say: "maximize everything." The maximization of present consumption is likely to reduce the level of future consumption, for it cuts down the surplus available for savings and investment. The maximization of future consumption, conversely, would call for a reduction of present consumption. The redistribution of consumption may dictate locating a new project in a relatively backward region, where its net contribution to aggregate consumption may be less than if it were located in an advanced region. Similarly, the rapid elimination of unemployment, the reduction of the trade deficit by dispensing with aid, or the allocation of substantial public expanditures to provide for merit wants, are all likely to interfere with the maximization of aggregate consumption, present and future.

Thus the various distinct objectives may well be mutually inconsistent in the sense that the dictates of one may conflict with the dictates of another. Unfortunately, however, one cannot be content with maximizing one particular objective at the expense of all the others, for each is inherently partial and insufficient. No policy-maker would recommend maximizing aggregate consumption this year at the expense of all future consumption and all considerations of redistribution or anything else. As a result, it becomes essential to inquire into the relative importance of different basic objectives, so that contributions to different basic objectives, and at different period of time, can be compared in assessing the total contribution of a project to national welfare.

This problem of reconciliation of multiple objectives will be taken up again in Chapter IV, after the separate objectives are discussed in greater detail in Chapter III in connexion with the measurement of benefits and costs.

Chapter III

THE MEASUREMENT OF BENEFITS AND COSTS

The concept of a benefit -- or a cost -- has meaning only in terms of a particular objective. A benefit describes a gain with respect to that objective, and a cost describes a corresponding sacrifice. In this chapter, the measurement of benefits and costs will be treated successively for each separate category of objective. The problems raised by having to compare benefits and costs over time will be postponed for later discussion; in this stage, the focus is on the measurement of benefits and costs in any given year.

The Aggregate Consumption Objective

Direct Benefits

The basic principle involved in calculating the aggregate consumption benefits of a project is to measure the consumers' "willingness to pay" for the output of the project. Assuming for the moment that the project involves the production of consumer goods for domestic consumption, it is necessary to study the pattern of consumer demand for the goods in question. When there is a clearly defined market price for the good, it can be regarded as a first approximation to the consumers' willingness to pay for each unit. However, if the good is not freely purchased on the market, or if the output of the project represents more than a marginal increment to the total supply of the good, then the market price valuation will have to be revised.

Assume first that the good is freely traded. It does not matter whether it is taxed or subsidized, so long as consumers are free to buy it at the prevailing price. Then the price which each consumer pays for the last unit of the product he purchases must just reflect the extent of his satisfaction from a marginal unit -- for if his satisfaction exceeds the price, he would be inclined to buy more, and if his satisfaction is less than the price, he would buy less of the product. If the project output represents only a marginal increment to the total supply of the product in question, it is unlikely to affect the price of the product -- and hence the total value of the output sold at this unchanged price can be taken to reflect the consumers' total satisfaction, or willingness to pay. However, if the project output is sufficiently large, relative to the total supply of the product in the country, that putting it on the market results in a lowering of the price which previously prevailed, then neither the old nor the new price is adequate to measure the consumers' willingness to pay.

This situation can be illustrated with reference to the accompanying Diagram 1. DD is a demand curve indicating the total annual demand for shoes (on the x-axis) at a range of possible prices (on the y-axis). Suppose that the current annual production of shoes is 100,000 pairs (Q_1); the demand curve shows that the market will just be cleared at a price of $11 a pair ($P_1$), and this is the price which would prevail under competitive conditions. If we now consider a project which would turn out another 100,000 pairs of shoes per year, bringing the total supply to 200,000 (Q_2), we observe from the demand curve that the equilibrium market price would fall to $9 a pair ($P_2$). But the consumers' willingness to pay for the additional 100,000 pairs of shoes is clearly not measured at the new price $9 x 100,000 (the area C D J H), for the willingness to pay for the 100,001st pair can be seen from the diagram to be $11 (A H). By the same token, the willingness to pay for the additional 100,000 pairs of shoes cannot be measured at the old price $11 x 100,000 (the area A B J H), for the willingness to pay for the 200,00st pair is clearly $9 (D J). Inspection of the diagram will show that the correct measures of consumer willingness to pay is the area A D J H: the excess value A C D over the competitively determined market payments for the additional 100,000 shoes (C D J H) is labelled the "consumers' surplus."1/

Now let us suppose that shoes are not freely traded on the market, but that they are rationed according to some quota system. Such a situation can arise only if the shoes are being sold at a price lower than required to bring the demand into equality with the supply. For example; in Diagram 1, let the current rate of production of shes equal 100,000 pairs per year (Q_1), and suppose that the government -- to help low-income consumers -- decides to fix a price of $7 a pair ($P_3$). This is well below the equilibrium price of $11

1/ Following Marshall, we will assume a constant marginal utility of money throughout.

(P_1); and calls forth an annual demand for 300,000 pairs (Q_3), Since this demand cannot be satisfied at existing production levels, the government is forced to devise a system for rationing the 100,000 available pairs among 300,000 claimants.

Clearly, under such circumstances, the current market price of $7 a pair is no guide to consumer willingness to pay for additional shoes. Whenever a product is rationed, it is a certainty that the market price understates consumer willingness to pay. In our example, the actual willingness to pay for an additional 100,000 shoes is of course again the area A D J H, which is substantially greater than the area E F J H which would be obtained by using the market price.

Thus if the output of the project is not freely purchased on the market, or if it results 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 of course is a more difficult task than simply applying a market price to the quantity involved, but it cannot be avoided. An even more difficult task arises when the output of the project is not purchasesed at all on the market, so that there is not even a first approximation in the form of a market price. This problem was touched upon in Part II in connexion with the discussion of the "merit want" objective. Public services such as education, health, sanitation facilities, welfare programmes and the like generally carry no meaningful market price, and it is a challenging job to evaluate the benefits of public investment in these fields. These problems will not be considered in any more detail here, for they are unlikely to figure prominently in the formulation and evaluation of most industrial and agricultural investment projects.

So far we have assumed for convenience that the output of the project in question consists of consumer goods produced for domestic consumption. When the output is not consumed directly, but is used as an intermediate or capital input into the production of other goods or services, the principle of measurement according to willingness to pay for the increase in consumption still holds. The only difference is that the ultimate increase in consumption made possible by the project may be far removed from the project itself, and this tends to make the problem of measurement more complex.

As a first approximation, the willingness of the producers -- who purchase the project output -- to pay for the goods or services in question can be taken as a measure of their value to the ultimate consumers. If the project output is bought freely on the market by producers, if those producers themselves do not enjoy monopoly or monopsony profits on their use of the output, and if the augmented supply of this output does not cause a change in its market price, then -- just as in the case of consumer purchases -- this market price can be used as a measure of the willingness of producers to pay for one unit of the output. If the project output is not marketed under competitive conditions, however, or if its price is lowered by the supply from the project, then the (future)market price will understate the producers' willingness to pay. In such cases it may be possible instead to measure willingness to pay by the residual remaining after deducting from the value of the producers' output the costs of all inputs other than the one provided by the project whose benefits we seek to measure.

This kind of indirect measurement can be illustrated with reference to the Panagua Project. Assuming for the moment that the agricultural programme is external to the project, we seek to measure the aggregate consumption benefits attributable to the irrigation water provided by the project. This water is of course not consumed directly; it is an intermediate input into the production of agricultural commodities which are sold for consumption or further processing. The actual payments made by the cultivators to the irrigation authority (the M.W.A.) are irrelevant for the purposes of measurement, since the water is rationed and the fees paid by the cultivators are fixed at a level at which demand greatly exceeds the available supply. The relevant measure is the cultivators' willingness to pay for the water, which in turn, can be measured by the net surplus of agricultural income remaining after the costs of cultivation -- other than irrigation fees -- are deducted from the market value of the agricultural output based on the irrigation water. This net surplus corresponds exactly to the concept of surplus defined in Table 5 of the Panagua Project, and it was correctly used in the initial evaluation of the Project to measure the value of the irrigation water.

There are two further cases which deserve special attention : these are when the project produces output which is exported or which substitutes for imports. In the case of exports, the immediate product can be regarded as foreign exchange, in the amount of the F.O.B. foreign currency value of the goods exported. (If the goods must be transported to the port of exit, the corresponding transport requirements should be included among project inputs). The ultimate aggregate consumption benefits resulting from these exports are measured by consumer -- or producer -- willingness to pay for the foreign exchange earnings. In the case of import substitutes, the immediate product should also be regarded as foreign exchange, in the amount of the c.i.f. foreign currency value of an equivalent supply of imported goods. This holds irrespective of whether the project output is actually used to replace imports, or whether it simply adds to the total supply on the market. As long as the project output could have been used to replace imports, it must be worth at least as much as the amount of foreign currency needed to import it. On the other hand, if the project output is worth more than the amount of foreign currency needed to import it, it would be possible for society to gain the excess benefits by increasing imports in the absence of the project, and these benefits cannot therefore be attributed to the project itself. Thus the ultimate aggregate consumption benefits due to the production of import substitutes are measured by consumer -- or producer -- willingness to pay for the foreign exchange (potentially) saved.

If the foreign exchange market is free, 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 corresponding market price, and the consumption benefits of exports or import substitutes can be measured by the official domestic currency equivalent of their foreign exchange value. If, instead, there is an excess demand for foreign exchange at the official rate which results in some kind of an exchange control scheme, the official rate clearly understates the domestic willingness to pay. Under these circumstances, it becomes necessary to estimate what is called the "shadow price" of foreign exchange which measures the true aggregate consumption value of a unit of foreign currency in terms of willingness to pay. This shadow price represents the price which -- in a free market -- would equate the supply of foreign exchange provided by export earnings (plus any external assistance) with the corresponding demand arising from imports.

Since the shadow price is required for the evaluation both of foreign exchange benefits and of foreign exchange costs, its measurement is clearly an important part of the process of project evaluation whenvever the foreign exchange market is not free.

Let us consider now the evaluation of the aggregate consumption benefits of the Panagua Project. The Project is defined to include both the public works and the accompanying agricultural programme, because they are clearly dependent on one another and would not be considered separately. Thus the project output consists of the agricultural crops produced on the irrigated land, and the social services provided by the investment in the urban center, farm housing and basic rural utilities. It does not include the irrigation water, which is an output for one phase of the project and an input for another and therefore cancels out in the final accounting.

It may reasonably be assumed that the agricultural commodities sold on the domestic market are freely traded, and that the relevant future markets will be large enough not to be affected by the increment in supply which will be provided by the Project. As a result, the aggregate consumption benefits of a unit of each crop in any future year can be measured by the domestic market price which is expected to prevail in that year. Expected future acreage, yeidls and prices for all the agricultural crops are given in Table 4 of the Project Report. Yields are assumed to rise progressively from year 5 to year 10 and then remain constant thereafter, while prices are assumed to remain constant for the full Project life. On the basis of the figures given in Table 4, the year-wise aggregate consumption benefits due to the agricultural progamme can be assessed as shown in Table 1 of this manual.

Thus far we have assumed that all of the crops are sold on the domestic market, whereas in fact a fraction of some of the crops may be retained for on-far consumption, and the full tomato crop is destined for export. That a fraction of any crop may be retained for on-far consumption is irrelevant for the purposes of the evaluation, for its value to the farmer remains the same whether or not it is sold. The situation would in no way be altered if the farmer would sell his own crop and buy someone else's — at the same market price — rather than keep his own off the market.

As for the exported tomatoes, it is necessary to consider whether or not a foreign exchange scarcity is anticipated for the Galivian economy in the years when the tomato crop will be exported. If so, the first approximation to the value of consumption benefits from the tomatoes, which is given in the table according to the official peseta equivalent of the dollar export price, must be revised upwards to the extent that domestic willingness to pay for foreign exchange will exceed its official price. The forecasting of the appropriate shadow price of foreign exchange is a task that must necessarily be carried out at the Central Government level, for it requires comprehensive information about the economy-wide demand for imports and supply of exports, present and future, taking into account the nature of the over-all development strategy, the availability of foreign economic assistance, and world trade prospects in general. This is a difficult calculation to make, but it is important to have some alternative quantitative estimate whenever the official rate appears inappropriate. For the purpose of evaluating the Panagua Project, it will simply be assumed that the shadow price of foreign exchange in Galivia is -- and remains indefinitely -- at twice the official price. Thus the aggregate consumption benefits from tomato exports amount to twice their peseta value at the official exchange rate.

It remains to consider the contribution to aggregate consumption benefits provided by the urban center and the rural housing and utilities, which form an integral part of the Project. The market value of such services is typically a poor guide to their actual value to consumers, and in any case the relevant prices are not provided in the Project Report. In the absence of more accurate information, it will simply be assumed that the aggregate consumption benefits of these services run at an annual rate of 7% of the initial investment. The total year-wise aggregate consumption benefits of the Panagua Project are summarized in Table 1.

Indirect Benefits

Up to this point, the elaboration of the measurement of aggregate consumption benefits has been limited to the willingness to pay of the immediate users of the project output, which might be labelled a measure of the "direct" consumption benefits. (Project output is understood here in the wide sense of all output produced on the project, or in ancillary activities, which would not have been produced in the absence of the project). Under certain circumstances, it becomes necessary to examine also the possibility of "indirect" consumption benefits, which are not reflected by immediate willingness to pay. Several categories of such "indirect" benefits will be discussed in the following paragraphs; the importance of each will vary greatly depending upon the nature of the project in question.

The first category applies only to cases where the output of the project is not directly consumed, but is purchased for use in further stages of processing. It was stated earlier that, as a first approximation, the consumption benefits of the project could be measured by the producers' willingness to pay for the output in question. This approximation holds only if it can be assumed that there are no departures from competition in the further processing of the project output, and that the project output is not significant enought 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 trade, then the immediate purchaser of the project output does not capture the full consumption benefit 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 projectoutput is also reduced. In principle, to measure the full value of project benefits, the immediate purchasers' willingess 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 competitivee 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 purchasers' 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 (the area A C D in Diagram 1).

To illustrate this category of secondary benefits, it may be helpful to refer again to the Panagua Project. Suppose that the wheat in the Project area is milled by a monopolist. The price which he pays the cultivators for wheat will not reflect the ultimate value to consumers of the flour, for in the meantime he is making some monopoly profits. The contribution of the Project wheat to aggregate consumption benefits includes not only the willingness to pay for water of the cultivators, but also part of the miller's monopoly profits — a part which corresponds exactly to the excess of the miller's willingness to pay for the wheat over what he actually pays the farmer. Suppose now that the market for wheat is competitive, but that the increase in the supply of flour made possible by the project is so great that its price in the region is reduced. Then again the price received for wheat by the farmer will fail to reflect the full consumption benefits of the wheat, for the final consumers are paying less for most of the Project-based flour (all but the last unit) than they would be willing to. Their consumers' surplus must be counted, too, as an indirect benefit.

A second category of indirect benefits encompasses what are sometimes called external effects, although this term should probably be avoided because of the confusion surrounding its definition When the existence or the operation of a project results in a net gain to society which is not realized by those who acquire the project output -- and which is hence not reflected in their willingness to pay for this output -- then the corresponding benefits should be added into the over-all contribution of the project to the aggregate consumption objective. Such a situation typically occurs when an ancillary good or service produced in connexion with the project contributes not only (internally) to the value of the project output, but also (externally) to the supply of output from other enterprises, or to the satisfaction of consumers other than those who received the project output.

Examples of such externalities are easy to suggest, although the means of measuring their quantitative contribution to the aggregate consumption objective is much harder to come by. In the construction of the Panagua Project, a system of access road was included for the purpose of maintaining the canal system. But the benefits provided by the roads are not limited to the service of the project;they will also improve communications and lower transport costs for the whole area, and this is likely to result in lower costs for local industries and hence net consumption benefits for the community as a whole.

Similar indirect benefits are provided by a project which involves the training of its labour force. The new skills acquired by the workers contribute to the output of the project, but if the workers eventually move on to other jobs, they bring with them opportunities for greater production than they could have without their acquired skills. These skills then result in a contribution to aggregate consumption made possible by the project, but not included among its direct benefits.

The above examples represent externalities which result in lower production costs for enterprieses which make use of a project by-product free of charge. Formally speaking, these by-products could also be included with the main project output, and evaluated according to the willingness to pay of the beneficiaries. A somewhat different kind of externality is illustrated by the case where the consumption of project output is enjoyed not only by the purchaser -- whose willingness to pay is measured as a direct benefit -- but also by other consumers, who benefit indirectly from the increased consumption of the purchaser. For some types of industrial projects -- such as telephones -- the measurement of consumption benefits will be seriously distorted if only the purchaser's valuation is considered.

Under the circumstances of the Panagua Project, indirect benefits of the first category do not arise. Part of the Project output goes directly into consumption, and the remaining part is sold to agricultural processing industries, or to other cultivators, where competitive conditions are assumed to obtain. There may, however, be some indirect benefits of the second category, arising from the external effects of building roads and introducing the various public utilities into the Secotuan valley. Since the Project Report provides no information on the basis of which to evaluate these benefits, they will have to be assumed insignificant.

There remains one final and important category of indirect consumption benefits which must be considered when the ultimate consumption value of the funds invested exceeds the immediate consumption value of the same funds used for consumption. When this is the case, it becomes necessary to inquire into the effect of project benefits on the investment-consumption mix of the economy as a whole. For the same reason, it will be necessary to inquire into the effect of project costs on the investment-consumption mix of the economy. Rather than pursue the matter at this stage, it is more convenient to turn first to a detailed discussion of the measurement of aggregate consumption costs, and then to examine together the final category of indirect consumption benefits and costs.

Costs

The basic principle to be applied in calculating costs with respect to any objective is that costs are simply equivalent to benefits foregone. The aggregate consumption costs of a given project measure the extent to which activities that the project displaces elsewhere in the economy would contribute to the aggregate consumption objective. This notion lies behind the term "opportunity cost": the cost of a resource is measured by the opportunity for benefits which it would provide in (the best)alternative use.

In a perfectly functioning competitive economy, money outlays measure the aggregate consumption costs of a project. Money outlays -- based on market prices -- may thus be used as a convenient first approximation to consumption costs. But if competitive conditions do not hold -- and we have observed in Chapter I that they are likely not to hold for many markets in developing countries -- then market prices are no longer appropriate, and it becomes necessary to correct the costs given by money outlays in order to reflect the actual opportunity costs that prevail in the economy. Although the principle is the same for all costs, it will be helpful to discuss the application of the principle separately for (domestic) labour inputs, imported inputs, and domestic inputs of goods and services. No distinction is drawn at this stage between inputs on current and on capital account, or -- what amounts to the same thing -- between the operating and construction costs of a project.

Labour Costs

It was observed already in Chapter II that in many developing countries with a large population relative to the endowment of other resources, a significant degree of unemployment of labour may coexist with a positive market wage. To the extent that labour services are drawn from previously unemployed labour, the direct opportunity cost of such services is clearly zero, even if a conventionally determined positive market wage must be paid. 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 family or social alternative sources of subsistence income for the unemployed.

Before proceeding to evaluate all labour costs at a shadow price of zero whenever there is a "labour surplus" in the economy, several words of caution must be entered. First, it is essential to distinguish between different types of labour: the term includes everything from unskilled construction workers to highly skilled technicians and administrators. While the opportunity cost of completely unskilled labour may well be zero -- if the jobs in question can be adequately filled by the currently unemployed -- the same is not necessarily true of semi-skilled and skilled labour. It is more than likely that where population is in surplus, skills are in short supply -- and hence that the opportunity cost of skilled labour is not only greater than zero, but perhaps, even greater than its 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 opportunity cost to the economy of bringing in unemployed labour from elsewhere must include the real 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 where an industrial project draws unskilled labour from rural into urban areas, when the real cost of essential public services is likely to be higher. The sum total of these transfer costs -- which represents the true social opportunity cost of unskilled labour -- may still be lower than the corresponding sum total of actual market wage payments, but it may well be greater than zero.

A final work of caution on the shadow price of labour applies even when the costs of skills and of transfer may be ignored. The payment of a market wage w to an unskilled worker whose opportunity cost is zero results in a transfer of income from the government (if this is a public project) to the worker in the amount of w. If the government has a greater propensity to invest out of its 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, and the ultimate opportunity cost of hiring the worker will be positive. This final correction is exactly analogous to the last category of indirect benefits noted earlier, and it will therefore be put off until the general discussion of the type of indirect benefits and costs at the end of Part A of this Chapter. A formal model of the labour surplus economy -- which treats of this and related points in more detail - will be taken up as a separate unit in Chapter VI.

Labour services are involved in the Panagua Project in four ways: for construction of the Project works, for operation and maintenance of the Project works, for agricultural extension and for cultivation itself. The construction and operation of the Project works calls for labour of varying skills: there is a substantial requirement of manual work which can be met by laregly unskilled labour, but there is also a need for qualified engineers and managers, as well as semi-skilled machinery operators. The agricultural extension service calls for specially trained field workers with acquired agricultural skills, while the actual farming is done mainly by owner-cultivators -- with the aid of family labour and some hired hands -- who are relatively unskilled. It is assumed that none of the labour-skilled or unskilled-is imported from outside Galivia: to the extent that foreign managers, technicians, or unskilled labourers are required, the cost would be included among the imported rather than (domestic) labour inputs.

The market value of the various types of labour services can be calculated from the figures given in the tables of the Project Report (1 and 2 for construction labour, 5 and 6 for farm labour, 7 for operating labour, and 8 for extension labour). These market values are set out on a year-wise basis in the accompanying Table 2. In order to calculate the corresponding opportunity costs -- which are required to evaluate the true aggregate consumption costs of the labour inputs -- it is necessary to have information on the state of the market for each type of labour, and the source from which the Project can expect to draw its labour force. For the purposes of evaluation, it will be assumed that skilled and semi-skilled construction and operating labour is fully employed and highly mobile in Galivia, so that the opportunity cost of this labour is very close to the corresponding market value of wages. In the case of agricultural extension workers, it will be assumed that these workers are in fact underpaid -- in the sense that the benefits attributable to the work of a single agricultural extension worker are worth - say - twice his salary. As a result, when the Ministry of Agriculture draws agricultural extension workers away from other projects to assign them to the Secotuan Valley, there are losses due to foregone benefits elsewhere of the order to twice the salary payments made by the Ministry. If these salaries reflect approximately the cost of training, it would clearly pay the Ministry to train new extension workers rather than relocate existing ones. The benefits which would arise from such an expansion of the training programme should not be attributed (via lower costs) to the Panagua Project, however, for they would presumably be available to the Ministry under any circumstances. The opportunity cost of extension workers from the point of view of the Panagua Project is the value of benefits foregone by diverting the (fully employed) workers from other activities; if in fact there is an expansion of the training programme, the benefits represented by the excess in the social value of an extension worker over the costs of training him should properly be attributed to the Ministry's training project. Thus, in evaluating the aggregate consumption costs of using agricultural extenstion workers, it is necessary to supplement the wages actually paid by an equal amount representing the excess of social opportunity cost over market wage.

It remains to consider the opportunity cost of unskilled labour -- for Project construction, operation and farm cultivators. It is known that in Galivia as a whole -- and in the relatively undeveloped region of Mendalva in particular -- there is overt unemployment There is also a substantial degree of disguised unemployment, in the sense that unskilled labourers could be withdrawn from their present (unproductive) occupations without any significant loss of national output. Since the Panagua Project is to be carried out in a rural area, and since part of the labour required is really family farm labour, the real costs of transfer are at a minimum. Therefore, it may safely be assumed that very little in the way of consumption benefits are foregone by the rest of the economy either because of the displacement of Project labour from other activities, or because of the costs of transferring the labour to the Project site. As a result, the social opportunity cost of unskilled labour may properly be assessed at zero -- abstracting for the moment from any effects due to the transfer of income through the actual market wage payments.

It should be noted here that in the case of family farm labour, the market wage is only imputed and may not actually be paid. This clearly makes no difference to the evaluation of the opportunity cost of the labour, and it also has no effect on the ultimate evaluation of net benefits with respect to any objective. To the extent that the cultivator pays less than the imputed market wage, his family receives less, and the benefits to the whole family unit are unaffected. After correcting for the discrepancies between market wages and social opportunity costs, the resulting year-wise evaluation of labour costs with respect to the aggregate consumption objective is presented in Table 2.

Foreign Exchange Costs

The reasons for distinguishing the evaluation of the costs of imported from domestically supplied inputs are exactly analogous to the reasons for distinguishing the evaluation of the benefits of exported from domestically sold output. If domestic currency is freely convertible into foreign exchange at the official exchange rate, then there is no reason to make these distinctions. But if -- as in the case in many developing countries -- there is a scarcity of foreign exchange at the official rate which results in a scheme for rationing foreign currency, then the official exchange rate necessarily understates the opportunity cost of foreign exchange, and the domestic currency equivalents of import prices understate the opportunity costs of imported goods of services.

The opportunity cost of an imported input -- whether it is obtained by license at the official exchange rate, or whether it is bought competitively at a premium -- is simply the value of the aggregate consumption benefits that could have been obtained by using the corresponding amount of foreign exchange elsewhere in the economy. The underlying assumption is that at any given time there is available a fixed amount of foreign exchange, and the use of some of it for imported inputs on one project prevents the use of the same amount elsewhere. Thus the immediate input can be regarded as pure foreign exchange --

rather than as a particular good or service -- and the opportunity cost of a unit of this foreign exchange is measured by its shadow price.

The only circumstance under which this approach is not valid is when the foreign exchange used for imported inputs by a project is not obtained at the expense of the foreign exchange available to the rest of the economy. This might happen, for example, in the case of foreign exchange loans or grants which are tied exclusively to particular projects. If a loan or a grant made to one project in no way reduces the changes of additional loans or grants to other projects, or the total availability of foreign economic assistance, then there is no immediate drain on the supply of foreign exchange available to the economy. If it is a grant, there is no opportunity cost; if it is a loan, the opportunity cost is determined according to the schedule of loan repayments, for when these repayments are made, there will have to be a diversion of foreign exchange away from other uses. (The opportunity cost of the repaid foreign exchange is then measured by its shadow price in the years when the repayments fall due). In practice, many loans and grants are likely to fall between the two polar cases of zero and total drain on foreign exchange resources available to the rest of the economy. This complicates the assessment of opportunity costs; part of the costs have to be measured in one way; and the remainder the second way, according to the estimated proportion of incidence.

The inputs into the Panagua Project which are not currently produced in Galivia -- and hence must be imported -- are assumed to include all types of machinery and equipment, including spare parts; fuel for the machinery; iron and steel for construction; and chemical fertilizers, pesticides, etc. for cultivation. To simplify the calculations, it will be assumed that these materials will continue to be imported throughout the life of the Project. On this basis, it is possible to derive from Tables 1, 2, 5, 6, 7 and 8 of the Project Report the year-wise foreign exchange costs for each phase of the project: construction, operation, cultivation, and farm assistance. The foreign exchange costs of construction -- which are to be financed by a World Bank loan -- are defined in terms of actual outlays rather than the loan repayments, because it is assumed that these outlays represent a drain on foreign exchange that the World Bank would otherwise be prepared to make available for use elsewhere in the economy. (In other words, it is assumed that in effect a quota system obtain with respect to Bank loans to Galivia). The year-wise foreign exchange costs -- expressed in terms of their peseta equivalent at the official exchange rate -- are given in the accompanying Table 3.

Unlike labour inputs, imported inputs can be reduced to a single homogeneous commodity -- foreign exchange -- with a single shadow price. Thus instead of having to evaluate separately the opportunity cost of each imported input, the total value of foreign exchange requirements in any given year can be multiplied by the shadow price of foreign exchange in that year to yield the corresponding total aggregate consumption cost of imported inputs. Since we have assumed earlier that the shadow price of foreign exchange in Galivia will be twice the official price for an indefinite period into the future, the official peseta value of foreign exchange costs must be doubled to reflect the true opportunity costs. In Table 3, the extra opportunity cost due to the foreign exchange premium is added to the peseta value in order to determine the year-wise total aggregate consumption cost of foreign exchange inputs.

Domestic Input Costs

We turn now to the evaluation of the cost of domestically supplied inputs of goods and services. Since the basic principle involved is to measure the aggregate consumption benefits foregone by using an input, we seek to evaluate the aggregate consumption benefits attributable to the input in question when it is used in an alternative activity from which it would be displaced by the project. This procedure is very closely related to the measurement of the aggregate consumption benefits of the output of a project when that output is purchased by a producer as an input for further processing. Producer willingness to pay for the input is the first approximation to its aggregate consumption benefits (or opportunity cost) Under competitive conditions, the market price reflects producer willingness to pay -- unless the demand by the project for the input is so great that its market price is bid up. In that case, producer willingness to pay is understated by the original -- lower -- market price and overstated by the future -- higher -- market price; the correct measure involves the addition of the "consumers surplus" enjoyed by the producer on the amount of input in question to the value of the input obtained by applying the original market price. The correction is analogous to that applied in the evaluation of project output consumption benefits, except that we now consider a marginal reduction in the supply of the good rather than a marginal increase.

All of the other qualifications relevant to the evaluation of domestic output benefits apply in analogous fashion to the evaluation of domestic input costs. When the input is rationed, or when the purchasers of the input enjoy monopoly or monopsony profits, its market price understates its opportunity cost. A tax or subsidy on the input in question does not affect the evaluation of its opportunity cost, so long as it continues to be traded freely on the domestic market. And the point made earlier with respect to agricultural extension workers also applies: even if the supply of the input can be and is expanded at a real cost lower than its appropriate consumption value in alternative use, it is the latter which is relevant in measuring the opportunity cost of the input to the project. The net gain resulting from expanding the production of a commodity, whose consumption benefits in use exceed its consumption costs of production, is properly attributed to the independent investment in expansion — except under the unlikely circumstance that the supply of the input could not have been profitably expanded in the absence of the extra demand from the project.

The domestically supplied inputs of goods and services into the Panagua Project consist of most of the inputs covered by the remaining cost items of Table 1, 2, 5, 6, 7 and 8 of the Project Report, after labour and foreign exchange costs have been removed. The item "compensation" in the costs of construction corresponds in principle to the value of theland which is acquired for use by the Project. Since the Government in fact has a variety of legal claims to much of the land involved, the compensation it pays to landowners can be considered as only a token of its real economic value. The inputs of farm machinery and agricultural credit are covered twice in the cost accounting: once by farmers (Table 6) and once by the Ministry of Agricultures (Table 8). It is the latter account which corresponds to the real resource cost, since the Ministry is responsible for obtaining the inputs in question. The farmer charges for rental and interest represent only (arbitrary) cash transfers.

In Table 4, the market value of the domestically supplied inputs to the Project are listed on a year-wise basis; the input of land is valued initially according to the amount paid in compensation by the Government. It will be assumed in general that reasonably competitive conditions prevail in the relevant markets, and that the Project demand is not large enough to upset the price structure in any market, so that the values given in the table can be taken as adequate measures of the corresponding opportunity costs (or aggregate consumption benefits foregone). In the case of the land input, the value of compensation is clearly an inadequate measure of the opportunity cost involved. The true opportunity cost of the land is represented by the net compensation benefits foregone because this land can no longer be cultivated as before. Hence a much better measure is the total annual surplus of production value over production costs realized by farmers cultivating the land prior to its irrigation by the Project. This surplus is calculated in Table 5 of the Project Report; it enters as a cost to the Project for every year after the un-irrigated cultivation is abandoned. With this revaluation of the cost of land, the total aggregate consumption cost of the domestic inputs is calculated for each year as shown in Table 4.

Indirect Costs

The discussion of aggreate consumption benefits began with an elaboration of the measurement of "direct" benefits and finished with a discussion of "indirect" benefits. The distinction is a matter of convenience, but it can be applied in the same way to the treatment of aggregate consumption costs. Thus far we have covered what might be called the "direct" costs; and it remains to discuss the "indirect" costs. To each of the three categories of indirect benefits there is a corresponding category of indirect costs.

The first category of indirect costs involves the correction of input costs measured according to producer willingness to pay. This correction does not apply in the case of labour or foreign exchange inputs, since the methods for determining their opportunity costs were independent of producer willingness to pay. The correction does apply to domestically produced inputs, however, in a manner anelogous to the correction of benefits from project output which is sold to producers for futher processing rather than directly to consumers. Indirect benefits of this category arise if -- in the further processing of the input in question -- there are either market imperfections or changes in prices due to the increment in demand brought about by the project. In such instances producer willingness to pay for the input must be supplemented by monopoly or monopsony profits in further processing, and/or losses of consumer surplus due to higher prices further along the line. As noted earlier, the correction differs from that applied to project benefits only in that we now consider a marginal reduction rather than a marginal increase in the supply of the good in question.

The second category of indirect costs is simply the negative counterpart of the corresponding indirect benefits: external effects which result in a net loss to society. A typical example is the pollution of air or water by industrial plants: the discharge is a by-product of the industrial process which results in net disbenefits to the surrounding population, although the people affected are not generally compensated for their discomfort by those responsible for the plant. In such cases, there is a consumption cost of society which ought to be included in the assessment of a project. A second type of external disbenefit results when the consumption of project output by one consumer adversely affects the welfare of other consumers. In such cases, the benefits to the immediate consumer must be corrected by the resulting costs to other consumers. Thus the purchase of guns may entrail indirect costs, just as the purchase of telephones entails indirect benefits.

Neither of the above categories of indirect costs is likely to play a significant role in the Panagua Project. Like the corresponding indirect benefits, they will simply be ignored for the purposes of the current evaluation.

Third Category of Indirect Benefits and Costs

We turn now to the last category of indirect costs, which will be discussed simultaneously with the corresponding indirect benefits. This category of benefits and costs assumes significance when the ultimate consumption value of funds devoted to investment -- the "social value" of investment -- exceeds the immediate consumption value of funds devoted to consumption -- the "social value" of consumption. The reasons for which this may occur, and the method for estimating the discrepancy between the social value of investment and of consumption, will have to be deferred until the discussion of intertemporal criteria in Chapter IV. For the present, it must simply be accepted that the value of <u>future</u> consumption made possible by investment in a given year t is equal to $_t$ times the corresponding value of consumption in year t itself.

Once this proposition is accepted, it becomes essential to evaluate the overall effect of the project -- benefits and costs -- on the mix of consumption and investment in the economy, for every year in which the project is in operation. 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 which 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 a 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 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 overall 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 a 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 sustain the opportunity 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. Two basic points must be emphasized: cash flows must only be considered if they would not have arisen in the absence of the project, and for every cash flow the benefits and costs sustained by the parties involved are necessarily equal to the net aggregate consumption benefits of the project as a whole.

Following this approach, let $\hat{B}_t$ be the unadjusted total value of net aggregate consumption benefits of a project in year t. Distinguish n groups or sectors affected by the project, and let the net benefits realized by each group i in year t be equal to $\hat{B}_t^i$, so that

$$\sum \hat{B}_t^i = \hat{B}_i$$

Now let the marginal propensity to save out of increased income (benefits) be σ_t^i for group i in year t. Then the net contribution of the project to investment in year t is given by

$$\Delta I_t = \sum_i \sigma_t^i \hat{B}_t^i$$

and the net contribution to consumption in year t is

$$\Delta C_t = \sum_i (1 - \sigma_t^i) \hat{B}_t^i$$

Since aggregate consumption benefits are initially valued in terms of their contribution to present consumption, there are extra indirect benefits (net of costs) to the extent that ΔI_t is non zero, and the social value of investment in year t, $\bar{p}_t$, exceeds the social value of consumption, 1. Thus the indirect net benefits of the third category in year t, amount to

$$B_t^* = (\bar{p} - 1) \Delta I_t$$

An alternative way of looking at this correction is to distinguish the consumption value of benefits and costs according to the group affected. Thus, the "value" of a unit of net benefits to group i in year t is defined by

$$v_t^i = [(1 - \sigma_t^i) \; 1 + (\sigma_t^i)\bar{p}_t]$$

according to the proportion in which group i divides its net benefits between consumption and investment. Then the overall net aggregate consumption benefits of the project in year t can be expressed as

$$B_t = \sum_i v_t^i \hat{B}_t^i = \hat{B}_t + B_t^* .$$

In either case, it is necessary to evaluate $\hat{B}^i_t$ and δ^t_i for each relevant group i and year t, whenever $\bar{p} = 1$. If $\bar{p} = 1$, it is clear that all $v^t_i = 1$, and $B^*_t = 0$, so that $B_t = \hat{B}_t$ and no correction is required.

We may now proceed to evaluate the overall net aggregate consumption benefit B_t for each year t of the Panagua Project. We begin by evaluating the term $\hat{B}_t$, which includes all net benefits other than the third category of indirect benefits and costs discussed above. Since it has been assumed that indirect benefits and costs of the first two categories are relatively insignificant, $\hat{B}_t$ may be calculated entirely on the basis of the "direct" benefits and costs discussed earlier.

Table 5 brings together the information from Table 1 to 4 which is required for measuring $\hat{B}_t$. Three sets of aggregate consumption benefits are distinguished from the figures in Table 1. The first set (1) includes the benefits from the agricultural crops produced on the Project land and sold in the domestic market; set (2) covers the benefits from the tomato crop which is exported; and set (3) covers the benefits flowing from the "social improvement works" included in the Project. The total value of these direct aggregate consumption benefits amounts to Ps. 84.6 million in year 5, the first year of operation of the Project, and rises to Ps. 166.4 million in year 10, at which level it is expected to remain for the duration of the useful life of the Project.

Six sets of aggregate consumption costs are distinguished in Table 5. The first three ((4), (5) and (6)) are drawn from Table 2 and cover the full range of labour inputs used in the Project: unskilled labour, agricultural extension workers, and other skilled labour (defined to include semi-skilled workers). Set (7) includes the total cost of imported inputs as calculated in Table 3. Set (8) and (9) cover the total cost of domestic inputs as given in Table 4; the cost of land (9) is distinguished from the remainder. The total value of these aggregate consumption (social opportunity) costs is calculated in Table 5 for each year of the Project. Subtracting these costs from the corresponding benefits, we arrive at the complete time stream of (direct) net aggregate consumption benefits $\hat{B}_t$. $\hat{B}_t$ is heavily negative during the first four years of construction; it remains below zero in the first year of cultivation; and thereafter it rises steadily to reach a plateau of Ps. 108.31 million from year 11 to the end of the Project.

If there were evidence that $\bar{p}_t = 1$ for all the years of the Project, there would be no indirect benefits or costs due to changes in the economy-wide consumption-investment mix, and no further calculations would be required. For the Galivian economy, however, the price of investment $\ddot{p}_t$ is estimated — according to methods to be discussed in Chapter V — at a value of 3.0, and this value is assumed to remain constant for the duration of the Project. It will also be assumed that the primary constraint on investment in Galivia is the rate of saving, so that, to calculate the indirect net benefits B_t^* for each year t, it becomes necessary to evaluate the distribution of net benefits $(\hat{B}_t^i)$ and the marginal properties to save (s_t^i) for each relevant group i.

We consider first the immediate impact of the Project benefits and costs as listed in Table 5. Each set of benefits and costs is associated with a group or sector which gains or loses, as shown in the first column of the Table. The Project output is divided three ways. The agricultural crops sold on the domestic market go to domestic agricultural consumers (C). The agricultural crops which are exported can be regarded — as before — as producing foreign exchange; since the foreign exchange market is controlled by the Government, it is the Government (G) which receives the foreign currency earnings in the first instance. The housing and social services provided by the Project represent benefits to the farmers (F). On the cost side, unskilled labour inputs, skilled labour inputs other than extension workers, and inputs of domentic materials and agricultural working capital, are simply withdrawn from alternative use in the private sector of the economy (P). Agricultural extension workers are shifted by the Ministry of Agriculture from other agricultural programmes; the loss is therefore sustained by farmers elsewhere (F). All inputs of foreign exchange must pass through the Government controlled market; the use of imported imputs on the Panagua Project thus draws down the foriegn exchange reserves of the Government (G). Finally, the opportunity cost of the land used in the Panagua Project is sustained by the farmers (F) who forego their prior net agricultural income.

In this way the Project benefits and costs are initially allocated among the groups C, G, F, and P. If the Panagua Project gave rise to no compensating cash flows, there would be no further distribution effects to examine. However, such a situation would clearly be most implausible. Project beneficiaries are likely to be charged something for their gains, and those who lose command over resources are likely to demand something for their losses. The farmers will not hand out their produce freely, nor will the Government be able to commandeer inputs for the Project works.

All of the cash flows which arise from the Project are listed in Table 6; also identified are the groups which gain and lose from each monetary transfer. To each set of benefits in Table 5 there corresponds a cash flow in Table 6. Thus C pays F for the agricultural output received (10); since the amount paid equals the aggregate consumption benefit (1) -- as measured by willingness to pay — there is no net gain for C and the benefit is redistributed to F. G receives the foreign exchange benefits of the tomato export (2), but must pay F in pesetas at the official exchange rate for the tomatoes (11). Since the peseta is overvalued, however, F gets only one half the aggregate consumption benefit value of the foreign exchange earnings, and the remainder stays with G. F benefits from the social improvement works constructed by G (3), but it is assumed that there is no charge made for the services (12) and hence F captures the full value of the benefits. (Various branches of the Galivian Government are affected by the Panagua Project: the M.W.A., the Ministry of Agriculture, the Treasury, the Foreign Exchange Control Agency, etc. Since all of these branches are ultimately financed out of the same budget, they are all included here under G.)

On the cost side there are a variety of cash flows associated with each item of Table 5. Unskilled albour (L) receives wages from G for work on the construction and operation of the Project works (13); unskilled labour also receives wages from F for farm cultivation, but since three fourths of this labour is family labour, only one fourth represents a transfer from F to L (15) and the remainder is a transfer from F to F (14). When the unskilled labourers give up their previous activity to join the Project, they forego earnings to the extent that they were employed (16). Since it has been assumed that they were not productively employed, the value of foregone earnings (16) is equal to zero. To the extent that they forego food or welfare provided by family or charity, there is a corresponding gain to others when they leave, so that the net effect on the group L can be considered zero. Agricultural extension workers (E)receive wages from the Ministry of Agriculture (6) on the

Panagua programme (17), but forego exactly the same wages elsewhere (18), so the net effect both on E and G is zero. Skilled labourers (S) also receive wages from G for work on the construction and operation of the Project works (19), but they forego wages of exactly the same amount from P (20). Thus P is exactly compensated for the opportunity cost of skilled labour (6), and the cost is redistributed to G; S is unaffected by the Project.

Just as G pays F in pesetas (11) for the foreign currency earned on exports, so F pays G (21) in pesetas at the official exchange rate for the foreign currency used for imported farm inputs. Since the peseta is overvalued, F is paying less than the social value of the foreign exchange, and is in effect receiving a subsidy for G from his fertilizer and other imported inputs. F also pays P for domestic material inputs (22), and G pays P for domestic inputs used in the construction and operation of the Project, as well as for the agricultural working capital made available to the farmer by the Ministry of Agriculture (23). These last two items (22) and (23) compensate P for the opportunity cost of domestic inputs (8), and thus the Project has no ultimate distribution effect on P. F is compensated for foregone income (9) by the land compensator payment (24) from G; whether the cost of (9) is thus fully transferred to G depends on the comparison of costs in different years (to be taken up in Chapter IV).

Thus far, all of the outlays involved in the construction and operation of the Project (by the M.W.A.), as well as in the supply of equipment and credit by the Ministry of Agriculture, have been put down as paid by the Galivain Government (G). A crucial question affecting the distributional effects of any public project is how the government finances its outlays. Do the funds come from the general budget, or are they raised by borrowing or by additional taxation. If the Panagua Project itself does not give rise to borrowing or taxation over and above the amounts which would have been raised in this way in its absence, then no further cash flows are involved, and the losses are correctly attributed to the general Government account (G). It will be assumed, however, that the Galivan Government is in a position to raise new taxes to pay for the domestic currency costs (a the prevailing market prices) of the construction of the Project works. (The foreign exchange component of construction costs is financed by a World Bank loan; this cost is attributed to G in (7) because all foreign exchange is subject to direct government control, and could be used by G for an alternative purpose if desired). Thus there is a cash flow from the taxed public (T) to G as shown in item (25) of Table 6. The last three items of the Table represent various payments levied by G on F for services rendered in connexion with the Project: the provision of irrigation water (26), the supply of farm equipment (27), and the supply of agricultural credit. The payments made by F do not necessarily match the costs to G; in the case of the irrigation fees (28), they are purposely set well below cost so as both to encourage the farmers to use the water and to redistribute benefits to the farmers.

This completes the enumeration of cash flows brought about by the Panagua Project. By combining and rearranging all the gains and losses described in Tables 5 and 6, one arrives at the ultimate distribution of net aggregate consumption benefits $\hat{B}_t$ given in Table 7. The four groups C,P, E and S are not affected by the Project -- gains exactly balance losses. All of the items in Table 5 and Table 6 (except for the cancelling flows to C, P, E and S) appear also in Table 7, where the remaining groups F, L, T and G share the net benefits $\hat{B}_t$ as shown. The farmer account involves gains due to receipts from the sale of output (29), from wages inputed to family labour (31), and from land compensation (34), as well as benefits from the social improvement works (32); There are losses due to the costs of cultivation (30); payments for housing and social services (32), and benefits foregone by the loss of farmer income (35) and the transfer of extension workers (36). Unlike the agricultural extension workers (E) and skilled labourers (S) who are merely shifted from one job to another, the unskilled labourers (L) are affected by the Project. They receive market wages (37) in excess of their foregone earnings (38), and the difference is a net gain of consumption benefits for them. The taxed public (T) sustains the loss due to additional taxation (39).

The Galivian Government (G) has the most complicated account, since it is affected by all flows involving the M.W.A., the Ministry of Agriculture, the Treasury and the Foreign Exchange Control Agency. Over-all receipts include the taxation payments (40) to the Treasury; farmer payments to the M.W.A.for housing and irrigation (41), and to the Ministry of Agriculture for equipment and credit (42). Payments by the M.W.A. and the Ministry involve labour and domestic inputs for the Project works, including working capital for the farmers (43), and compensation to landowners (44). The Foreign Exchange Control Agency receives foreign currency from the tomato exports (47) and pays foreign currency for all the imported inputs needed by the Project (45); in addition, it receives pesetas from the farmers for the inputs which it imports for them (46), and it pays the farmers in pesetas for the tomatoes which it exports (48).

The resulting ultimate distribution of Project net benefits by year can be read from the total rows of Table 7. Farmers as a group are clearly significant beneficiaries of the Project, with the consumption value of benefits rising rapidly to an annual rate of Ps. 71.78 million by year 11. Unskilled labourers also gain, by virtue of their employment at a market wage which exceeds their alternative opportunities for gain. The taxed public is the biggest lose, receiving nothing in the way of immediate benefits from the Project. Finally, the Galivian Government suffers net losses in the first five years of the Project, but thereafter manages to recover benefits in excess of costs. The sum of the net benefits distributed to F, L, T and G in each year (as given in the bottom row of Table 7) necessarily equals the overall net benefits calculated in Table 5.

We turn now to the respective marginal propensities to save s_t^i of each group i. Information on the s_t^i must be provided from above the Project level, so that consistent value can be used in assessing alternative projects. The value of s_t^t in any year t depends upon the incidence of the additional taxation. It will be assumed that in Galivia any increase in taxes must come from upper income groups and corporations whose marginal propensity to save is very high; s_t^t is estimated at 0.8. The Galivian Government uses all of its revenues at the margin for investment, so that $s_t^G = 1$ for all t. Farmers are believed to consume approximately 80% of their marginal earnings, while unskilled labourers consume all of their wages, so that $s_t^F = 0.2$ and $s_t^l = 0.0$, and these values are assumed -- in the absence of better forecasts -- to remain constant for the diration of the Project.

Since $\bar{p}_t$ has been estimated at 3.0 for each year of the Project, it is now possible to solve for the social value v_t^i of a unit of net benefits to each group i in any year t, using the equation derived earlier:

$$v_t^i = [(1 - \sigma_t^i)\ 1 + (^{i}_{t})\ P]$$

According to this formula, $v_t^T = 2.6$, $v_t^G = 3.0$, $v_t^F = 1.4$ and $v_t^i = 1.0$. These values may be used to adjust the net benefits $\hat{B}_t^i$ given in Table 7 for $i = F, L, T, G$ to account for the indirect net benefits -- to the economy as a whole -- due to the social premium on investment. The calculations are carried out in Table 8. It will be observed that, in each year, the indirect net benefits are very significant by comparison with $\hat{B}_t$, so that B_t -- the overall net benefits -- amounts to a multiple of the immediate net benefits $\hat{B}_t$ calculated in Table 5. During the period of construction of the Project -- years 1 to 4 -- B_t is more than three times as great as $\hat{B}_t$ This reflects what may be called the "opportunity cost of public investment" in the Galivan economy. Funds devoted to capital investment in the Panagua Project must be withdrawn from use elsewhere in the economy. Some of these funds come from taxpayers with a high marginal propensity to save, and some come from the Government with an even higher marginal propensity to save. The result is that most of the funds investment in the Panagua Project are drawn away from alternative investment opportunities, and -- given the high value of investment relative to consumption -- this represents an important social loss.

The Panagua Project will make a positive contribution to the aggregate consumption objective only if the net benefits in later years are great enough to pay for the initial withdrawal of investible funds from alternative projects. The net benefits B_t are positive from year 6 on, and they are also greater than the corresponding $\hat{B}_t$ because of indirect benefits due to the reinvestment potential of the immediate benefits. The multiple is in this case appropriately two -- less than in the case of construction costs, because the beneficiaries of the Project (primarily the farmers) have a much lower marginal propensity to save than the groups which pay for the Project. Whether the net benefits of the later years make up for the net costs of the earlier years depends upon the weights given to the different years; this topic will be treated in Chapter IV.

Redistribution Objectives

A redistribution benefit (cost) is simply an aggregate consumption benefit (cost) that accrues to a particular region or group which is singled out for special treatment. Thus the evaluation of redistribution benefits and costs involves exactly the same principle used in the previous section to determine the ultimate allocation of project benefits and costs among different economic groups. The net gain with respect to a given redistributional objective is measured by the value of the net aggregate consumption benefits received by the favoured region or group, minus the value of any net cash payments made to other regions or groups.

In principle, it is necessary to examine all the aggregate consumption benefits and costs of the project, as well as all the accompanying cash transfers, and to determine to what extent each item affects the region or group in question. Direct project benefits can usually be associated with particular groups of beneficiaries without any difficulty, and the corresponding cash payments -- if any -- can be deducted from the willingness to pay for the benefits to determine their net redistributional effect. The same net redistribution benefits which flow to the beneficiaries as a group also represent redistribution benefits for the region in which they live. Indirect project benefits of the first two categories may be somewhat harder to allocate to beneficiaries, but -- to the extent that they are significant enough to be included among aggregate consumption benefits -- this should not be an insurmountable problem. Typically, there are no cash payment counterflows to such indirect benefits.

On the cost side, the issue becomes more complex. When a worker is withdrawn from employment elsewhere in the economy to work on a public project, the opportunity cost is usually passed to the government: the private sector employer loses a man but saves his wage and -- assuming the wage reflects his marginal productivity -- comes out even; the worker himself changes employers but gets the same wage as before; and the government pays a wage which it wouldn't otherwise have to pay. From the point of view of redistribution among groups, the government is the ultimate loser and the worker is unaffected. From the point of view of redistribution among regions, however, there is a net gain to the Project region in which the worker now earns his wage, and an equal net loss to the region where the worker used to make his living. This follows from the definition of a region in terms of the people who live in a particular geographical area. If the worker in question was previously unemployed, there is no opportunity cost to the econmy when he is put to work on the public project. The government still loses the wage it must pay, but this wage now represents a net consumption gain to the worker and there is hence a redistribution effect in his favour. From the point of view of redistribution among regions, there is now a net gain to the project region as before, but no net loss to any other region.

When a material input is withdrawn from an alternative use in the economy to be applied in a public project, the opportunity cost is generally passed to the government in the same was as for employed labour: a private sector firm loses the input but saves the costs with which it would have been purchased, and -- assuming the market is competitive -- comes out even; the government pays for an input which it previously had not bought. Unlike the case of labour inputs, there are no regional or group redistribution effects involved here unless there are market imperfections which lead to discrepancies between willingness to pay and market prices. The situation is the same 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 regional or group gains of losses only to the extent that actual payments for foreign exchange differ from willingness to pay. 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 taxpaying or the lending public, in which case new cash flows arise with redistributional implications. To the extent that taxation is increased, there are not lossed to each group and region which 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.

Indirect project costs of the first two categories figure in the same way as the corresponding indirect benefit discussed above. It remains only to consider the indirect benefits and costs of the third category. When the construction of a public project draws funds away from alternative use in investment rather than in consumption, the loss to those who provide the funds is not measured by foregone present consumption, but by foregone future consumption that would have resulted from the investment. But some of this future consumption may well have accrued to persons other than those who did the saving, in which case the net loss to society exceeds the net loss to the individual. Similarly, any indirect aggregate consumption benefits due to the propensity to save out of direct benefits -- given a social value of investment greater than that of consumption - may not correspond to redistribution benefits for the group or region which receives the direct benefits The extra net consumption benefits of the third category are thus likely to be spread over many groups and regions, and are difficult to attribute to any one.

It is clear from the foregoing discussion that certain kinds of redistributional effects of a project are fairly easy to evaluate, while others are almost impossibly difficult. In particular, it is usually possible to assess fairly accurately the redistributive consequences of consumption benefits and costs -- or cash transfers -- which are confined to the project region, and affect solely a well-defined group within that region. Thus the employment of labour on a project, or the consumption of project output by local consumers, involve readily measurable redistributive effects. On the other hand, it is generally very difficult to isolate the redistributive effects of benefits and costs -- or cash transfers -- which affect "the rest of the economy" or the economy as a whole. What region ultimately loses when a worker moves from "outside" into the project region? Which regions or groups gain or lose when the rate of investment is increased in the economy as a whole, with a resulting gain in future consumption that exceeds the value of the alternative present consumption? In practice, one may well have to abandon the attempt to measure the economy-wide redistributive consequences of a given project, and concentrate simply on its major impact on the local region and various local groups.

We may now proceed to evaluate the contribution of the Panagua Project to two distinct redistributional objectives of the Galivian Government: redistribution of benefits in favour of the Mendalvan region, and redistribution of benefits in favour of the small farmers of the Seootuan Valley. Starting from scratch, we could proceed to examine each aggregate consumption benefit of Table 5, and each cash transfer of Table 6, to determine which items have a direct bearing on the welfare of the region and the group in question. Since, however, some of the work has already been done in connexion with the group-wise allocation of net consumption benefits in Table 7, it will be simpler to make use of those results.

The direct net consumption benefits redistributed to the Mendalvan regions include the net benefits realized as Mendalvans by all inhabitants of Mendalva. The Panagua Project affects four groups of Mendalvans: farmers, unskilled labourers, agricultural extension workers, and other skilled workers. The farmers are native Mendalvans, who are simply resettled in the Project area. Their net benefits thus correspond exactly to the net benefits to farmers in the regions from which the agricultural extension workers are withdrawn. The remaining items (29) to (35) are simply reproduced in Table 9 as part of the net regional benefit calculations. The unskilled labourers are also mostly native Mendalvans, but their origin does not affect the evaluation. Previously they were unemployed and received no wages; now they are employed in Mendalva and have gained consumption benefits equal to their wages, as covered by item (37) from Table 7 entered in Table 9. The agricultural extension workers are transferred from outside Mendalva and will earn income within the regions as (temporary) Mendalvans; their new earnings (17) must be included as regional benefits, while their foregone earnings (18) are disbenefits to the region from which they came. Finally, skilled labour is also brought into Mendalva to work on the Project, and the corresponding earnings (19) are Mendalva's gain. Even if these skilled workers had in fact been employed elsewhere in the same region, their displacement from other jobs would presumably have resulted in the immigration of another set of workers to fill their shoes, so that the net redistributional effect on Mendalva would be the same. Adding up the net consumption gains made by each group of Mendalvans, the total direct net regional benefits are derived for each year of the Project as shown in Table 9.

The consumption benefits redistributed by the Panagua Project to the small farmers of the Secotuan Valley can be calculated from the benefit and cost items (29) to (35) affecting all of the farmers in the area. For each item, it is necessary to assess the proportional impact on small farmers — defined as cultivators of land units of 10 hectares or less. As shown in Table 3 of the Panagua Project, there are at present 1907 small farm units in the Secotuan Valley area, and this number will rise to 3579 when the project is completed. Not all of the 3579, however, belong to the original class of small farmers, since some of these 10-hectare units are to be formed by paring down larger holdings of the farmers whom own land in the irrigated area. Apart from the 1907 small units, there are at present 173 units in excess of 10 hectares. Of these, 134 are expected to remain in excess of 10 hectares, and the remaining 39 will be cut down to 10 hectares. Thus, of the total of 3579 10-hectare units to be located on the irrigated land, 1907 will belong to the original small holders, 1633 will belong to small farmers relocated from the surrounding area, and 39 will belong to farmers in the previously larger holdings.

According to Table 3, the 1907 small farmers cultivate at present 42.9% of the land area to be taken over by the Project. It will be assumed that they earn likewise 42.9% of the annual net agricultural income resulting from current cultivation. No figures are available on the current earnings of the 1633 small farmers to be relocated from adjacent areas, but it may be reasonable to assume that their holdings are so small and the land so marginal that their sacrifice of current farm income is negligible. Thus the net agricultural income foregone by small farmers because of the Project may be estimated as .429 (35), where (35) refers (in Table 7) to the total benefits foregone by farmers because of the new use of the irrigated land.

After the Panagua Project is underway, the 3540 small farmers will hold 35,400 of the 40,000 cultivated hectares, or 88.5% of the total cultivated area. As before, it may be assumed that they receive the same percentage of the total market value of agricultural production and of imputed family wages, and that they incur the same percentage of cultivating costs, so that their net farm earnings amount to .885 [(29) - (30) + (31)]. With respect to net benefits from housing and social services, however, the percentage is different: it is more appropriate to assume that these benefits will be enjoyed by small farmers according to their fraction in numbers rather than in acreage. Thus the relevant value of net benefits becomes 3540/3713 [(32) - (33)] = .954 [(32) - (33)]. Finally, it is evident that none of the land compensation payments (34) are made for small holdings, so that this item does not appear in the redistribution account of the small farmers. Adding up the various items in the account, the total net small farmer benefits are derived for each year of the Project as shown in Table 9.

The figures shown in Table 9 describe the direct impact of the Panagua Project on Mendalva as a region and on the small farmers as a group. In the case of the regional redistribution of net consumption benefits, there remains one further adjustment which must be made to take account of the indirect as well as the direct impact of the project. Whether the direct benefits are consumed or invested, a part of them will be respect within the project region. To the extent that they result in a net transfer of wage or profit earnings from elsewhere in the economy to the project region, they will result in a new round of benefits to the region. For example, the expenditures arising from incomes earned on the Project may draw small businesses 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 f represents the proportion of (marginal) direct net regional consumption benefits R' which -- when respent -- result in additional net benefits to the region, then the value of indirect net regional consumption benefits R" can be expressed as

$$R'' = R'f + (R'f)f + (R'f^2)f + ...$$

or

$$R'' = R' (f + f^2 + f^3 + f^4 + ...)$$

and the total direct and indirect net regional consumption benefits R is given by

$$\begin{aligned} R &= R' + R'' \\ &= R' (1 + f + f^2 + f^3 + ...) \\ &= R' \left(\frac{1}{1-f}\right) \end{aligned}$$

The expression $(\frac{1}{1-f})$ is called the "regional income multiplier". It is applied to the <u>direct</u> net regional consumption benefits R'_t in a given year t to yield the resulting <u>total</u> net regional consumption benefits R_t. The use of the above formula for the regional income multiplier is subject to one qualification: the successive rounds of benefits fR', f^2R', f^3R' 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, and to apply different weights for different time periods according to the time-preference weighting system described in Chapter V. In practice, however, the calculations are likely to be sufficiently rough so that no such careful distinctions will be called for.

For the purpose of evaluating the net contribution of the Panagua Project to the objective of redistributing benefits to Mendalva, it will be assumed that 20% of the marginal consumption benefits accruing to Mendalvans are respent so as to result in additional benefits to the regions. This value of f is another another item of information that must be provided from above the project level in order to permit an adequate assessment of project benefits. With f= .2, the regional income multiplier for Mendalva is equal to 1.25, so that the direct net marginal benefits for each year, as shown in Table 9, must be increased by 25% to include the corresponding indirect benefits.

In the case of benefits redistributed to groups — as opposed to regions there is clearly no counterpart to the regional income multiplier. No matter how the small farmers of the Secotuan redistribute additional benefits to themselves in successive spending rounds. Thus the figures shown in Table 9 for the direct impact of the Panagua Project on the small farmer group represent at the same time the total impact.

Pricing Policy

The detailed discussion of the redistributional effects of a project — as between investors and consumers, between different regions, and between different groups -- serves to bring out clearly one aspect of the role which is played by pricing policy in public projects. The price which is charged by the Government to the consumers of the output of a public project determines directly the distribution of the corresponding benefits. The consumers gain to the extent that their willingness to pay exceeds their actual payments, and their actual payments are determined by the price set by the Government. By getting a (relatively) high price, the Government can capture the bulk of project benefits for itself; by setting a (relatively) low price, it passes them on to consumers. It these consumers live in a region or belong to a group to which the Government wishes to redistribute income, there would appear to be a good case for a low price to serve these redistributional objectives. On the other hand, if the consumers have a much lower marginal propensity to save than the Government, and if the social value of investment exceeds the social value of consumption, a greater contribution to consumption benefits for the ration as a whole would be obtained by setting a high price to keep most of the benefits in Government hands. The same set of potentially conflicting goals apply to all the prices in the project over which the Government has some control, for every price has distributional consequences. The determination of an optimal price policy -- just as the evaluation of the Project itself -- can be made only with knowledge of the relative importance attached to conflicting objectives.

The distributional effects described above are only one aspect of the pricing problem. A second aspect is that the price charged for a good or service has an important bearing on how that good or service is used, and -- in particular -- on whether it is put to use in such a way to provide a maximum of aggregate consumption benefits to the economy as a whole. Prices which are below "what the traffic will bear" call for a system of rationing to determine who gets the good or service in question at the favourable rate. Rationing may result in careless allocation of resources by the beneficiaries, and it may also entail significant administrative costs. Against this argument for relatively high prices -- to aid in allocating scarce resources in accordance with their most productive uses -- must be placed an argument for concessional prices to ensure the quick response of potential users to a new and profitable good of which they are initially skeptical. The case for such promotional pricing clearly becomes less compelling over time; once the users of the resource in question have become familiar with it, a subsidy cannot be justified by the aggregate consumption objective.

All of these issues may be illustrated with reference to the Panagua Project, in which the Galivian Government undertakes to provide irrigation water to the farmers of the Secotuan Valley. The irrigation fees actually charged to the farmers (item (26) in Table 6) amount to Ps. 20 million a year for the total irrigated areas. The excess of the farmers' willingness to pay for the water over his actual payments may be measured by subtracting the total costs of cultivation, inclusive of the irrigation fees (item (30) in Table 7), from the corresponding receipts for the sale of agricultural output (item (20) in Table 7). This excess rises from Ps. 16.7 million in year 5 to Ps. 53.40 million in years 11 through 54. These amounts represent benefits which could in principle be captured by the Galivian Government through higher irrigation fees, but which in practice the Government has chosen to place in the hands of the farmers.

By charging concessional fees for irrigation water, the Government increases the yearly net regional benefits to the Mandalvan region, as well as the yearly net group benefits to the small farmers (see Table 9). On the other hand, it decreases the yearly net aggregate consumption benefits to Galivia as a whole because benefits are shifted from the Government with a "social value of income" equal to 3.0 -- to the farmers -- with a "social value of income" equal to 1.4 (see Table 8); the net effect is to reduce the rate of reinvestment out of benefits in each of the years in question. Apart from the contribution to redistributional objectives, the Galivian Government may defend its concessional price policy on the grounds that the incentive of substantial profit from irrigated farming is necessary in order to encourage the farmer to use the water. If higher irrigation fees were charged, the farmer might prefer not to use the water ataall: there would thus be an aggregate consumption loss, as well as a redistribution of the remaining benefits from the farmer to the Government.

The main point which emerges from this discussion is that pricing in public investment projects affects different national objectives in different ways. It is therefore necessary in formulating a price policy to examine the implications of a given price for each separate objective, and to consider the relative importance of the conflicting objectives to the nation as a whole. The need to recover costs through revenues -- however crucial in the investment decisions of private enterprise -- should play a decisive role neither in the allocation of public investment funds nor in the pricing policy of public projects.

<u>Other Objectives</u>

In addition to aggregate consumption and redistribution objectives, three more distinct categories of objectives were proposed in Chapter II. These are: the reduction of unemployment (*per se*), the improvement of the balance of trade (*per se*), and the fulfillment of merit wants. For reasons discussed in Chapter II, these objectives are likely to play a much smaller role in the calculus of national welfare than the first two. The discussion of the measurement of benefits and costs with respect to these objectives will therefore be much briefer.

In the case of the employment objective, the principle of measurement is very simple, Every unemployed person who gains employment as a result of the project represents a unit benefit; any otherwise employed person who loses his employment as a result of the project represents a unit cost. There are benefits to the extent that the project, or any ancillary activity attributable to the project, hires previously unemployed labour; there are costs to the extent that labour is laid off elsewhere in the economy because other activities have been adversely affected by the Project. In practice, it is difficult to conceive of a situation in which a project could give rise to net unemployment elsewhere. This would be possible only if otherwise unemployable labour were required in fixed proportions to another resource withdrawn from alternative use for input to the project. Even if such a case did arise, it would clearly be very difficult to assess its quantitative significance. As a result, the measurement of net benefits with respect to the reduction of unemployment is likely to be confined to the immediate effect of the project itself. In the case of the Panagua Project, the benefits would be measured by the number of unskilled labourers working on the irrigation system or cultivating the land in any given year, for unskilled labourers are assumed to have no alternative source of employment.

The contribution of a project to the objective of improving the balance of trade is measured by its net effect on the supply of foreign exchange available to the economy. If the project output is exported, or if it substitutes for products which could otherwise have been imported, the earnings (or savings) of foreign exchange represent benefits with respect to the trade objective. The total foreign exchange value of imported inputs to the project, on the other hand, clearly represents a cost with respect to the trade objective. In addition to these direct effects, a variety of possible indirect effects must be considered. Thus if the project stimulates the expansion of production in other industries -- either via external effects or by supplying inputs for processing -- then the corresponding (net) export earnings or import savings of these industries should also be counted as benefits. Similarly, if the project brings about an expansion of production from industries supplying the project with domestic inputs, the corresponding imported input requirements of those industries must be counted as costs. In either case, the benefits and costs attributable to the expansion of related industries should be associated with the project in question only if the expansion would not have occurred in the absence of the project.

Under certain circumstances, an additional category of indirect net benefits with respect to the trade objective might arise from the redistribution of income that accompanies the undertaking of a project. As noted earlier, certain groups suffere losses in the initial years when a project investment is made, while other groups share the benefits when the returns come in later. If these groups have positive effective propensities to import out of marginal net benefits, the over-all availability of foreign exchange in the economy will be affected. Those who suffer losses when resources are drawn into a public investment project will cut down their imports and reduce the econcmy-wide drawn on foreign exchange; those who receive benefits will increase their imports and the corresponding drawn on foreign exchange.

In order for these effects to materialize, it must be assumed that the Government does not have sufficient control over the allocation of foreign exchange resources to prevent thepprivate sector form satisfying its marginal demands. Since the trade objective itself is only likely to be relevant when there is a scarcity of foreign exchange at the official price, there is bound to be a certain measure of control in effect. And even if this control is not at all complete, it is likely to complicate the market for foreign exchange to such an extent that it would no longer be meaningful to reckon with fixed marginal propensities to import. As a result, it would be unrealistic, and/or unnecessary to try to link the redistribution of income brought about by a project with its contribution to the objective of improving the balance of trade.

The direct effect of the Panagua Project on the availability of foreign exchange in Galivia includes the foreign exchange value of the exported tomatoes as benefits, and the foreign exchange value of all imported inputs as costs. Using the official rate of exchange of ten pesetas to a dollar, these benefits and costs in dollar units are shown for each year of the Project in Table 8a.

The indirect effects arising from changes in production stimulated by the project elsewhere in the economy are assumed to be negligible. Such effects might have arisen if -- for example -- the wheat produced in the project gave rise to increased exports of flour. In that event, the expansion of flour milling -- including all of the associated benefits and costs -- would be treated just as if it formed part of the original Project, in the same way that the agricultural programme for the Secotuan Valley is treated as a part of the Panagua irrigation complex.

The measurement of benefits and costs with respect to the objective of fulfilling merit wants varies with the nature of the merit want in question. The important thing is to find a well-defined quantitative yardstick for assessing the contribution of projects to the output of the goods or services that public policy has elevated above tests based on market prices, i.e., on individual willingness to pay. Thus one might measure nutritional benefits in units of calories, vitamins, protiens, etc.; educational benefits in terms of the number of students emerging from different categories of educational establishments; health benefits in terms of the number of hospital beds; etc. Merit-want costs exist only if the project requires a sacrifice with respect to the merit want in question. This might occur, for example, if the preservation of fresh water is considered a merit want, and a project plant pollutes a local river with its refuse. This example also illustrates the possibility of indirect merit-want benefits and costs, defined analogously with indirect consumption benefits and costs.

Chapter IV

INTERTEMPORAL CRITERIA

So far we have measured benefits and costs with respect to:
(a) a <u>single</u> objective at a time; (b) a <u>single</u> year at a time.

Now we require a method for comparing benefits and costs with respect to different objectives, and in different years. Comparison of different objectives to be taken up in Chapter V. In this Chapter, we take up comparison of (net) benefits in different years, with respect to a single objective at a time.

Start with aggregate consumption objective. We have a time stream of net benefits B_t over lifetime of a project (e.g. Panagua Project, years 1 to 54). How to determine value of all the B_t together? One solution is to ass them up: $\sum_t B_t$. But do we really want to count 100 dollars of benefits in year 50 as equal to value of 100 dollars in year 1? No. We prefer benefits sooner rather than later. Measure total contribution by $\sum_t \lambda_t B_t$, where λ_t is weight attached to year t benefits, and we presume that $\lambda_{t+1} < \lambda_t$ for all t.

Reasons for preferring earlier to later benefits $(\lambda_{t+1} < \lambda_t)$: (a) Nation will be richer in the future, and <u>extra</u> unit of benefits will mean less satisfaction by comparison with present situation. Just like redistrubuting income from rich to poor at any given time, may be desirable to redistribute income from richer (future) generations to poorer (present) generations; (b) Possibility of "pure time preference."

Define discount rate for year t as follows:

$$i_t = \frac{\lambda_t - \lambda_{t+1}}{\lambda_{t+1}}$$

so that i_t = the percentage rate at which λ_t changes over time. No essential reasonf for $\lambda_t / \lambda_{t+1}$ to remain constant for every year t, and so no reason for i_t to remain constant. But it is customary and very convenient to assume that i_t is constant, for lack of any better information to the contrary. It is also customary to fix $\lambda_0 = 1$, so that present (year 0) benefits are worth 1 per unit, and future benefits are worth less than 1 per unit (this involves no sacrifice of generality). Then we have:

$$i = \frac{1 - \lambda_1}{\lambda_1} = \frac{\lambda_1 - \lambda_2}{\lambda_2} = \frac{\lambda_2 - \lambda_3}{\lambda_3} = \ldots$$

so that

$$\lambda_1 = \frac{1}{1 + i}, \; \lambda_2 = \frac{1}{(1+i)}, \; \lambda_3 = \frac{1}{(1+i)^3}, \text{ etc.}$$

and we may measure the total contribution of a project to the aggregate consumption objective by

$$pv_i(0) = \sum_t \lambda_t B_t = \sum_{t=0}^{\infty} \frac{1}{(1+i)^t} B_t$$

$pv_i(0)$ is called the "net present value" of aggregate consumption benefits evaluated at the discount rate i, where "present" corresponds to year 0.

The discount rate can also be defined for continuous -- as opposed to discrete -- time as

$$i(t) = - \frac{d\lambda(t)}{dt} \cdot \frac{1}{\lambda(t)}$$

where $\lambda(t)$ is a continuous weighting function. Then, assuming i(t) is constant and $\lambda(0) = 1$, the corresponding net present value is measured by

$$pv_i(0) = \int_0^{\infty} \lambda(t)B(t)dt = \int_0^{\infty} e^{-it}B(t)dt$$

If the aggregate consumption objective is the only relevant objective (an unlikely event!), then a project should be undertaken if and only if $pv_i(0) > 0$, where i is the "social rate of discount." Discussion of how to determine i is put off until later; now we will consider alternatives to net present value which are sometimes suggested for evaluating a time stream of (net) benefits.

The Recoupment (or Payoff) Period, defined as the number of years T that it takes for a stream of net benefits $\sum_{t=0}^{t} B_t$ to make up for the initial capital outlay of a project, Use: rank project according to quickest payoff, or set maximum recoupment period $\bar{T}$ and undertake all projects for $T < \bar{T}$. Advantages: easy to apply and easy to understand. Disadvantages: (1) Useful only for point-input continuous output projects -- otherwise not clearly defined. (2) Net benefits after the recoupment of initial outlay are not taken into account. (3) Choice of unique $\bar{T}$ is not appropriate when projects compared have different lifetimes, and different time patterns of inputs and output. Summary: a crude method, useful only for comparison of basically similar projects, where future is highly uncertain after a relatively short period of time and the data do not warrant more accurate calculations. Ease of application may recommend it for screening purposes. Note: in socialist countries various refinements have been introduced to permit greater sophistication and accuracy. These methods are beyond scope of present discussion.

The Internal Rate of Return, defined as rate of discount ρ such that the net present value of a project equals zero: solve

$$pv_{\rho}(0) = \sum_{t=0}^{\infty} \frac{1}{(1+\rho)^t} B_t = 0$$

Use: rank projects according to highest ρ, or set minimum value $\bar{\rho}$ and undertake all projects for which $\rho > \bar{\rho}$. Advantages: in ranking projects, there is no need to determine a value for i (as in present value calculations); need only data from the projects themselves. Disadvantages: (1) It is difficult to compute ρ: require a tedious trial-and-error procedure. (2) The solution for 1 may not be unique: multiple values for ρ can appear whenever the time stream of net benefits changes sign more than one (e.g. -1, +5, -6 has ρ=1 and 2!). This won't cause trouble if — as in the Panagua Project — time stream is first negative (initial outlays for years 1-5) and then always positive (benefits exceed costs for years 6-54). This is likely to be typical. But in examining differences between alternative projects, it may not hold. (3) Value of ρ does not convey any information about size of project; when we have to choose between two mutually exclusive alternatives, may prefer big project with greater absolute benefits but lower rate of return than smaller project. Further comments: If ρ is unique, and if $\bar{\rho}$ is fixed at i, then the criterion $\rho > \bar{\rho}$ yields same yes-no decision as the criterion $pv_i(0) > 0$.

But the ranking of projects may well differ according to the two methods (for any given i). Summary: There is nothing which the internal rate of return methods does that cannot be done more easily and usually more accurately by the net present value method.

Profitability, or equivalent annual rate of return on investment is defined as

$$\Pi = \frac{B-C-D}{K} = \frac{B-C}{K} - d$$

where B, C and D are annual flows of (gross) benefits, current costs and depreciation; K is the initial capital outlay, and d is the annual rate of depreciation as a fraction of the capital outlay (d = D/K). Use: rank projects according to highest Π, or set minimum value $\bar{\Pi}$ undertake all projects for which $\Pi > \bar{\Pi}$. Advantages: (1) like the internal rate of return requires only project data for ranking;[1/] (2) Π is much easier to calculate than ρ. Disadvantages: (1) like ρ, does not distinguish size of a project; (2) applies only to point-input continuous-output projects were annual flow of net benefits is constant. Further comments: If $\bar{\Pi}$ is set equal to i, and if d is calculated accoring to the sinking-fund rule with the same interest rate $i = \bar{\Pi}$, then the criterion $\Pi > \bar{\Pi}$ yields the same yes-no decision as the criterion $pv_i(0) > 0$. But, as in the case of ρ, the ranking of projects may differ. Summar: It can be shown that $\Pi = \rho$ for the special case to which Π applies, if d is calculated according to the sinking-fund rule with an interest rate of Π. So Π shares some advantages and disadvantages with ρ, but has more limited application and easier to compute. Like the payoff period, the simplicity of Π may recommend it — where applicable — for screening purposes, but the net present value method is ultimately the most reliable.

Benefit-Cost Ratios: (a) The equivalent annual benefit-cost ratio is defined as

$$\mathcal{B}_r = \frac{B}{C+rK+D} = \frac{B}{C+(r+d)K}$$

where B, C, d and D are defined as above, and r is the annual cost of capital

---

1/ Except that the formula for d must be provided from outside the project.

funds. Use: rank projects according to highest β_i, or undertake all projects for which $\beta_r > 1$. Comments: β_r is like Π in that (1) it applies only to point-input continuous-output projects where the annual flow of net benefits is constant, and (2) it is easy to compute. It differs from Π in requiring an estimate of r from outside the project, just as the present value criterion differes from ρ. But the decision rule $\beta_r > 1$ is exactly the same as the decision rule $\Pi > \bar{\Pi}$ when $\bar{\Pi} = r$, as can be seen from the equality

$$\beta_r \equiv \frac{C+D+iK}{C+D+rK}$$

Thus, when r = i, the criterion $\beta_r > 1$ yields the same yes-no decision as the criterion $PV_i(0) > 0$.

(b) The present value benefit-cost ratio is defined as

$$\beta_r^* = B_r^* / C_r^*$$

where B_r^* and C_r^* denote the present value of the whole time stream of project gross benefits and costs, respectively, discounted at the rate r. It can be shown that if d is calculated according to the sinking-fun rule with an interest rate of r, β_r represents simply a special case of β_r^* when annual benefits and current costs are constant, and there is an initial (one-period) capital cost of K. If r = i, it is clear that the decision rule $B_r^* > 1$ is equivalent to the rule $PV_i(0) > 0$, since

$$PV_i(0) = \sum_{t=1}^{\infty} \frac{1}{(1+i)^t} B_t \equiv B_i^* - C_i^*$$

in terms of the notations used here. Like ρ and Π, neither β_r nor β_r^* can distinguish the size of alternative projects, and they are hence less useful than the present value method: Only the PV approach give a clear expression of the total net benefits expected from a project, and does so in a manner which involves consistent time-weighting for all projects. Hence the PV approach is to be preferred to all others.

To use the PV approach for comparing net benefits in different time periods, must choose discount rate i. How? The rate at which the weight on marginal contributions to consumption declined with time (i.e., the discount rate i) ought to reflect the intertemporal preferences for collective decisions held by individuals of the society; hence i is often called the "social rate of discount." i should represent the marginal rate of substitution between present and future consumption which the society would apply to decisions affecting it as a whole. Point: this rate i cannot be determined from observable economic data, for reasons given below. In choosing i, the policy makers must make a value judgment on the basis of intertemporal preferences which they hold by proxy for the people.

How about the market rate of interest r^M (abstracting from the multiplicity of market rates of interest)? Provided there are no institutional obstacles resulting in quotas, rationing, etc. (which there usually are in developing countries!), r^M at best reflects the rate at which it pays private investors marginally to borrow funds for investment, i.e. the marginal private rate of return to private investment: r^P. (r^P = marginal ρ as defined earlier if all benefits and costs are interpreted from the private investor's point of view, i.e., in terms of after-tax profits and market costs).

How about using r^P? Does it reflect society's marginal rate of intertemporal substitution? The argument is that a perfect capital market exactly balances individuals' marginal time preferences with the marginal productivity of investment opportunities in the economy. In other words, the marginal rate of intertemporal substitution (i) equals the marginal rate of intertemporal transformation (r^T), and r^T can be measured by r^P. Objection: r^P is unlikely to equal r^T because of differences between private and social calculations, and because of departures from competition in many markets: e.g., (1) direct taxes and part of indirect taxes must be included in social yield, but are not included in private yield, of investment. (2) gaps between prices and the marginal productivity of resources result in differences between private money costs and social costs (as discussed at length in Chapter III).

Counter Suggestion: Correct r^P to reflect marginal social rate of return to private investment: r^S (r^S = marginal ρ as defined earlier if all benefits and costs are interpreted from the point of view of society as a whole, i.e., in terms of the aggregate consumption benefits and costs defined in Chapter II). Now we can say that r^S measures r^T, and since r^T is equal to i, r^S also measures i. Objection: If capital market allows for discrepancy between r^P and r^S, how can we expect it to balance r and i? The balancing of r^T and i in any economy means that the rate of investment is optimal. But in a world of market imperfections and private-social discrepancies, there is no reason to believe it so. Further Objection: Even a perfect capital market may be inadequate to register society's collective intertemporal preferences, because these may differ from preferences expressed in private, atomistic investment decisions. In general, there is probably not enough weight given to future generations, and a tendency to save too little, so that r remains too high -- above the level of i.

Counter Suggestion: The failue of capital markets to balance r^T and i does not matter: even so, government should discount project net benefits and put together an investment programme using r^T rather than i. Why? Because government can subsequently distribute consumption over time in accordance with i, (just like a Fisherian individual decision-maker!) Objection: The government is not like a Fisherian individual! It can't distribute consumption benefits over time at will because it hasn't got that much fiscal and monetary control over the mix of private consumption and investment. In other words, it can't change the rate of investment so much that society's collective rate of discount i is raised enough, and/or that the marginal rate of intertemporal transformation r is lowered enough, so that i is brought into balance with r.

The upshot is that the government operates in a sub-optimal world, where $r^P \neq r^S = r^T \neq i$. There are political and institutional constraints, as well as explicit or implicit policy objectives other than aggregate consumption, which prevent the government from bringing about an "optimal" rate of investment for which $r^T = i$. Therefore, one cannot infer an appropriate i from r^P or r^S, and one cannot read i from any direct economic measurement. There remains no alternative but for policy makers to articulate views on the relative value of benefits at different times according to their best judgment of the intertemporal preferences held by society as a whole, and on that basis to determine the appropriate social rate of discount i.

The social rate of discount can be expressed formally in terms of a total social utility function U, defined as the sum of instantaneous utilities U(t), which are in turn functions $U[C(t)]$ of current consumption C(t). The time weight $\lambda(t)$ can be identified with the instantaneous marginal utility of consumption:

$$\lambda(t) = \frac{\partial U[C(t)]}{\partial C(t)} = U'(t)$$

and thus the social rate of discount i(t) can be expressed as

$$i(t) = \frac{d\lambda(t)}{dt} \cdot \frac{1}{\lambda(t)} = - \frac{\dot{\lambda}}{\lambda} = - \frac{\dot{U}'}{U'}$$

i(t) is the percentage rate at which the marginal utility of consumption <u>declines</u> over time.

<u>The simplest constant-elasticity utility function</u>. Suppose U(t) is given by

$$U(t) = U[C(t)] = -A[C(t)]^{-v} \quad (A, v > 0)$$

U is always negative, but approaches zero, as C increases. The elasticity of (instantaneous) utility with respect to consumption is given by

$$\frac{\partial U[C(t)]}{\partial [C(t)]} \cdot \frac{C(t)}{U[C(t)]} = U' \cdot \frac{C}{U} = -v$$

and the elasticity of (instantaneous) <u>marginal</u> utility with respect to consumption is given by

$$\frac{\partial U'[C(t)]}{\partial [C(t)]} \cdot \frac{C(t)}{U'[C(t)]} = U'' \cdot \frac{C}{U} = -(1+v)$$

The discount rate may be calculated as follows:

$$i = - \frac{\frac{d}{dt} U' [C(t)]}{U'[C(t)]} = - \frac{\dot{U}'}{U'} = (1+v) \frac{\dot{C}}{C}$$

Thus under the simplest constant-elasticity utility function, the social rate of discount is proportional to the <u>rate of growth</u> of consumption (but neutral with respect to the level of consumption), and the factor of proportionality is the negative of the <u>elasticity of marginal utility</u> with respect to consumption.

The utility function discussed above does not take into account population growth. Consider now the following alternative:

$$U(t) = U[C(t), N(t)] = N(t)u\left[\frac{C(t)}{N(t)}\right] = -AN(t)\left[\frac{C(t)}{N(t)}\right]^{-V}$$

where N(t) denotes the size of the population and U(t) is the per-capital utility at the time t. V now represents the negative of the elasticity of per-capita utility, and (1+V) the negative of the elasticity of per-capita marginal utility: The discount rate may be derived as follows:

$$i = -\frac{\dot{U}'}{U'} = -\frac{\dot{U}'}{U'} = (1+V)\left[\frac{\dot{C}}{C} - \frac{\dot{N}}{N}\right]$$

Thus when total utility is defined as the product of population and per capita constraint elasticity utility, the discount rate is proportional to the rate of growth of per-capital consumption, and the factor of proportionality is the negative of the per-capita elasticity of marginal utility.

The fact that the marginal rate of intertemporal substitution i -- the marginal social rate of discount -- is likely to differ from the marginal rate of intertemporal transformation r^T — the marginal social rate of return to (private) investment — has important consequences for the formulation of public investment criteria. It means that the (social) present value of the future consumption benefits provided by (marginal) investment is different from the (social) present value of the current consumption benefits provided by (marginal) consumption.

Suppose that the social rate of return to a unit of marginal private investment (at time 0) appears as a perpetual stream of net aggregate consumption benefits at a rate of r per year, and that all of these benefits go dir directly into consumption. The present value of this stream of benefits can be calculated according to the formula given in (6) above:

$$PV_1(o) = \int_o^\infty e^{-it}\, r\, dt = \left[\frac{r}{i}\right]$$

Thus we may say that the (social) present value $\bar{p}$ of a marginal unit of current private investment is equal to r/i in terms of current consumption.

In fact it is unrealistic to assume that all of the net aggregate consumption benefits will be consumed. Suppose now that (perpetually) a constant proportion μ of these benefits is saved and results in future investment. Then we must calculate $\bar{p}$ as follows. The initial unit of invested funds produces a stock of capital S whose value at time 0, $S(0) = 1$. This stock grows exponentially at a rate given by μr, where r is the annual yield of the capital and μ is the proportion saved, so that μr represents the amount reinvested. Thus we have

$$S(t) = e^{\mu r t}$$

Now the share of benefits going to consumption at any time t is given by

$$C(t) = (1-\mu)\ rS(t) = (1-\mu)\ r\ e^{\mu r t}$$

The present value of this stream of benefits can be calculated according to the (continuous time) present value formula as

$$PV_i(o) = \int_0^{\infty} e^{-it} C(t)\, dt$$

$$= (1-\mu)r \int_0^{\infty} e^{(\mu r - i)t}\, dt$$

$$= \boxed{\frac{(1-\mu)r}{i-\mu r}}$$

provided that the integral coverges, i.e., that $\mu r < i$. That is the formula used in the analysis of the Panagua Project to derive the 'social value of investment' $\bar{p}$. If $\mu = 0$, the formula reduces to the simpler case of $\bar{p} = r/i$.

In the above derivation, it was assumed for simplicity that i, μ and r remain constant over time. It follows then that the value of $\bar{p}$ is also constant over time. This suggests an alternative drivation of the constant value of $\bar{p}$. The social value of the annual flow of benefits from a marginal unit of investment is no longer equal to r where some of the benefits are saved; the fraction μ which is saved must be re-evaluated at a price of $\bar{p}$ instead of 1. Thus we have

$$\text{social value of annual benefits} = \underset{\text{investment}}{r\mu\bar{p}} + \underset{\text{consumption}}{r(1-\mu)} = r[\mu\bar{p}+1-\mu]$$

The present value of the above stream of consumption benefits is given by

$$PV_1(0) = \int_0^{\infty} e^{-it}\, r[\mu\bar{p} + 1 - \mu]dt$$

$$= \frac{r[\mu\bar{p} + 1 - \mu]}{i}$$

But this present value is itself precisely the social value of a marginal unit of current private investment, which is equal to $\bar{p}$ by definition. Thus we may solve for (the constant) $\bar{p}$ as follows:

$$p = \frac{r[\mu\bar{p} + 1 - \mu]}{i}$$

$$\bar{p} = \boxed{\frac{(1-\mu)r}{i - \mu r}}$$

When the social value of investment $\bar{p}$ differs from 1, the (social) value of aggregate consumption benefits and costs must reflect the way in which these benefits and costs are divided between consumption and investment. To the extent that project outlays divert funds away from investment in alternative projects, the sacrifice to society is greater than the direct consumption costs, by the factor ($\bar{p}$ = 1). (The "opportunity cost of public investment funds" is different from 1). Similarly, to the extent that project benefits are reinvested in new projects, the social gain is greater than the direct consumption benefits by the factory ($\bar{p}$ - 1). These effects proved to be very important in the evaluation of the consumption benefits and costs of the Panagua Project; they are discussed in detail in Part A of Chapter II under the heading of "the third category of indirect benefits and costs."

Strictly speaking the price $\bar{p}$ applies to a marginal unit of investment undertaken by the private sector, since r - the marginal rate of intertemporal transformation in the economy - is assumed to be measured by r^S, the marginal social rate of return to private investment, this assumption is appropriate when most of the investment in the economy is in fact undertaken by the private sector, and public investment is relatively small, Under these circumstances, however, it is important to recognize the possibility that the social value of a marginal unit of public investment ($\hat{p}$) may differ from the corresponding social value of a marginal unit of private investment ($\bar{p}$).

Budgetary constraints.

If there is an effective limitation on the financial resources available to the public sector, the government may not be in a position to investmin a sufficient number of public projects to drive the marginal social rate of return to public investment ($\hat{r}$) down to the prevailing marginal social rate of return to private investment (r^S). Then it becomes necessary to estimate $\hat{p}$ separately from $\bar{p}$, and to use $\hat{p}$ in evaluating the fraction of aggregate consumption benefits (costs) which result in increased (decreased) public investment. One way to estimate $\hat{p}$ would be to substitute $\hat{r}$ and μ into the formula for $\bar{p}$ (μ representing the fraction re-invested out of public project aggregate consumption benefits). This method implicitly assumes that the re-invested funds also yield returns at a rate of $\hat{r}$ rather than r^S.

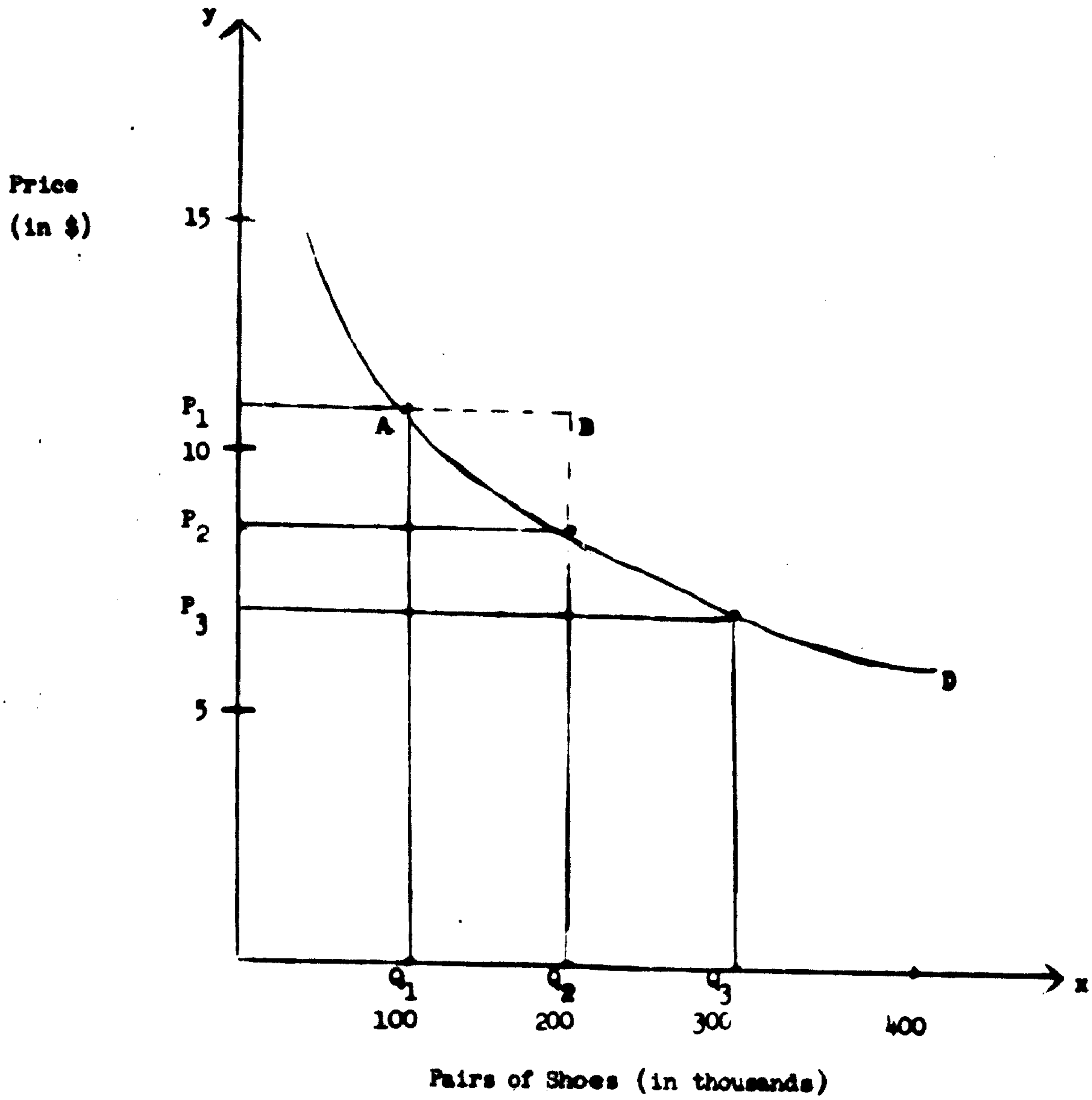
If the aggregate consumption objective were the sole determinant of public policy, it would be desirable to exploit all the investment opportunities -- public and private -- with a positive present value of net aggregate consumption benefits (discounted at the rate i).. In this event both $\hat{r}$ and r^S(but not necessarily r^P!) would be dirven into equality with i. But political and institutional constraints on the size of the government budget are likely to prevent the government from equating $\hat{r}$ with i, and similar constraints operating on government fiscal and monetary policy in general may prevent it from bringing r^S into equality with i. Furthermore, the existence of objectives other than aggregate consumption may well mean that the government does not necessarily want to equate either $\hat{r}$ or r^S with i. Under these circumstances, not only will the equalities $\hat{r} = r^S = i$ fail to hold, but little can be said about the relationship between $\hat{r}$ and r^S (and hence between $\hat{p}$ and $\bar{p}$). It is possible that $\hat{r} > r^S$, as suggested earlier, but it is also possible that $\hat{r} < r^S$. In any event, so long as $\hat{r} \neq r^S$, it is necessary to distinguish $\hat{p}$ from $\bar{p}$. In Chapter II, and in the evaluation of the Panagua Project, this distinction was not made; it was implicitly assumed that $\hat{r} = r^S$.

Intertemporal criteria for other objectives.

Up to this point we have been concerned solely with intertemporal criteria for the aggregate consumption objective. It is also necessary, of course, to compare the net benefits with respect to other objectives which occur at different points ón time. The same principle is involved: time weights λ_t or $\lambda(t)$ must be assigned, and if these are assumed to decline at a constant percentage rate over time, a single constant discount rate i may be used. There is no reason why the time weights (or discount rate) should necessarily be the same with respect to all objectives. On the contrary, it is much more likely that that time pattern of weights will <u>differ</u> for different objectives, since the ratesaat which constributions are made to different objectives are likely to be quite different. The relationship between weights and contributions will be explored at greater length in the following chapter. For the purpose of evaluation the Panagua Project, it is assumed for convenience that the constant discount rate of i = 10% applies to all of the objectives considered.

DIAGRAM 1

Demand for Shoes



Chapter V

THE RECONCILIATION OF MULTIPLE OBJECTIVES

Previous chapter concerned with reconciliation of multiple time periods. Now we are concerned with reconciliation of multiple objectives, i.e. finding method to compare net benefits with respect to differing and conflicting objectives.

One solution is to assign complete priority to one objective; this is simple and in fact usually practiced with the aggregate consumption objectives (of the original Panagua Project evaluation). Objection: this method implies that government policy makers are insensitive to the "trade-offs" between different objectives that are afforded by alternative designs or projects. Aggregate consumption benefits may be more important than redistribution benefits, but would the government not sacrifice a small amount of aggregate consumption benefits if it could thereby bring about an enormous redistribution gain? There are ultimately no absolute priorities; these are only relative desirabilities.

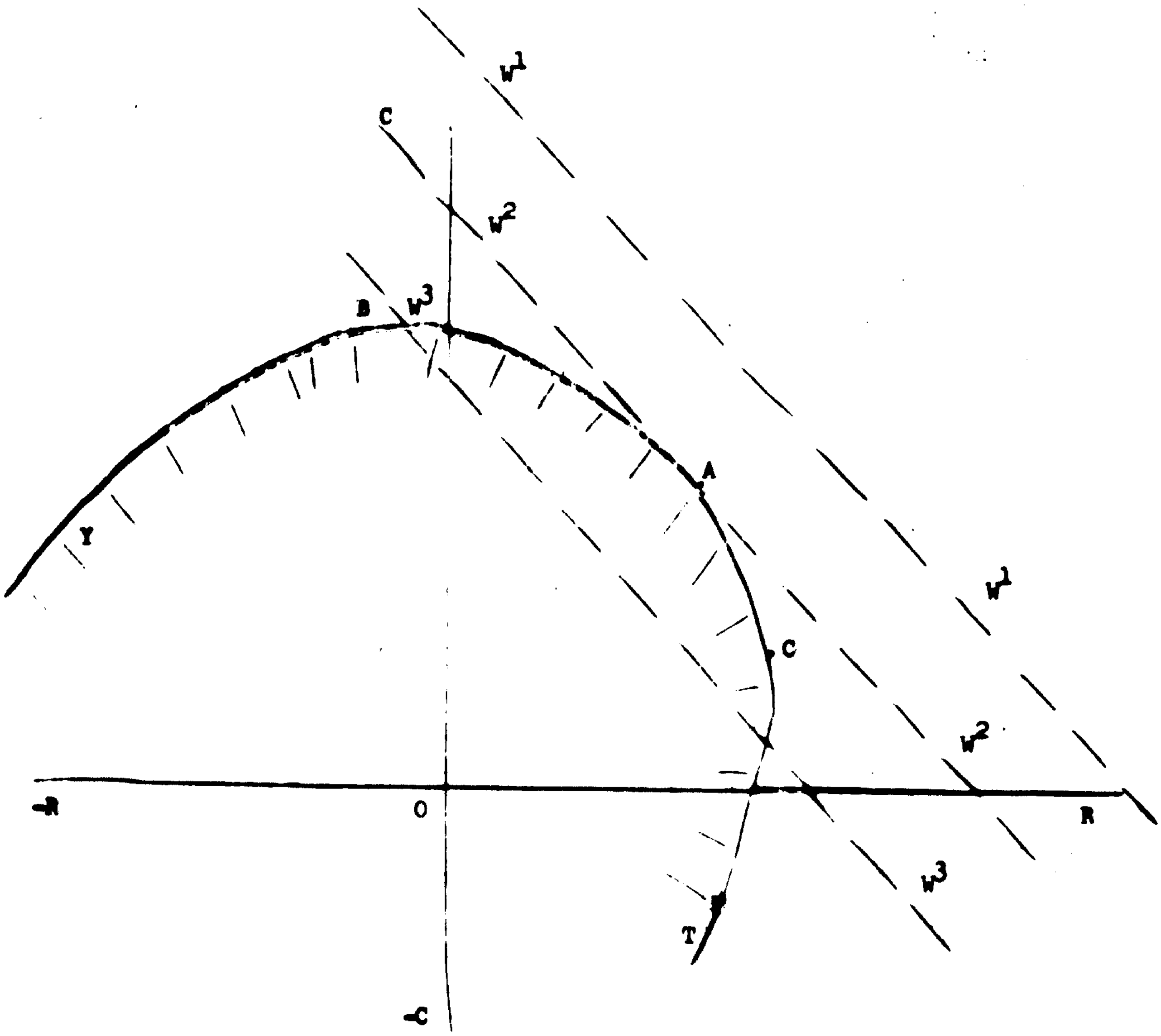
An alternative to absolute priorities is to assign weights to contributions to different objectives (just as weights were assigned to different time periods in Chapter IV), and to indicate the relative importance of the different objectives by the corresponding numerical weights. Then the guiding principle of project formulation and evaluation becomes to maximize the weighted sum of net benefits with respect to each objective. This is the procedure used in the analysis of the Panagua Project; its overall net present value - the worth of the undertaking is measured by: $V = \theta^{C}C + \theta^{RM} R^{M} + \theta^{RSF} R^{SF}$ where C, R^{M} and R^{SF} are the quantitative contribution to the three major objectives (aggregate consumption, redustribution to Mendalva, and redistribution to small farmers) and $\theta^{C} = 1$, $\theta^{RM} = 0.25$, $\theta^{RSF} = 0.50$ are the corresponding numerical weights.

The maximization - at the project level - of a weighted sum of net benefits with respect to different objectives can be illustrated diagramatically. (Diagram 2 measures net consumption benefits along Y-axis and net redistribution benefits along X-axis; convex transformation curve T and linear welfare isoquants W^i are shown). Transformation curve T defined as boundary of set of feasible combinations; shows technological trade-off between the two objectives. Welfare isoquants W^i are linear because of assumption of constant weights. Maximum overall net present value V* obtained by tangency condition; proceed to undertake project if $V^* > 0$, reject project if $V^* < 0$. Note that V* does not maximize benefits with respect to either objective considered separately.

The question is now how are the values for weights on different objectives determined? From the point of view of the industrial project these values are given from above by policy-makers at the central government level, just as the rates of discount with respect to any single objective must also be handed down from a central source. But how are the values determined at the center? Assume for convenience that the weight on the aggregate consumption objective is always set equal to one. The government must then decide how much of net aggregate consumption benefits it would be prepared to sacrifice (at the margin) in order to gain one unit of net benefits with respect to another objective, e.g. redistribution of consumption benefits to a poor region. The answer to this question is clearly dependent on how poor the region is. The whole point of placing special weight on consumption benefits in a particular region - over and above the weight placed on consumption benefits in the country as a whole - is to help raise the level of income (or welfare) in that region. The poorer the region, the greater the extra weight which it presumably deserves.

The preceding discussion suggests an alternative way of reconciling multiple objectives at the national level. Instead of specifying weights for each objective and maximizing the weighted sum of net benefits, the government could specify a minimum requirement of net benefits with respect to one or more objectives, and maximize the (weighted sum of) net benefits with respect to the remaining objective(s). Thus, (assuming for the moment that there are only two erelevant objectives) the Galivian Government could set a target for regional consumption benefits in Mendalva, and go about maximizing aggregate consumption benefits subject to the constraint that the target for Mendalva is attained. It might well be easier for the Government to think in terms of quantitative targets (constraints) than in terms of relative weights.

DIAGRAM 2



Net consumption benefits (C) on vertical axis
Net redistribution benefits (R) on horizontal axis

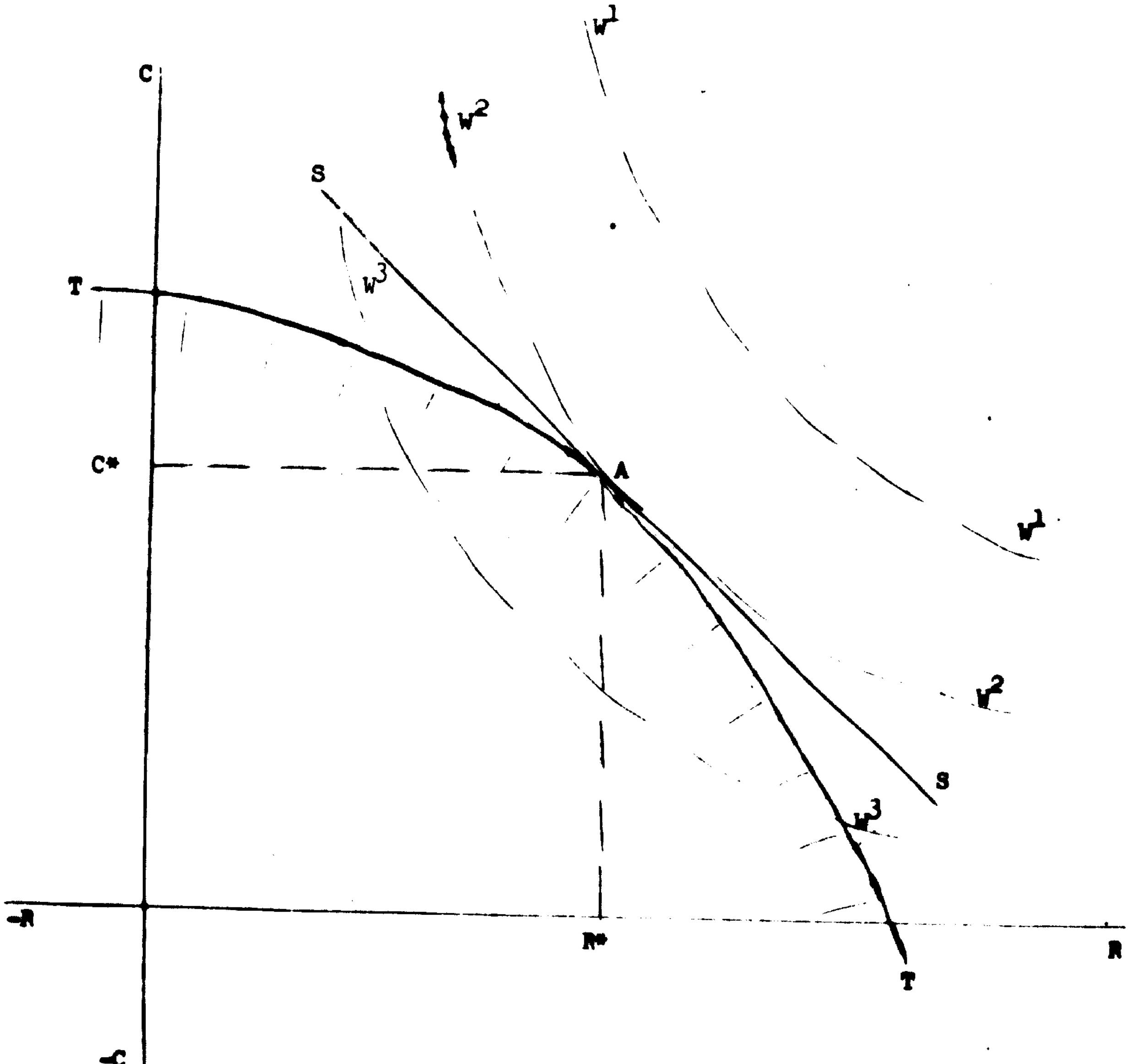
C maximized at point B
R maximized at point C
W maximized at point A

In fact, the alternative approaches to harmonizing conflicting objectives are fundamentally the same. Specification of constraint levels, superficially a different kind of decision from the choice of weight, implicitly specifies the marginal weights involved. Thus, when the Galivian Government set a target for Mendalvan regional consumption benefits, it implies a weight for redistribution to Mendalva relative to aggregate consumption benefits. A small reduction in the level of the regional consumption targets would presumably allow a small increase in aggregate consumption through marginal adjustment in the public investment programme. The ratio of the change in aggregate consumption to the change in Mendalvan consumption represents an implicit marginal weight on Mendalvan consumption relative to aggregate consumption. By the same token, the specification of a (marginal) weight on Mendlavan consumption relative to aggregate consumption implies a level of Mendalvan consumption that will be attained by carrying out the whole government programme using those weights; this consumption level corresponds to an implicit target.

The relationship between weights and constraints can be illustrated with the help of Diagram 3. (Diagram measures net aggregate consumption benefits and net regional consumption benefits as before; convex transformation curve T and convex welfare isoquants W^i are shown). T now represents the boundary of feasible contributions to each objective by the whole range of investment under government control, not just by a single project. Each point on the curve represents a different investment programme. The welfare isoquant W^i are no longer linear; the marginal weights on different objectives vary with the actual contributions made to the respective objectives. The greater the net consumption benefits accruing to Mendalva, the less the corresponding marginal weight. The optimal programme is determined by the point on T touching the highest possible W^i. At this point, the slope of tangency measures both the marginal rate of substitution (W) and the marginal rate of transformation (T). The quivalence of maximizing a weighted sum of contributions, and of maximizing one contribution subject to a constraint on the other, can be demonstrated.

In setting weights on different objectives for use in evaluating individual projects, the policy makers clearly want to approach the position of tangency which defines the optimal overall investment programme - given the

DIAGRAM 3



W maximized at point A, where:

$C=C^*$, $R=R^*$, $W=W^2$

Slope of SS measures at point A both:

marginal rate of transformation $(-\frac{\partial C}{\partial R})_{T=const.}$

marginal rate of substituion $(-\frac{\partial C}{\partial R})_{W=const.}$

Equivalence between:

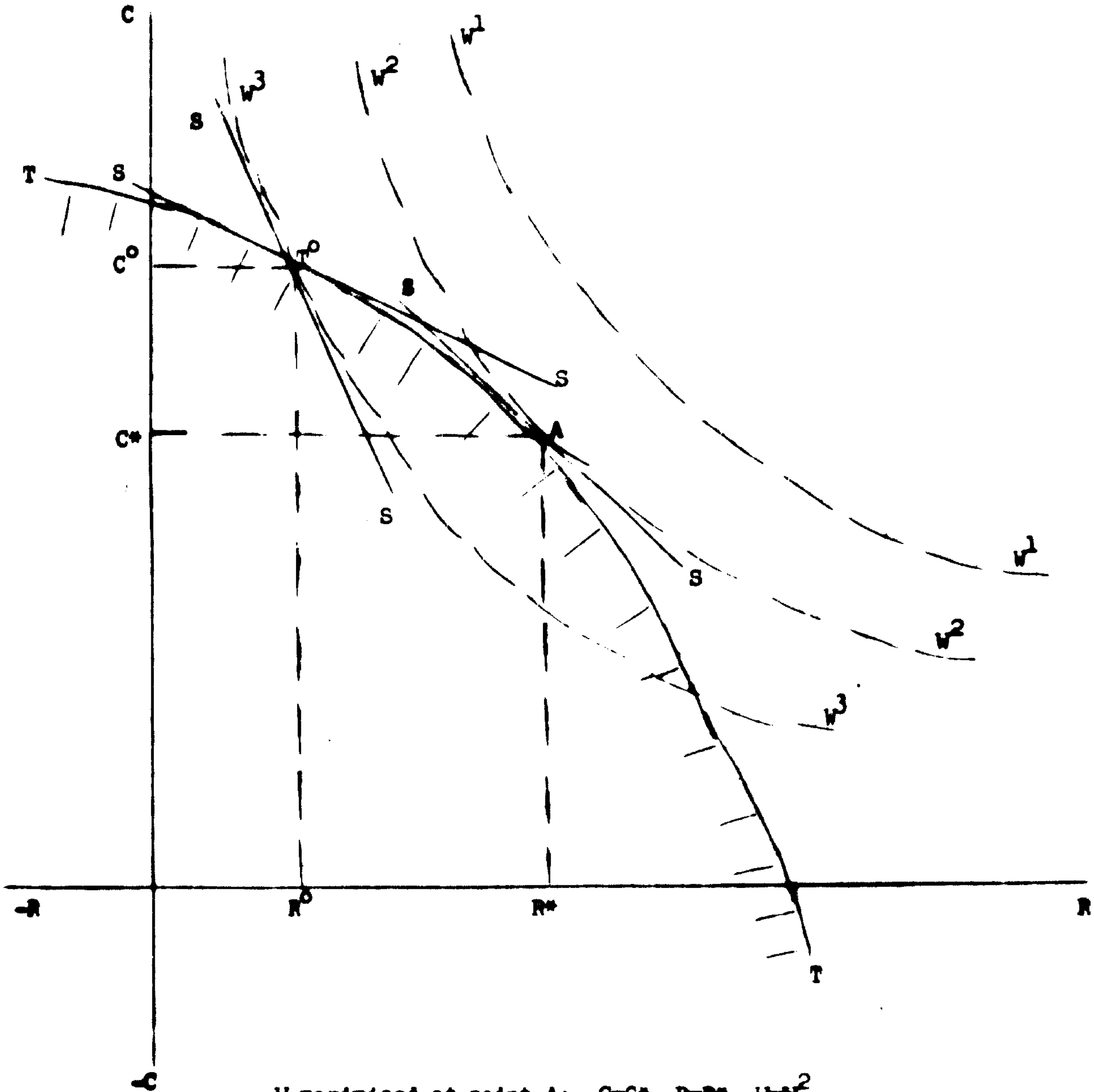
1) Max C subject to $R=R^*$
2) Max R subject to $C=C^*$
3) Max $W = \partial^c C + \partial^r R$,

where ∂^r / ∂^c = slope of SS transformation possibilities (T) of the economy, and the welfare preference map (W) held by the government as proxy for the people. If W and T were perfectly defined and known in advance there would be no problem in determining the appropriate weights and the corresponding targets. In fact, of course, the policy makers cannot know the shape of the transformation function (T) in its entirety, nor are they likely to be able to articulate their preferences in the form of a complete welfare map (or set of isoquants W^i). Only a small part of the T-curve is likely to be identifiable at any given time, and the preferences of the policy-makers depend directly on the alternative physical possibilities available to them. Thus it becomes necessary to think in terms of an iterative trial and error approach to the optimal investment programme, in which there is a regular two-way flow of information between technicians who design the programmes (underlying the T-curves) and policy-makers who express the relative preferences for different objectives (underlying the W-curves).

Such an iterative process can be illustrated by the simplified case in which the Galivian Government wishes to frame an investment programme catering to the two objectives of aggregate consumption and redistribution to the Mendalvan region. Diagram 4 reproduces the basic T- and W-curves shown in Diagram 3, with the optimal solution as before at point A. However, the policy-makers do not have sufficient information to discover immediately the set of weights θ^R and θ^C - in the ratio of the slope of SS - which would lead through the maximization of $\theta^{cC} + \theta^{rR}$ to the optimal investment programme. Instead, they must make an initial tentative estimate of their marginal preference for redistribution vis-à-vis consumption benefits, and direct the technicians to put together an investment programme on the basis of the corresponding weights. Using these weights to formulate and evaluate each individual project, the technicians will draw up a programme which corresponds to the point on the T-curve where the marginal rate of transformation - the slope - is equivalent to the initial marginal rate of substitution the ratio of the weights - enunciated by the policy-makers.

Suppose that the initial weights θ^C and θ^R correspond to the slope of S^TS^T in the diagram, so that the initial investment programme will be represented by the point T^O on the transformation curve. Having compiled the programme, the technicians can announce to the policy-makers that it provides them with

DIAGRAM 4



W maximized at point A: C=C*, R=R*, W=W²

Initial position at point T°: C=C°, R=R°, W=W³

At point T°, slope of S   slope of S

Slope of S = marginal rate of transformation at T°

Slope of S = marginal rate of substitution at T°

C^o and R^o units of consumption and redistribution benefits, respectively. On the basis of this initial position, the policy-makers should then ask themselves how much of C they would be willing to give up for an additional unit of R - i.e., what is their marginal rate of substitution at this point T^o. This rate is represented formally by the slope of welfare isoquant W^3 passing through T^o: it is equivalent to the slope of the straight line S^WS^W in the diagram. Since the slope of S^WS^W is steeper than the slope of S^TS^T, the diagram suggests that the policy-makers - in the light of the new information generated by the technicians - would now prefer to give greater emphasis to redistributing benefits to Mendalva (R) than they anticipated in setting the initial weights.

At the point T^o, the marginal (physical) rate of transformation between consumption and redistribution benefits is given by the slope of the T-curve at T^o, which corresponds exactly to the ratio of the initial weights specified by the Government. So long as the marginal rate of <u>substitution</u> differs from the marginal rate of <u>transformation</u> at a given point on the T-curve, it pays the Government to alter the investment programme. At the point T_o, extra redistribution benefits are inexpensive enough in terms of consumption benefits to warrant a change in the investment programme giving greater weight to the former. Thus the next step in the iterative process would be for the policy-makers to announce new weights - with a higher ratio of θ^R to θ^C - and direct the technicians to revise their initial programme by reformulating and re-evaluating projects so as to maximize the new weighted sum of $\theta^C C$ and $\theta^R R$. Having done this, the technicians would arrive at a new point on the T-curve - with lower C and higher R - and would again present the results in terms of C and R to the policy-makers. The same procedure could then be repeated until the optimal point would be reached at A, where the marginal rate of transformation and substitution are equal and the policy-makers would have no further desire to change the weights on the different objectives.

The foregoing discussion of an iterative process for arriving at optimal investment programmes clearly involves a great measure of simplification and idealization. The limitation on data availability and on time would surely not permit more than a few iterations over a planning period. However, the discussion does serve to emphasize several important aspects of the determination of weights for different national objectives. First of all, these weights cannot be setindependently of actual or potential achievements with respect to the objectives. Thus the specification of the weights must be made on the basis of information about the range of technically feasible possibilities, and part of the problem of setting weights is precisely to determine the range of possibilities. The second basic point is that it would be enormously wasteful and time-consuming even to try to make available in advance all of the relevant information about preferences and technology that go into the determination of an optimal investment programme. Instead, an economy of information must be achieved by decentralizing the process. Rather than a single solution calculated by a central body with all the information at hand, a decentralized procedure relying on a continuous exchange of information between policy-makers and technicians would appear to offer the only realistic hope of approach to an optimal investment programme. The number of iterations carried out, and the extent of the adjustment of individual projects in each case, would depend both on the capacity of the planning process for revising plans and on the size and importance of the projects in question.

Technical note: the approach to investment planning suggested above depends critically on the assumption of strict convexity of the set of feasible combinations to the different national objectives. This assumption will be satisfied so long as there exists severe complementarity between the contributions to different objectives over the relevant range of technically feasible alternative investment programmes.

Chapter VI

A SIMPLE MODEL OF THE LABOUR SURPLUS ECONOMY

This chapter presents the analyzes a model of an economy characterized by a surplus of labour at an institutionally given wage rate. Although the model necessarily represents a great simplification of reality, it does capture some of the distinctive features of developing economies with high rates of overt or disguised unemployment. The purpose of the discussion is twofold: to gain some insight into the problems of resource allocation - and hence project evaluation - in countries for which the model can be regarded as reasonably representative, and to illustrate some of the issues raised in earlier chapters - in particular, the concept of shadow pricing - with reference to a self-contained description of an economy.

The model focusses on the growth of the (modern) industrial part of the economy, and does not deal explicitly with (traditional) agriculture. A single sector is posited which produces the entire range of industrial output, and it is assumed that this sector can draw labour from elsewhere in the economy - or from "the reserve army of the unemployed" - without any corresponding loss in output. This is the basic assumption of the labour surplus. A second, equally basic, assumption is that the wage which is paid to all labour employed in the industrial sector is institutionally fixed. The second assumption provides the rationale for the first, the absorption of labour by the industrial sector is limited because of the necessity of paying the fixed wage, at which the supply of labour greatly exceeds the demand. Employed labour demands and gets a certain minimum compensation, and neither private employers nor the government can deny this to them. The third of the basic assumption is that all wage income is consumed,1/ while a certain fraction of non-wage income (profits) is saved. This assumption implies that the consumption investment mix in the economy depends upon the distribution of income, and cannot be independently controlled by the government. The three basic assumptions presented above describe the institutional constraints under which the labour-surplus economy

1/ It is enough to assume that there is an effective ceiling to the amount of savings the government is able to force or coax out of wage income. The ceiling is here assumed to be zero in order to simplity the discussion.

operates, and result in a situation in which market prices fail to reflect the corresponding social benefits and costs.

In algebraic terms, the model is formulated as follows: Industrial Output Q is produced by two factors of production, capital (K) and labour (L), with a production function,

$$(1) \qquad Q = Q(K,L)$$

The production function is assumed for simplicity to reflect constant returns to scale and not to change over time. The marginal productivities of capital and labour areaassumed to be positive and diminishing:

$$(2) \qquad Q_K > 0, \; Q_L > 0, \text{ where } Q_K = \frac{\partial Q}{\partial K}, \text{ and } Q_L = \frac{\partial Q}{\partial L}$$

$$(3) \qquad Q_{KK} < 0, \; Q_{LL} < 0, \text{ where } Q_{KK} = \frac{\partial^2 Q}{\partial K^2}, \text{ and } Q_{LL} = \frac{\partial^2 Q}{\partial L^2}$$

The output Q can be used either for consumption or for investment

$$(4) \qquad Q = C + I$$

And investment must be non-negative

$$(5) \qquad I \geq 0$$

The wage rate of fixed at the level W and is constant over time; thus total wage income W can be written:

$$(6) \qquad W = wL$$

and total nonwage income - or profits - is:

$$(7) \qquad P = Q - wL$$

A constant fraction of nonwage income is saved so that investment in the economy is given by:

$$(8) \qquad I = \alpha P = \alpha(Q - wL)$$

All of wage income is consumed, so that total consumption is equal to:

$$(9) \qquad \begin{aligned} C &= W + (1-\alpha)P \\ &= sL + (1-\alpha)(Q-wL) \\ &= (1-\alpha)Q + wL \end{aligned}$$

The model can be illustrated with reference to Diagram 5. Given an initial stock of capital K_o, output Q is a function of L showing diminishing marginal returns ($Q_{LL} < 0$). The ray W represents the total wage bill wL as a function of L. The residual after deducting the wage bill W from total output Q is equal to profits P, of which the proportion γ results in investment. Up to the point $\underline{L}$ - where the slope of $Q(K_o, I)$ equals the slope of W, so that the marginal productivity of labour Q_L equals the wage rate W - an increase in employment leads both to higher wage income and to higher non wage income, resulting both in higher consumption and in higher investment. Clearly, there is no reason to employ fewer than $\underline{L}$ workers. Beyond $\underline{L}$, increasing employment leads to greater wage income and total consumption, but to less nonwage income and total investment (since each woerker is given more consumption W than his marginal product Q_L). At employment $\bar{L}$, the wage bill just exhausts the total product and there can be no more investment. Thus $\bar{L}$ represents the maximum feasible employment. It is evidently optimal for the economy to operate somewhere between $\underline{L}$ which provides maximum profits and maximum investment) and $\bar{L}$ which provides maximum consumption and no investment. The optimal point depends on how the inherent conflict between consumption and investment is resolved.

The equation given earlier describe the productive structure of the economy, given the institutional constraints under which it operates. From these equation we can derive an expression for the "supply price of investment" in terms of consumption in other words, how much it costs in terms of consumption (how much consumption must be sacrificed) in order to obtain one additional unit of investment. With the capital stock K fixed at any given point of time, the only way to change consumption - investment mix in the economy is vary the level of employment L. The change in consumption resulting from a unit change of employment can be obtained by differentiating equation (9):

$$(10) \qquad \frac{\partial C}{\partial L} = (1 - \alpha) Q_L + \alpha W.$$

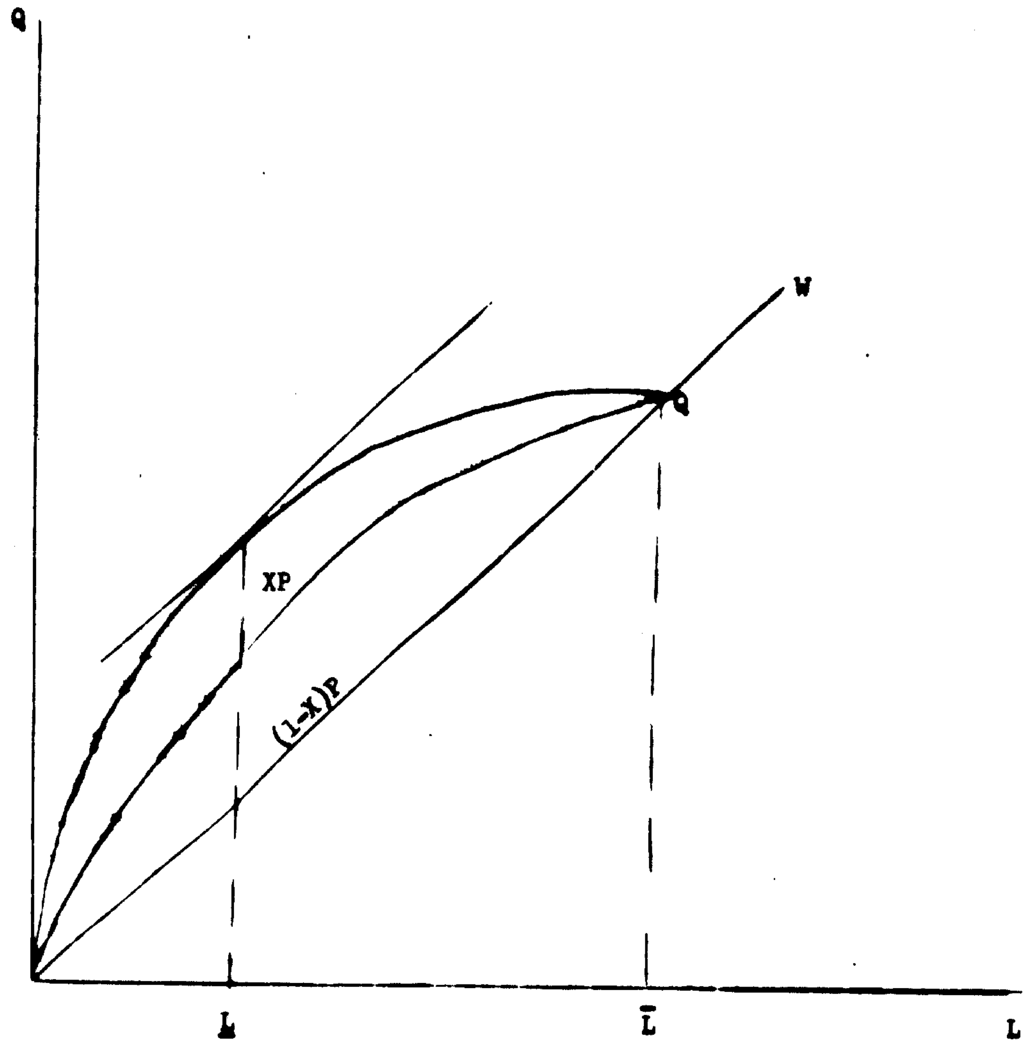
The corresponding change in investment is given by

$$(11) \qquad \frac{\partial I}{\partial L} = \alpha (Q_L - W)$$

(Note that $\frac{\partial C}{\partial L}$ is always positive, but $\frac{\partial I}{\partial L}$ is positive only for $Q_L > W$ (i.e. up

DIAGRAM 5

THE LABOUR SURPLUS ECONOMY



$$Q = Q\ (\bar{K}_o, L)$$

$$W = wL$$

$$P = Q - W$$

to the point L in Diagram 5). The supply price of investment - denoted P_α because of its dependence on α - is obtained by dividing the change in investment ($\partial I/\partial L$) by the corresponding sacrifice of consumption ($-\partial C/\partial L$):

$$(12) \qquad P_\alpha = \frac{\partial I/\partial L}{-\partial C/\partial L} = \frac{(1-\alpha)Q_L + \alpha W}{\alpha(W-Q_L)}$$

Note that $P_\alpha > 0$ for $W > Q_L$: a positive amount of consumption must be sacrificed to obtain an additional unit of investment beyond the point L. But $P_\alpha < 0$ for $W < Q_L$: a negative amount of consumption must be sacrificed to obtain additional investment before the point L. If all profits are invested, $\alpha = 1$ and we get:

$$(13) \qquad P_1 = \frac{W}{W-Q_L}$$

The supply price of investment P_α is to be contrasted with the demand price of investment $\hat{P}_\alpha$. The former denotes the amount of consumption that must be sacrificed - given the physical and institutional constraints on production described by the preceding equation - in order to obtain an additional unit of investment. The latter denotes the amount of consumption that society would be willing to give up in order to obtain an additional unit of investment (with its potential for future consumption). This distinction is exactly analagous to the distinction between transformation and substitution made in the previous chapter. If P_α is not equal to $\hat{P}_\alpha$, the economy is not functioning optimally, and it would be desirable to change the rate of investment so as to bring the two prices into equality. Under circumstances in which the rate of investment is not optimal, and the government is unable to bring about the optimal rate, it is the demand price $\hat{P}_\alpha$ which is relevant for measuring the social benefits and costs of investment provided by or used up by an individual project. Thus the demand price $\hat{P}_\alpha$ corresponds to the "social price of investment" defined in Chapter IV.

Now we proceed to derive an expression for the demand price of investment $\hat{P}_\alpha$. To do this, we must compare the utility to society of a unit of investment with the utility of a corresponding unit of current consumption. A unit of investment at time 0 augments the capital stock K_0 by one unit; this addition to capital stock provides for a time stream of additional consumption amounting to $\partial C(t)/\partial K_o$ at each point of time from 0 to ∞. The utility of the unit of investment is equal to the sum of the utilities of these additions to future consumption. If we denote the instantaneous marginal utility of consumption at time t as U' (t) (where U is total utility), we can write the utility of the unit of investment in time 0 as:

$$(14) \qquad U^I = \int_0^\infty U'(t) \frac{\partial C(t)}{\partial K_o} dt$$

The corresponding utility of the marginal unit of consumption at time i 0 is simply:

$$(15) \qquad U^c = U'(o)$$

Thus we can define that demand price of investment at t time 0 as:

$$(16) \qquad \hat{P}_\alpha(o) = \frac{U^I}{U^c} \frac{1}{U'(o)} \int_o^\infty U'(t) \frac{\partial C(t)}{\partial K_o} dt$$

In Chapter IV, the social rate of discount i was defined as:

$$(17) \qquad i(t) \equiv - \frac{\dot{U}'(t)}{U'(t)}$$

from which we may write:

$$(18) \qquad U'(t) = U'(o) \exp \left[- \int_0^t i(\tau) d\tau \right]$$

Note that if i (t) is assumed to be constant over time, we have:

$$(19) \qquad U'(t) = U'(o)\, e^{-it}$$

We now proceed to evaluate $\partial C(t)/\partial K_o$. From equation (8) and (9) we have:

$$(20) \qquad C(t) = (1-\alpha) Q[L(t), K(t)] + \alpha wL(t)$$

$$(21) \qquad I(t) = \alpha [Q [L(t), K(t)] - wL(t)]$$

Since the production function for Q is first-degree homogeneous, we may write:

$$(22) \qquad Q[L(t), K(t)] = K(t) Q \left[\frac{L(t)}{K(t)}, 1 \right]$$

and, using the following capital-intensive variables,

$$(23) \qquad l(t) = L(t) / K(t)$$

$$(24) \qquad q[l(t)] = Q[L(t), K(t)] / K(t)$$

We may rewrite equations (18) and (19) as:

(25) $$C(t) = [(1-\alpha)\, q\, [1(t)] + \alpha\, wl(t)]\, K(t)$$

(26) $$I(t) = \alpha [q\, [l(t)] - wl(t)]\, K(t)$$

By definition, the rate of investment I(t) equals the rate of change of chapital stock K(t), so that the relative rate of growth of capital stock is

(27) $$\frac{\dot{K}(t)}{K(t)} = \alpha [q\, [l(t)] - wl(t)]$$

and we may solve for K(t) as follows:

(28) $$K(t) = K_o \exp\left[\int_0^t \alpha [q\, [l(t)] - wl(t)]\, d\tau\right]$$

substituting into equation (25), we have:

(29) $$C(t) = [(1-\alpha)\, q\, [l(t)] + \alpha\, wl(t)]\, K_o \exp[\quad]$$

and, differentiating with respect to K_o,

(30) $$\frac{\partial C(t)}{\partial K_o} = \left[(1-\alpha)\, q\, [l(t)] + \alpha\, wl(t)\right] \exp[\quad]$$

Note that if l(t) is assumed to be constant over time, equation (28) reduces to:

(31) $$\frac{\partial C(t)}{\partial K_o} = [(1-\alpha)\, q\, l + \alpha\, wl]\; e^{\alpha[q - wl]t}$$

We may now solve for $\hat{P}_\alpha(o)$ by substituting equations (18) and (30) into the original definitional equation (16):

(32) $$\hat{P}_\alpha(o) = \int_0^\infty [(1-\alpha)\, q\, [l(t)] + \alpha\, wl(t)]\; \exp E\, dt,$$

where: $$E = \int_0^t [\alpha\, q\, [l(\tau)] - wl(\tau) - i(\tau)]\, d\tau$$

This equation (32) gives $\hat{P}_\alpha(o)$ in the general case when i(t) and l(t) are variable over time. If i(t) and l(t) remain constant, a simpler expression can be derived for (constant) $\hat{P}_\alpha$ by substituting equations (19) and (31) into equation (16):

(33) $$\hat{P}_\alpha = [(1-\alpha)\, q\, l + \alpha\, wl] \int_0^\infty e^{[\alpha(q - wl) - i]t}\, dt$$

$$= \frac{(1-\alpha)\, q + \alpha\, wl}{i - \alpha(q - wl)}$$

The same expression for the demand price of investment $\hat{P}_{\alpha}$ may be derived from the general formula for the social price of investment given in Chapter IV:

$$(34) \qquad \bar{P} = \frac{(1-\mu)r}{1-\mu r}$$

where r is the (social) rate of return to a marginal unit of private investment, μ is the proportion of the return which is saved (and re-invested), and both μ and r are assumed to remain constant over time. In the labour-surplus economy with constant l, a unit increase in investment adds a marginal unit to capital stock which - with a complementary unit of labour in the proportion l - results in an increase of output in the same proportion (because of the assumption of constant returns to scale). Thus:

$$(35) \qquad r = \frac{\partial Q(L,K)}{\partial K} = \frac{Q}{K} = q$$

The rate of re-investment of income, μ, is given simply by the average proportion of investment in output:

$$(36) \qquad \mu = \frac{I}{Q} = \frac{\alpha(Q-wL)}{Q} = \alpha\left(1 - \frac{wl}{q}\right)$$

Substituting into equation (34), we get

$$(37) \qquad \bar{p} = \frac{\left[1-\alpha\left(1-\frac{wl}{q}\right)\right]q}{i-\alpha(q-wl)} = \frac{q - \alpha(q - wl)}{i - \alpha(q - wl)}$$

$$= \frac{(1-\alpha)q + \alpha wl}{i - \alpha(q - wl)} = \hat{P}_{\alpha}$$

It was noted earlier that the optimal rate of investment in the economy is characterized by the equality of the demand and the supplypprices of investment. Setting equal the expression for $\hat{P}_{\alpha}$ and P_{α} given in equations (33) and (12), an equivalent condition can be derived for the case of constant i and l:

$$(38) \qquad \hat{P}_{\alpha} = \frac{(1-\alpha)q + \alpha wl}{i - \alpha(q - wl)} = \frac{(1-\alpha)Q_L + \alpha w}{\alpha(w - Q_L)} = P_{\alpha}$$

Solving for i in equation (38), we get:

$$(39) \qquad i = \frac{\alpha w(q - lQ_L)}{(1-\alpha)Q_L + \alpha w}$$

It will be shown in the next paragraph that the expression on the right-hand side of equation (39) is precisely equal to r*, the marginal social rate of return __in value terms__ to private investment. Thus the optimal rate of investment can also be characterized by the quality of i and r* when i and l are constant over time.

The marginal social rate of return in __value__ terms, r*, which may be called the marginal __value__ productivity of investment, is to be distinguished from the marginal social rate of return in __physical__ terms, r, which is simply the marginal __physical__ productivity of investment Q_k.

To calculate r* we must evaluate both the initial investment and the return of this investment in value terms. The value of investment - in terms of consumption - in this context is given by the supply price P_α. Thus we must replace the expression:

$$(40) \qquad r = \frac{\partial Q}{\partial K}$$

by

$$(41) \qquad r^* = \frac{\partial C/\partial K + P_\alpha \, \partial I/\partial K}{P_\alpha}$$

The two shares $\partial C/\partial K$ and $\partial I/\partial K$ of the increment in output $\partial Q/\partial K$ per marginal unit of investment will be determined according to the rate of consumption and saving out of profits, since the return to increased capital stock go into profits. Thus we have:

$$(42) \qquad \frac{\partial C}{\partial K} = (1-\alpha)Q_k.$$

$$(43) \qquad \frac{\partial I}{\partial K} = \alpha Q_k$$

and we can substitute into equation (41) to get:

$$(44) \qquad r^* = \frac{(1-\alpha)Q_K + P_\alpha \alpha Q_k}{P_\alpha} = \frac{(\alpha P_\alpha + 1-\alpha)}{P_\alpha} Q_k$$

Substituting the formula for P_α given in equation (12) into (44), we obtain:

$$(45) \qquad r^* = \frac{\alpha w(q - lq_1)}{(1-\alpha)q_1 + \alpha w}$$

which is the form in which r^* appears in equation (39). Observing that:

$$(46) \qquad \alpha P_\alpha + 1-\alpha = \frac{w}{w-Q_1} = P_1$$

we may use the following equivalent expression for r^*:

$$(47) \qquad r^* = \frac{P_1}{P_\alpha} Q_k$$

from which it follows that $r^* = r$ if and only if

$\alpha = 1$, i.e., if all profits are saved.

It was observed in Chapter IV that the quality of i and r implies that the social price of investment $\bar{P}$ is equal to unity. (This follows directly from the equation 34). The same result can be obtained for the labour-surplus economy, under the assumption of constant i and l, by substituting $i = r = \eta$ into equation (33); and this result can be generalized for the case of variable i(t) and l(t) as well. The equality of i and r must be distinguished, however, from the equality of i and r^*. The former implies that $\hat{P}_\alpha = 1$, but it does not imply that the rate of investment is optimal. In fact, the rate of investment cannot be optimal when $\hat{P}_\alpha = 1$, for

$$P_\alpha = \frac{Q_L + \alpha(w-Q_L)}{\alpha(w-Q_L)} = 1 + \frac{Q_L}{\alpha(w-Q_L)}$$

must always be different from 1 (since $Q_L > 0$ by assumption of equation 2). In the relevant range $\underline{L} < L < \bar{L}$, $w > Q_L$, and hence $P_\alpha > 1$.

<u>The evaluation of benefits in the labour-surplus economy</u>.

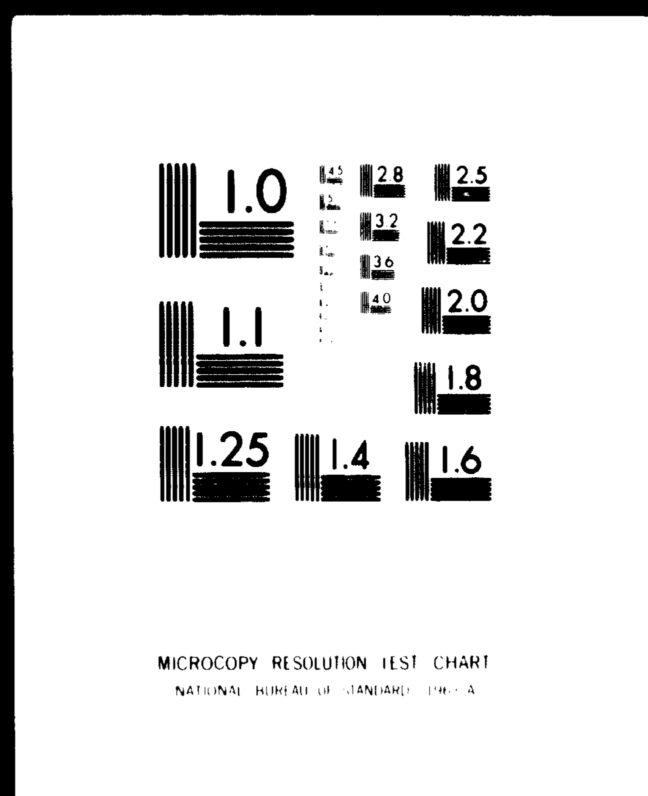
Suppose that a public sector project results in gross aggregate consumption benefits at a rate of $\Delta Q(t)$ from t = 0 to T. These benefits will be divided among workers (wage-earners) and capitalists (profit-earners) in some proportion $\Delta Q^w(t)$ and $\Delta Q^c(t)$. If the government charges fees to the project beneficiaries, there will be corresponding payments denoted by $\Delta R^w(t)$ and $\Delta R^c(t)$. Thus the net gain to workers, capitalists and the government may be expressed as:

$$(51) \qquad \Delta B^w(t) = \Delta Q^w(t) - \Delta R^w(t)$$

$$(52) \qquad \Delta B^c(t) = \Delta Q^c(t) - \Delta R^c(t)$$

C-671

78. 11.09



(53) $\Delta B^G(t) = \Delta R^W(t) + \Delta R^c(t)$

The total social value of these aggregate consumption benefits depends upon the way in which they are divided between consumption (whose unit value is 1), and investment (whose unit value is $\hat{P}\alpha(t)$.) By assumption, workers consume all of their income: hence the social value of the consumption benefits accruing to workers is simply $\Delta B^W(t)$. Capitalists, on the other hand, save a proportion α of their income, so that benefits accruing to capitalists have a social value of $(\alpha\hat{P}\alpha(t) + 1-\alpha)$ and the total value of these benefits is $(\alpha\hat{P}_\alpha(t) + 1-\alpha)\,\Delta B^c(t)$ If it is assumed that the government invests all of its income at the margin, the receipts of the government from the project must be valued at $\hat{P}\alpha(t)\,\Delta B^G(t)$. The total social value of aggregate consumption benefits B(t) at time t can these be expressed as:

$$
\begin{aligned}
(54) \quad B(t) &= B^W(t) + [\alpha\hat{P}\alpha(t) + 1-\alpha]\,\Delta B^c(t) + \hat{P}\alpha(t)\,\Delta B^G(t) \\
&= \Delta Q(t) + \alpha[\hat{P}\alpha(t) - 1]\,\Delta Q^c(t) \\
&\quad + [\hat{P}\alpha(t) - 1]\,\Delta R^W(t) \\
&\quad + 1-\alpha[\hat{P}\alpha(t) - 1]\Delta R^c(t)
\end{aligned}
$$

If the economy is growing optimally, we can substitute $P\alpha$ for $\hat{P}\alpha$ and P_1 for $(\alpha P\alpha + 1-\alpha)$ to get:

$$
\begin{aligned}
(55) \quad B(t) &= \Delta B^W(t) + P_1(t)\,\Delta B^c(t) + P\alpha(t)\,\Delta B^G(t) \\
&= \Delta Q(t) + [\bar{P}_1(t) - 1]\,\Delta Q^c(t) \\
&\quad + [\bar{P}\alpha(t) - 1]\,\Delta R^W(t) \\
&\quad + [\bar{P}\alpha(t) - P_1(t)]\Delta R^c(t)
\end{aligned}
$$

In each case, B(t) can be written as the sum of the <u>direct</u> benefits $\Delta Q(t)$ and the <u>indirect</u> benefits (of 1the third kind discussed in Chapter III) resulting when $\hat{P}\alpha(t) > 1$, and evaluated according to the effect on total investment of the distribution of project benefits.

Assuming a constant social rate of discount i, we may determine the (social) present value B of the whole time stream of aggregate consumption benefits by discounting the benefits B(t) at each point in time back to the initial point 0:

$$(56) \qquad B = \int_0^t B(t)e^{-it}\,dt$$

The evaluation of costs in the labour-surplus economy

There are two factors of production in the simple model under consideration: labour and capital. The social cost of using these factors depends upon the method by which the corresponding payments are financed. Consider first the cost of construction labour, which is assumed to be financed out of the capital funds raised for the project by taxing private sector capitalists. The direct cost to the economy of employing labourers (at any wage rate) is zero because the assumption of supplus labour implies that no output is sacrificed elsewhere in the economy when an additional labourer is employed. Accompanying the employment of each labourer, however, is a money transfer from capitalists - whose income has a social value of: $(\alpha \hat{P}_\alpha(t) + 1 - \alpha)$ - to workers - whose income has a social value of 1. Thus if the wage rate is w, there are indirect costs amounting to: $(\alpha \hat{P}_\alpha(t) + 1 - \alpha - 1)w = \alpha(\hat{P}_\alpha(t) - 1)w$, because of the transfer to the group with a lower propensity to save (invest). If construction labour employed at time t is noted by $\Delta\tilde{L}(t)$ the total social cost $\Delta\tilde{C}^L(t)$ of employing this labour is given by:

$$(57) \qquad \Delta\tilde{C}^L(t) = \alpha[\hat{P}_\alpha(t) - 1]\, w \Delta\tilde{L}(t)$$

and we can define the corresponding shadow wage rate $\tilde{w}^*(t)$ as:

$$(58) \qquad \tilde{w}^*(t) = [\hat{P}_\alpha(t) - 1]\, w$$

In the case of operating labour, we assume that payments are made out of project revenues that would otherwise accrue to the government. The direct cost of employing operating labour is of course also zero, but the indirect cost must be evaluated according to the money transfer from the government - whose income has a social value of $\hat{P}_\alpha(t)$ - to workers. The total social cost $[\Delta C^L(t)]$ of operating labour employed at time t $[\Delta L(t)]$ thus comes to:

$$(58) \qquad \Delta C^L(t) = [\hat{P}_\alpha(t) - 1]\, w \Delta L(t)$$

and the corresponding shadow wage rate $w^*(t)$ is:

$$(59) \qquad w^*(t) = [\hat{P}_\alpha(t) - 1]\, w$$

In evaluating the social cost of capital inputs, we must distinguish between capital services used only during the period of construction and capital goods installed for the operation of the project. When a unit of capital is (temporarily) transferred from the private sector for use in construction of a public sector project, the corresponding loss of output in the private sector is Q_k, assuming there is no change in employment. Q_k can be regarded asthe direct cost of the capital service, Since, however, this cost must be financed by taxation of private sector profits, the corresponding loss is sustained by capitalists whose income has a social value of $(\alpha \hat{P}_\alpha(t) + 1-\alpha)$. Thus the total social cost is properly measured by $(\alpha\hat{P}_\alpha(t)+1-\alpha)Q_k$, which includes, and indirect cost component of $\alpha(P_\alpha(t)-1)Q_k$. If the total amount of capital employed in construction at time t is denoted by $\Delta\widetilde{K}(t)$, then we can write the total social cost $\Delta \widetilde{C^K}(t)$ of these capital services as:

$$(60) \qquad \Delta \widetilde{C^K}(t) = [\alpha\hat{P}_\alpha(t) + 1-\alpha]\, Q_k\, \Delta\widetilde{K}(t)$$

and we can define the corresponding shadow rental rate $\widetilde{\pi}^*(t)$ as:

$$(61) \qquad \widetilde{\pi}^*(t) = [\alpha\hat{P}_\alpha(t) + 1-\alpha]Q_k$$

In the case of capital goods installed with the project, the direct cost is simply equal to the price of the goods - which represents the output foregone by not using these goods for private sector investment. Since this cost is financed by taxation of private sector profits, the total social cost must be measured by the social value of capitalists income: $(\alpha\hat{P}_\alpha(t) + 1-\alpha)$. If the total amount of capital goods installed with the project at time t is denoted by $\Delta\widetilde{I}(t)$, then we can write the total social cost $\Delta \widetilde{C^I}(t)$ of these goods as:

$$(62) \qquad \Delta\widetilde{C^I}(t) = [\alpha\hat{P}_\alpha(t) + 1-\alpha]\, \Delta\widetilde{I}(t)$$

and the corresponding shadow price of capital goods is:

$$(63) \qquad \widetilde{P}^*(t) = [\alpha\hat{P}_\alpha(t) + 1-\alpha]$$

The total social value of aggregate consumption costs C(t) at time t can now be expressed as:

$$(64) \qquad C(t) = \Delta\widetilde{C^L}(t) + \Delta C^L(t) + \Delta\widetilde{C^K}(t) + \Delta\widetilde{C^I}(t)$$

$$= \alpha[\widetilde{P}_\alpha(t) - 1]w\, \Delta\widetilde{L}(t)$$

$$+ [\bar{P}(t) - 1]w\Delta L(t)$$

$$+ [\alpha P_\alpha(t) + 1-\alpha]Q_K\, \Delta\widetilde{K}(t)$$

$$+ [\bar{\alpha}P_\alpha(t) + 1-\alpha]\, \Delta\widetilde{I}(t)$$

If the economy is growing optimally, we can substitute P_α for $\hat{P}_\alpha$ and P_1 for $(\alpha P_\alpha + 1 - \alpha)$ to get:

$$(65) \quad C(t) = [P_1(t) - 1] w \Delta\hat{L}(t) + [P_\alpha(t) - 1] w \Delta L(t) + [P_1(t)] Q_K \Delta\tilde{K}(t) + [P_1(t)] \Delta\tilde{I}(t)$$

Assuming again a constant social rate of discount i, the (social) present value C of the whole time stream of aggregate consumption costs is given by:

$$(66) \quad C = \int_0^t C(t) e^{-it} dt$$

and the net constribution N of the project to the aggregate consumption objective is equal to:

$$(67) \quad N = B - C$$

The evaluation of benefits and costs as described in the preceding paragraphs is to be contrasted with the alternative methods of 1) using market prices and 2) calculating only direct benefits and costs (i.e. ignoring the indirect benefits and costs due to the difference between the social value of consumption and investment). Using market prices, the benefits of the project at time t would amount simply to $\Delta Q(t)$,

and the costs at time t would be the sum of $w\Delta\tilde{L}(t)$, $w \Delta L(t)$, $Q_K \Delta\tilde{K}(t)$ and $\Delta I(t)$. Labour costs would be evaluated at the market wage w and no corrections would be made for the differential social value of consumption and investment. The second alternative would eliminate labour costs altogether - on the grounds of the labour surplus - and treat only the capital costs $Q_K \Delta \tilde{K}(t)$ and $\Delta I(t)$ as "real" social costs. This approach still fails to take into account the institutional constraints that raise the social value of investment above the corresponding value of consumption. To the extent that such constraints do hold in a labour - surplus economy, it is just as misleading to use a shadow wage rate rate of zero as a shadow rate equal to the market wage.

Chapter VII

UNCERTAINTY

Investment by definition yields its fruits only with the passage of time, and investment is therefore inherently uncertain.[1/] How ought uncertainty be reflect in public investment criteria?

Private firms use a variety of techniques to take account of uncertainty in calculating commercial profitability. These techniques vary in detail but share the common purpose of biasing project design and selection against uncertain projects.

This may or may not be sound practice for private industry, but there is an important difference between public and private enterprise. The typical private enterprise specializes in a few products. As a result, the performance of each of its investment projects is highly correlated with the overall performance of the firm. Moreover, a single enterprise typically undertakes a small number of projects; failure of one may spell bankruptcy. The government, on the other hand, typically undertakes a large number of projects. Each is small relative to aggregate consumption, and the contribution of many project to aggregate consumption is less highly correlated with the level of aggregate consumption than the contribution of the project to a single enterprise profit is correlated with the enterprise's total profit. Hence, the government can take advantage of the law of large numbers to an extent that the typical private firm cannot. Because of its larger number of projects and the greater diversity of its investment "portfolio", the government can be much more confident than the private firm that unexpected failure of one project will be matched by extraordinary success of another. The result is that the government can be less concerned than the private firm with the uncertainty associated with each individual project. This argument must be qualified in one respect: capital markets augment the private sector's capacity to pool risks. Insofar as company shares are

---

1/ It is often useful to distinguish between "risk" and "uncertainty". Risky situations are those whose outcome can be characterized by known probability distributions. An uncertain situation is one for which even the probability widely held and <u>individuals</u>' protfolios are diversidied, the uncertainty caused for a single company by the small number of projects it undertakes (and augmented by the high correlation among projects' performances) need not affect the firm's decisons. It could leave it to each shareholder to adjust his holdings in accordance with his attitude towards uncertainty. A shareholder could reduce his risk by buying a small number of shares in each of a large number of companies in a variety of industries. With individuals thus able to achieve in miniature the risk pooling that size and diversity allow the government, the advantage claimed for the government would seem to disappear. Enterprises, it would appear, need pay no more attention to uncertainty than does the government in its calculations. The allocation of risk becomes a problem separate from the choice of investments.

This line of reasoning has a certain amount of validity: the distinction between the government and the individual firm does leave an essential feature out of the picture, namely, the existence of capital markets that permit risk-pooling. Yet the positions of the private entrepreneur and the public enterprise are not the same. The contrary conclusion of the last paragraph is implicitly based not only on the existence of capital markets but on the assumption that capital markets function in a perfectly competitive manner. In fact, capital markets tend to be among the least competitive, and this tendency is probably more pronounced in underdevelped economies. Lack of knowledge is one reason for the imperfections of capital markets, increasing returns to scale another. Thus private businessmen do not in general treat the allocation of risk as a problem separate from the choice of investment projects; instead private firms often reject projects investments because of uncertainty despite the fact that the same firms would eagerly undertake miniature replicas of those projects if such replicas could be produced.2/ The government has no

---

1/ (con't)..distribution of the outcome is not known. The energy output ten years hence of a hydroelectric project on a river for which long, reliable records of stream flow exist in a risky event. The <u>value</u> of the output ten years hence is an uncertain event. In this discussion uncertainty and risk will be used interchangeably; decision-makers will be assumed to know probabilities for both risky and uncertain events.

2/ Part of the caution of private enterprise is due, no doubt, to the imperfections in the market for the services of business managers, rather than to imperfections in capital markets. There is no way the market for managers can judge decisions or decision-making ability directly, and the market relies on outcomes as a surrogate measure of abilities. Since extraordinary failure is reason to view most project differently from miniature replicas; relative to the size of the government's total investment most project are already to small that no substantial reduction in uncertainty would result from replacing, say, a $10 million project with ten $1 million scaled-down replicas.

Thus public investment criteria ought not to reflect the biases of private enterprise with respect to uncertainty. And, indeed, if the only problem were the uncertainty of the consumption stream generated by each project, the government could ignore uncertainty altogether in its calculation of aggregate consumption benefits. The government need only look at the average benefits and costs ("expected values") in each year, so that the transition from the certainty models of previous chapters to the uncertaintly model of the present chapter would require only the substitution of expected values for outcomes previously assumed known with certainty. For example, in place of the benefit B_t for year t, we would write

(1) $$E(B_t) = {}_{t1}B_{t1} + \ldots\ldots + {}_{tS}B_{tS} ,$$

where B_{t1} is the benefit from the project in year t if "state 1" prevails, and $_{t1}$ is the probability assigned to "state 1." A similar interpretation is to be placed on all other contingent benefit assessments, $B_{t2}, \ldots B_{tS}$, as well as on other probability assessments $_{t2}, \ldots, {}_{tS}$. By the rules of the probability calculus

$${}_{t1} + \ldots + {}_{tS} = 1.$$

A "state is a description of all facts relative to the project's performance. For example, two facts relevant to the benefits provided by a textile factory producing for the export market are the world price of textiles and the size of the domestic ootton crop. If we assume that these are the only relevant uncertain facts, and moreover, that price prospects can be described in terms of "high," "medium," and "low," and crop prospects in terms of "good," "fair," and "poor," then the nine possible states can be described in the table below:

2/ (con't)..penalized more than extraordinary success is rewarded,managers are led to caution, rejection the idea of leaving risk adjustment to shareholders.

Possible states in a two-variable three-value model

State	World Price of Textiles	Domestic Cotton Crop
1	high	good
2	high	fair
3	high	poor
4	medium	good
5	medium	fair
6	medium	poor
7	low	good
8	low	fair
9	low	poor

In this case the technician calculates the benefits in each of the nine states and assigns probabilities to the states. Naturally, past history is some guide to the assessment of probabilities.

The shortcoming of this procedure is that it implicitly assumes either (a) that benefits are equally valuable in each state, or (b) that the probability distribution of benefits provided by the textile project is not correlated with the probability distribution of aggregate consumption. The first assumption -- that benefits are equally valuable in all states -- might be reasonable if (1) textile exports were a small fraction of national income, (2) the world price of textiles were the only variable, and (3) the world prices of other exports were uncorrelated with the price of textiles. But hypothesis (3) isnot likely to hold, for the world prices of primary products and their derivatives show a strong tendency to move together. Thus over-all foreign exchange earnings are likely to be highly correlated with the price of textiles, and the sensitivity of aggregate consumption to export earnings means that present and, more important, future aggregate consumption is likely to be much more sensitive to the price of cotton than the direct role of textile exports would indicate. If -- as was assumed in the discussion of intertemporal criteria -- the marginal utility of consumption declines with the level of consumption, the value of the benefits of the textile project is inversely related to the price of cotton. Moreover, since the benefits of the textile project vary directly with the price of cotton, the second assumption -- uncorrelated probability distribution of benefit and aggregate consumption -- is also violated by the textile project.

Even if the world price of cotton were uncorrelated with the export prices, the second determinant of state -- the size of the cotton crop -- makes it highly unlikely that either assumption (a) or (b) could be fulfilled. Cotton production is usually highly correlated with over-all agricultural production, and in the underdeveloped countries agriculture generally provides a large share of aggregate consumption. Thus the marginal utility of benefits will vary inversely with the size of the cotton crop. Moreover, the performance of the project will vary inversely with aggregate consumption <u>via</u> the correlation of both with the size of the cotton crop.

The upshot of the dependence of the marginal utility of benefits on state and the existence of correlation between the benefits and their marginal utility (which results from the correlation between project performance and aggregate consumption) is that the expected value of benefits $E(B_t)$ must be replaced by the expect value of the marginal utility of benefits $E(\lambda_t B_t)$, the λ's representing the marginal utility of aggregate consumption in each state, That is, in place of equation (1), benefits are taken to be

$$(2) \qquad E(\lambda_t B_t) = \pi_{t1} \lambda_{t1} B_{t1} + \ldots + \pi_{tS} \lambda_{tS} B_{tS} \,..$$

The "numeraire," or unit of account, for this analysis is consumption in the state used to determine the discount faction $(1+i)^{-t}$ for year t; this state is assigned a λ of unity. With the weight associated with the numeraire in year t relative to present consumption $(1+i)^{-t}$, the weight for state <u>s</u> in year t relative to present consumption becomes $\lambda_{st}(1+i)^{-t}$. The λ's are calculated from the government's utility function in a manner exactly analagous to that by which the discount factor $(1+i)^{-t}$ was derived from the utility function in the discussion of intertemporal criteria.

Thus to take account of uncertainty it is necessary, first, to assess the probabilities of the determinants of benefits, the π's; second, to estimate the benefits contingently on each state occuring; the B's; third, to determine the aggregate consumption contingently on each state occuring, which allows determination of the λ's by means of the utility function. The reflection of uncertainty in cost calculations is analagous.[1/]

The importance of taking into account variability of the marginal utility of consumption over states cannot be overemphasized. Consider the comparison between a fertilizer project and an irrigation project. Suppose that the expected value of the fertilizer project's benefits, equation (1), is higher than the expected value of the irrigation project's benefits. But suppose that the fertilizer project's benefits are positively correlated with rainfall and that the irrigation project's benefits are negatively correlated with rainfall. (In a relatively dry area this is very likely to be the case, since moisture and fertilizer are complements, whereas natural precipitation and irrigation are substitutes.) Now, if as is likely, agricultural production and, hence, aggregate production is positively correlated with rainfall, then the marginal utility of benefits will be negatively correlated with the fertilizer project's performance and positively correlated with the irrigation project's performance. The result is that the correct calculation of benefits, according to equation (2), well may reverse the ranking of projects that emerges from the calculation of equation (1). The possibility that the irrigation project will be preferred to the fertilizer project despite the fact that (by assumption) the expected value of the irrigation project's benefits is lower than the expected value of the fertilizer project's benefits has an intuitive rationale; planners often speak of the "insurance value" of irrigation. The present analysis suggests that the notion of insurance value can be given an operational meaning.

The discussion up to now has implicitly assumed that the marginal utility of consumption in year t depends only on the state of the word in year t, or in other words, that the list of variables required to describe each state in year t is limited to year t phenomena. This assumption can be dropped, but at the cost, in general, of greatly increasing the complexity of the analysis. However, simple kinds of intertemporal state dependence can be comprehended within a workable framework of analysis. Suppose, for example, that the benefits of a certain project depend critically on the

---

1/ The discussion thus far has revolved about the aggregate consumption objective. But the same principles apply to other objectives. All that is necessary is to reinterpret benefits (costs) and marginal utilities in terms of the objective in question.

continuation of foreign aid. Suppose furthermore that assurances have been given that aid will continue for five years but the future beyond is in doubt. Then, if for simplicity, foreign aid is assumed to be the only determinant of benefits, benefits for years 1 through 5 are certain. Now suppose we can assume that if foreign aid is continued beyond year 5, it will be continued indefinitely. Then the distribution of project performance in every year beyond year 5 can be described by a two state model, state one reflecting the decision to continue aid beyond year 5, state two reflecting the cessation of aid in year 5, If we take state one as the numeraire state, then year t's benefits can be written

$$E(\lambda_t B_t) = \pi_{1t} B_{1t} + \pi_{2t} \lambda_{2t} B_{2t}.$$

The present value of benefits after year 5 becomes

$$(3) \qquad \sum_{t=5}^{T} \frac{E(\lambda_t B_t)}{(1+i)^t} = \sum_{t=5}^{T} \left\{ \frac{\pi_{1t} B_{1t}}{(1+i)^t} + \frac{\pi_{2t} \lambda_{2t} B_{2t}}{(1+i)^t} \right\}$$

When T is the terminal date of the project's benefits. In the present case it is quite likely that consumption would grow at a slower rate in state 2 than in state 1 over the foreseeable future. It follows that λ_{2t} will increase without bound as t becomes large. Indeed, if λ_{2t} is increasing at a geometric rate, then the right hand side of (3) can be replaced by the simpler expression

$$(4) \qquad \sum_{t=5}^{T} \left\{ \frac{\pi_{1t} B_{1t}}{(1+i)^t} + \frac{\pi_{2t} B_{2t}}{(1+i')^t} \right\}$$

where

$$\frac{1}{(1+i')^t} = \frac{\lambda_{2t}}{(1+i)^t} .$$

Equation (4) shows that where the state determinant is of a once-and-for-all kind, the variation of the marginal utility of benefits over state and over time can sometimes be reflected by the use of state-specific discount rates (i and i' in the above example). But it should be noted that the situation in which uncertainty can be taken into account in the discount rate is a very special one.

Appendix

TIMING AND SEQUENCE

Suppose benefit rates are expected to change over time, either because the physical quantities of outputs are expected to change, or because prices[1] are expected to change. When is the optimal time to construct a project? Suppose expenditures are restricted by budgetary constraints so that every project cannot be constructed at its optimal time. What is the optimal sequence for construction projects?

It is useful to segregate the changes in benefits (and costs) associated with any given project into two kinds, those that depend on project age and those that are exogenous to the project (that is, those which so far as the given project is concerned depend only on calendar time). Project-age determined benefit changes include all changes associated with the gestation period of a project. Calendar-time determined changes include, among others, price changes associated with changes in the total demand and supply of products of which the project's output forms a part.[2]

For purposes of determining construction times and sequences, present values should reflect all project-age induced benefit and cost changes. Likewise declines in benefits and increases in costs associated with calendar time. But -- and this is perhaps somewhat surprising -- increases in benefits and decreases in costs associated with calendar time should not be reflected in present value calculations. Instead, the smaller of current and future prices

---

1/ "Price" is used here in the extended sense of social value. Hence it [illegible] includes shadow prices, [illegible], weights on objectives

2/ It is important to note that only relative price changes are at issue here. If all prices change proportionately -- if general price inflation takes place -- capital costs will be incurred at a time when prices are lower than the prices that prevail at the time benefits are reaped. The financial performance of the project will be improved by price inflation, but this improvement reflects the real project merit. In benefit-cost analysis either a constant price level should be employed, or the rate of inflation should be added to the interest rate.

should be employed for benefit calculations and the larger for cost calculations. A project should be built at the first time for which its "pseudo" net present value is positive, "pseudo" net present value reflecting the calculation of benefits and costs according to the rule just stated. In case budgetary constraints limit expenditure, construction priorities should be awarded to the projects with the highest "pseudo" present values per dollar (or per rupee) of constrained funds.

The basis for employing the smaller of current and future prices is easy to set forth. Suppose the (relative) price of fertilizer is expected to increase over time in response to exogenous development of improved seeds. If the price of fertilizer in year 20 is employed in the calculation of year 20's aggregate consumption benefits, the present value of the fertilizer project's contribution to aggregate consumption might be very high largely because of the returns expected 20 years hence. Yet, neglecting gestation lags, the project should be initiated only if its present contribution to aggregate consumption covers its present operating, interest, and amortization costs. The benefits in year 20 can always be reaped by building the project later on, and these benefits should not be allowed to lead to premature construction.

TABLE I

AGGREGATE CONSUMPTION BENEFITS BY YEAR

(all figures in millions)

	YEAR					
	5	6	7	8	9	10-54
AGRICULTURAL PROGRAM						
Beans	1.73	2.08	2.42	2.77	3.11	3.46
Corn	5.15	6.18	7.21	8.24	9.27	10.30
Sesame	3.20	3.84	4.48	5.12	5.76	6.40
Sorgum	2.86	3.43	4.00	4.58	5.15	5.72
Alfalfa	7.26	8.71	10.16	11.62	13.07	14.52
Safflower	3.10	3.72	4.34	4.96	5.58	6.20
Soybeans	13.57	16.28	19.00	21.71	24.43	27.14
Tomatoes	16.00	19.20	22.40	25.60	28.80	32.00
Vegetables	3.70	4.14	5.18	5.92	6.66	7.40
Wheat	3.83	4.60	5.36	6.13	6.89	7.66
Other crops	5.40	6.48	7.56	8.64	9.72	10.80
TOTAL	65.80	78.96	92.12	105.28	118.44	131.60
EXTRA FOREIGN EXCHANGE BENEFITS FROM TOMATOE EXPORTS	+16.00	+19.20	+22.40	+25.60	+28.80	+32.00
HOUSING AND SOCIAL SERVICES	2.80	2.80	2.80	2.80	2.80	2.80
TOTAL AGGREGATE CONSUMPTION BENEFITS	84.60	100.96	117.32	133.68	150.04	166.40
of which Domestically sold output	49.80	59.76	69.72	19.68	89.64	99.60
Exported output	32.00	38.40	44.80	51.20	57.60	64.00
Social improvement works	2.80	2.80	2.80	2.80	2.80	2.80

TABLE II

LABOUR COSTS BY YEAR

(all figures in millions)

	YEAR										
	1	2	3	4	5	6	7	8	9	10	11-54
MARKET VALUE OF LABOUR COSTS											
Construction: skilled	6.40	7.50	18.80	15.20	-	-	-	-	-	-	-
semi-skilled	5.30	5.70	12.30	10.10	-	-	-	-	-	-	-
unskilled	20.30	24.90	69.40	64.40	-	-	-	-	-	-	-
Operation: skilled	-	-	-	-	0.80	0.80	0.80	0.80	0.80	0.80	0.80
semi-skilled	-	-	-	-	0.12	0.12	0.12	0.12	0.12	0.12	0.12
unskilled	-	-	-	-	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Agriculture Extension	-	-	-	-	3.00	3.00	3.00	3.00	3.00	3.00	0.60
Farm: family	-	-	-	-	8.73	10.48	12.22	13.97	15.71	17.46	17.46
hired	-	-	-	-	2.91	3.49	4.08	4.66	5.24	5.82	5.82
TOTAL	32.00	38.10	100.50	89.70	17.16	19.49	21.82	24.15	26.47	28.80	26.40
EXTRA OPPORTUNITY COST OF AGRICULTURE EXTENTION	-	-	-	-	+3.00	+3.00	+3.00	+3.00	+3.00	+3.00	+0.60
EXTRA OPPORTUNITY COST OF UNSKILLED LABOUR											
Construction	-20.30	-24.90	-69.40	-64.40	-	-	-	-	-	-	-
Operation	-	-	-	-	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60
Farm cultivation	-	-	-	-	-11.64	-13.97	-16.30	-18.63	-20.95	-23.28	-23.28
TOTAL											
AGGREGATE CONSUMPTION COST OF LABOUR INPUTS	11.70	13.20	31.10	25.30	6.92	6.92	6.92	6.92	6.92	6.92	2.12
of which											
Skilled and semi-skilled	11.70	13.20	31.10	25.30	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Agriculture extention workers	-	-	-	-	6.00	6.00	6.00	6.00	6.00	6.00	1.20
Unskilled labour	0	0	0	0	0	0	0	0	0	0	0

TABLE III

FOREIGN EXCHANGE COSTS BY YEAR

(all figures in millions)

	YEAR									
	1	2	3	4	5	6	7	8	9	10-54
OFFICIAL PESETA VALUE OF FOREIGN EXCHANGE COSTS										
CONSTRUCTION										
Machinery and parts	14.60	15.70	33.90	27.50	-	-	-	-	-	-
Fuel	6.60	7.10	15.40	12.50	-	-	-	-	-	-
Iron & steel.	1.10	1.70	4.70	2.40	-	-	-	-	-	-
OPERATION										
Machinery & parts	-	-	-	-	0.33	0.33	0.33	0.33	0.33	0.33
Fuel	-	-	-	-	0.15	0.15	0.15	0.15	0.15	0.15
FARM ASSISTANCE										
Equipment & parts	-	-	-	-	30.00	6.00	6.00	6.00	6.00	6.00
CULTIVATION										
Fuel	-	-	-	-	1.45	1.74	2.03	2.33	2.62	2.91
Fertilizers	-	-	-	-	5.24	6.29	7.34	8.38	9.44	10.48
Pesticides, etc.	-	-	-	-	1.46	1.75	2.04	2.33	2.62	2.91
TOTAL	22.30	24.50	54.00	42.40	38.63	16.26	17.89	19.52	21.16	22.78
EXTRA OPPORTUNITY COST OF FOREIGN EXCHANGE	22.30	24.50	54.00	42.40	38.63	16.26	17.89	19.52	21.16	22.78
TOTAL AGGREGATE CONSUMPTION COST OF IMPORTED INPUTS	44.60	49.00	108.00	84.30	77.26	32.52	35.78	39.04	42.32	45.56

TABLE IV

DOMESTIC INPUT COSTS BY YEAR

(all figures in millions)

	YEAR										
	1	2	3	4	5	6	7	8	9	10	11-54
MARKET VALUE OF DOMESTIC INPUT COSTS											
Construction:											
Cement	4.50	5.70	15.20	7.60	-	-	-	-	-	-	-
Other Materials	5.20	6.70	18.30	12.30	-	-	-	-	-	-	-
Land	-	5.00	-	-	-	-	-	-	-	-	-
Operation:											
Cement	-	-	-	-	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Other Materials	-	-	-	-	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Farm Assistance:											
Agricultural Credit	-	-	-	-	7.50	1.50	1.50	1.50	1.50	1.50	-
Cultivation:											
Fodder	-	-	-	-	2.91	3.49	4.08	4.66	5.24	5.82	5.82
Seeds	-	-	-	-	1.46	1.75	2.04	2.33	2.62	2.91	2.91
TOTAL	9.70	17.40	33.50	19.90	12.87	7.74	8.62	9.49	10.36	11.23	9.73
CORRECTION FOR TRUE OPPORTUNITY COST OF LAND	-	-5.00	-	-	+0.68	+0.68	+0.68	+0.68	+0.68	+0.68	+0.68
TOTAL											
AGGREGATE CONSUMPTION COST OF DOMESTIC INPUTS	9.70	12.40	33.50	19.90	13.55	8.42	9.30	10.17	11.04	11.91	10.41
of which Materials & working capital	9.70	12.40	33.50	19.90	12.87	7.74	8.62	9.44	10.36	11.23	9.73
Land	-	-	-	-	0.68	0.68	0.68	0.68	0.68	0.68	0.68

Table V: DISTRIBUTION OF IMMEDIATE NET BENEFITS BY YEAR

(all figures in millions)

	Group	1	2	3	4	5	6	7	8	9	10	11-[illegible]
BENEFITS												
(1) Agricultural outputs sold domestically	O+	-	-	-	-	49.80	59.76	69.72	79.68	89.64	99.60	99.60
(2) Agricultural output exported	O+	-	-	-	-	32.00	38.40	44.80	51.20	57.60	64.00	64.00
(3) Social improvement works	F+	-	-	-	-	2.80	2.80	2.80	2.80	2.80	2.80	2.80
TOTAL BENEFITS		-	-	-	-	84.60	100.96	117.32	133.68	150.04	166.40	166.40
COSTS												
(4) Total input of unskilled labour	F-	0	0	0	0	0	0	0	0	0	0	0
(5) Agricultural extension workers	F-	-	-	-	-	6.00	6.00	6.00	6.00	6.00	6.00	1.20
(6) All other input of skilled labour	F-	11.70	15.20	31.10	25.30	0.92	0.92	0.92	0.92	0.92	0.92	0.92
(7) Total input of foreign exchange	G-	44.60	49.00	108.00	84.80	77.26	32.52	35.78	39.04	42.32	45.56	45.56
(8) Total input of domestic materials & credit	F-	9.70	12.40	33.50	19.90	12.87	7.74	8.62	9.49	10.36	11.23	9.73
(9) Use of land	F-	-	-	-	-	0.68	0.68	0.68	0.68	0.68	0.68	0.68
TOTAL COSTS		66.00	76.60	172.60	130.00	97.73	47.86	52.00	56.13	60.28	64.39	58.09
NET BENEFITS		-66.00	-76.60	-172.60	-130.00	-12.93	+53.10	+65.32	+77.55	+89.76	+102.01	+108.31

TABLE VI: DISTRIBUTION OF CASH FLOW BY YEAR

(all figures in millions)

RELATED TO BENEFITS	Group Gaining	Group Losing	YEAR 1	2	3	4	5	6	7	8	9	10	11-50
(10) Payment for agriculture output sold domestically	F+	C-	-	-	-	-	44.80	59.76	69.72	79.68	89.64	99.60	99.60
(11) Payment for agriculture output exported	F+	G-	-	-	-	-	16.00	19.20	22.40	25.60	28.80	32.00	32.00
(12) Payment for housing and social services	G+	F-	-	-	-	-	0	0	0	0	0	0	0
RELATED TO COSTS													
(13) Payment to unskilled labour on Project works	L+	G-	20.30	24.90	69.40	64.40	1.60	1.60	1.60	1.60	1.60	1.60	1.60
(14) Payment to unskilled farm labour: a) family	F+	F-	-	-	-	-	8.73	10.48	12.22	13.97	15.71	17.46	17.46
(15) Payment to unskilled farm labour: b) hired	L+	F-	-	-	-	-	2.91	3.49	4.08	4.66	5.24	5.82	5.82
(16) Loss of payment to unskilled labour elsewhere	F+	L-	0	0	0	0	0	0	0	0	0	0	0
(17) Payment to agriculture extension workers on project	E+	G-	-	-	-	-	3.00	3.00	3.00	3.00	3.00	3.00	0.60
(18) Loss of payment to extension workers elsewhere	G+	E-	-	-	-	-	3.00	3.00	3.00	3.00	3.00	3.00	0.60
(19) Payment to other skilled labour on project	S+	G-	11.70	15.20	31.10	25.30	0.92	0.92	0.92	0.92	0.92	0.92	0.92
(20) Loss of payment to other skilled labor elsewhere	F+	S-	11.70	15.20	31.10	25.30	0.92	0.92	0.92	0.92	0.92	0.92	0.92
(21) Payment for farming foreign exchange inputs	G+	F-	-	-	-	-	8.15	9.78	11.41	13.04	14.68	16.30	16.30
(22) Payment for farming domestic material inputs	F+	F-	-	-	-	-	4.37	5.24	6.12	6.99	7.86	8.73	8.73
(23) Payment for other domestic inputs except land	F+	G-	9.70	12.40	33.50	19.90	8.50	2.50	2.50	2.50	2.50	2.50	1.00
(24) Payment of compensation for land	F+	G-	-	5.00	-	-	-	-	-	-	-	-	-
(25) Taxation for financing domestic construction costs	G+	T-	41.70	57.50	134.00	109.60	-	-	-	-	-	-	-
(26) Payment of irrigation fees	G+	F-	-	-	-	-	20.00	20.00	20.00	20.00	20.00	20.00	20.00
(27) Payment of rental of farm equipment	G+	F-	-	-	-	-	4.36	5.23	6.10	6.97	7.85	8.73	8.73
(28) Payment of interest on farm credit	G+	F-	-	-	-	-	0.58	0.70	0.81	0.93	1.04	1.16	1.16

TABLE VII: ULTIMATE DISTRIBUTION OF NET BENEFITS BY YEAR

(all figures in millions)

		Y E A R										
TO FARMERS (F)		1	2	3	4	5	6	7	8	9	10	11-54
+(29) Receipts for sale of agricultural output	+(10)+(11)	-	-	-	-	+65.80	+78.96	+92.12	+105.28	+118.44	+131.60	+131.60
-(30) Costs of cultivation (including imputed wages)	-(14)-(15)-(21)-(22) -(26)-(27)-(28)	-	-	-	-	-49.10	-54.92	-60.74	-66.56	-72.48	-78.20	-78.20
+(31) Wages imputed to family labour	+(14)	-	-	-	-	+8.73	+10.48	+12.22	+13.97	+15.71	+17.46	+17.46
+(32) Benefits from housing and social services	+(3)	-	-	-	-	+2.80	+2.80	+2.80	+2.80	+2.80	+2.80	+2.80
-(33) Payment for housing and social services	-(12)	-	-	-	-	-0	-0	-0	-0	-0	-0	-0
+(34) Compensation for land	+(24)	-	+5.00	-	-	-	-	-	-	-	-	-
-(35) Benefits foregone by new use of land	-(9)	-	-	-	-	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68
-(36) Benefits foregone by withdrawal of extension workers	-(5)	-	-	-	-	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-1.20
	TOTAL (F)	-	+5.00	-	-	+21.55	+30.64	+39.72	+48.81	+57.89	+66.98	+71.78
TO UNSKILLED LABOURERS (L)												
+(37) Wages received on project and farms	+(13)+(15)	+20.30	+24.90	+69.40	+64.40	+4.51	+5.09	+5.68	+6.26	+6.84	+7.42	+7.42
-(38) Wages foregone and payments for transfer	-(16)	0	0	0	0	0	0	0	0	0	0	0
	TOTAL (L)	+20.30	+24.90	+69.40	+64.40	+4.51	+5.09	+5.68	+6.26	+6.84	+7.42	+7.42
TO TAXED PUBLIC (T)												
-(39) Taxation payments for project construction	-(25)	-41.70	-55.50	-134.00	-109.60	-	-	-	-	-	-	-
	TOTAL (T)	-41.70	-55.50	-134.00	-109.60	-	-	-	-	-	-	-
TO GOVERNMENT (G)												
+(40) Receipts from taxation	+(25)	+41.70	+55.50	+134.00	+109.60	-	-	-	-	-	-	-
+(41) Receipts for housing and social services and irrigation fees	+(12)+(26)	-	-	-	-	+20.00	+20.00	+20.00	+20.00	+20.00	+20.00	+20.00
+(42) Receipts for farm equipment and credit	+(27)+(28)	-	-	-	-	+4.94	+5.93	+6.91	+7.90	+8.89	+9.84	+9.89
-(43) Net payments for labour and domestic inputs (exc. land)	-(13)-(17)+(18) -(19)-(23)	-41.70	-52.50	-134.00	-109.60	-11.02	-5.02	-5.02	-5.02	-5.02	-5.02	-3.52
-(44) Payments for land compensation	-(24)	-	-5.00	-	-	-	-	-	-	-	-	-
-(45) Opportunity cost of all foreign exchange inputs	-(7)	-44.60	-49.00	-108.00	-84.80	-77.26	-32.52	-35.78	-39.04	-42.32	-45.56	-45.56
+(46) Receipts from farmers for foreign exchange used on farm	+(21)	-	-	-	-	+8.15	+9.78	+11.41	+13.04	+14.68	+16.30	+16.30
+(47) Benefits of foreign exchange for exported tomatoes	+(2)	-	-	-	-	+32.00	+38.40	+44.80	+51.20	+57.60	+64.00	+64.00
-(48) Payments to farmers for tomatoes to be exported	-(11)	-	-	-	-	-16.00	-19.20	-22.40	-25.60	-28.80	-32.00	-32.00
	TOTAL (G)	-44.60	-51.00	-108.00	-84.80	-39.19	+17.37	+19.4[illegible]	+22.48	+25.03	+27.61	+29.11
	OVERALL NET BENEFITS	-11.00	-76.60	-172.60	-130.00	-12.93	+53.10	+65.32	+77.55	+89.76	+100.01	+108.37

TABLE VIII

CALCULATION OF OVERALL NET AGGREGATE CONSUMPTION BENEFITS BY YEAR

(all figures in millions)

	YEAR										
	1	2	3	4	5	6	7	8	9	10	11-54
Net Benefits to Farmers (F)	-	+5.00	-	-	+21.55	+30.64	+39.72	+48.81	+57.89	+66.98	+71.78
times V_t^f = 1.4	-	+7.00	-	-	+30.17	+42.90	+55.61	+68.33	+81.05	+93.77	+100.49
Net Benefits to Unskilled Laborers (L)	+20.30	+24.90	+69.40	+64.40	+4.51	+5.09	+5.68	+6.26	+6.84	+7.42	+7.42
times V_t^L = 1.0	+20.30	+24.90	+69.40	+64.40	+4.51	+5.09	+5.68	+6.26	+6.84	+7.42	+7.42
Net Benefits to Taxed Public (T)	-41.70	-55.50	-134.00	-109.60	-	-	-	-	-	-	-
times V_t^T = 2.6	-108.42	-144.30	-348.40	-284.96	-	-	-	-	-	-	-
Net Benefits to Gov't (G)	-44.60	-51.00	-108.00	-84.80	-39.19	+17.37	+19.92	+22.48	+25.03	+27.61	+29.11
times V_t^g = 3.0	-133.80	-153.00	-324.00	-254.40	-117.57	+52.11	+59.76	+67.44	+75.09	+82.83	+87.33
Sum of Net Benefits to F.L.T.G	-66.00	-76.60	-172.60	-130.00	-12.93	+53.10	+65.32	+77.55	+89.76	+100.01	+108.31
OVERALL NET BENEFITS TO ECONOMY	-221.92	-265.40	-603.00	-474.96	-82.89	+100.10	+121.05	+142.03	+162.98	+184.01	+195.24

TABLE VIII a.

CALCULATION OF NET BALANCE OF TRADE BENEFITS BY YEAR

(all figures in millions)

	YEAR										
	1	2	3	4	5	6	7	8	9	10	11-54
Value of Tomato export earnings	-	-	-	-	1.600	1.920	2.240	2.560	2.880	3.200	3.200
Value of imported input requirements	-2.230	-2.450	-5.400	-4.240	-3.863	-1.626	-1.789	-1.952	-2.116	-2.278	-2.278
OVERALL NET TRADE BENEFITS	-2.30	-2.450	-5.400	-4.240	-2.263	+0.296	+0.451	+0.608	+0.764	+0.922	+0.922

TABLE IX: CALCULATION OF NET REDISTRIBUTIONAL BENEFITS BY YEAR

(all figures in millions)

		YEAR										
TO MENDALVAN REGION		1	2	3	4	5	6	7	8	9	10	11-54
Farmer receipts for sale of agricultural output	+(29)	-	-	-	-	+65.80	+78.96	+92.12	+105.28	+118.44	+131.60	+131.60
Farmer costs of cultivation	-(30)	-	-	-	-	-49.10	-54.92	-60.74	-66.56	-72.48	-78.20	-78.20
Wages inputed to farm family labor	+(31)	-	-	-	-	+8.73	+10.48	+12.22	+13.97	+15.71	+17.46	+17.46
Benefits from housing and social services	+(32)	-	-	-	-	+2.80	+2.80	+2.80	+2.80	+2.80	+2.80	+2.80
Payment for housing and social services	-(33)	-	-	-	-	-0	-0	-0	-0	-0	-0	-0
Compensation for land	+(34)	-	+6.00	-	-	-	-	-	-	-	-	-
Benefits foregone by new use of land	-(35)	-	-	-	-	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68
Wages received by unskilled labor on project and farms	+(37)	+20.30	+24.90	+69.40	+64.40	+4.51	+5.09	+5.68	+6.26	+6.84	+7.42	+7.42
Wages received by agriculture extension workers	+(17)	-	-	-	-	+3.00	+3.00	+3.00	+3.00	+3.00	+3.00	+0.60
Wages received by skilled labor on project and farms	+(19)	+11.70	+15.20	+31.10	+25.30	+0.92	+0.92	+0.92	+0.92	+0.92	+0.92	+0.92
TOTAL DIRECT NET REGIONAL BENEFITS		+32.00	+45.10	+100.50	+89.70	+35.98	+45.65	+55.32	+64.99	+74.65	+84.32	+91.92
TO SMALL FARMER GROUP												
Receipts for sale of agricultural output	+.885 (29)	-	-	-	-	+58.30	+69.90	+81.50	+93.30	+104.80	+116.50	+116.50
Costs of cultivation	-.885 (30)	-	-	-	-	-43.50	-48.70	-53.80	-58.90	-64.20	-69.20	-69.20
Wages inputed to family labor	+.885 (31)	-	-	-	-	+7.72	+9.28	+10.82	+12.36	+13.90	+15.45	+15.45
Benefits from housing and social services	+.954 (32)	-	-	-	-	+2.67	+2.67	+2.67	+2.67	+2.67	+2.67	+2.67
Payments for housing and social services	-.954 (33)	-	-	-	-	-0	-0	-0	-0	-0	-0	-0
Benefits foregone by new use of land	-.429 (35)	-	-	-	-	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29
TOTAL DIRECT NET GROUP BENEFITS		-	-	-	-	+24.90	+32.86	+40.90	+49.14	+56.88	+65.13	+65.13

C-671

78. 11.09