J. ENVIRON. SYS., Vol. 4(4), Winter, 1974

# BENEFIT-COST ANALYSIS: A QUESTIONABLE PART OF ENVIRONMENTAL DECISIONING

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**ABSTRACT**

Benefit-cost analysis is frequently suggested as the appropriate method for evaluating environmental policy. Here in this paper it has been attempted to demonstrate that BCA is only of limited use for environmental policy. The use of monetary criteria are not appropriate for environmental decision-making because they do not prevent theproblem of sub-optimization. Ecological stability requires a level of economic activity, which is quite different than the one determined by the Pareto-optimum condition. Consequently the results of the BCA are either misleading or superfluous.

## Introduction

On the issues concerning environmental policy there is a great deal of disagreement between environmentalists and economists. This is not particularly surprising for both derive their arguments from different theoretical concepts: the ecologists work with a concept of "dynamic equilibrium" or "steady state," whereas the economists focus their attention on "maximum economic welfare;" it will be shown that these two concepts are not identical. However, at present environmental policy is predominantly guided by economic considerations. The actual policy problems will involve defining the optimum in specific environmental cases and designing economic solutions to approach this optimum. The government will therefore compare the pros and cons of its planned actions to accomplish specific environmental objectives, i.e., in very general terms, the government and its affiliated agencies are basing the environmental decisions on benefit-cost analyses of one kind or another.





doi: 10.2190/KKWT-J931-1Q0W-EP6L
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Benefit-cost analysis is an attempt to make a rather direct transposition of the price mechanism into the sector of public and environmental goods. As such, the benefit-cost technique is an economic rationale, and not an ecological one. The purpose of this paper is to investigate the question whether there is anything in the way of the application of benefit-cost analysis for environmental decisioning.

## Benefit-Cost Analysis and Environmental Decisioning

### THE ECONOMIC OPTIMUM LEVEL OF POLLUTION CONTROL

Benefit-cost analysis is frequently suggested as the appropriate method for evaluating environmental protection policy, because BCA is apparently being considered as a suitable technique for evaluating intangible benefits and costs of economic activities where no market mechanism operates.[1] BCA in its present form is an application of neo-classical welfare economics. It involves a systematic evaluation in monetary terms of the social benefits relative to the social costs generated by the planned project. In selecting the program or project which promises to make a net contribution to society's economic welfare BCA provides a decision criterion for adopting policies based upon a potential Pareto improvement.

Society's economic welfare (W) is determined by the flow of goods and services available for private consumption, government and investment (Q) and the net flow of environmental services (A), both expressed in monetary terms. Pollution is defined here as the reduction of environmental services due to the waste disposals into the ecosystem. If $\bar{A}$ stands for the value of the stream of services of an unpolluted environment, then the difference, $\bar{A}$-A, is the social damage (D) afflicted to society by pollution. Accordingly, the economy could produce $\bar{Q}$ worth of commodities if no resources have to be diverted for purposes of pollution abatement. However, pollution control requires scarce resources (R) and thus the flow of commodities reduces to Q. These statements can be written as follows:[2]

(i) $W = Q + A$, or
(ii) $W = (\bar{Q} + \bar{A}) - (R + D)$

The sum of R and D is the total social cost of pollution and, furthermore, it represents a decrease in economic welfare. The impact of pollution abatement on economic welfare can be shown as follows:

[1] See for example: D. J. Etzold: Benefit-Cost Analysis; An Integral Part of Environmental Decisioning, *Journal of Environmental Systems*, Vol. 3, No. 3, 1973, pp. 253. J. V. Krutilla and Ch. J. Cicchetti: Evaluating Benefits of Environmental Resources with Special Application to the Hells Canyon; *Natural Resources Journal*, Vol. 12, No. 1, 1972, pp. 1.

[2] A. M. Freeman III, R. H. Haveman, A. V. Kneese: The Economics of Environmental Policy, J. Wiley and Sons, New York, pp. 80.

(iii) $\Delta W = \Delta D - \Delta R$.

A welfare improvement can be achieved by a reduction of environmental damages (-CD) holding abatement costs constant, a cutback in abatement costs ($-\Delta R$) assuming damages remain unchanged, or an increase in pollution control costs that is more than compensated by lower pollution damages. Consequently, BCA of a comprehensive or specific anti-pollution policy would justify on economic grounds pollution abatement program only as long as additional treatment expenditures bring about at least an additional reduction in damages of equal value. Thus, economic welfare is maximized at the point were $\Delta R$ equals $\Delta D$. This formulation of an economic optimal level of pollution is demonstrated geometrically in Figure 1.

Figure 1 shows on the vertical axis the marginal social cost of pollution (MSCP) and the marginal social cost of pollution abatement (MSCA) (e.g., industrial costs of installing less polluting production equipment). Moving to the right of the horizontal axis represents increasing concentrations of waste in the environmental media (e.g., ppm of solid waste in a river bed). Conversely, moving to the left means improving environmental quality. In absence of any anti-pollution policy the level of pollution depends upon the level and type of economic activity. Here it is assumed that at a given point in time, the polluters will pollute up to point E where abatement costs of pollution are zero. If the level of pollution should be reduced than scarce resources are required for pollution control. The above explained optimum condition of economic welfare is fulfilled in point B where the marginal social costs of pollution are just equal to the marginal social cost of pollution

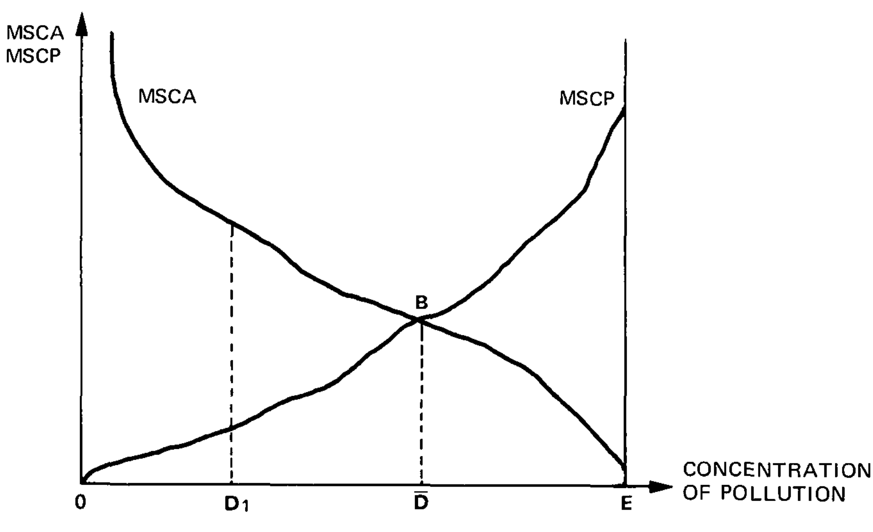


Figure 1

abatement.[3] Continuing to control pollution beyond that level ($\bar{D}$) will add more to the cost of abatement than it will reduce the pollution damages, indicating that pollution abatement has been carried too far and resources are not efficiently employed (e.g. at $D_1$).

If this analysis is correct, it follows that a certain amount of externality always remains (e.g., at point $\bar{D}D$ the remaining social costs are $O\bar{D}B$). Since the Pareto optimum condition underlies BCA the application of BCA for environmental policy will always determine an optimum position like $\bar{D}$ which is consistent with a substantial amount of pollution. Environmentalists who are frequently demanding a zero-pollution level as the only appropriate answer to our present environmental problems must therefore base their argument on other grounds other than benefit-cost criteria, because as it has been demonstrated economic optimality is generally consistent with a certain amount of environmental damages.

## SOME PROBLEMS OF MEASUREMENT

A further issue is the necessity of measuring benefits and costs as accurately as possible. However, the problems of measuring environmental costs and benefits are controversial matters. Both the benefits of pollution abatement and the costs of environmental damages are essentially non-market variables in character. Many of these benefits and costs cannot be quantified and are even less adequately expressed in monetary terms. Numerous ingenious and dubious methods of indirect estimations of costs and benefits have been developed.[4]

The shadow prices with which a BCA of environmental problems is predominantly conducted reflect monetary values determined according to the compensation principle (or the principle of willingness to pay). Various serious objections can be brought forward against the use of this principle.[5]

First, what a person is willing to pay for clean water or to accept as

[3] This result seems to be generally accepted by many economists writing on environmental problems. For example see: A. V. Kneese and B. T. Bower; Managing Water Quality: Economics, Technology, Institutions. RFF, John Hopkins University, 1968, pp. 82. R. G. Ridker; Economic Costs of Air Pollution; Studies in Measurement. F. A. Praeger 1968, pp. 4. Daly and F. Giertz; Pollution Abatement, Pareto Optimality, and the Market Mechanism, in: Transfers in an Urbanized Economy; K. Boulding, M. Pfaff, A. Pfaff (eds.), Wadsworth Publishing Co., 1973, pp. 253.

[4] Very useful methods are developed by Marion Clawson and Jack L. Knetsch: Economics of Outdoor Recreation, RFF, John Hopkins University, 1966. As an example of a questionable method, see P. Bohm who assumes that the social costs afflicted to the society as a result of the pollution of a lake can be measured in terms of the transportation costs to the nearest unpolluted lake. P. Bohm: Pollution, Purification et thèorie des effets externes, Annales de l'INSEE, Janvier-Avril 1970, p. 7.

[5] For a comprehensive assessment of BCA see for example: O. Eckstein: Water Resource Development, Harvard University Press, 1958, pp. 24. E. J. Mishan, Cost-Benefit Analysis, George Allen University Ltd., 1971.

compensation for tolerating pollution damages to his health depends essentially upon his income. Some incomes are unequally distributed, the ability and the willingness to pay are consequently as arbitrary as the price and income structure of which they are the result.[6]

Second, in order to reveal a rational preference an individual must be able to assess all the short and long run environmental effects as a result of his choice and to evaluate benefits and costs of environmental improvements. However, it is quite obvious that the majority of consumers and producers do not possess the full awareness and knowledge that environmental pollution is the result of their consumption behaviour and production decisions. In other words, the causation and the effects of environmental disruption are predominantly invisible to the individual or the effects only become recognizable after the individual has already made his choice. If this is the case, then individual preferences will not take into account all of the environmental effects and, therefore, a BCA conducted on the basis of the market values revealed by individual preferences alone would incorrectly represent the actual benefit and cost of environmental policies.[7]

Finally, the problem of whose preferences should be considered arises; these of the present generation or those of future generations. The choices executed by present generations may impose environmental damages on future generations, depending upon whether or not these damages are reversible. Where these effects are reversible, the options of future generations remain unaffected. However, if they are irreversible then future generations' ranges of choices are reduced. Consequently, in this case, all methods of abating environmental disruptions become meaningless.[8]

In conclusion, the use of monetary criteria (such as willingness to pay) are not appropriate for environmental decisioning because they do not adequately evaluate environmental effects and, therefore, do not prevent the problem of sub-optimization, within the ecological and economic systems.

## ECONOMIC VERSUS ECOLOGICAL OPTIMUM

Ecologists frequently emphasize that zero pollution is the optimum solution to environmental problems.[9] Such a solution is very unlikely to be prescribed according to BCA evaluations. In the following we will explain the rationale of

[6] K. W. Kapp: Social Costs, Neo-Classical Economics, Environmental Planning: A Reply; in: Political Economy of Environmental Problems of Method, Mouton 1972, pp. 119.

[7] The market values derived from individual preferences could be replaced by certain market surrogates (e.g., opinion polls). However, pollution abatement as a public good has significant "free rider" effects, i.e., the preferences being deliberately over–or understated.

[8] A Coddington, H. Opschoor, D. Pearce: Some Limitations of Benefit-Cost Analysis in Respect of Programmes with Environmental Consequences; in: Problems of Environmental Economics. OECD 1971, pp. 120.

[9] B. Commoner: The Environmental Cost of Economic Growth; in: Energy, Economic Growth and the Environment, S. H. Schurr (ed.), RFF, 1972, pp. 30.

the zero pollution argument. If economic processes are being regarded as the means of deciding the allocation and use of resources available to society, then it is obvious that a stable ecosystem, which guarantees the continued services of natural resources provided by the ecosphere (e.g., assimilative capacity of water), is a necessary requirement for the continuation of the economic system. Every ecosystem changes over time due to internal factors (e.g., the impact of the present inhabitants on their own habitat) and external factors (e.g., weather). Over time new inhabitants replace the old ones and this process of species succession takes place continuously. However, at any point in time, the organisms existing in the ecosystem depend upon a delicate life support system maintained by complex feedback mechanism.[10] Such an ecological system can be considered stable, if the disturbances cause only temporary modification in the species structure and the system returns to its initial state after the course of disturbance is removed. Pollution, as a result of man's economic activity must be regarded as such a disturbance to the ecosystem. However, pollution is not a single once-for-all injection into the ecosystem, but a continuously and ever-increasing one. Human activities introduced into the environment not only intensify stresses caused by natural agents (e.g., organic waste but also complete new materials not encountered in natural processes: detergents, plastics, various toxic gases etc. These human intrusions on the environment have impaired major segments of the ecosystem and the apparent environmental pollution is the symptom of the breakdown of the ecological cycles. Consequently, the environment is less suitable for life and leads to the elimination of some species. Each species, however, exercises a particular function in the ecosystem which provides "checks and balances." Removal of sufficient checks and balances will, therefore, cause repercussions in other species populations and reduce the diversity and the stability of the ecosystem. Some ecological studies suggest that the dominant species is the most endangered one by pollution. While man may not be regarded in general ecological terms as the dominant species, he certainly controls an important part of the food chain pyramid. Thus it is suggested that the human race runs a risk of survival, or at least to the quality of life of the present and future generations, if mankind continues to tolerate the present amount of pollution.[11] The applicability of BCA in this case is irrelevant. Money criteria cannot be applied if the objectives are not commensurable. BCA does not possess any method to assess and to evaluate the benefits and costs of the elimination of species or the liquidation of mankind.[12] According to these

[10] For example see: B. D. Collier, G. W. Cox, A. W. Johnson, P. C. Miller: Dynamic Ecology, Prentice-Hall, 1973, pp. 429. E. P. Odum: The Strategy of Ecosystem Development; Science, Vol. 166, April 1969, pp. 262.

[11] A Blueprint for Survival; *The Ecologist*, Vol. 2, No. 1, January 1972, pp. 2. S. Brubaker; To Live on Earth, The John Hopkins University Press, 1972, pp. 32.

[12] For a very critical assessment of BCA see: P. Streeten: Cost-Benefit and Other Problems of Method, in: Political Economy of Environmental, Problems of Method, op. cit., pp. 47.

considerations, ecologists request that the instability should be minimized and pollution be prevented.

The above presented context can be demonstrated in the following graphs, showing that the BCA is an ill-suited method to evaluate ecological instability. Part (a) of Figure 2 depicts the environment as a waste receptor. The horizontal line EE represents the absorptive capacity of a particular environment, (for example of a river) to transform and/or disperse waste products into valuable substances, which again become inputs in the ecosystem.[13] The curve OR shows

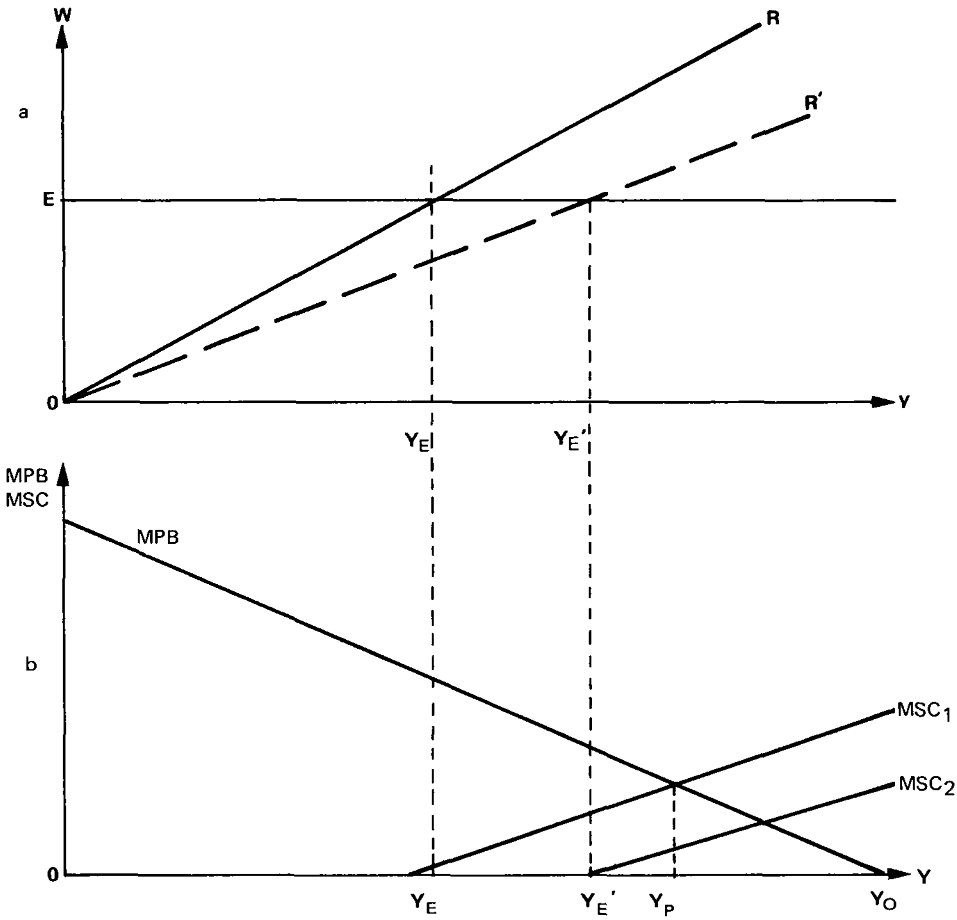


Figure 2

[13] For the sake of simplicity, EE is assumed to be constant. However, in reality, for example, the assimilitative capacity of a river depends upon various factors such as temperature of the water of the stream flow, etc. For a detailed discussion of the absorptive capacity of water see: L. D. James and R. R. Lee; Economics of Water Resources Planning, McGraw-Hill, 1971, pp. 383.

*the residuals dumped into the environment. It illustrates in physical terms,* the amount of waste (W) generated from the production process (Y) according to the scale of operation.[14] Part (b) of the graph relates the waste residual OR and the absorption capacity EE to the amount of marginal social cost of environmental disruption MSC. Up to the point of $Y_E$ in Figure 2 (a) and (b) no physical pollution and no MSC occur because the environment's capacity to absorb exceeds the amount of generated waste. Beyond this point the MSC–curve begins to rise. The MPB–curve represents the firm's marginal private benefits from producing and selling its output Y that generates as its joint-product waste, which is released into the environment.[15] While the firm would like to maximize its profits at an output level O $Y_O$, the social optimum according to the Pareto criterion is achieved at an output level $OY_P$ where MPB = $MSC_1$. However, "ecological stability" would be maintained only up to an output level of $OY_E$, where by definition the marginal external social costs are zero. The point $Y_E$ can, therefore, be considered as "ecological optimum" or a "steady-state" situation. From this graph it can be concluded, that the ecological optimum lies before the economic optimum. Environmental stability cannot be sustained at out output level of $OY_P$, because the flow of waste exceeds the absorptive capacity of the environment. If it is true, that environmental stability is prerequisite for human survival and quality of life, than a society which allows an output level $OY_P$ is jeopardizing its survival probability through increasing instability of the ecosystem.

The BCA cannot integrate the two different concepts: the economic social optimum with the ecological optimum. This is mainly due to the inability of prices and values to reflect the interrelations between the environment and the economy. If the ecological approach is correct, then only the identification of the absorptive capacity of the various environmental media and the ability of regeneration of the ecosystem is required.[16] According to Figure 2 (b) the point $Y_E$ has to be regarded as a constraint for economic activities, if quality of the environment should be maintained. An increase in output would be, therefore only desirable, if the OR- curve turns downward, e.g., due to the introduction of a less polluting technology, and, consequently, a new ecological "threshold" can be established (e.g., point $Y_E$). The assessment of BCA leads us to the *conclusion that the results of the BCA are either misleading or superfluous. Its*

[14] A similar graph is used by D. W. Pearce: An Incompatibility in Planning for a steady state and planning for maximum economic welfare; Environment and Planning, Vol. 5, 1973, pp. 269.

[15] For reasons of simplification this model implies perfect competition. The MPB-curve can be interpreted as the marginal benefit which the firm receives from supplying an additional unit, i.e., MPB is actually the marginal profit. The firm's profits would be maximized at $Y_O$, where MPB = 0.

[16] In many cases the identification of all the long-run ecological effects will be very different and even impossible. However, resource engineers, biologists and even some resource economists are working with these constraints. See for example L. D. James and R. R. Lee: Economics of Water Resources Planning, op. cit., pp. 373.

results are an unreliable guide for environmental decision-making, because of the considerable problems of identifying ecological effects and the even more controversial methods of evaluating them. BCA would determine an economic optimum ($Y_P$) which lies to the right of the ecological optimum ($Y_E$) in Figure 2, (b). As Kapp writes "... monetary criteria are ... not appropriate, because they do not evaluate the characteristics which define the quality of the environment and its potentially negative impact on human health, human well-being, and human survival."[17]

The results of BCA are furthermore superfluous. Even if BCA is successful in identifying and evaluating all environmental benefits and costs such that it determines $Y_E$ as the ecological optimum, BCA is redundant, because $Y_E$ can already be determined by referring to physical facts about the assimilative capacity and pollution alone, information which is already a necessary prerequisite to the valuation process of BCA. The critical assessment of BCA should not be understood as a general refusal to analyze the cost of pollution abatement. It only means that benefit-cost studies cannot establish standards of environmental quality which guarantee ecological stability. However, if these standards (in physical, biological terms) are identified, then BCA can become a useful method of selecting the most economical method to achieve these environmental standards.

## Conclusion

Our concern here has been to demonstrate that BCA is only of limited use for environmental policy. The use of monetary criteria are not appropriate for environmental decisioning, because they do not evaluate adequately environmental effects and do not prevent the problem of sub-optimization. Ecological stability requires a level of economic activity, which is quite different than the one determined by the Pareto-optimum conditions. The results of the BCA are either misleading or superfluous. They are misleading because of the controversial methods of evaluation of ecological effects, and superfluous, because ecological stability can be determined by referring to physical facts about the environment.

[17] K. W. Kapp, Social Costs, Neo-Classical Economics, Environmental Planning; A Reply, op. cit., pp. 122. In a study on air pollution and human health L. B. Lave and E. P. Seskin are attempting to translate health damages into monetary values. Their estimates are based upon the principle of the willingness to pay. However, they are aware that their findings are only vague approximation of the "true" social costs. L. B. Lave and E. P. Seskin: Air Pollution and Human Health, in: R. Dorfman and N. Dorfman (eds.): Economics of the Environment, W. W. Norton and Co., 1972, pp. 356.