CRITERIA OF EFFICIENCY IN GOVERNMENT EXPENDITURES [1]

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A good deal of progress has been made in certain analytical techniques, for example, those of estimation and computation, that can help us choose efficient courses of action. But one aspect of seeking efficiency, that of devising appropriate criteria or tests of preferredness, is almost as troublesome as ever. Moreover, it is a crucial aspect of choosing efficient policies; for with or without painstaking measurements and sophisticated computational techniques, poor criteria can lead to some very peculiar choices. As a simple illustration, consider the criterion and one of the choices of the efficiency expert in the play The Pajama Game:

> While I am still in bed I shave
> And the lather drips and the bed gets wet,
> And, oh, what a lousy shave I get
> But think of the time I save.[2]

But let us turn to more serious problems of choice and criterion difficulties. In this paper, I shall discuss a major complication in the devising of criteria, a few generalizations about appropriate tests of preferredness, and their application to specific governmental problems of choice. These remarks apply particularly to the use of quantitative analysis—whether called economic analysis, operations research, or systems analysis—in seeking efficient government programs and activities.

In comparing alternative government operations or courses of action, we cannot apply what might be called ultimate criteria. Thus we cannot apply such tests as "maximum well-being from available resources." Without more precise definitions, this is merely saying that we want the best. And when we spell out tests of preferredness more precisely, we find that we are using proximate criteria—that is, practicable tests which are not necessarily or obviously consistent with ultimate goals. The fact that we have to use such criteria makes it easy to adopt erroneous ones.

Suboptimization and Criteria [3]

There is a mjor complication in the process of choosing that multiplies the possibilities of going astray. This complication is the fact

[1] The discussion here is based upon parts of ch. 2 in a forthcoming book, tentatively entitled "Efficiency in Government Through Systems Analysis, With Emphasis on Water Resources Development." This volume, to appear in 1958, is one of a series of Publications in Operations Research sponsored by the Operations Research Society of America and published by John Wiley & Sons, Inc.

[2] The Pajama Game, book by George Abbott and Richard Bissell, music and lyrics by Richard Adler and Jerry Ross, Random House, New York, 1954, p. 125.

[3] For many of the points mentioned here, see Charles Hitch, Suboptimization in Operations Problems, Journal of the Operations Research Society of America, May 1953, pp. 87–99.

that we inevitably have to break our problems of choice into manageable pieces or subproblems. As some have put it, the process of choosing efficient courses of action is a process of suboptimization. In a government or department, one man or one committee cannot possibly examine all problems of choice simultaneously and select each course of action in the light of all the other decisions. The task is divided among various persons along hierarchical lines, some of the broader policy choices being made by high-level officials or groups, and others being delegated to lower levels. Similarly analysis-making must be broken into manageable pieces, since it is impossible for a single analysis to examine all of the alternatives. Thus comparisons of possible courses of action always pertain to parts of the government's problem. Other parts of the overall problem are put aside for the moment, decisions about some matters being neglected, specific decisions about others being taken for granted. The resulting analyses are intended to help in finding optimal, or at least good, solutions to subproblems: in the language of systems analysis and operations research, they are suboptimizations.

Table 1 may help to show precisely what is meant by suboptimization and what kind of difficulties are involved. In the allocation of money for forest development among its component activities (labeled "Subproblem 2"), what should be done depends in part upon decisions at other levels. That is, the best allocation of these funds depends partly upon the way the whole Federal budget is allocated and partly upon the way forest management, fire suppression, and pest control are carried out. Nevertheless, decisions at all these levels cannot be made simultaneously. To be sure, each decision will not be made in complete ignorance of the others. But the allocation of funds for forest development may be made more or less independently of decisions about new operating procedures, work layout, and equipment. In the selection of specific fire-suppression equipment (subproblem 3), the allocation of the forest budget, a higher-level choice, and the selection of detailed operating procedures, a lower-level choice, will probably not be accomplished at the same time. Similarly, analysis intended to assist in such decisions inevitably looks at pieces of the Department's problem, with many other facets of the overall problem temporarily fixed or ignored, because of the sheer size and complexity of the Department's operations.

Piecemeal analysis and decision-making have their advantages. For one thing, as problems are broken down into smaller parts, more detail can be taken into account. A high degree of decentralization is often desirable so that the "man on the spot" can decide about many matters. In analysis, somewhat similarly, considerable breakdown of governmental problems is desirable so that the models used in estimating results can be "on the spot," that is, less aggregative and more nearly correct in their predictions than departmentwide models would be. On the other side of the fence, there is a danger inherent in piecemeal analysis, one whose importance can hardly be overemphasized. This danger is that the criteria adopted in lower-level problems will not be closely related to higher-level criteria. As mentioned before, proximate criteria would have to be used in any event; but since problems must be examined a piece at a time, a whole hierarchy of possible criteria comes into play, and potential inconsistencies are abundant.

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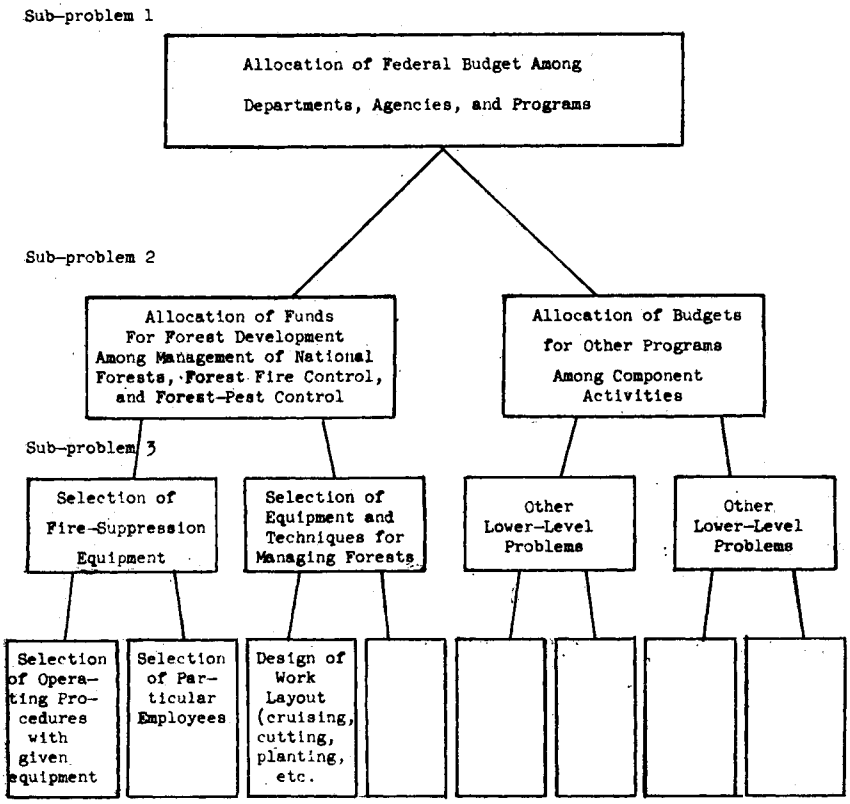

Figure 1. Sub-optimization at Different Levels

For example, consider subproblem 3—the selection of fire-suppression equipment for the national forests. This problem of choice is somewhat removed from top-level policy formation. In the case of firetrucks, maximum capacity (e. g., rate of flow that pumps can maintain) per dollar cost may seem like a plausible criterion. Yet there is no assurance that this test is consistent with overall aims. Suppose one engine costing $10,000 can maintain a flow of 10,000 units of water per minute—a capacity of 1 unit per dollar cost. Another engine costing $50,000 can maintain a flow of 25,000 units of water per minute—a capacity of one-half unit of water per dollar cost. Is there good reason for choosing the former engine? Is this test closely correlated with higher-level criteria? No, not necessarily. The smaller engine may simply be an inexpensive way to let fires get out of control.

The higher-level criterion—that is, our overall goal in forest development and forest-fire control—is something like maximum profits to the Nation or, more specifically, maximum net value of output. Physical output, such as the volume of water that can be pumped per minute, need not be highly correlated with value of output. Moreover, even when output is in value terms, the ratio of output to cost, i. e., output per dollar cost, has no particular relationship to maximum net value of output. Since ratios permit the scale of output or cost to wonder willy-nilly, nothing insures their consistency with higher-level tests. It is always hazardous, therefore, to use them as criteria.[4]

Some Remarks on Proper Criteria

So much for "suboptimization" and the fact that one must be extremely wary in devising criteria. What of a constructive nature can be said? If output and costs can be measured in the same unit—that is, dollars—a suitable criterion form is maximum output minus costs. For instance, in selecting fire-suppression equipment and methods, the test can be maximum value of output; that is, timber and property saved, minus costs. In order to estimate value of output, of course, one cannot examine fire trucks (or tools for constructing fire breaks, or fire-finder devices) in isolation. In those circumstances, only a measure of physical output could be devised. It is necessary instead to fit the fire trucks (or other equipment being considered) into the system in a realistic context and estimate the value of assets saved annually with the alternative kinds of equipment.[5] The kind that yields maximum value minus costs or, if the budget is fixed, maximum value for the given budget, is the most efficient.

To be sure there are supplementary considerations that cannot be embraced in a practicable test of economic efficiency. One major consideration of this sort is uncertainty. Which equipment is to be preferred if type A is more efficient on the average but type B gives a higher probability of avoiding catastrophic fires? Other supplementary considerations, for example, so-called intangibles, are always present. Nonetheless, the preceding test of economic efficiency is certainly a major consideration—one that is highly relevant to the final choice. This is more than can be said for many plausible criteria.

If output and costs cannot be measured in the same units, it is impossible to maximize value of output minus costs. This is the typical situation in defense activities, various loan programs, social security programs, and many other activities that provide special services to the public. Prices that are widely acceptable cannot be given to these outputs. Voters and officials have to attach values to various programs, at least implicitly, but one man's evaluation need not always be valid for other persons. In the case of such activities, analyses have to express output in physical terms, and the use of output minus costs

[4] This is not to say that ratios should never be used in any manner. To adjust activities until two ratios are equal is often a very useful device. But the maximization or minimization of some ratio is always a dubious criterion. For a more complete discussion of this matter, see Hitch, op. cit.

[5] The streams of gains and costs should be discounted at the marginal rate of return that could otherwise be earned, but the treatment of time streams cannot be taken up in this short paper.

(e. g., 20,000 patent applications processed minus $10 million) as a criterion becomes impossible.

The next best procedure appears to be to fix either the costs or the output at a reasonable scale. The test can then be minimum cost of achieving the specified physical output (e. g., patent applications processed, capability in particular military missions) or maximum physical output for the given cost. These two criterion forms are equivalent if the size of either gain or cost is the same in the two tests. If the test of maximum gain for a $50 budget points to the policy that yields a gain of 100, then the test of minimum cost to achieve a fixed gain of 100 will point to the same policy—the one that achieves the gain of 100 at a cost of $50. The choice between these two criterion forms depends mainly upon whether it is gain or cost that can be fixed with the greater degree of correctness.

This leads us to a most important question: How does one determine the right achievement or budget? If the achievement or budget is set uncritically, the test is not necessarily consistent with higher level criteria. In many problems of choice, the size of the budget or the scale of the mission is fixed by higher authority. In these circumstances, whichever is fixed can indeed be taken as given. If neither is fixed, one must try to select the mission or budget that seems reasonable in the light of higher level objectives. This calls for careful inquiry into those higher level objectives and their relationship to the mission or budget under consideration. Another possible procedure is to try several budget sizes or mission levels. If the same equipment is preferred for all task levels or budgets, that system is dominant. If the same course of action is not dominant, the use of several tasks or budgets is nonetheless an essential step, because it provides the policymaker with vital information.

Application to Specific Problems

What implications do these observations have concerning the comparison of specific alternatives? Let's look briefly at two problems that confront government officials periodically: (1) Choosing among alternative sizes of the budget for forest management, and (2) choosing among alternative personnel policies in government. In determining the efficient size of the forest-management budget,[6] we can devise sensible monetary measures of both output and cost. In this problem, then, a proper test would be similar to the criterion that private firms presumably use—maximum expected profits or, in other words, maximum gains minus costs (given whatever constraints exist). That is, choose the scale of timber planting, cutting, and selling that would yield the greatest excess of gains (discounted to their present value) over costs (similarly discounted). The Forest Service sometimes prepares analyses employing this sort of test; yet in this problem, and in many other investment choices, less meaningful criteria are often employed. Note that it is misleading to use a benefit-cost ratio as a test in this case (as in most others). Unless applied with special constraints and solely to small increments in

[6] I assume here that Federal management of the national forests is to continue. By "the" forest-management budget, I mean the funds for activities leading to the sale of timber.

the budget, maximizing such a ratio would favor restricting operations to a small but golden opportunity—say, cutting a small amount of high-quality and easily accessible timber. Commonsense would rule out this extreme, but the point is that the ratio would have little significance.

The second problem, determining personnel policies (e. g., in the military) is one in which output under alternative arrangements cannot satisfactorily be measured in dollars. If we slice off one particular part of the problem, i. e., setting the pay structure, a proper criterion is minimum cost of obtaining a designated set of services (i. e., physical output). The designated set of services should be consistent with the functions and tasks that are to be performed. The cost, of course, should not be confined to the coming year's expenses, but should be the present value of the costs for at least several years ahead. This example too is one in which appropriate criteria have been adopted, at least in some instances. With respect to military, personnel, the Cordiner report has made use of a criterion similar to the one above in comparing its proposed pay structure with the existing one.

Suppose we examine other alternatives in determining personnel policies. The designated set of services, for civilian as well as military activities, should be called into question, too. We should like to eliminate overstaffing, to find more economical combinations of men and equipment, to design equipment and methods of operation that make more efficient use of personnel. For such purposes, the minimum cost of obtaining specified services will not serve as a criterion. Nor will such tests as physical output per worker, gain-cost ratios, or the minimum cost of doing some casually specified job. The test would have to be, in very general terms, the minimum cost of performing a function or mission that is specified carefully in the light of higher level criteria. To state that such a criterion form should be used is to leave the hard work still ahead, namely, putting down those appropriate specifications of the function to be carried out. But the hard work is there because the problem is hard. To avoid it by adopting nonsense criteria will not lead to sound choices.

The problems just mentioned—determining personnel policy and the forest-management budget—are but two of myriad choices that must be made in deciding upon government expenditures. In each of these choices, criterion selection is a crucial aspect of either analyzing the problem quantitatively or of just thinking about the alternatives. And in this matter of criterion selection, it is imperative that we draw on economic principles, together with caution and commonsense, instead of adopting the first plausible test that occurs to us.