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Selected Readings

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# 19

## Criteria for Social Investment

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### INTRODUCTION

The following paper was originally prepared as an exposition of the general principles of social investment. It is clear, however, that it has been most strongly influenced by the United States' experience in investment in water resources. The three major problems treated are the discounting of future benefits, the measurement of benefits, and the measurement of costs: the last category, however, is much less complex than the first two. As will be seen, the problems of discounting relate to the general economy rather than to the particular project at hand; thus the discussion is as applicable to water investments as to any other investments. The different problems in the measurement of benefits are important for different classes of water projects. For example, the divergence between social and private costs and the problem of appropriability is liable to be most acute for water purification. On the other hand, issues relating to economies of scale and the difficulties that they raise for the evaluation of benefits are likely to be much more important in irrigation projects. The importance of consumption (as opposed to production) benefits is less in water resource problems than in health or education, but it is illustrated by recreation. Thus, all the issues raised in this paper have applicability to the water resources area.

"Criteria for Social Investment," by Kenneth J. Arrow, from *Water Resources Research*, vol. 1, no. 1, pp. 1-8, 1965. Copyright by American Geophysical Union. Reprinted by permission.

## REMARKS ON INVESTMENT IN GENERAL

Investment is the allocation of current resources, which have alternative productive uses, to an activity whose benefits will accrue over the future. The benefits take the form of production of goods and services.

The cost of an investment is the benefit that could have been derived by using the resources in some other activity.

An investment, then, is justified if the benefits anticipated are greater than the costs. This, of course, is an optimality condition for any productive activity. It takes particular forms for investment activities and, more specifically, for the special class of activities referred to as social investment.

The central problem in the evaluation of investments in general is commensuration over time. Benefits accrue at different times from each other and from the costs. To add up the benefits, we must establish rates of exchange between benefits at different times, weights to be assigned to the benefits before adding them together; the same procedure must be followed for costs.

One possibility, indeed, is simply to add benefits without regard to time period, i.e., to weight the benefits in all future time periods equally with each other and with the present. This practice is, however, unsatisfactory for two reasons: (1) time preference and (2) the opportunity cost of capital. (1) It can be taken as a datum that, from almost any point of view, present benefits are preferred to equal future benefits, especially if they are sufficiently removed in time. (2) The given investment must be compared with other investments also capable of yielding deferred benefits. If there exists an alternative investment capable of yielding a benefit of, say, 1.10 units of benefit a year hence for a present cost of 1 unit, then the given investment, to be justified, must be capable of yielding at least as much. This proposition is a straightforward statement of technical efficiency and is independent of any value judgments as to time preference. The most convenient way of expressing this demand is to define the present value of a future benefit as the current expenditure of resources which, if invested in the alternative manner, could yield the same benefit. If  $r$  is the rate of return on the alternative investment, then 1 unit of resources invested there could yield  $1 + r$  units of benefit in 1 year,  $(1 + r)^2$  units in 2 years (including reinvestment of the first year's return), and, in general,  $(1 + r)^t$  units of benefits after  $t$  years. Hence, the present value of a benefit  $B_t$  due in 1 year is

$$B_t / (1 + r)$$

The present value of a benefit  $B_t$  to occur in the  $t$ th year ahead is

$$B_t / (1 + r)^t$$

Finally, the total present value of an investment which will yield benefits  $B_1, \dots, B_T$  in the first,  $\dots$ ,  $T$ th year ahead, where  $T$  is the last year in which benefits are expected (the horizon), is

$$V = \sum_{t=1}^T B_t / (1 + r)^t$$

The precise operational sense in which  $V$  is the present value of the given investment is now given. Suppose the amount  $V$  were invested today in the alternative investment. From the proceeds available at the end of 1 year, including recapture of some or all of the principal and additional income, withdraw benefits to the extent of  $B_1$  and reinvest the remainder in the alternative investment. Repeat the process in each subsequent year,  $t$ . The result will be that precisely  $B_T$  can be withdrawn in year  $T$  with nothing else to reinvest. Thus, it can be seen that for an initial investment of the quantity of resources  $V$  in the alternative investment, it is possible to achieve the same benefits at each point of time as in the given investment. It follows that the given investment is justified (as against making an equal investment in the alternative) only if the cost  $C$  of the given investment is less than  $V$ . Thus, the condition that the present value of future benefits from a given investment, discounted by the rate of return on alternative investment opportunities, exceed cost is necessary for the efficient use of resources.

The efficiency or opportunity-cost interpretation of discounting is independent of any questions of time preference. In and of itself, however, it is only a partial solution to the determination of investment. If the present value of an investment, discounted at the rate of return of an alternative, falls short of the cost, it should certainly not be undertaken; if any investment at all is made, it should be in the alternative. On the other hand, if the alternative investment is in fact being made and if the present value of the given investment is greater than the cost, then the given investment should certainly be undertaken, at the expense of the alternative if necessary. But the opportunity-cost criterion is not an answer to the question of whether both the given and the alternative investment should be undertaken. The answer to this question depends on the aggregate volume of resources that will be devoted to investment as against current consumption and, hence, basically on the relative preferences for present and future benefits in relation to the rates of return on investments.

At an over-all optimum of the economy, therefore, the discount of future benefits according to opportunity costs must equal the discount according to time preference. However, in establishing criteria for a relatively limited body of investments, such as social investments will fe-

quently be, the opportunity-cost criterion may be adequate if it can be presupposed that time preference has already been allowed to operate in the determination of the over-all volume of investment and, therefore, indirectly in the determination of the rate of return on alternative investments.

### THE SPECIAL CATEGORY OF SOCIAL INVESTMENT

The majority of investments yield their benefits in the form of identifiable goods which can be marketed or withheld. These benefits are in a very natural way *appropriable*, in the sense that the organization producing them can without difficulty charge individual consumers for them, so that those who want and need the product can buy and others can refrain. The production of food and clothing provides, perhaps, the purest example of appropriate benefits. The future benefits from such an investment can be fairly measured by the output evaluated at the price at which it can all be sold less, of course, all current production costs (wages and materials).

But a wide and important class of investments yield benefits which, in their very act of production, inure to a wide class of individuals. They cannot be excluded from the benefit, and, hence, a price cannot be charged that will effectively discriminate between those who want the service and those who do not. Water purification provides a simple example; if it is decided to install equipment that will improve the purity of the water, all users will receive the benefits over the lifetime of the equipment, whether or not they would be willing to bear the cost in a free choice. (This choice is not only a matter of individual tastes for pure water; some of the uses of household water, such as gardening, have much lower purity requirements than others, so that some individual consumers may, in fact, derive very little additional benefit.) The price system is not operative, for it would require that each consumer be given the freedom to buy water at both the older and the newer levels of purity or, at the very least, be given his option between the two, with price differences reflecting cost differences. Water purification is really of the same order as the general run of collective services provided by government. In this context it is differentiated from the rest only in that there is an investment component, i.e., the benefits and costs do not accrue at the same point of time.

There are other instances in which pricing of benefits would be technically feasible, but for other reasons it is not regarded as performing an appropriate social function. Elementary, secondary, and, to a considerable extent, higher education have begun to belong to this category. The public schools could charge their pupils or their parents for the cost of education, but in the first place there may be a divergence of interest between the parents, who are capable of paying, and the children, who are

receiving the benefit. This is part of a wider class of cases in which the beneficiaries are incapable of appreciating the benefit, either because of natural limitations of understanding (as in children or mental patients) or because the benefits would not really be understood until they have been experienced. The second reason, in the case of education, is that the benefits of education accrue not merely to the students but to the society of which they are a part.

In general, the line between appropriate and inappropriate cannot be drawn very sharply. There are very few acts, even of private consumption, which do not have some direct effect on the welfare of others. It is a matter partly of empirical and partly of value judgment as to when the external effects of benefits are sufficiently widespread to set aside the principle that the individual is the best judge of his own welfare.

There is another and very important reason rooted in the facts of technology for the treatment of wide-scale classes of benefits as inappropriate, even though it would be technically feasible to set prices, namely where there are increasing returns to the scale of operation. In that circumstance a collective agreement to undertake a productive enterprise and to share the costs in some way may benefit everyone, yet any ordinary pricing system would fail. For example, competition among electricity systems would certainly not ensure an optimal allocation of resources but instead would probably reduce the supply of electricity to small proportions. It is, to be sure, often possible, for example in irrigation to determine the benefits through a pricing calculation, but the supply must nevertheless be arranged through a monopoly; because of the dangers of monopoly in certain circumstances, the investment must actually be provided socially.

The remarks in this and the preceding section establish general outlines for the discussion to follow. In the next three sections we consider the following problems of evaluating the discounted benefits and costs: the measurement of benefits, the determination of the rate of discount, and the measurement of costs.

### PROBLEMS IN THE MEASUREMENT OF BENEFITS

The benefits derived from social investment are by nature more difficult to measure than benefits from private investment. There is inevitably some failure in the extent to which the price system will be adequate. The price system, however, even in its ordinary form does have an important role in the estimation of benefits, and, in a more extended sense, there really is no benefit calculation possible that is not based on a set of at least hypothetical prices.

In our discussion we will distinguish between market prices and accounting or shadow prices. Market prices are prices actually charged for

the benefits, leaving each consumer free to use or not use them and thereby incur or avoid the price. In investments lacking a social character, the highest market price that will lead consumers to buy the entire output is an adequate measure of the benefit per unit of product, and aggregate benefits are appropriately measured by the volume of aggregate sales less, of course, the aggregate of current operating costs. The process of allocation still involves the nontrivial element of forecasting and its inevitable counterpart, uncertainty. But it would take us too far afield to discuss these questions here. Instead, we wish to concentrate on those problems in the measurement of benefits that specifically differentiate private from social investments.

The basic reason for the difficulty of relying entirely on market prices is, as we have seen, the inappropriability of some benefits, the impossibility or, at any rate, difficulty of separating the creation of benefits for individuals from the act of production or, at least, the act of consumption by others. For these instances we must make a calculating equivalent of the price system, and to this equivalent the name of shadow or accounting price has variously been given.

### Uses and Limits of Market Prices

For many purposes, and probably for more purposes than now realized, it would be feasible and useful to market the benefits from a project at a suitable price, as when the benefits are fully appropriable and the reason for the social character of the investment is rather the existence of economies of scale. In effect, the enterprise, though publicly operated, is still being required in the long run to pay its way. One may equivalently suppose that the investment is given a separate organization which borrows the initial capital and has to repay it with interest. The condition is that, with these costs added to current operating costs, the enterprise will still cover these total costs over the life of the investment.

The obvious advantage to such a system is the pressure for efficiency and responsibility, both in the initial act of investment and in the subsequent operation. At least after the event, there is a clear-cut determination of the profitability of the enterprise. This not only helps in supplying a record for the future but also imposes caution on the determination of the investment, since it is known that there will be such a check and in what terms the check will be. Finally, by making the benefits definable in fairly straightforward operational terms, it should improve the ability to forecast the profitability and, therefore, the desirability. To the extent that market prices are used in the distribution of benefits, we may speak of them as being recoverable. Recoverability is not an all-or-none proposition, of course. It is perfectly possible to charge a price to a direct beneficiary and still argue that the benefits that are covered are less than the total

benefits because of indirect effects. For example, fees are frequently charged for public higher education, yet they are very far below the costs. This practice is presumably justified on the basis of indirect benefits.

Although the efficiencies gained by full, or even partial, recoverability of benefits are considerable, too much emphasis should not be placed on recoverability as a condition for investment. Well-known propositions of welfare economics tell us that the product of any investment should be offered at marginal cost up to the limits of its capacity. These marginal costs may or may not be adequate to recover the cost of the original investment. This point is of particular importance when there are widespread economies of scale, for then the marginal cost is almost sure to be below the long-run average cost, and recovery through market prices is necessarily less than total. It might be possible to achieve a greater recovery with a price above marginal cost (depending, of course, on the elasticity of demand), but then the investment, in effect, is not being used from the social point of view as well as it might be. By increasing the volume of recoverable benefits through higher prices, the aggregate benefits, recoverable and otherwise, have been reduced.

### Divergence between Social and Private Benefits

A classic in economic theory is the case in which there is a direct beneficiary from whom the product can be withheld, but his act of consumption, or the act of production in order to achieve this consumption, yields benefits to other parties against whom no exclusion is possible. The water purification example cited above is an extreme case. To supply pure water to even one individual, it is necessary to supply it to everyone. Milder interactions are very common. Thus, treatment of infectious diseases is beneficial to the patient, but, in addition, the possibility of spread to other individuals is also reduced. Under these conditions it would be necessary to take into account the fact that the aggregate benefits are greater than the part that can be allocated privately with ease. Hence, to justify itself an investment in public health, including medical care of infectious diseases, need not expect to be fully made up from fees charged to patients.

### Shadow Pricing

In the absence of market prices, it is necessary to impute value to the benefits. In the case of water purification, it might be asked what price, *if it could be charged*, would suffice to clear the market. More generally, the shadow price should be estimated for all beneficiaries, not only the primary ones. Computation replaces the market.

There is no difficulty with the concept of a shadow price; but there is

the intensely practical problem of measuring it. Whereas market prices are operationally revealed in the market, shadow prices must be indirectly estimated, often by introspection on the part of a questionnaire-answering public or its governmental representatives. The difficulty of estimating a shadow price that represents the value of social, as opposed to private, benefits has led in practice to two opposite errors: (1) ignoring the additional benefits not representable by market prices and thus failing to make socially desirable investments, or (2) introducing nonprice and nonquantifiable justifications for projects which make difficult the rational weighing of alternatives (e.g., justifications such as the development of land as an end in itself or the provision of water as an absolute need).

Ultimately, a shadow price is a subjective valuation which must be made by individuals. In a democratic society it is perfectly proper that the valuation be made by the political process. It would, however, be a major improvement in the relevance of the discussion if the shadow price were the explicit subject.

### Economies of Scale and Consumers' Surplus

Prices, shadow or market, strictly speaking are valuations only for small changes in quantities. Suppose, for example, it is contemplated to bring in a water supply for a desert region. The price in the absence of an aqueduct is prohibitive, but, once the aqueduct is installed, the marginal cost of water may be very small. If water is sold at its marginal cost, each individual will be better off than he would be if he had to pay the pre-aqueduct price; hence, there is a certain maximum lump sum payment (a fixed payment per year independent of the amount he consumes) which he could make and still be no worse off, according to his tastes and needs, than he was in the absence of the aqueduct. The benefits for the project are the aggregate of these hypothetical lump sum payments plus the benefits recovered from the marginal cost pricing less current operating costs. The measurement of these benefits for the purpose of making decisions about social investments is not necessarily tied to any attempt to recapture some or all of these benefits through taxes or a two-part price system.

The aggregate of lump sum payments is one of the many definitions of consumers' surplus. Although there are some conceptual difficulties that have been overlooked in this simplified exposition, the basic problem here, as with shadow prices, is one of measurement. All practical approximations are one form or another of the area under the demand curve as the price drops from its preproject to its postproject level. Considerations of this type are too well known to require further expansion here; it need only be remarked that they apply to shadow prices as well as to market prices. In each case the benefit per unit of output will lie between the preproject and postproject prices.

### Production and Consumption Benefits

All benefits are, in the last analysis, benefits to individuals whom we may think of as consumers, but the relation may be direct or it may be indirect, through facilitating the production of goods desired by consumers. Most social investment activities yield benefits of both types. A highway increases the convenience of private automobile travel, a direct benefit to consumers; it also decreases the cost of trucking operations, which ultimately decreases the cost or increases the supply of consumers' goods.

Consumption benefits are those whose immediate beneficiaries are individuals in their capacities as consumers; production benefits are those whose immediate beneficiaries are economic units engaged in production for a market. The distinction has no significance from the point of view of determining the total benefits for evaluating a social investment project. The importance is rather that production benefits are far more easily measurable; in effect, the production unit imputes the market valuation of the final product back to the benefit yielded by the investment project. Thus, as a first approximation, the production benefit of a highway is the saving in cost on the volume of traffic originally carried. If the effect is large, the problem discussed in the preceding section arises, and some measure of surplus is needed; the cost saving will lead to a larger flow of traffic, and the benefit is measured instead by the cost saving on a volume of traffic intermediate between the original and final levels.

Hence, even if the production benefits are not recovered for one reason or another (in particular, under marginal-cost pricing of the benefits of a project with large economies of scale), they are fairly easily measurable. Any help in the measurement of benefits should be used. But there is a danger that the superior measurability of production benefits will lead to an underestimate or complete disregard of consumption benefits. A striking example has occurred in some discussions of the economies of public health. Benefits are measured in terms of the work-days saved, a production benefit, in complete disregard of the direct consumption benefit of prevention of or recovery from illness.

### THE RATE OF DISCOUNT

#### The Measurement of the Opportunity Cost of Capital

As has been seen, it is a straightforward implication of efficiency that the sum of benefits, discounted at the rate of return on alternative investments, exceed the cost. But which of the many other investments in an economy is the alternative?

If the economy as a whole were operating at perfect efficiency before considering a possible new social investment, the rates of return on all alternative investments would be equal (at least at the margin, i.e. for small additions to investment). Further, each individual in such an economy has full access to the capital market, so that his division of current income between consumption and saving has been made on the assumption that the rate of return on saving equals the common rate of return on all investments. In such a situation there can be no doubt of the proper rate of discount; further, the mode of financing the social investment makes no difference either. If the resources are obtained by taxation, they are drawn either from consumption or from investment. A dollar drawn from private investment reduces aggregate output in future years by  $r$  dollars, where  $r$  is the rate of return; but an individual is, at the margin, indifferent between consuming and saving a dollar, which means that he is indifferent between consuming the dollar immediately and receiving a permanent income of  $r$  dollars per annum from it. Hence, the social investment must yield an equivalent income or be condemned as inefficient, whether the dollar invested came from investment or from consumption. Finally, if the money is borrowed, the rate of interest would have to be the same as the rate of return on private investment opportunities; otherwise no one would buy government bonds. Again the government would be confronted with the common rate of return on private investments as the appropriate discount rate to be applied to future benefits from a proposed social investment.

In free-enterprise societies it does not appear at first glance that the rate of return is, in fact, the same on all private investments. Savings-bank deposits, government bonds, and corporate bonds certainly yield different rates of return. Two interpretations of this observation have been offered: (1) Investments differ in riskiness, and the observed differences in rates of return are, in fact, compensations for these differences. It is argued in this interpretation that the risk-corrected rates of return are really the same. (2) There are imperfections and limitations of entry in capital and product markets so that rates of return really differ. Which of these explanations is in fact the better is an empirical question which cannot be dealt with here. The two hypotheses are not, of course, mutually exclusive, and both undoubtedly play a role in actuality—with what weights is certainly not easy to determine.

The two interpretations have very different implications for the determination of the opportunity cost of capital appropriate for discounting future benefits. (1) It remains true that the mode of financing has no influence on the appropriate discount rate, since each individual is presumed to have come into equilibrium as among consumption and the investments of varying degrees of riskiness. There is a uniquely defined pure rate of return, corresponding to riskless investments, which is usually taken to be the rate on government bonds of long maturity. Clearly, riskless social investment should be discounted at the pure rate of return

under the hypothesis that observed rates of return differ because of riskiness. The implications for the rate of discount to be applied to benefits from risky social investments are less clear. According to one view, the rate to be applied is that which obtains in the private sector for investments of equal riskiness. Another position is that the government is necessarily in a better position to bear risks than any private investor. In fact, since it is involved with so many risky ventures, the law of large numbers ensures an aggregate certainty. It is therefore argued that the rate of discount should be the pure rate. The benefits to which the discount rate should be applied are uncertain; this uncertainty is what is meant by saying that the investment is risky. The single number that should represent a benefit is the expected value.

(2) If the view that differences in observed rates of return are due to market imperfections is correct, the mode of financing investments becomes important. The rate of discount is the rate on the alternative private investments available to the particular individuals from whom the money was drawn, whether taxpayers or bondbuyers. This alternative rate would be different for different individuals; thus the discount rate used by the government would have to be an approximate average.

It should be noted that the second view has implications not merely for the determination of the rate of discount but also for the preferred mode of financing. To the greatest extent possible, funds should be drawn from those individuals and fields of economic activity for which the rates of return on alternative investments are the lowest.

### Social and Private Time Preference

As noted in a previous section, full optimality requires that the rate of time preference and the opportunity cost of capital be equal. This condition is, however, only of significance if the volume of social investment is not completely infinitesimal compared with private investment.

Suppose again that there is a perfect capital market; then for each individual, his rate of time preference equals the opportunity cost of capital. It has, however, been argued that even in this case it is not correct for society to be governed by the private rate. The government has an obligation to the future and, in particular, to unborn generations who are not represented in the current market. It should be made clear that this interest must be over and above the interest felt by individuals in the future welfare of their own heirs, born and unborn, for the latter is already reflected in individual time preference. This argument has been put in the form of divergence between private and social benefit. Each individual derives satisfaction from having wealth added to future generations. Each one can, by his own actions, add only infinitesimally to this wealth, but a collective agreement to do so will increase everyone's welfare.

If this argument is accepted, it does not necessarily lead to a special rate

of discount for social investment. Indeed, the optimal solution would be to lower the required rate of return on all investment, private and social, for example by lending to private business at a lower rate than the market or by driving the rate of interest down through a budgetary surplus and debt retirement. More private investment would be undertaken, so that the marginal investment would have a lower rate of return and the opportunity cost of capital would be lower. Then, without changing the rule of discounting the benefits of social investment at the opportunity cost, the interest rate would be lowered.

If, however, it is accepted that there is an institutional limit on the extent to which the government can engage in direct or indirect financing of private investment, the social rate of time preference may remain below the common value of the opportunity cost of capital and the individual rate of time preference. It would clearly not be socially advantageous to withdraw resources from private investment to social investment with a lower rate of return, but it would be socially advantageous because of the some resources from consumption to social investment because of the divergence between social and individual time preference. Under these assumptions the appropriate rate of discount on future benefits from social investment will depend on the source of financing; it will be an average of the social rate of time preference and the opportunity cost of capital, with the weights depending on the extent to which resources are drawn from consumption or investment.

If we drop the assumption of a perfect capital market and admit differences in rates of return, we consider again the implications of the two alternative hypotheses of the preceding subsection. The first leads to much the same results as the case of a perfect market. The second hypothesis tends to reinforce the statements of the preceding paragraph.

The argument for a social rate of time preference distinct from individual rates is basically a matter of value judgment. Its validity and its importance, if valid, are both subject to considerable dispute.

## THE MEASUREMENT OF COSTS

The analysis of costs offers fewer difficulties than those of benefits and the rate of discount. For most purposes even a large volume of investment will have little effect on the costs of the inputs, so that evaluation at market prices is usually satisfactory. There are, however, two major qualifications, arising out of the possible presence of unemployment and out of neighborhood or amenity effects of certain classes of costs.

### Unemployed Resources

During a period of unemployment of labor or capital, the market price of an input will exceed its true social cost. Putting the idle worker or machine to work costs society nothing, but there is a wage or other price to be paid. The government, as guardian of the nation's economic welfare, should properly reckon only with true social costs. Hence, during a depression the cost of an investment should exclude costs of labor and plant that would otherwise be unemployed. Even in times of generally high employment there may be local areas of unemployment; the same rules should hold for projects in such an area. The allowance for unemployment applies only to the initial investment cost; in estimating future operating costs to be deducted from future benefits, it should normally be assumed that full employment will prevail.

### Amenity Costs

Just as there can be a divergence between private and social benefits, so there can be divergence between private and social costs. A highway may conduce to an increase in air pollution; it may also, through its noise, be a source of disutility to the neighborhood. Since social investment projects are frequently large in magnitude, they frequently are so physically large that they impinge upon human sensibilities in a major fashion. Although it is hard to frame any general statement about amenity costs, they should in principle be assigned shadow costs which should be deducted from benefits or added to costs in making a benefit-cost calculation.



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