A Policy Framework for Irrigation Water Charges

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The Bank's policy has been to require a recovery of at least the public sector's operation and maintenance (O & M) costs, and up to 100 percent of all direct public costs of any irrigation project, with revenues and costs in future years suitably discounted and adjusted for general inflation and with costs measured at domestic market prices. In practice, negotiated recovery rates in Bank projects have indeed exceeded O & M costs, but have fallen well short of total costs. According to a survey of 17 Bank irrigation projects, anticipated recoveries averaged only 30 percent of total costs. The policy has therefore allowed wide discretion in setting the level of charges, at least in relation to public costs. Justifications of proposed charges have referred mainly to the need to help users, especially the poorer ones and, occasionally, the need to preserve user incentives. Unfortunately, the absence of a sound framework for incorporating distributional and other objectives into the assessment of charges has led to rather simplistic and vague rules for setting their level; and these rules may have contributed to the poor record of estimated recoveries. This paper is intended to assist decisions on cost recovery by providing an appropriate framework for determining the desirable means and degree of cost recovery.

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SUMMARY AND CONCLUSIONS

1. Advising on plans for cost recovery is an important and controversial step in the appraisal of irrigation projects. The Bank informs borrowers of recovery requirements during appraisal, loan negotiation and supervision, and the position it takes can have a significant influence on a project's worth and on a borrower's recovery policies. The Bank’s requirements are bound to be controversial because recovery policies affect the distribution of project benefits.

2. The Bank's policy has been to require a recovery of at least the public sector's operation and maintenance (O & M) costs, and up to 100 percent of all direct public costs of a project, with revenues and costs in future years suitably discounted and adjusted for general inflation and with costs measured at domestic market prices. In practice, negotiated recovery rates in Bank projects have indeed exceeded O & M costs, but have fallen well short of total costs. According to a survey of 17 Bank irrigation projects, anticipated recoveries averaged only 30 percent of total costs. The policy has therefore allowed wide discretion in setting the level of charges, at least in relation to public costs. Justifications of proposed charges have referred mainly to the need to help users, especially the poorer ones and, occasionally, the need to preserve user incentives. Unfortunately, the absence of a sound framework for incorporating distributional and other objectives into the assessment of charges has led to rather simplistic and vague rules for setting their level; and these rules may have contributed to the poor record of estimated recoveries. This paper is intended to assist decisions on cost recovery by providing an appropriate framework for determining the desirable means and degree of cost recovery.

Cost Recovery Principles

3. In principle, cost recovery issues involve two sets of considerations. The first is concerned with the level and structure of the prices to be charged for the output from a project so as to maximize its net economic benefits to the economy, i.e., with "efficiency" prices. The second set of considerations relates to the desirability of adjusting the efficiency prices, or charging alternative taxes, because of fiscal and financial concerns or on income distribution grounds. Among the questions that arise in this context are: How pressing is the need of the government for additional fiscal resources; what is the current and expected income position of the beneficiaries; how important is financial independence of the project entity; how feasible is it to levy additional charges; and how seriously do they affect the net benefits from the project? 1/

1/ This paper follows the general approach developed in Ray (6).
4. The scope for efficiency pricing of irrigation water is limited, however. In the case of canal irrigation projects, especially those serving numerous small lots, metered sale of water is costly to implement and administer, and is rarely practiced in developing countries. Nonetheless, the potential advantages of volumetric pricing are great, both for bringing about optimal water use in the command area and for revenue generation. For this reason, it is advisable to seriously investigate the possibilities of volumetric pricing in Bank-supported irrigation projects, at least on an experimental basis, rather than rule out such options ab initio.

5. In the absence of volumetric pricing, the extent of cost recovery of irrigation projects depends on their fiscal implications and the feasibility and desirability of special levies on beneficiaries. These aspects of cost recovery give rise to a number of practical questions. Irrigation projects, like other projects, typically induce numerous changes in public sector revenues. All such effects on public sector incomes are relevant from the point of view of judging the impact of a project on savings and consumption, and on income distribution. For example, revenues from general taxes (such as agricultural commodity taxes, income taxes, taxes on fertilizers, "marketing margins," etc.) may increase as a result of the project, contributing substantially to the recovery of public funds spent on the project. Any increase in public revenues as a result of the project that would not otherwise have occurred is pertinent to a measure of the fiscal impact of the project. Likewise, any increase in public revenues as a result of public rather than private financing of the project is pertinent to a measure of the fiscal impact of public financing of the project when private financing is feasible. However, changes that may be desirable in such general taxes involve much wider issues which cannot be resolved from the perspective of a single investment project: adjustments to such general taxes are, therefore, not appropriate for cost recovery. Along with the possibilities for efficiency pricing of water, discriminatory taxes on project beneficiaries (i.e., benefit taxes) should be the focus of attention for cost recovery policies.

6. The amount of recoveries from benefit taxes should not of course exceed the incremental monetary income that accrues to beneficiary farmers before payment of such taxes. In fact the maximum amount that the farmers can pay and still benefit from the project, or "project rent", will usually be less than the incremental monetary income because of the incremental family labor and management costs that the farmers incur. A further downward adjustment may be required to allow for the effects of uncertainty: farmers may regard an uncertain income as equivalent to a lower but certain income.

7. One may distinguish between two classes of beneficiaries, those below and those above the "critical consumption level," the latter being defined as the (consumption) level at which the social value of a unit of extra consumption equals the social value of a unit of extra tax revenue. In principle, those who remain below the critical consumption level are

2/ In the case of flood irrigation, efficiency pricing is technically impossible as water cannot be allocated between individual lots.
judged to be so poor that no additional tax burden should be imposed on them, while those who remain above the critical consumption level should be taxed up to the maximum amounts, as discussed above, unless the taxes cause adverse effects on incentives, which will depend, among other things, on the kind of benefit taxes used. The critical consumption level may vary widely among countries. But as a rough guide, it is likely to range between two-thirds and one-third of the national average level income.

8. The design and implementation of desirable benefit taxes are in practice constrained by various administrative and political factors. Two common difficulties relate to the measurement of income, and the problems of controlling tax evasion. First, accurate monitoring of the incomes of project beneficiaries may be very difficult, especially when the beneficiaries also have non-agricultural sources of income. Even apart from this, the land ownership pattern, and changes in the pattern, need to be taken into consideration, as progressivity implies that, say, a person owing 10 hectares should pay more than 10 times the tax payable by another owning only 1 hectare. Second, partly because of the income measurement problem it is difficult to avoid tax evasion especially if the tax structure is made too progressive. The higher the progressivity the higher is likely to be the incentive to evade and greater also may be the political problems of implementing benefit taxes.

9. Finally, benefit taxes should be chosen and designed so as to minimize any adverse effects that these taxes may have on production and consumption decisions of the farmers and of others in the economy. For example, in some cases it may be possible to recover costs by selling farm inputs to the project beneficiaries at prices higher than those paid by others. However, such discriminatory pricing of farm inputs, even if feasible, will tend to induce the farmers to adopt the wrong production techniques. Similarly, discriminatory taxes on farm outputs (or monopolistic "marketing margins") may induce the choice of wrong crops by the farmers. Although it may be impossible in practice to avoid such adverse effects completely, betterment levies on land holdings may often be the best of the available options.

Desirable Recovery Policies

10. Given these considerations, the desired level of cost recovery in a particular case will depend on:

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3/ Taxes or subsidies may be desirable in some cases to offset "wrong" market prices, but their effects on revenue generation are then incidental. For example, if the farm output is exported and foreign demand is less than perfectly elastic it will generally be preferable to levy an export tax to maximize the export profits from the point of view of the country. Variation of that tax for cost recovery purposes will then tend to be counter productive.
(a) the need of the government for fiscal resources. This is independent of the project, 4/

(b) the exemption level of poverty, i.e., the level of poverty below which a person should not be taxed at all. This is also independent of the project,

(c) the income status of the different beneficiaries, 5/ and the size and distribution of project benefits,

(d) the feasibility of the desirable benefit taxes.

11. There is no prima facie reason why total recovery should not exceed the total financial costs incurred by the Government for the project. Those beneficiaries whose incomes are above the exemption level should be taxed as much as possible consistent with their continued participation in the project, and taking into account the adverse effects that the benefit taxes may have on production and evasion incentives. If all beneficiaries have sub-exemption levels of income, the optimum cost recovery will be zero. The lower limit of recovery should not therefore be set by the requirement that at least 0 & M costs be recovered.

12. Cost recovery policies should ideally be an integral part of project selection, design and evaluation. The scarcity of public sector income, and the desired social weights on the consumption gains of different income classes, are matters that affect not only the desired cost recovery policies but also the project's worth to the country.

13. The adoption of the approach presented in this paper should lead to recommended recoveries of between 75 and 125 percent of the financial costs for most types of irrigation projects supported by the Bank. This judgment is necessarily tentative as we have little experience so far with this approach. 6/ Consequently, while it is convenient to work with a quantitative "norm" of 100 percent, it should not distract us from applying the basic principles of cost recovery and from recommending variations from this working norm. This kind of flexibility has been a familiar tenet of past policy. The principal recommendations of this paper are summarized below:

4/ See Ray (4) and van der Tak and Squire (7) for discussions of the appropriate premium on government income.

5/ Their savings propensities also matter. The value of government income relative to the value of additional income to a particular beneficiary depends on the latter's savings propensity. The higher the propensity the less desirable is it to tax him.

6/ An illustrative exercise is presented in Annex 4.
(a) cost recovery policy in the context of a specific project should concentrate on efficiency pricing of water and on discriminatory benefit taxes. The effects of a project on revenues from general taxation should be taken into consideration, but it would not be desirable to adjust such taxation to achieve the cost recovery objectives of a particular project;

(b) volumetric pricing of water is desirable in public tubewell and pumping schemes where water deliveries are relatively easily metered. Where metering is too difficult to allow pricing -- as in major canal schemes -- the most suitable means of recovery is a benefit tax. Crop rates, which are an attempt to tailor such a tax to a particular service, need careful construction to support heavy rates of recovery. Otherwise, they may induce distortions to cropping patterns and water use. The most robust form of benefit tax is a land betterment tax spread over, say, the life of the project; as long as the tax base is an accurate measure of the benefit conveyed, it should meet the test of user acceptability. Land taxes may also offer scope for a progressive rate structure and achievement of distributional objectives;

(c) the level of cost recovery should not be related to the average income of the project beneficiaries, but rather to the average income levels of the different income classes involved. It may be desirable to exempt some from benefit taxes altogether, and to tax rich landowners, if any, very close to their capacity to pay, as long as this structure of charges is not defeated by tax evasion. Progressivity will tend to increase the level of cost recovery from that experienced in the past in Bank supported projects;

(d) where progressive benefit taxes are desirable but cannot be implemented, the Bank should consider the feasibility of land redistribution within the command area;

(e) appraisal reports should always fully discuss the appropriateness of the proposed cost recovery: in this context it may be useful for descriptive purposes to present two indices relating revenues to costs and benefits respectively. These indices
should always be computed in real (constant price level) terms, and the discount rate used should represent the best estimate of the opportunity cost of capital (or 10% if no estimate is available). The indices may be defined as follows:

(i) **Cost Recovery Index:** the ratio of (incremental revenues from water sales, if any, and benefit taxes to be paid by beneficiaries) to (incremental project costs at market prices borne by the public sector).

(ii) **Benefit Recovery Index:** the ratio of (incremental revenues from water sales, if any, and from benefit taxes to be paid by beneficiaries) to (incremental income accruing to beneficiary farmers before payment for water and benefit taxes, but net of their incremental payments of general taxes). 7/

(f) To facilitate evaluation of the recommended charges, benefit recovery indices should be presented separately for beneficiaries in different income classes (see (c) above). It is suggested that at least the following income classes be distinguished, viz.

(i) those with income above the national average,

(ii) those with income below the national average,

(iii) those with income below the critical consumption level (if no estimate is available half the national average level may be used as a rough guide), and those who are very rich.

(g) The benefit recovery index should be less than 100% to allow for various factors such as incremental costs of family labor, uncertainty of income gains, adverse effects of benefit taxes on production incentives, and administrative and collection costs.

(h) Cost recovery policies should give less weight to recovery of O&M costs per se than has been the practice so far. A value of 100% for the cost recovery index is a preferable working norm or reference point than O&M costs.

14. There is a need also to promote volumetric pricing and to proselytize Bank policy on water charges more effectively among member countries:

7/ In some cases the incremental payments of general taxes, e.g. an income tax, will depend on the benefit taxes imposed and this interdependence will affect the denominator in the benefit recovery ratio.
(a) a limited form of efficiency pricing -- metered deliveries to individuals or small blocks of users at nominal rates -- should be encouraged as a practical means of curtailing conspicuous waste of water when it is scarce, and to inhibit over-watering when supplies exceed prudent levels of demand,

(b) experimentation with fully demand-based systems of water distribution, based on efficiency prices, should be encouraged to test their feasibility and costs. If the benefits are significant, but the costs of implementation are prohibitive, some of the favorable results can still be adopted within the traditional framework of designing and operating irrigation projects,

(c) cost recovery deliberations for individual projects should be a part of a continuing overview of water charges in each country at the sector level. Also the Bank should not merely advise countries on the overall level of recoveries, but should look into the design and implementation aspects as well,

(d) considering the gap between these recommendations and what is typically accomplished, the Bank should support a modest program of technical assistance to aid borrowing countries in designing and implementing desirable water charge policies.
I. INTRODUCTION

1.1 The purpose of this paper is to recommend guidelines for establishing water charges in Bank-sponsored public irrigation projects. Since member countries are unlikely to enforce one set of water charges for these projects and a different set for their other projects, it is clear that the paper addresses the whole question of water charges policy in developing countries.

1.2 The types of public irrigation projects considered are mainly those provided with water fed by gravity from river diversion works, either alone or in combination with storage works upstream or pumped from streams or lakes by relatively large pumping plants. These types of projects have tended to raise the most intractable policy problems in the past and, therefore, deserve to be the principal focus of our analysis. Other types, such as tubewells, and small-scale pumping, are frequently financed also by private interests, so that public charges for these services are not of such vital concern. Still, the principles to be outlined are general, and can be applied to all types of public irrigation services.

1.3 The guidelines should provide broad answers to questions dealing with why charges are levied, what services they relate to, who should be levied, how charges should be implemented and how much should be collected—keeping in mind the typical characteristics of public irrigation schemes in developing countries, such as their lack of proper water control, uneven distribution of water, lack of metering and the small size of farms.

1.4 The need for such guidelines has arisen out of periodic disagreements and some bewilderment over what share of irrigation project costs should be recovered from beneficiaries and what forms of recovery are acceptable; for example, whether production taxes are acceptable. To understand these and the other issues, it is first necessary to examine historical Bank policy.

Past Policy

1.5 Policy on irrigation water charges has been remarkably consistent over the last fifteen years, with most of the changes of recent years being merely a strengthening of detail. According to a review by Wapenhans (6) of 14 irrigation projects financed between 1961 and 1968, loan agreements usually provided for the following: 1/

(i) recovery of current operation and maintenance costs; and

(ii) at least partial recovery of investments.

1/ The substance of paragraphs 1.5-1.10 which follow in the text is also drawn from this source. A list of references is given at the end of the main text.
1.6 An illustrative sample of the water rate clauses used in loan and credit documents states:

The Borrower shall make suitable arrangements for the recovery, by means of charges for the use of irrigation water and by means of increased taxes on land in the Project Area, of all operating and maintenance costs and of as much as practicable of the moneys invested in the Project together with reasonable interest thereon. 1/

1.7 In general, the Bank's appraisal of the revenue generating capacity of an irrigation project was usually limited to charges, levies and taxes affecting the users of the irrigation facilities. Appraisal missions normally found that it was impracticable to venture beyond the narrow confines of a project, into the wider aspects of resource mobilization in the agricultural sector.

1.8 A limited number of exceptions were made to this policy regarding policy instruments, as with Thailand where revenues from a heavy tax on exported rice was deemed to partly offset the costs of providing free irrigation water to rice farmers. Where such compensatory arrangements were firmly built into a government's fiscal policy, strong resistance frequently emerged to any rationalization of practice in the direction of assigning costs more directly to users. In such cases, the resistance to suggestions for change constituted a practical consideration which was taken into account in reaching agreement on irrigation charges.

1.9 In contrast with this apparent agreement about what kinds of charges were desirable, no standard formula evolved about what levels of charge were desirable. Each case was reviewed carefully, the various factors considered, and a plan or program was tailored to the circumstances which existed in each project. Normally, appraisal missions could assess only some of the factors relevant to irrigation charges, and they often thought it imprudent to request assurances on fixed, specific charges for a project's life at the time of negotiations. This uncertainty about users' ability-to-pay led to a practice of allowing borrowers one or two years to make a study, with the assistance of consultants or others.

1.10 The organization of water charge studies signalled a trend towards a more systematic assessment of farmers' repayment capacities, in light of factors such as taxes, subsidies, price policies, climate, markets and cropping potential. The reasons advanced for these studies were threefold: first, at the time of appraisal, it was normally impracticable to determine the level of charges above which farmers refused to transform their production processes from non-irrigated to irrigated agriculture (or from low intensity to high intensity irrigated agriculture); second, it was equally impracticable to

1/ Excerpt from Sect. 5.09 of Loan Agreement, Kemubu Irrigation Project (Malaysia), Loan Number 500-MA, dated June 15, 1967.
identify beneficiaries other than users; and third, new charges usually did not take effect prior to completion of construction; thus, time was available for more detailed studies and consultation between the borrower and the Bank, although this also meant that enforcement of such project conditions required more supervision during the latter part of the disbursement period.

1.11 The core of the above policies was restated in a Directors' memorandum (1) to Irrigation Divisions I and II on January 6, 1972:

The Bank's guiding principle regarding the adequacy of water charges in irrigation projects continues to be the full recovery of operating and maintenance costs plus investment costs at a reasonable interest rate. A recommendation for subsidization should be made only where it can be clearly demonstrated by such considerations as the need for adequate incentives, impact on income distribution, etc. In no case should the recovery be less than operating and maintenance costs.

In addition, directives were issued for Appraisal Reports to feature more uniform information on the expected contribution of water charges towards cost recovery, the nature of the charges recognized for this purpose and the justification of any implied subsidies.

1.12 Two financial statistics have since been required for each project:

(i) the net present value of any surplus or subsidy. This is the difference between (a) discounted investment, operating and maintenance costs, and (b) discounted revenues from water charges.

(ii) the cost recovery index. This is the present value of total revenues expressed as a percentage of the present value of total public costs--to indicate the proportion of costs recovered.

In calculating the net present value of the surplus or subsidy, the discount rate used is the opportunity cost of capital in the country or, if this is not readily available, the lower of (a) the internal rate of return of the project or (b) 10 percent.

1.13 Eligible revenues include water rates, and other charges linked directly to the supply of water such as additional land taxes, and a limited range of indirect charges. The latter have not been clearly defined, but include buying and selling price differentials for project commodities introduced for purposes of cost recovery. General taxes on agriculture are not accepted. Costs include all investment, operating and maintenance costs of the project. Price contingencies are defined as part of costs, unless it is expected that revenues will also increase in line with price inflation. Where significant sunk costs have already been incurred, the presentation
indicates the degree of cost recovery both with and without such costs. Costs which are recovered by other charges, such as roads for which there may be gasoline or other user charges, are omitted.

1.14 The reported justification for the proposed level of water charges is supposed to indicate its relation to the incremental income of the beneficiaries, the relative per capita income of the beneficiaries compared to per capita farm or national income, the level of charges needed for full cost recovery and the implication for incentives and income distribution, and any other relevant considerations justifying the proposed charges.

1.15 The following paragraph illustrates the additional information which has been required on cost recovery:

Recovery of costs would be achieved (i) by special water charges and (ii) by cash surpluses generated from government operations through the difference between the sale price of rice and cash payments for paddy to farmers. Total recoveries would cover operation and maintenance costs and all direct investments chargeable to the project at 2 percent interest. In order to measure the subsidy element, the full project cost as well as all project revenues were discounted at 9 percent over 40 years. The calculation shows that the present value of the government subsidy to the beneficiaries amounts to about US$3.8 million or 50 percent of costs. The recovery rate as proposed is considered reasonable to assure adequate incentives for farmers to intensify rice production. Moreover, despite the fourfold increase in farm family income which the project would produce, projected per capita income would still be only US$60 annually by 1980, well below the country's per capita national income estimated to exceed US$200 by that time. 1/

1.16 How has policy been interpreted? We can only refer to the particulars of appraisal reports, since actual supervision of projects does not extend very far into their operational phase.

1.17 In practice, direct irrigation charges in most Bank-financed projects are set at levels exceeding the minimum requirement of meeting operation and maintenance costs. Annex 1 shows this. It compares estimated annual charges in 14 projects against annual O&M costs at full development. The two projects for which recovery of O&M costs only is assumed (22-PAK and 121-CE) are pumping schemes with high operation and maintenance costs.

1.18 Early in 1972, the Irrigation Divisions calculated for 17 irrigation projects: (a) their projected cost recovery index; and (b) the relation of projected water charges to incremental farm income--an index of user

1/ See (6).
benefit recovery. Data were not available for other projects. Annex 2 gives the Division's findings 1/ which we summarize in the following four paragraphs.

1.19 The cost recovery index (the percentage of total costs expected to be recovered) averages 29%, and ranges from 8 to 49 percent. Thirty percent of the projects have indexes falling between 8 and 20 percent, sixty percent are in the 25 to 40 percent recovery range, and the remainder lie between 45 and 49 percent.

1.20 There seems to be no obvious, meaningful pattern. Indonesia Rehab. III has the second lowest cost recovery index (10 percent), but Indonesia Rehab. IV (40 percent) and II (49 percent) are in the upper range. India Pochampad has the lowest recovery (8 percent), but India Kadana is slightly above average at 31 percent. Both Korean projects are at the low end of the range (14 percent and 16 percent). The two Malaysian projects are somewhat above the average (31 percent and 37 percent).

1.21 The benefit recovery indexes for the 17 projects (the percentage of incremental farm incomes expected to be recovered by water charges) average 17 percent and range from 5 percent to 33 percent; 60 percent of the projects are in the 5 to 16 percent range and the remaining 40 percent range between 20 and 33 percent.

1.22 Except for their modest levels, there seems to be no clear, meaningful pattern in these data either. For example, water charges for India Pochampad are only 10 percent of incremental farm income, and 11 percent for India Kadana. For the two Korean projects, recoveries are 13 and 31 percent. For the three Indonesian and two Malaysian projects, the recovery tends to be relatively low.

1.23 There seems to be no obvious correlation between the cost recovery index and the benefit recovery index. For example, the cost recovery index for Korea Pyongtaek-Kumgang is a low 16 percent, even though water charges as a percentage of incremental farm income are among the highest at 31 percent. Conversely, for Indonesia Rehab. II the cost recovery index is the highest at 49 percent, but water charges account for a relatively low proportion of incremental farm income (5 to 20 percent).

1.24 One might speculate that past policy's emphasis on recovering at least O & M costs has weakened prescriptions for recovering capital costs; hence recommended recoveries would be smaller, the more capital-intensive

1/ It should be noted that water charges in respect of some of the projects listed in Annex 2 have been increased since its cost recovery estimates were prepared. Furthermore, the charges reported in both Annexes 1 and 2 are believed to be direct irrigation charges only, i.e. water rates, additional land taxes and betterment levies. Apparently, no indirect methods of recovery of any importance were proposed for these schemes.
the project. This is certainly the case, for there is a significant correlation of 0.73 between the 17 projects' cost recovery indexes and their O & M expenditures expressed as percentages of project costs. 1/

1.25 Summing up, two interrelated questions have pre-occupied past Bank consideration of the general revenue objectives of irrigation projects: what should be the revenue target? and what kind of revenues count towards it? In the past, these questions have been asked in the context of a fairly simple view of cost recovery which limited the definition of costs to direct contractual investment and operational expenditures by the public sector. The scope of the response has been to recover at least O&M expenditures and up to 100 percent of total contractual costs of a project by means of user charges. Less than full recovery is tolerated if justified by need for incentive, income distribution, etc., but guidance on these points is not well detailed. With the recovery target thus clarified, at least within limits, the focus of concern seems to have shifted to determining what kinds of indirect revenues (for example, commodity taxes) count, in addition to direct user charges, towards the target's achievement, so that specific recommendations can be made about the level of direct user charges. The traditional approach has been to exclude revenues from general taxation, but to count revenues which are rather more specific to an irrigation project, such as rice export taxes. Estimated rates of cost recovery in a sample of Bank projects tend to be low, averaging about 30%, and representing only about 17% of incremental farm incomes; recovery rates have also been highly correlated with the current expenditures (O & M) element of project costs.

Problems and Issues for Bank Policy

1.26 For the general class of projects which earn revenue 2/--for example, railways, ports, roads, power, and irrigation services--two main issues for consideration are: (i) the role of prices in aiding efficient product use and (ii) the need for cost recovery. The latter requires examination of (a) the revenue implications of efficiency pricing; (b) the revenue needs of the public sector; and (c) the revenue needs of project entities. We propose to consider the above set of issues in organizing a preliminary discussion of the strengths and weaknesses of past Bank policy. In each case, a general guiding principle will be put forward, drawn from Ray (6), followed by an examination of its relevance and implications for water charge policy.

1/ The variables correlated were the present values of revenues and O & M costs, each expressed as a percentage of the present value of project costs. The discount rate used for obtaining present values was 10 percent for all projects. A discount rate of 7 percent also gave a correlation of 0.73; 13 percent gave 0.72.

2/ Some sectors in which the Bank lends do not generate revenue; for example, population control, most education activities, and public health. The presumption is that such services constitute public goods which are best financed directly from general revenue, or else unduly high costs of administering user charges make their collection uneconomic.
1.27 Efficiency. Where unit pricing is possible, it is desirable to follow the traditional rule of product pricing: the price should equal the economic cost of producing the last unit of product sold. If, however, demand is not fully satisfied at such a price, the price should be raised to clear the market. This type of pricing induces purchasers to make correct decisions regarding their use of the product, and thus to realize the highest net economic benefit for the project. 1/

1.28 Past policy has virtually ignored the role of charges in promoting efficient water use. Irrigation experts in the Bank argue that there is not much scope for efficiency pricing, and they suggest that the efficiency issue is a minor one at this time. Nevertheless, we shall explore two questions: (1) whether any significant benefits can be obtained from designing and operating projects so that price determines water distribution; and (2) whether such benefits are feasible and economical to obtain.

1.29 Cost Recovery and the Public Sector. The measure of a project's impact on the balance of public resources is the present discounted value of the annual deficits and surpluses due to the project, these being estimated as follows (in real terms): 2/

(a) the total incremental public sector expenditures due to the project (including changes in expenditures induced outside of the project boundaries, such as the project's additional claims on public transportation services);

(b) minus the total incremental revenues that accrue to the public sector due to the project (extending similarly to changes in revenue induced outside of the project boundaries, such as changes in income taxes paid by suppliers).

1.30 This measure is therefore all-inclusive regarding the sources of public income and claims on public spending, and so too is any recovery index derived from it. Financial costs include all additional public expenditures. Financial income includes all additional public revenues, some of which come from beneficiaries not usually regarded as project users. While all-inclusive measures give the full financial implications of a project for government, many of these implications do not depend on the source of project finance; that is, many of them would ensue even if an erstwhile public project were funded privately. This would be true, for instance, of project-induced claims on public transport services, and of changes in income taxes paid by project suppliers. Perhaps this is why our intuitive concept of cost recovery recognizes mostly revenues that we feel are comparable to charges levied in private projects.

1/ For a comprehensive and rigorous discussion of the various aspects of efficiency pricing see Ray (4).

2/ See Ray (4) for a further breakdown of these cash flows.
1.31 The Bank's regular cost recovery index for irrigation projects, as defined in paragraph 1.12, is simply a partitioned version of an all-inclusive recovery index. It measures the relationship between the more direct public expenditures on an irrigation project and (mainly) direct user charges. In our view, this less inclusive index gives a better measure of project-specific recovery efforts. It compares user charge revenues, which are most easily controlled by policy to achieve project-related recovery objectives, with that portion of public costs that benefits users most conspicuously.

1.32 Two considerations should guide the determination of user charge revenues. First, in addition to charging prices, the public sector may levy benefit taxes, restricting their incidence to project beneficiaries, and relating them to net project benefits so that any individual tax burden does not exceed capacity-to-pay. Second, revenue policies of all public enterprises must reflect the budgetary resources position of the public sector overall. For instance, if there is an acute scarcity of such resources—the normal situation in most developing countries—charges for public services must reflect the many problems of obtaining revenue from other sources.

1.33 The main questions to explore, therefore, are: (1) whether there is a conflict between scarcity of public funds and low recovery rates for irrigation projects—both of which are common in developing countries; (2) whether the Bank's recovery floor of O&M costs and recovery ceiling of total contractual costs might also be anomalous in the presence of a scarcity of public funds, or if project benefits are poorly distributed; (3) whether benefit taxes should discriminate between users having different initial levels of income, and also extract disproportionately greater revenue from those enjoying larger project benefits; and (4) whether discriminatory direct and indirect taxes both count equally toward recovery.

1.34 Cost Recovery and the Irrigation Project Entity. Cost recovery issues arise at the level of the project entity mainly when these entities earn revenues directly from the public and are required to maintain satisfactory and viable financial positions. The immediate financial objectives of these entities might differ, therefore, from those that are in the wider, public interest. Typical examples of such project entities are public utilities and public railways.

1.35 No special difficulties should be encountered in classifying most project entities involved in managing public irrigation schemes. Invariably, the entities which construct and operate public irrigation facilities are government departments, which are financed directly from public funds. Even if these entities actually collect water charges, the latter are generally passed to consolidated revenue. It seems unlikely therefore that water charges should be influenced by any special financial needs of project entities.
1.36 Nevertheless, the Bank has insisted in the past that recoveries be not less than project operation and maintenance costs. Does this policy rest on a need to keep O&M entities autonomous? There may be other reasons for such a policy, but let us pretend that this is one of the reasons. A policy of covering at least O&M costs acknowledges indirectly that autonomy, if it is an issue, is not one for irrigation planning and construction agencies of government, but implies that it is one for O&M agencies. This would be rather strange for several reasons. First, most O&M agencies show little sign of being autonomous and, in fact, may not be very distinguishable from the planning and construction agencies. Second, user charges are rarely earmarked for supporting any O&M budget. Third, the Bank often obtains assurances anyway from borrowing governments that they will provide adequate support of project O&M budgets. Fourth, the Bank does not insist on any parallel legal safeguards of agency independence. Clearly, the policy does not rest on such a consideration.

1.37 Should the O&M agency be autonomous? This may be an important requirement for certain projects, in which case it would be desirable also to insist on a minimum recovery of O&M expenditures by the agency. As long as no other explanation of this recovery policy exists, therefore, the minimum recovery of O&M costs should not be a centerpiece of Bank policy on water charges, as it has been, but simply a possible requirement that is invoked whenever financial autonomy is a key issue.

1.38 The balance of the paper deals first with the efficiency issues, in Part II; this considers the conditions of water supply and demand in irrigation projects, and the revenue forthcoming from either a market price system or at least a system having metered charges. Part III deals with what have been the main issues in the past: the fiscal and distributive aspects of cost recovery. Finally, Part IV examines almost the same range of issues, but in a more narrow context, by reviewing the properties of available policy instruments.

II. EFFICIENCY ISSUES

2.1 We want to know if water charges can be a useful tool of project management. Since efficiency pricing of canal irrigation water does not exist in developing countries, or in developed countries as far as we can judge, we can only speculate: by drawing on insights from price theory, and by analogy with pricing policy in other sectors. We propose first to describe how a gravity-fed irrigation system is designed and managed, typically without reference to pricing policy, then to speculate about the probable impact of efficiency charges on project performance, and finally, to consider the scope for implementing these charges.
Design and Management of Irrigation Systems

2.2 An irrigation project's performance depends on: (i) its design, the main features of which are the area of land to be irrigated from available water supplies, and the spacing and capacity of canals and drains; and (ii) its management, concerned chiefly with the way available water is spread among users.

2.3 For instance, a gravity-fed irrigation system is usually designed to meet the needs of the "best" cropping pattern. Once this cropping pattern is defined, the water needs of various crops over time plus allowances for field and canal losses determine the necessary capacities of the distribution system. Engineers design a canal's capacity to meet maximum demand for water, which may last for only a few weeks each year. For the rest of the year, when crops need less water, the canal system is relatively underutilized; additional watering at such times could be harmful to crops, or might contribute to drainage problems.

2.4 The rules for operating canal systems are already anticipated, therefore, in their design. In many cases, the rules depend on user conformity in cropping patterns and their acceptance of water delivery schedules. Typically, the canal authority's objective is to supply all users having the same crops with roughly equal amounts of water per acre of culturable command. Most canal systems are equipped with control gates so that water can be rotated among watercourses with, say, two being shut off while a third is running.

2.5 Consider three successive watercourses, each with a capacity of 28 liters per second (one cusec) and serving seven farm units, each of two hectares. Each watercourse is kept running for one week out of three. Allowing for 10 percent infiltration losses in the water courses, each farm unit receives 2,100 m³ of water every 21 days. This is equivalent to a depth of 10 cm. Of this water, some 3 cm may infiltrate to the ground water reservoir, while 7 cm brings the root zone up to field capacity and is thus available to the crops.

2.6 Such a pattern of distribution might be repeated over an entire command. However, many things can go wrong. Unseasonal rains in the command can quickly reduce user demand for canal water. Inadequate rains in upstream catchments can interfere with supplies. For the system to work, competent systems management is required plus cooperation from users.

2.7 The types of charges usually levied in return for the kind of water supply just described do not reinforce the discipline which is required of water users. Betterment levies, land taxes and various kinds of
crop or seasonal rates levied per acre irrigated do not penalize users who take more than their entitlement. 1/ Hence, any mismanagement of supplies is readily overlooked by users who benefit from it.

2.8 In periods of maximum supply and perhaps moderate demand, when all distributories are operating and deliveries are possible once every week, water may have a very low productivity at the margin. There is frequently a danger in fact that users will accept water to the point where it is harmful by raising water tables over time, and causing salinization. Good canal management can avoid this danger. But, since a little extra canal water is "free" when not charged for on a metered basis, there is no automatic financial discipline on users to pursue the social objectives of water use independently when unforeseen events lead to a lapse in canal management.

2.9 In periods of maximum demand and perhaps insufficient supplies to maintain normal deliveries to watercourses, very strong discipline is required. If canal management loses control, it is generally users in the "tail ends" of the canal system who suffer most, their share of supplies being pre-empted by users situated further up the watercourses and canals. Once again, the usual types of water charges do not help to reinforce the discipline that is required, since the user who can somehow obtain more than his proper share is not charged for it.

2.10 Finally to be efficient, project management should cease operations (either temporarily or permanently) if expected project benefits are less than avoidable costs (public &M costs). This scenario is considered to be an infrequent one for irrigation projects, however, and a difficult one to predict. Technically, it might justify charging users at not less than O&M costs as one way of monitoring this critical level of user ability-to-pay, which, in turn, is one way of monitoring this extreme form of project failure. But the need would be infrequent, and its consideration adds very little in our opinion, either to the operational efficiency of projects or to the design of water charge policy. (See discussion of & M costs and marginal cost pricing in Annex 3.)

2.11 Drawing these observations together, charges for promoting efficient use of water must recognize three important problems of design and management. First, increasing the area designed to be irrigated—spreading water more thinly—leads inevitably to increasing water losses from the delivery system and from users' fields. Second, users who receive water from the same minor canal, the same water course, and especially the same outlet have to act in some kind of unison, as there are economies to rationalizing delivery schedules. Third, operation of a canal system requires anticipation of user needs, competent scheduling of deliveries, and discipline on the part of users in their use of water and occasionally in their competition for it. The typical charges which are levied in irrigation projects play virtually no role in scheduling deliveries to their most efficient use, in reinforcing the user discipline required, or in providing information to project management on the state of water supply and demand.
Potential Contribution of Efficiency Charges

2.12 Consider a project designed and operated according to the norms discussed in the last section, but with emphasis on distributional objectives so that water is spread widely throughout a geographical area to increase the number of beneficiaries. Bank staff have frequently encountered this type of project. They claim that design and operating policies for this type of "extensive" irrigation emphasize distributional objectives to the point where there is heavy over-investment in canals. For example, the actual intensity of irrigation might even drop below 100 percent, in which case water is carried past irrigable land at the cost of higher investment in canals, and of losses of water in transit.

2.13 As might be imagined, there would be difficulties in changing over from the kind of delivery mechanism described in the last section to one which allocates water in line with users' assessment of its productivity. Suppose, however, that the necessary marketing and physical structures were installed and it were possible to deliver metered water, if not to individuals, then at least to blocks of farmers served by an outlet or even a whole water-course ... according to whichever bloc offered the highest bids for the available water. For example, a canal authority might hold a series of auctions of supplies available during the coming period, measured at the head of the canal, and make separate charges for transport of water to farms in all reaches of the command at marginal cost, with users bearing any transit losses of water. Losses would be fairly well known and could be estimated according to the distance transported, the particular canals used and their prior condition (wet or dry). As such, water losses could be incorporated into the estimate of other marginal costs of effecting delivery of water to a particular outlet or distributory. (See related discussion of marginal cost pricing in Annex 3.)

2.14 This hypothetical marketing system reveals characteristics that are unique compared with the traditional method of rationing water. Quite apart from the novelty of having prices as such, water prices would tend to be higher at the extremities of the command than elsewhere, especially during periods of scarcity, because of extra losses experienced in transport and additional costs of supervising transport. Such losses might be smaller or non-existent during other periods, but contractual operational costs would remain. Other things being equal, these prices would encourage a concentration of water in the upper reaches of the command during periods of scarcity; value added by users and employment per unit of water would be maximized; and some public distribution costs would be reduced. Even in relatively normal periods of supply, irrigation users located in the extremities of the command would buy water only when it was plentiful.

2.15 Hence, efficiency pricing could have important consequences for project design, not only for the total area commanded and the canal system, but also for the package of investments called "command area development." For instance, efficiency pricing would favor an intensive/extensive mix of
irrigation activities according to location and perhaps other factors such as soils within a command; because it would be pointless to favor the same levels of on-farm development in the tail ends of a canal system as in more favored areas.

2.16 In the absence of compensatory arrangements (offsetting benefit taxes), the efficiency price marketing system would therefore favor landholders in the upper reaches of the command and landless laborers. It would disfavor landholders elsewhere in the command, except for smaller landowners who might benefit from the greater demand for labor. 1/

2.17 It is easy though to flaw extreme forms of extensive irrigation on efficiency grounds, and more efficient strategies can also be devised within the conventional framework of project design and operation. Engineers can redesign canals to serve more compact areas and they can overcome the problem of sharing water during seasonal shortages partly by servicing in rotation only a section of the command during these shortages.

2.18 Nevertheless, important differences in design and management would still persist. The levels of command area development under efficiency pricing would still tend to be less uniform throughout the command than those expected with conventional planning. Water users under efficiency pricing, would not be subject to the same pressures of conformity. They could pursue, within wider limits perhaps, cropping patterns and irrigation practices closer to individual preferences. Most important perhaps, efficiency pricing would provide incentives to users to avoid waste and harmful overwatering, and it would furnish a radically new kind of information to management on the behavior of users' demand for water.

Scope of Information

2.19 Since no working projects use efficiency prices for distributing public canal irrigation water in developing countries, it would be quite speculative to claim that this is a workable solution to the problems of water management and cost recovery. We can examine its feasibility, however, by spelling out its requirements. The technical and economic requirements of efficiency pricing are:

(i) an acceptable method of measuring or metering deliveries, as a basis for unit pricing;

(ii) either a prescient canal authority, which can forecast a market clearing unit price, or an impersonal system of auctioning total water supplies to the highest bidders;

(iii) an operationally meaningful bloc of buyers;
(iv) a physical capability of delivering water to buyers and withholding it from non-buyers, probably involving improved control structures and increased managerial supervision; and

(v) that the present value of increase output, resulting from gains in efficiency, exceed the present value of any increased costs of project design and operation.

2.20 Viewing these requirements, there are some circumstances perhaps in which the relevance of efficiency pricing can be dismissed a priori. For example, existing canal projects which are designed for continuous field-to-field flooding, and where lack of control structures are of little consequence--many of the paddygrowing areas of South and South East Asia--would simply not allow the required discrimination against "non-buyers." There are other situations also: where canal authorities cannot enforce their preferred patterns of water distribution even under existing arrangements, because of undisciplined, unlawful user behavior and their own lack of enforcement ability. It would be quixotic to attempt sophisticated improvements to water marketing if more fundamental problems like these were left untouched.

2.21 At the same time, many other circumstances exist for which the above requirements should not be too difficult to meet. Some early experiments with, and appraisal of efficiency pricing are therefore urgently needed: first, to provide direct signals to project authorities and users for the most efficient management of their systems; and, second, to provide indirect guidelines for designing and operating other projects that may still have to be managed under traditional rules for water distribution.

2.22 The case for some minimum form of unit pricing is even stronger, and since it involves only the first-mentioned requirement of full efficiency pricing, it deserves a more proximate place in Bank policy. In order that this recommendation may be understood clearly, let us distinguish two types of inefficient water use: (i) utterly conspicuous waste by users, resulting mainly from zero unit prices (paras. 2.7-2.9), and (ii) less conspicuous waste and misuses, resulting from non-zero unit prices that reflect other than the opportunity cost of water.

2.23 We often hypothesize that the first type of user waste--such as allowing water to run freely into drainage ditches when it is scarce elsewhere in the command--can be prevented by metering deliveries and charging quite nominal unit prices. This kind of pricing discipline has been introduced in some schemes of developing countries; for example, in the East Ghor Irrigation Project, Jordan.1/ Where farms are small, a meter should monitor the consumption of a group of individuals. The group can then arrange for the billing of its members.

1/ As reported by Natur (3).
2.24 Metering is not uncommon in the case of lift irrigation and tube-wells and in the basis for charging volumetric rates for water from these sources; for example, in certain states of India. In these cases, metering is simplified by a knowledge of the rated capacity of the pump, diameter of piping, height of lift and period of delivery. Measurement of water delivered through an open ditch in gravity-fed projects presents added difficulties and costs. Several features though are common. Knowledge of the shape and cross-sectional area of orifices, of the head of water in the watercourse, and of the period of delivery gives a fair basis for estimating the volume of water supplied from a watercourse. The features that are not common, however, are the main source of trouble. Canal schemes supply large numbers of users spread over a wide area. Users can easily tamper with most devices for measuring flows, and they can bribe the ditchriders who control local deliveries. There is scope here for research to develop cheap, automatic measuring devices, and also for appropriate studies of canal personnel management and proper accounting of water flows throughout the system.

2.25 Finally, although unit pricing of water would contribute more than any other form of charge to improved water marketing, pricing of some irrigation services is also possible without metering. In the absence of metering, some gains in efficiency are still attainable from issuing users with negotiable rights to preferential water deliveries in the event of water scarcity. Making these rights negotiable allows market forces to allocate water to those users who, presumably, can use it most efficiently. Note, however, that this method of marketing the traditional services of irrigation projects also needs the last four of the five technical and economic requirements of efficiency pricing (para. 2.19). The method offers an interesting alternative form of efficiency charge for those projects where metering seems hopeless.

III. COST RECOVERY ISSUES

3.1 In principle, cost recovery issues involve two sets of considerations. The first is concerned with the level and structure of the prices to be charged for the output from the project so as to maximize its net economic benefits to the economy, i.e. with "efficiency" prices. The second set of considerations relates to the desirability of adjusting the efficiency prices, or charging alternative taxes, because of fiscal and financial concerns or on income distribution grounds. Among the questions that arise in this context are: how pressing is the need of the government for additional fiscal resources; what is the current and expected income position of the beneficiaries; how feasible is it to levy additional charges; and how seriously do they affect the net benefits from the project?

3.2 The scope for efficiency pricing of irrigation water is limited, however, as discussed above in Part II. In the case of canal irrigation projects, especially those serving numerous small lots, metered sale of
water is costly to implement and administer, and is rarely practiced in developing countries. Nonetheless the potential advantages of volumetric pricing are great, both for bringing about optimal water use in the command area and for revenue generation. For this reason, it is advisable to seriously investigate the possibilities of volumetric pricing in Bank-supported irrigation projects, at least on an experimental basis, rather than rule out such options ab initio.

3.3 In the absence of volumetric pricing, the extent of cost recovery of irrigation projects depends on their fiscal implications and the feasibility and desirability of special levies on beneficiaries. These aspects of cost recovery give rise to a number of practical questions. Irrigation projects, like other public sector projects, typically induce numerous changes in public sector revenues. All such effects on public sector incomes are relevant from the point of view of judging the impact of a project on savings and consumption, and on income distribution. For example, revenues from general taxes (such as agricultural commodity taxes, income taxes, taxes on fertilizers, "marketing margins," etc.) may increase as a result of the project, contributing substantially to the recovery of public funds spent on the project. Any increase in public revenues as a result of the project that would not otherwise have occurred is pertinent to a measure of the fiscal impact of the project. And any increase in public revenues as a result of public financing of the project that would not have occurred had private financing been feasible is pertinent to a measure of the fiscal impact of public rather than private financing. However, judgment on changes that may be desirable in such general taxes involve much wider issues which should not be viewed from the perspective of a single investment project; adjustments to such general taxes are, therefore, not an appropriate instrument of cost recovery policies. Along with the possibilities for efficiency pricing of water, discriminatory taxes on project beneficiaries (i.e. benefit taxes) should therefore be the focus of attention for cost recovery policies.

3.4 It may be helpful to indicate this as follows: If \( R \) is total incremental recoveries due to a project, then we can write:

\[
R = R_e + R_b + R_o,
\]

where \( R \) indicates incremental revenues from water sales, if volumetric pricing is undertaken; \( R_e \) indicates incremental revenues from benefit taxes; and \( R_o \) indicates the net influence of general taxes and other changes in public income such as higher profits for public monopolies etc. 1/ Cost recovery policies at the project level should be concerned with only the first two sources, \( R_e \) and \( R_b \). When volumetric pricing is not feasible, or too costly to implement, the relevant source of revenue for cost recovery policies is benefit taxes (\( R_b \)). The option of charging benefit taxes to capture a part of the incremental project benefits results from public financing of the

1/ See Section III.b of Ray (4) for detailed discussions of fiscal effects. See also para 1.29.
project and should be examined thoroughly during project preparation, appraisal and implementation. In contrast the option of adjusting general taxes that bear on many others beside project beneficiaries is always there regardless of the project and should be examined at the wider sector or national level.

3.5 The discussion is arranged as follows:

- The principal factors involved in decisions on recoveries from benefit taxes;
- progressivity of benefit taxes;
- recovery indices and norms;
- operational needs

Revenue Determinants

3.6 It is convenient to illustrate the cost recovery issues with the following example. Consider a group of farmers who benefit from the project because of a lower price of (or new access to) water. Ignoring benefit taxes and income taxes for the moment, the effects of the project on the group's incomes and costs may be written as follows:

\[
\begin{align*}
R &= \text{Incremental sales at farm gate prices.} \\
n &= \text{Incremental cost at imputed supply prices of family labor and management incurred.} \\
p &= \text{Incremental outlays on water, if volumetric pricing is undertaken.} \\
q &= \text{Other incremental production expenses, at market prices, incurred by the farmer.} \\
C &= n + p + q = \text{Incremental production cost.} \\
Y &= R - C = \text{Incremental income gain net of family labor costs (n), or project "rent".}
\end{align*}
\]

If benefit taxes are introduced, and returns to family labor and management are recognized as a form of group income, the following terms may be defined:

\[
\begin{align*}
b &= \text{Incremental revenues from a benefit tax.} \\
B &= Y - b = \text{Incremental net benefits received by farmers.} \\
M &= B + n = \text{Incremental net disposable monetary income.}
\end{align*}
\]
If there is an income tax at the rate of \( t \), it will presumably be levied on \( M \), so that \( B \), measured net of income taxes, must be redefined as \( B' = Y-b-t(Y-b+n) \). Hence,

\[
B' = (1-t)B - tn = \text{Incremental net benefits received by farmers after income taxes.}
\]

\[
M' = (1-t)M = \text{Incremental net disposable monetary income after income taxes.}
\]

\[
T = tM = \text{Incremental income tax revenues}
\]

While it is dangerous to generalize from such a simplified analysis, for a given \( t \) there is a partial substitution between revenue derived from \( b \) and revenue derived from income taxes: the greater is the level of \( b \), the smaller is the level of income tax revenues, though the greater is the level of the two revenues combined.

3.7 The basic fiscal and distributional issues of cost recovery concern the size of the incremental net benefits \( (B') \) that should be received by the farmers. The larger is the desired \( B' \), the smaller the incremental revenues realized by the public sector, and conversely. A judgment on the desired cost recovery rate necessarily involves a comparison, whether done explicitly or not, between the social value of additional public income and the social value of additional income of the beneficiaries concerned.

3.8 The project level policy instruments that "control" the distribution of benefits between the farmers and the public sector are the price of water \( (p) \) (or more generally the prices of all the public sector services provided), and the benefit taxes \( (b) \). While cost recovery policies should focus on these two instruments, general taxes are clearly relevant to the determination of the farmers' net gain \( (B') \). For example, for any given 'target' level of net gain \( (B') \), the necessary benefit taxes will be less the greater the level of a general sales tax on farm output (i.e. the lower the farm gate price), or the greater the level of a general income tax. Adjustments to such general taxes, however, are not appropriate for cost recovery at the project level, as noted earlier (para. 3.3), so that such taxes should be taken as fixed. Nonetheless, while we concentrate on the recoveries \( (p + b) \), the existence of general taxes and their bearing an benefit distribution should be taken into consideration.

3.9 There may be cases, however, when a "sales tax" would be a suitable benefit tax, e.g. when farm output is purchased by public agents with 'monopsony' powers to charge discriminatory prices. Similarly, some input taxes may sometimes be suitably discriminatory. Such taxes will then be adjustable in the project context and should be treated as benefit taxes. Similarly, if some of the taxes on the goods and services that farmers purchase out of their disposable incomes are suitably discriminatory, then such taxes may also be regarded as benefit taxes.
3.10 The social value of additional public revenues depends on the distribution, at the margin, of public expenditures between various uses, and the effectiveness and productivity with which such expenditures are carried out. The value of public income is a country parameter which can be regarded as independent of the project. One would expect this value to be greater than the value of additional consumption expenditures of at least the affluent members of the society. 1/ The greater the scarcity of savings in the economy, the greater is likely to be the "premium" on public savings, and on private savings as well, over private consumption.

3.11 The social value of the income gains of a beneficiary will depend on his consumption standard relative to that of others in the country. The more affluent the beneficiary, as compared to the national average level, the less the appropriate social weight is likely to be for valuing his consumption gains, and conversely the poorer the beneficiary the greater is likely to be the appropriate social weight. At a particular consumption level, called the "critical consumption level (CCL)"; the social value of additional consumption will equal the social value of additional public revenues. Beneficiaries below the CCL should thus, by definition, be considered so poor as to be tax exempt. In principle all consumption gains to beneficiaries above the CCL should be taxed away, although in practice this is of course not possible. The CCL, or the "poverty line", may in practice be as low as 1/5th the national average in some cases implying tax exempt status to the very poor only, or as high as say 2/3rds the national average income. Generally, the greater the premium on savings over consumption (i.e. the greater the preference for growth) the lower the CCL, and conversely. 2/

3.12 Benefit taxes may reflect regional preferences of the government. Regional preferences, however, often reflect regional disparities in income levels; such disparities are taken into account automatically if benefit taxes are geared to income levels. Care must be taken to distinguish between regional preferences reflecting income differences (as discussed above) and regional preferences on grounds other than such differences.

3.13 All benefit taxes are likely to affect production and consumption decisions of the beneficiaries to some extent, the importance and severity of which depend on the margins affected. Taxes on land value increments are probably to be preferred over discriminatory taxes on farm production inputs and outputs, as the latter type of taxes tend to lead more easily to sub-optimal input mixes and crop choices.

1/ See Ray (4), and van der Tak and Squire (5).

2/ An example of how these factors can be introduced formally in cost recovery analysis is provided in Annex 4.
3.14 In practice the analysis of desired benefit taxation cannot naturally be done on the basis of perfect discrimination between the individual beneficiaries. Aggregation of individuals into groups generally leads to less recoveries than otherwise would be possible, as uniform taxation of beneficiaries in a group tends to be constrained by the needs of the most disadvantaged members of the group. For this reason it is preferable to have at least a distinction between those who have more income than the national average and those less, and to identify the extremities, i.e. very rich landowners and those who are poor enough to merit tax exemption.

3.15 Benefit taxes should be geared to income levels as modified by the project, and not to the distribution of project benefits per se. However, the distribution of income and project benefits among the beneficiaries are likely to be strongly and positively correlated with each other and with the distribution of land holdings, adjusted for quality differences, e.g. soil quality, drainage characteristics, and access to water.

3.16 In designing benefit taxes one should distinguish ownership of land from tenancy as the benefits created by the project often accrue mainly to the owners. The distribution of burden of the tax between landowners, tenants and sharecroppers also needs to be considered.

3.17 Comparisons of the wealth of landowners should not be based on physical units of land, but rather on the market values of land of different types. Estimates of at least the unimproved values of land of different types may be available relatively easily, and need to be derived in any case for monitoring land value increments brought about by the project.

Progressivity

3.18 Figure 1 illustrates how a progressive benefit tax compares with a flat rate benefit tax, the latter being a common type in developing countries. The vertical axis measures benefit tax per unit holding size, and also project financial rent (maximum user capacity-to-pay) per unit holding size. The horizontal axis measures size of irrigated holding adjusted for quality. This could also be a surrogate for the income of users. Suitable measures for holding size might be its area, as shown in Figure 1 or, alternatively, the unimproved value of its land. Several holdings owned by a single user would need to be aggregated.

![Figure 1](image-url)
\[ Y_1 = \text{Financial rent per unit size of holding, in favored areas.} \]
\[ Y_2 = \text{Financial rent per unit size of holding, in unfavored area.} \]
\[ b_1 = \text{Benefit tax per unit size of holding, in favored area} \]
\[ b_2 = \text{Benefit tax per unit size of holding, in unfavored area.} \]
\[ b_0 = \text{Flat rate of benefit tax applicable to all areas of command.} \]

3.19 The relationships in Figure 1 reveal the important advantages of the progressive over the flat benefit tax. The relevant tax base (project rent) used with progressive benefit taxes gives recognition to differences in project services, wherever these exist across a command, by distinguishing \( b_1 \) from \( b_2 \). If the without-project income of certain beneficiaries plus the supplement bestowed on them by the project is less than a policy norm, the government could waive their benefit taxes entirely (for those with holdings smaller than OA and OB in Figure 1). For example, the government might apply such a provision to holdings of one acre in the upper reaches of a command, or two acres in the lower reaches (see para. 3.21 below and para. 16 of Annex 4, however, for reservations about any waiving of charges). At higher levels of income, the progressive tax shifts a greater share of the recovery burden onto those who can afford it. Taxes could be made so progressive or confiscatory, that they would amount to, or be consistent with, a land reform policy.

3.20 The principle of the progressive benefit tax is similar to that of the progressive income tax: by distinguishing large from small capacities to pay, progressive rates of tax can recover much more revenue than a flat rate of tax that is constrained by the low capacity-to-pay of the poorest and least-affected beneficiaries. As we saw in Part I, recoveries estimated for seventeen Bank irrigation projects averaged only 17 percent of incremental farm incomes; although recoveries of project rents would be higher than 17 percent, we suspect they were still at modest levels. 1/ Too much attention has been given in the past to the low capacity-to-pay of the majority of users who are very poor, and not enough to the high capacity-to-pay of the minority which both earns a large share of total project rent and is generally well-off, in a relative sense, even without the project.

3.21 There are inherent draw backs, of course, to progressive taxation: notably, the incentives it creates for cheating. Progressive land taxes will tend to induce landowners to distribute their holdings in the names of relatives and functionaries to gain more favorable tax treatment. Where authorities can detect these deceptions and enforce taxes successfully, the revenues must also finance the heavier cost of collection.

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1/ The project rent (see para 3.6) is net of family labor costs and thus lower than the incremental monetary gain before benefit charges.
3.22 An indication of the data and analytical requirements of implementing a system of optimum, progressive benefit taxes is given in Annex 4. Using data from a Bank appraisal report, we show that little additional information or analysis is required for deriving appropriate user charges, beyond that needed to implement the new proposals for project evaluation given by van der Tak and Squire (7). Although the example worked through is hypothetical, we feel that the suggested increase in recovery—from 31 percent of project costs to 93 percent—would not be unduly high.

Recovery Indices and Norms

3.23 There is no a priori reason why the recommendations on cost recovery, based on the various considerations discussed above, should have any fixed relationship to total project costs or parts thereof. The optimal cost recovery will be zero if all the beneficiaries are so poor as to deserve tax exemption and volumetric pricing is not possible. On the other hand, the optimal rate may be above 100% of total costs if either volumetric pricing is possible, or the beneficiaries are affluent, or both.

3.24 By and large the policy of recovering at least O&M costs have tended to make the level of O&M costs a reference point. This has led to a low bias in recommendations on cost recovery. It is our judgment that a reference point, or "working norm", of 100% of total costs (at market prices) incurred by the public sector will be a better policy as we expect the optimum cost recovery rates to fall in the 75% - 125% range in practice in most cases. Cost recovery might be measured as follows, in constant prices and in present value terms (discounted at the opportunity cost of capital):

- Ratio of (incremental revenues from water sales, if any, and from benefit taxes) to (incremental project costs at market prices undertaken by the public sector).

In terms of the example in para. 3.6 above, this ratio might be written as \((p + b)/A\), where A is incremental financial costs incurred by the public sector.

3.25 It may also be useful to compute benefit recovery ratios for the principal beneficiary classes (see para. 3.14 above), as follows:

- Ratio of (incremental revenues from water sales, if any, and from benefit taxes) to (incremental income accruing to beneficiary farmers before payment for water and benefit taxes, but net of their incremental payments of general taxes).

In terms of the notation used for the illustration in para. 3.6 this ratio can be written as \((p + b)/(M' + p + b)\), to be measured as present values in real (constant price) terms.
3.26 When volumetric pricing is not warranted this ratio becomes \( b/(M' + b) \) (or \( b/(B' + n + b) \)). Logically the preferred ratio should be \( b/(B' + b) \) as this treats the incremental cost of family labor \( n \) like other items of production cost. However, in practice it is more convenient to use the incremental monetary income \( (M') \) in the denominator. In either case, the allowance for the incremental costs of family labor and management should be separately presented and justified. 1/

3.27 It should be noted that if the benefit recovery ratio is maximum for a beneficiary then that beneficiary does not gain anything from the project. One would expect the optimal value of the benefit recovery ratio to be less than the maximum. Apart from reasons related to the income status of the beneficiaries, several other reasons might concern (i) the uncertainty of the income gains, (ii) adverse effects on production decisions due to the benefit taxes, (iii) administrative and collection costs, and (iv) allowance for incremental costs of family labor and management if the \( b/(M' + b) \) measure is being used.

3.28 These cost recovery and benefit recovery ratios should be regarded as descriptive devices, designed to facilitate deliberations on cost recovery. However, the design of satisfactory cost recovery policies should not be reduced to the mechanical computation of cost and benefit recovery ratios as such ratios may often hide important deficiencies. In particular, 100% cost recovery is neither good nor bad per se. Use of such ratios should therefore be supplemented by a full analysis of the proposed prices and charges as they bear on economic efficiency, income distribution and the need for additional savings.

Operational Requirements

3.29 Recommendations on water charges and cost recoveries need to consider the uncertainties involved in any \textit{ex ante} analysis. For this reason it is desirable to set forth criteria by which recommended cost recovery policies can be revised in the light of developments.

3.30 The data needed to support an \textit{ex ante} determination of benefit levies differ from the data needed to support a government's continuing reassessment of its charges. In the first case, estimates of desirable recovery levels are based on direct projections of future output and its distribution among users over a long period. In the second case, charges can be reassessed every few years, based on projections which are closer to a project's actual performance.

1/ The ratio \( b/(M' + b) \) reaches its maximum value, \( b/(b + n(1-t)) \), which is less than unity, when \( B' = -tn \) and \( b = Y \). The corresponding maximum value of the alternative ratio is greater than unity, also when \( b = Y \). It is understood of course that \( b \) cannot exceed \( Y \), which is the benefit tax base.
3.31 For example, the benefit tax base considered to be most desirable for a particular area of command is the project's rent for that area. The typical ex ante assessment, such as that given in project appraisal reports, employs a direct estimate of the rent for a period of perhaps 20-30 years ahead, or more. But governments can also estimate the same rent indirectly, and revise it repeatedly during the life of the project, by employing users' own valuation of the assets that produce it: namely, the increments to the unimproved value of land due to irrigation. The main operational requirements for measuring these increments are: (i) a project unit that monitors land values for, say, 10-20 sections of a command, so that irregularities in the distribution of project benefits are detected; the same unit should also assemble economic statistics for the command and adjacent "control" areas; (ii) a central (sector) unit which determines uniform criteria for setting a land betterment tax schedule; and (iii) a collection agency.

3.32 According to the Indian Irrigation Commission (2), the main obstacle to enforcing laws that require betterment levies to be tied to productivity has been the difficulty of assessing effects of irrigation on land values. This may be a particular problem on which the Bank could organize research, cross-country evaluation and some technical assistance.
IV. POLICY INSTRUMENTS

4.1 This part of the paper summarizes and compares the properties of policy instruments that can be used for cost recovery in irrigation projects.

4.2 Several instruments or forms of recovery are employed in developing countries, often in combination. Desirable forms are those that satisfy the following requirements, most of which were at least identified in Parts II and III: (i) all must have the power to discriminate between a project's direct beneficiaries and non-beneficiaries; that is, between water users and non-users; (ii) they should either guide the efficient allocation of resources; or be neutral or, at worst, interfere as little as possible in this regard; (iii) at least one instrument should have the capacity to permit progressive rates of charges, and the others should not be regressive to the point of cancelling the overall capacity of charges to be progressive; and (iv) they should be fair, in the sense of requiring users who are equally poor or equally rich to pay the same charge for the same benefit or service.

Discriminatory Attributes

4.3 Income taxes, taxes on consumer goods and most production taxes (taxes on farm inputs and outputs) tend to affect project users and non-users equally. Alteration of these tax rates for cost recovery purposes, therefore, would fail to put the burden of recovery on project beneficiaries. This limits us to considering the following types of charge:

a. Unit prices for water.

b. Charges against specific irrigation contracts; for example, charges per acre of crop irrigated (crop rates).

c. Betterment taxes against command land.

d. Any other production taxes, mainly indirect, which are highly discriminatory between project users and non-users; for example, a surcharge on marketings of output through project marketing boards.

e. Any discriminatory income transfers from project users to domestic consumers as a result of commodity pricing policies.

4.4 The first three types of charge are completely discriminatory. The fourth and fifth raise difficulties, however, because the few examples that arise are not always project-specific. If reasonably specific to the public irrigation sector -- as has probably been the case for instance with rice export taxes and related domestic pricing policies that favor consumers at the expense of producers in Thailand -- it is probably necessary to analyse
the burden of general taxation within society as a whole, to see if this sector is being discriminated against overall; without such analysis, the relevance of the fourth and fifth instruments for water charge policy may still be unclear.

Efficiency Attributes

4.5 Contractual obligations to pay water prices and crop rates are entered into by users in return for specific arrangements for the supply of water. In contrast, obligations to pay land and other production taxes and discriminatory prices are linked only indirectly with water supplies. This helps to explain the varying potential of the five types of charges for influencing water use.

4.6 The most effective means of influencing water use through charges is to price it; this involves volumetric metering and, ideally, frequent market-clearing quotations (efficiency pricing) and related sales. A market-clearing price seldom has any relationship with any of the accountancy concepts of project costs, such as O&M costs, and it is difficult to determine without a market (see Annex 3). Good conditions for pricing water at market-clearing rates arise in the disposal of surplus water from private pumping schemes and tubewells, where the volume of water delivered can be assessed fairly accurately; public authorities might copy these practices in public tubewell and pumping schemes. But such conditions are seldom met anywhere in major canal schemes. Metering and sales at fixed, frequently nominal prices are found in major canal schemes in developed countries, but metering is rare in developing countries, partly because of the much larger number of meters required (smaller holdings). Nevertheless, even nominal prices for irrigation water serve some aspects of an efficiency objective; they offer users incentives to eliminate the conspicuous waste and overwatering that occurs when water is treated as a free good. If metering is too costly, some gains in efficiency are still obtainable, but currently not availed of in developing countries, from issuing users with negotiable rights to assured supplies in the event of water scarcity.

4.7 Crop rates can distort cropping patterns if their structure is not set properly. In certain cases, avoidance of distortions requires setting rates in proportion to the expected water consumption needs of crops. Crop rates may also deter irrigation altogether if their level is set close to the expected pay-off from irrigating a crop. Similarly, land taxes, payable whether irrigation facilities are used or not, can affect water use if set high enough, but then only indirectly, by forcing out of business inefficient, inept irrigators. Hence, both land taxes and crop rates can contribute favorably to water management, under certain conditions, in the absence of efficiency pricing. For the most part, however, the real task of promoting water use efficiency, in the absence of efficiency pricing, falls to physical rationing; in fact, rationing is generally the sine qua non of most systems.
of public water distribution. Realism has demanded, therefore, that this paper concentrate on the distribututional and fiscal aspects of water charges. Beyond indicating a few opportunities for implementing efficiency pricing and similar marketing improvements, we have not attempted to resolve the problem of achieving efficient water use in public irrigation projects.

4.8 Indirect production taxes on water users are a potential cause of resource misallocation, because they tend to discourage the use of the factors taxed. Hence, the more effective these taxes are as recovery instruments, the more likely it is that they diminish a project's worth.

Distributional Attributes

4.9 Progressivity means that users having a large "capacity-to-pay" should pay proportionately more than others. By their nature, land taxes are the most robust means of effecting progressivity of recovery. Since a user's capacity-to-pay (net of other water charges) will be reflected in the value of his land, the most appropriate base for a land tax is the increment in the total unimproved value of command land attributable to the project. A distributionally neutral tax in this case is a flat percentage rate. Hence, a progressive tax schedule requires rates to increase directly with the size of the tax base. (Naturally, the impact of land betterment taxes on land values also needs to be anticipated in the tax formula; although not covered here, this impact is not difficult to analyse).

4.10 Because the potential of poorly constructed crop rates to misallocate water increases with their level, and because the area of a single crop is a poor measure of user wealth, crop rates are probably a poor vehicle for making charges progressive. In any case, legal responsibility for crop rates may fall on share croppers and tenants, not landowners. If implemented in pursuit of efficiency objectives, water prices offer no opportunities for progressivity. Rather, they favor owners of the most productive resources. Revenues and income transfers resulting from production taxes and pricing policies vary with the amount of input purchased or output sold. Although these taxes therefore bear only on traded surpluses and may be progressive in that weak sense, the impact of production taxes and pricing policies on user income distribution is judged rather neutral. As with water prices, however, recovery by production taxes or discrimination against users through pricing policies diminishes the capacity of all other instruments of recovery (for example, land taxes) to be progressive.

Fairness

4.11 Users also have a say in determining which policy instruments are effective. They generally resist charges that recover the same amount for unequal services, unless the justification for this is clear. For example,

1/ Land betterment taxes are an exception, because the supply of command land is not responsive to the tax.
a common set of crop rates is usually legislated to apply to all public irrigation users irrespective of location. Yet the quality of irrigation services can and does vary widely within a command and between projects. Such charge systems are basically unfair, and this is one reason why crop rates tend to be fairly nominal. Whenever significant levels of recovery via crop rates have been tried, they have most likely generated too much political opposition from those treated unfairly.

4.12 Significant recoveries from irrigation projects may be possible only if (i) user charges that are linked to the amount of service provided, like crop rates, reflect accurately the expected amounts and timing of water deliveries; and (ii) the tax base for charges that are independent of the amount of service provided, like land betterment taxes, reflects accurately the size of potential rent conveyed.
BIBLIOGRAPHY


### Sample Comparison of Estimated Level of Water Charge Collections and O & M Costs at Full Development: 14 Projects

<table>
<thead>
<tr>
<th>Country</th>
<th>Loan/Credit Number</th>
<th>Project Description</th>
<th>Year Signed</th>
<th>Estimated Annual Water Level of Loan/Credit Year Charge</th>
<th>Estimated Annual O&amp;M Cost</th>
<th>Surplus</th>
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<tr>
<td>Taiwan</td>
<td>7-CHA</td>
<td>Groundwater</td>
<td>1961</td>
<td>2.31</td>
<td>1.37</td>
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<td>India</td>
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<td>1.31</td>
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<td>1966</td>
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<td>0.98</td>
<td>0.76</td>
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<td>1967</td>
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<td>0.27</td>
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<td>Colombia</td>
<td>502-CO</td>
<td>Atlantico-3</td>
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<td>a/</td>
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<td>0.15</td>
<td>0.00</td>
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<td>Rio Colorado</td>
<td>1968</td>
<td>7.02</td>
<td>3.82</td>
<td>3.20</td>
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*a/* To be determined within two years of signing in light of findings of Government study.

**Source:** World Bank Projects Reports.
COST RECOVERY INDEX AND PROPORTION OF WATER CHARGES TO INCREMENTAL FARM INCOME: 17 PROJECTS

<table>
<thead>
<tr>
<th>NAME OF PROJECT</th>
<th>COST RECOVERY INDEX %</th>
<th>WATER CHARGES AS % OF INCREMENTAL FARM INCOME %</th>
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<tr>
<td>INDIA - Pochambad 268-IN</td>
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<td>10</td>
<td>5; 9 a/</td>
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<td>13</td>
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<td>KOREA - Pyongtaek Kumgang 600-KO</td>
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<td>20</td>
<td>5</td>
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<td>MALAYSIA - Kemalbu 196-IN</td>
<td>31</td>
<td>14; 16 b/</td>
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<td>INDIA - Kadana 181-UAR</td>
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<td>MALI - Mopti Rice 184-MA</td>
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<td>IRAN - Dez 1 594-IRN</td>
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<td>7; 10 c/</td>
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<td>CAMEROON - Semry Rice 46-IND</td>
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<td>INDONESIA - Rehab. II 195-IND</td>
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</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>29</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

---

- **a/** Depending on location.
- **b/** Tenant and owner, respectively.
- **c/** Depending on crops. **Source:** World Bank Projects Reports.
- **d/** Depending on other inputs.
- **e/** Revised in light of Annex 3.
Analysis of Project Rent and Project Cost

1. Project rent was defined in paragraph 3.6 as incremental farm income induced by a project less sufficient allowances to compensate for additional farm family labor and management costs incurred. Project rent is defined in a different, but equivalent way in the Figure below, as the area $E + C$ under the $DH$ portion of the demand schedule for project water, $DD_1$. This demand schedule is purely expository, as prices are not typically charged for irrigation project services; hence the equilibrium quantity of water supplied ($Oq_1$) is also expository, as the Figure implies that it is determined by the interplay of both the supply (marginal cost) and demand schedules. Moreover, we are assuming that the only project service supplied is irrigation water.

2. The demand schedule $DD_1$ shows the maximum prices that users are prepared to pay for various quantities of water per unit time. It assumes that the prices of other productive factors such as fertilizer, hired labor and farm family labor, are held constant. Hence, the area under $DH$ ($E + C$) represents the maximum amount that users would be prepared to pay as a benefit tax if given the limited choice of $Oq_1$ of water, or none at all.

3. The Figure also gives a framework for analysing several notions of public financial costs. These are: capital costs; operation and maintenance (O & M) costs, and short-run marginal costs.

4. Public construction and installation costs of irrigation projects fall into the category of "capital" costs, as distinguished in past treatments of irrigation charges by the Bank. During the operational phase of projects, capital costs may also be treated as "sunk" costs. Their measurement is complicated by the proper choice of interest rate for the calculation of interest, and by their probable depreciation in practice by a general rise in prices over time.
Let us assume that these problems of measurement have been resolved and that the area A measures an appropriate charge for financial capital costs per unit time.

5. Operation and Maintenance (O & M) costs have an "overhead" component -- area B -- which is avoidable only by abandoning an irrigation scheme entirely. The overhead component is thus a "variable" cost only if this policy option is exercised; it can therefore be a marginal cost only with respect to this option. Short of abandoning the project, i.e. under most operating conditions, the overhead component would be regarded as the fixed cost of administering the project and of carrying a minimum inventory of repair materials, irrespective of how much water is delivered to users; this overhead component would therefore provide only limited guidelines for promoting efficiency of water use, even if it were used as a basis for pricing water.

6. If we ignore the choice of abandoning the project, variable O & M costs would be given by area C only, on the assumption that the quantity $Oq_1$ of water is delivered to users. These costs are simply the area under the short-run marginal cost curve.

7. None of the financial accounting concepts of costs serve as a guide for pricing water to promote its most efficient use; only short-run marginal
costs can provided this guide. Probably the most difficult problem of estimating marginal costs of supplying irrigation water for most canal irrigation projects derives from the seasonal fluctuations in storages and the need to anticipate future demands; that is, marginal costs should include an element of opportunity cost of supplying current rather than future needs.

8. No support can be found, therefore, for believing that the policy of recovering at least O & M costs stimulates efficient water use. Such a belief is founded on a mistaken identity between O & M costs and marginal costs of supply. It also ignores the question of manner of charge; for, charges should be levied as prices if they are meant to influence resource uses. 1/

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1/ The correct rule for efficiency pricing of irrigation water would be the "short-run marginal costs" pricing rule. This rule and the various amendments to it that may be necessary depending on the circumstances of the case are discussed in detail in Ray (6). We have ignored here the question of adjusting financial marginal cost for relative price distortions in an economy. This would be an improvement, conceptually, but it would be premature to worry about such refinements in the current context.
Application of Recommended Benefit Levy to Kadana Irrigation Project (Credit 176-IN)

1. The following example demonstrates a procedure for deriving irrigation benefit taxes using information drawn partly from the Kadana Project Appraisal Report. 1/ It employs simplifying assumptions to keep the exercise brief. Its purpose is to illustrate both the nature and feasibility of such a procedure.

2. The benefit taxes derived are progressive with respect to the size of project rent conveyed and the initial well-being of users. The rate of progression is determined partly by the choice of weights applied to the valuation of user benefits. In this exercise, the kinds of weights used are the same as those proposed for economic analysis of projects by van der Tak and Squire, and the reader is referred to their paper 2/ for both justification and derivation of these weights.

3. The procedure determines simultaneously both the total amount of revenue to be collected and the distribution of payments by users, and is part of the distributional analysis in project appraisal. There is no need therefore to consider the recovery and appraisal steps iteratively.

The Project

4. Table 1 shows expected farm incomes on several sizes of holdings with and without the project, given the forecast incidence of water charges. About Rs 4.0 million in water revenue was already being collected in the project area against existing irrigation facilities, and the project was expected to add Rs 17.3 million to public revenue at prevailing water rates and related taxes. As indicated in Table 1, these incremental revenues represented 11 percent of incremental project income at full development and, according to Annex 2, a cost recovery index of 31 percent. The distribution of project charges among users (column (8) of Table 1) appears to be somewhat regressive, although this may simply reflect small discrepancies in the budgets rather than actual water charge policies for the project. Nevertheless, we can say quite definitely that the prevailing benefit taxes are not very progressive.

5. The distribution of project benefits is biased heavily in favor of those having holdings larger than 4 ha. Even though these larger holdings represent only 9 percent of total project holdings, they receive about 50 percent of the benefits. Unless user charges can be adjusted somehow to offset this bias, it is inevitable that the most fortunate group of landowners without the irrigation project will also be the principal beneficiaries of the project.

Table 1. Farm Incomes and Water Charges at Full Development, by Size of Farm: Kadana Project

<table>
<thead>
<tr>
<th>Size distribution of holdings in project area</th>
<th>Size of &quot;model&quot; farms</th>
<th>Net Farm Incomes Without project(^a) (net of existing water charges)</th>
<th>Net Farm Incomes With project(^a) (net of expected water charges)</th>
<th>Increments to Farm Incomes &amp; Water Revenue</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
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<td>0-1</td>
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<td>1-2</td>
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<td>4-8</td>
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<td>4593</td>
<td>7692</td>
<td>3099</td>
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<tr>
<td>8 &amp; over</td>
<td>3344</td>
<td>16.0</td>
<td>12033</td>
<td>20859</td>
<td>8826</td>
</tr>
<tr>
<td>All project farms</td>
<td>176000</td>
<td>x</td>
<td>246.5m</td>
<td>390.4m</td>
<td>143.9m</td>
</tr>
</tbody>
</table>

\(^a\) A subsistence allowance of Rs 833 per family of 6, which was used in the Appraisal Report, has been added to estimated cash incomes to give net farm incomes. Incremental cash incomes had been estimated with a zero wage allowance for family labor. Actually, net cash incomes without the project were given by the Appraisal Report gross of existing water charges. However, their distribution was not reported and column (4) assumes that the reported incomes are net.
Recovery Analysis

6. We want to consider the consequences, for a social evaluation of a project, of redistributing incremental project income among farm families by varying their liability for user charges in various ways. In considering the social consequences, it is not necessary to alter the value of net project output on account of its distribution. The choice of efficiency prices already gives a correct valuation of that output to the economy. Rather, it is proposed that we account for the distributional consequences by attaching a (positive) social value to the increased consumption resulting from increments to farm income and offsetting this with the simultaneous loss of resources to the economy that this consumption represents.

7. Estimates of incremental net farm incomes reported in the Kadana Appraisal Report include returns to farm family labor and management (which were costed at zero), and reflect local market price valuations of output. Economic analyses of the project were based on four alternative assumptions about the appropriate efficiency prices for output; in the recovery analysis, we shall employ only one of these assumptions below for illustrative purposes: viz. that local prices are appropriate.

8. Let us assume for simplicity that all holdings' net farm incomes are used entirely for consumption purposes (i.e. none is saved). Table 2 presents a set of consumption weights that might have been used during appraisal for the purpose of weighting the beneficial value of additional consumption resulting from the project. The weights are based on premises that the elasticity of marginal utility of consumption (\( n \)) is unity, the marginal utility (\( U \)) of consumption (\( C \)) is given by \( U = C^\eta \), and a level of consumption per holding corresponding to the national consumption average is Rs 3,000 (i.e. Rs 500 per capita at market prices in 1968-69).

9. Given our assumption of nil savings, a government can use consumption weights to assess the social value of the forecast distribution of incremental project incomes. For example, column (5) of Table 2 gives the weights to apply to the non-marginal increments of income (i.e. consumption) forecast by the Appraisal Report; column (2) gives weights for valuing marginal increments of income at without project levels; column (3), the weights for marginal increments at "with project" levels net of expected water charges; and column (4) the weights for marginal increments at "with project" levels in the absence of water charges. For purposes of comparison, column (6) gives the weights used implicitly in the project appraisal report.

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1/ For derivation of such weights, see van der Tak and Squire, (5) Annex, pp. 5-19.
10. Without undertaking any restructuring of the project, it is easy to see how its social benefits might be improved: for example, by increasing user charges to those enjoying the most benefits and who were comparatively well-off to begin with, and perhaps by reducing charges to those who receive least benefits and were the poorest to begin with.

11. The desirable directions of these adjustments are clear for the smallest and largest project holdings, but not for the intervening sizes. How does one determine the optimum level and distribution of charges? At this point, we must introduce two other parameters that also feature in the new appraisal procedures under review: \(v\), the value of public income (measured as the number of units of consumption at domestic prices consumed by someone at the average level of consumption that are believed to be worth one unit of foreign exchange in the hands of the government), and \(\beta\), the foreign exchange cost of a unit of private consumption. We shall assume that \(v\) and \(\beta\) have values of 2.5 and 0.66 respectively. 1/ Casting the exercise in terms of measuring the net benefits of consumption, we need to weight additional consumption with the term \((d/v - \beta)\), where the first part of the term measures the distributional benefit, and the second measures the distributional cost. 2/

12. At least the determination of who pays zero charges is relatively simple, ignoring for the moment other considerations raised below in paragraph 16. It derives from the value of \(d\) where \(d = v\beta = (2.5)(0.66) = 1.65\). This weight corresponds to a "critical" level of consumption of Rs 1,818 per holding in the project area, or 61 percent of the national average level of consumption. Consequently, regarding the level of charges reported in the project Appraisal Report (Table 1), we can say that the first two categories of farm size should not have been levied any benefit taxes at all. This much is clear whether we compare the critical level of consumption with income and water charges given in columns (4), (5) and (7) of Table 1, or whether we compare the critical value for \(d\) of 1.65 with those for marginal increments to consumption in columns (2) - (4) of Table 2. The same kinds of comparison also reveal that farms of 3 ha and above definitely should pay something.

13. Now, let us suppose that the Kadana project is reappraised using the new appraisal procedures -- with foreign exchange in the hands of the government as numeraire, and consumption distribution weights of the kind given in columns (2) - (5) of Table 2, etc.-- without any option of redistributing


2/ Note that \(d\) is a pure number, \(v\) is in units of domestic currency per unit of foreign exchange, and \(\beta\) is in units of foreign exchange per unit of domestic currency. Hence, the two parts of the term are conformable.
water or land in the project area, but with the option of varying water charges. What are the conditions that would satisfy an unconstrained maximum net present value for the project? First, the poorest users, those whose additional consumption is judged to be worth at least as much as public income should not be taxed. Second, those for whom $d < 1.65$ should ideally be taxed so that they receive no increases in consumption.
Table 2. Consumption Distribution Weights (d) for Different Levels of Consumption a: Kadana Project

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sizes of &quot;model&quot; farms</td>
<td>Values of d for marginal changes in consumption from following levels of income b</td>
<td></td>
<td></td>
<td>Values of d for non-marginal change in consumption from I1 to I2</td>
<td>Implicit values of d used in Appraisal Report (based on n = 0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>3.60</td>
<td>3.26</td>
<td>3.16</td>
<td>3.29</td>
<td>1.0</td>
</tr>
<tr>
<td>1.5</td>
<td>2.82</td>
<td>1.97</td>
<td>1.88</td>
<td>2.33</td>
<td>1.0</td>
</tr>
<tr>
<td>3.0</td>
<td>2.08</td>
<td>0.74</td>
<td>0.71</td>
<td>1.18</td>
<td>1.0</td>
</tr>
<tr>
<td>6.0</td>
<td>0.65</td>
<td>0.39</td>
<td>0.37</td>
<td>0.40</td>
<td>1.0</td>
</tr>
<tr>
<td>16.0</td>
<td>0.25</td>
<td>0.14</td>
<td>0.14</td>
<td>0.19</td>
<td>1.0</td>
</tr>
</tbody>
</table>

a Assuming for convenience that all income is consumed.

b I1 = Net farm income without project (net of existing water charges)
I2 = Net farm income with project (net of project water charges)
I3 = Net farm income with project (gross of project water charges)
14. Plainly, an unconstrained solution having the attributes just mentioned is unlikely to be very practicable. The reason is that the kinds of constraints to determining socially optimum user charges are virtually the same as the constraints that lead us to use distribution weights in project analysis in the first place — the inadequate capacity of fiscal policy to correct distributional ills. Furthermore, the ideal set of charges are levied against increased consumption, not on project rent.

15. We must first distinguish therefore, project rent as a component of net farm income. Column (3) of Table 3 shows project rent per farm estimated on the assumption that either 50 percent of incremental income or 500 rupees, whichever is smaller, represents the incremental earnings of a farm family’s labor and management on Kadana. Incremental income gross of benefit taxes is shown in column (2). Column (4) gives an optimal set of benefit tax rates except that they are not levied against extra family labor and management earnings. We shall refer to this set of rates as the base solution.

16. Now we must face some of the other weaknesses of the reappraisal exercise. First, an implicit assumption of the original solution is that small farmers earn no income from outside their holdings. Yet they may also earn wages on larger holdings. The base solution is solicitous, therefore, of the welfare of project smallholders, but ignores the welfare of landless laborers on the project and of landless laborers and smallholders outside the project command. The concern for raising smallholder consumption to the critical level of consumption would make sense only if this were part of a larger, more general social welfare program. Second, if average taxation rates range from 0 percent to 100 percent of project rent, as they do in the base solution, marginal tax rates with respect to the tax base must exceed 100 percent over the upper part of the range, creating extraordinary incentives for the larger landowners in the command to misrepresent the extent of their holdings. Both of these considerations suggest that we ought not try unduly to waive charges for poor smallholders. Too much concern for helping them by waiving user charges could destroy the attempt to make charges progressive. More direct forms of assistance would be preferable.

17. Third, we must try to recognize the political and other constraints facing governments when they set user charges. Perhaps the most common way of recognizing constraints on user charges in the past has been to accept maximum limits to charges, expressed as a fraction of incremental income, either average or marginal. Suppose we follow this practice, expressing maximum charges, though, as a fraction of project rent rather than of incremental income. Such maximum limits should represent the most that a government feels it can recover. Let us assume, for example, that the maximum limits for the Kadana project are those described by the average benefit tax rates in column (5) of Table 3. The figures for the upper income range appear to be operative constraints, because they are less than the corresponding optimum rates in column (4). Other considerations allowing, therefore, we propose to adopt the 40 percent constraint for 6 hectare farms and the 50 percent
Table 3  Notional Account of Optimal User Charges: Kadana Project

\( Y = \text{project rent} \)

<table>
<thead>
<tr>
<th>Sizes of &quot;model&quot; farms</th>
<th>Increments to annual net farm income ignoring user charges</th>
<th>Project rent per annum, ( y^b )</th>
<th>Unconstrained optimum rates of recovery from ( Y^a ) based on distribution of ( Y ) only</th>
<th>Perceived Maximum feasible rates of recovery from ( Y ) on grounds of political risks, etc.</th>
<th>Constrained optimum rates of recovery from ( Y ): minimum of cols. (2), (3) with lowest recovery set not more than 30 points below highest</th>
<th>Increments to annual public revenue from user charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>ha</td>
<td>Rs</td>
<td>Rs</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>Rs</td>
</tr>
<tr>
<td>0.5</td>
<td>115</td>
<td>57.5</td>
<td>-</td>
<td>25</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>1.5</td>
<td>530</td>
<td>265</td>
<td>-</td>
<td>30</td>
<td>20</td>
<td>53</td>
</tr>
<tr>
<td>3.0</td>
<td>2800</td>
<td>2300</td>
<td>100</td>
<td>35</td>
<td>35</td>
<td>805</td>
</tr>
<tr>
<td>6.0</td>
<td>3440</td>
<td>2940</td>
<td>100</td>
<td>40</td>
<td>40</td>
<td>1176</td>
</tr>
<tr>
<td>16.0</td>
<td>9800</td>
<td>9300</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>4650</td>
</tr>
<tr>
<td>all project farms</td>
<td>161.2m</td>
<td>150</td>
<td>4.7</td>
<td>41</td>
<td>35</td>
<td>52m</td>
</tr>
<tr>
<td>NPV of project</td>
<td>($4.0m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>($2.0m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a These rates are purely illustrative and assume that all of \( Y \) would be consumed.

b On assumption that incremental family labor and management earnings are 50% of incremental farm income ignoring user charges, or Rs.500, whichever is smaller. Project rent equals incremental farm income ignoring water charges, less incremental family labor and management earnings.
constraint for 16 hectare farms (see column (6) of Table 3). For 0.5 hectare and 1.5 hectare farms, we have chosen not to waive charges, for the reasons given above in para. 16. Instead, we have adopted a policy of restricting the spread of recovery rates to 30 percentage points. Since our main aim is to recover as much as possible from those benefitting the most, this policy fixes recoveries for smallholders to 20 percent of their project rent.

18. Column (7) of Table 3 therefore presents the consequences -- some still quite notional -- of accepting the result of a constrained maximization of the project's social net present value. For the sake of completeness, we might suppose that the net present value (NPV) of the project using unconstrained optimum rates of recovery is $4 million, that using constrained optimum rates is $2 million, while that using the rates reported in the Appraisal Report is $0.1 million.

19. The base solution has therefore been amended, except for one category of beneficiaries, by adjusting it for perceived political constraints. Was the analysis leading to the base solution worthwhile? Its main value lies in providing at least one objective measure of ideal benefit taxes to levy on the more fortunate project beneficiaries. But the base solution depends almost entirely on the estimate of the critical consumption level. To the extent that \( v \) and \( \beta \) are "country" parameters rather than "project" parameters, estimates of the critical consumption level can be made independently of projects; hence, benefit tax formulae for base solutions can be derived for the irrigation sector as a whole and not just for projects. Since the political forces that modify this solution will also tend to be mainly sectoral in character, there are strong grounds for the Bank to work directly towards sectoral policies on irrigation charges in a particular country. If these are not reasons enough for working at the sectoral level, it is perhaps sufficient to recall that most governments already have sectoral charge policies which they apply to Bank projects.

20. The total additional revenue from the constrained optimal charges proposed in Table 3 is notionally put at Rs. 52 m. per annum at full development. This is three times the additional revenue reported in the Appraisal Report, and would recover 93 percent of project costs, instead of the 31 percent expected. Of course, with more liberal constraints or a more productive project, the new cost recovery index might well have exceeded 100 percent. With the procedures reported in this Annex, the cost recovery index simply becomes a rather incidental measure of recoveries, and cost recovery norms would not play any role in determining recoveries.