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THE ROLE OF CONSTRAINTS IN POLICY ANALYSIS

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1. A Mathematical Analogy

It is hard to overestimate the methodological importance of the idea, so revolutionary when it was first conceived, of proving the unsolvability of certain problems, such as geometrical constructions by ruler and compass, and the determination of the roots of equations of degree five or higher, by means of rational operations and radicals. To this idea, we owe the great discoveries of Abel, Galois, Lindemann and the beginning of modern algebra and of group theory.

It is important to understand clearly the way in which the question was formulated. With regard to the solution of equations, the problem was not to determine whether an algebraic equation of arbitrary degree n has roots; this fact had already been established by Gauss in his doctoral dissertation (1799). The question that interested Ruffini and Abel was quite different, and concerned the means by which the solution was to be found.

Similarly, in order to decide which geometrical constructions are possible, it is first necessary to define sharply the meaning of the term "construction", by specifying the instruments which are allowed in each case. Such questions could not be answered within the domain of elementary geometry; it was first necessary to translate geometrical operations into the algorithms of algebra and analysis.

This chapter of the history of mathematical thought contains a lesson of general methodological interest; a lesson which every policy analyst and decision maker should learn. Too often we take it for granted that any social problem can be solved, if sufficient resources are available. But the manageability of a social task cannot be rationally discussed until we have specified the acceptable means of collective action, as well as the limitations imposed by the availability of resources, knowledge, and organizational skills.

Thus, the analysis of a policy problem must start from the explicit recognition of the constraints. In the language of systems analysis, the

set of constraints specifies the boundary of the system under consideration; it is, therefore, equivalent to its definition. In spite of this fact, the literature of policy analysis and socioeconomic planning does not usually give to the systematic study of constraints an attention proportionate to its methodological importance.

The existence of constraints in any policy problem is, of course, readily admitted; but the number and types that are explicitly considered are generally very limited. It is not recognized with sufficient clarity that any theory or hypothesis relevant to a decision can actually be utilized only if it leads to a constraint, i.e., if it is expressed in "technological form" (Popper, 1959; 1960).

We are naturally inclined to conceive constraints only in a negative sense, as restrictions on our freedom of choice. Actually, when an important constraint has been identified, advantage can usually be taken of this knowledge. An organism can adapt just as the real world is constrained, and no more; learning and predicting are possible only when the environment shows constraint (Ashby, 1963).

It has been observed that social science, and especially economics, developed largely as the result of the critical investigation of successive utopian proposals, that is, of proposals of reform which disregard essential constraints (Hayek, 1933; Popper, 1960). Hence, while the recognition of objective limits to our ability to manipulate social institutions forms the very foundation of social technology, the theoretical explanation of those limits is the primary task of social science, and probably the most important stimulus to further progress.

This paper is devoted to a preliminary exploration of the role and use of constraints in policy analysis. We introduce a distinction between logical, empirical and policy constraints (defined below) which, without being exhaustive, can provide useful guidance in the analytic formulation of policy problems. The distinction also sheds some light on the respective role of deductive reasoning, empirical research, and "political" insights in policy evaluation.

As an indication of possible specific applications, we briefly examine some often debated issues concerning the methodology of economic and social planning, and the viability of these instruments of national policy.

In stressing the importance of an accurate knowledge of constraints, we do not mean to imply that all the relevant constraints can be known in every case. In policy problems such a complete knowledge is, of course, usually impossible. Strictly speaking, we can never be sure that our solutions are feasible, let alone optimal. Here lies the fundamental justification for the rationality of an incremental and evolutionary

approach to socioeconomic reform (Lindblom, 1963; Popper, 1966; Wildavsky, 1969). However, an adequate treatment of strategies suited to a state of limited knowledge cannot be attempted here, and must be left for future publications (but see Majone, 1973a, 1973b).

2. Logical Impossibilities

There is a widespread tendency to belittle the importance of deductive reasoning in the analysis of social problems. In this section, we try to show that, on the contrary, impossibilities deduced on purely logical grounds are also quite important for a rational assessment of the manageability of concrete social tasks.

Some rather obvious examples of logical impossibilities follow directly from general praxeological principles (e.g., it is impossible to maximize the benefits, and, at the same time, minimize the costs of a given action). It may be somewhat more difficult to discover that the objectives of a proposed policy are mutually incompatible; for instance, when the goal of income equalization is combined with a criterion of free, universal and equal benefits for everybody (Hagenbuch, 1958).

At a higher level of generality, we find some impossibility theorems which are in many respects the analogues for policy analysis of the mathematical propositions to which reference was made in the preceding section. We shall discuss here two such theorems of particular relevance for social policy.

The first is Kenneth Arrow's impossibility theorem (Arrow, 1963). It states that, if there are at least three alternatives which the members of a community are free to order in any way, then every group decision rule (social welfare function) satisfying some reasonable properties, and yielding a social ordering R that is connected (for all alternative social states x and y, xRy or yRx) and transitive (for all x,y,z, xRy and yRz implies xRz), is either imposed or dictatorial. In other words, there is no method of voting (of aggregating individual preferences) which will produce an acceptable result in every conceivable case.

Arrow's theorem generalizes the well-known paradox of voting of Condorcet (1785) which demonstrates the possible intransitivity of majority voting. If individuals I_1, I_2, and I_3 order their preferences as xyz, yzx, and zxy respectively, (i.e., I_1 prefers x to y, y to z and hence, x to z, etc.) then, the group, by majority vote, will prefer x to y and y to z, but z to x: group preferences are intransitive.

Doubts have been expressed as to the practical relevance of Arrow's impossibility theorem. But the question of the frequency with which

intransitive group preferences actually occur, or of the mechanisms, such as logrolling, by which similar phenomena may be avoided has nothing to do with the logical problem studied by Arrow. In terms of our mathematical analogy, it would be like questioning the methodological importance of the proof of the unsolvability of an equation of degree $n>4$, on the grounds that its roots can always be found by numerical methods, to any degree of accuracy. The real significance of Arrow's results is best appreciated against the background of a long history (excellently summarized by Black, 1958) of attempts at *positive* solutions of the paradox of voting. The existence of a system of voting capable of producing a majority that could be reasonably taken as the "genuine will of the people" seemed too much a part of democratic theory to be seriously doubted.

This belief has been shattered by the proof that, regardless of the chosen rule of aggregation of the individual preferences, group decisions do not necessarily satisfy even some minimal requirements of rationality. We have here a logical impossibility, whose consequences in terms of the cost of decision making (in the sense of Buchanan and Tullock, 1962) must be carefully assessed in deciding between collective and decentralized decision making.

The second impossibility theorem to be briefly discussed, Ashby's "law of requisite variety" (Ashby, 1963), is even more obviously relevant to policy analysis, since it bears directly on the controllability of complex systems.

Let P and S denote, respectively, the "planner" and the system which he tries to control. To any state s_i, $i = 1, 2, ..., n$, of S, P can answer by a move $p_j, j = 1,2, ..., m$, with a resulting outcome o_{ij}. We can represent the situation in tabular form, where the rows correspond to the states of S and the columns to the moves of P:

	p_1	p_2	..... p_m
s_1	o_{11}	o_{12}	..... o_{1m}
s_2	o_{21}	o_{22}	..... o_{2m}
.			
.	.....		
.			
.			
s_n	o_{n1}	o_{n2}	..... o_{nm}

The number of different moves (or, if more convenient, its logarithm) is P's variety; the variety of S and of the set O of outcomes are defined similarly.

The question is: how far can P stabilize the results, i.e., what reduction can he achieve in the variety of the set of outcomes? Suppose that $o_{hj} \neq o_{kj}$, i.e., no repetitions occur in each column. A moment's reflection will show that, even under the most favorable conditions, P cannot reduce the variety in the outcomes below the bound n/m (i.e., S's variety divided by P's variety). If variety is measured logarithmically the theorem can be expressed compactly as: $V_o \geqslant V_s - V_p$. Complete control can be achieved only if $m = n$, i.e., if P's variety matches S's variety, an unlikely event for systems of any complexity. Thus, when S is given, the variety in the outcomes, if minimal, can be reduced further only by a corresponding increase in that of P. More vividly: only variety can destroy variety (Ashby, 1963).

We have again arrived at a purely logical statement, whose validity does not depend on any empirical evidence, but only on the structure of the problem as represented by the tabular form (or in a continuous version of it, in which case the result follows from the formal properties of the entropy measure). In practical terms, the result shows that there will always exist a definite upper bound to the possibility of controlling large socioeconomic systems, regardless of the particular institutional setting in which the control problem arises, as historical experience abundantly shows. We can, of course, try to increase the power (variety) of P, but beyond a certain point this will imply the violation of other (legal, political, organizational) constraints. Alternatively, $V_s - V_p$ can be decreased by reducing the size and complexity of the system to be controlled, by aggregation, standardization and the setting of norms; or else, by expanding the role of decentralized decision making.

Finally, it should be noted that while impossibility theorems can have great practical significance, as we have tried to indicate, the statement that a given policy scheme is logically possible, i.e., does not violate any logical constraint, is, by itself, of very limited usefulness. Actual feasibility involves much more than logical possibility.

3. Social Theories as Constraints

To attack a socioeconomic problem with a reasonable hope of success, we also need empirical knowledge about the underlying processes, and the structural characteristics of the social mechanisms which we propose to use. Theories and hypotheses concerning the behavior of individuals and institutions are the most important sources of such knowledge.

Now, every law or hypothesis expresses a regularity, an invariant

property, hence, it excludes that certain types of behavior or systems of events may be observed; on the other hand, only knowledge expressed in the form of a prohibition or constraint is falsifiable, and therefore, truly empirical (Ashby, 1963; Hayek, 1952; Popper, 1959).

These basic epistemological propositions are extremely important for the methodology of policy analysis. They explain why the social sciences, like all the other sciences, can really contribute to the solution of specific social problems only when they are used to point out constraints which the decision maker would have otherwise ignored. The prevailing philosophy seems to be quite different. Many experts see their task as that of formulating policy objectives or, at least, indicating "optimal" solutions (which is another way of introducing a particular criterion of choice). Neither of these claims can be justified on the basis of the specialized knowledge and skills available to the social scientist or policy analyst.

The very possibility of valid generalizations in the social field has often been doubted, and this sceptical attitude has had important consequences on popular ideas regarding the scope of economic, social and political reform. For, if it is admitted that only natural and technological laws and resource limitations can be binding constraints on public policy, then social institutions must appear as purely conventional constructions which may be remodelled at will.

The regularities which linguists have discovered in the evolution of natural languages, perhaps the most important of all social institutions, would be sufficient to refute this thesis. Other significant regularities, of particular importance for the policy analyst and the social technologist, have been observed in the behavior of the complex organizations which make social action possible. Knowledge of the operational characteristics of these tools, is, for the social technologist, what knowledge of the resistance of materials is to the physical engineer.

Consider, for instance, the following basic principles of organizational control (Downs, 1967): "no one can fully control the behavior of large organizations" (law of imperfect control); "the larger any organization becomes, the weaker is the control over its actions exercised by those at the top" (law of diminishing control); and "the larger any organization becomes, the poorer is the coordination among its actions" (law of decreasing coordination). The first proposition is, really, a particular application of Ashby's theorem, and thus, it represents a logical constraint; but the other two are genuinely empirical statements, which all available evidence strongly supports.

To take another example, the proposition that if the price elasticity of individual demand is higher than zero (over a given range), govern-

ments cannot efficiently provide goods and services at zero user prices, can be derived from general praxeological principles concerning the efficient allocation of scarce resources. However, when we consider a specific problem, such as the provision of medical services under a system of socialized medicine, we need estimates of the price elasticities of demand for different health services (Buchanan, 1965) and these must be derived empirically.

Thus, logical and empirical constraints are both important, usually at different moments of the analysis; but they should be carefully differentiated because while logical impossibilities are unconditionally binding, empirical constraints may always be modified by new knowledge and factual criticism.

4. Policy Constraints

Anything which is given for the time period relevant to a decision problem, and affects the outcome of that decision is a constraint. Clearly, logical and empirical constraints are not the only limitations present in policy problems. In formulating economic and social programs, some legal, institutional, and political factors must always be considered fixed.

We can speak, in such cases, of policy constraints, since they do not follow from a logical impossibility or empirical knowledge, but from a preliminary decision or convention of the decision maker(s).

The fact that policy constraints are the result of a convention does not change their role in the decision process; once adopted, they reduce, like any other constraint, the domain of feasible alternatives (think of a manager who, in examining alternative ways of reducing costs, eliminates those that would entail a reduction in the present level of service to the customers). However, only in relation to a policy constraint, is it really meaningful to calculate the corresponding opportunity cost (what could be gained by relaxing the constraint).

Policy constraints cannot be conclusively tested on the basis of empirical facts or theories. They can, however, be rationally discussed, and facts and theories are relevant here. Thus, the distinction between empirical and policy constraints corresponds to that, introduced by L.J. Russell, between propositions and proposals (Russell, 1948; Popper, 1966).

Political insights; assessments of the possible indirect consequences of a decision; the recognition of the advantages of adaptive adjustments to the goals and decisions of other decision makers (Simon, 1964;

Lindblom, 1965), and many other subjective evaluations of a factual situation, often find expression in policy constraints.

In fact, "political rationality" (Wildavsky, 1966) reveals itself primarily in such constraints. This does not imply a contrast between different types of rationality (political, economic, technical, etc.). On the contrary, there is essentially only one type of rationality in policy making. It consists in the careful search for, and critical evaluation of, *all* the constraints which effectively limit the range of feasible choice.

5. Constraints and the Methodology of Socioeconomic Planning

To sum up: the analysis of constraints is a crucial step of policy analysis; the set of constraints embodies all relevant knowledge, and, together with the objective function, completely defines the logic of the situation; while it is useful, for analytical purposes, to distinguish different types of constraints, it must be borne in mind that they all play the same role in decision making, and must be equally considered.

We shall now briefly outline possible applications of these conclusions to some important issues in the methodology of planning. One question, which has often been subject for discussion, is the relation between economic and social planning. A good deal of controversy on the best methods of coordinating the two would simply be eliminated by a more precise conception of the decision process. It is usual to distinguish economic from social planning on the basis of the objectives of the decisions which are being considered (economic growth, in one case, social development, in the other).

But objectives are not the only important elements in decision making. Constraints are just as important; in fact, more important, for, if we consider two players, A and B, such that A can choose the objective function, while B is free to pick the constraints, then B, by a suitable choice, can make A's power largely illusory.

Incidentally, this simple fact is overlooked in many discussions on participation in decision making. We can have very effective participation even if only one person has the power or duty of choosing a preferred alternative, so long as he is willing (or forced) to accept constraints set by other interested parties. Conversely, group decision making may have very little substance if a large number of constraints is imposed from the outside.

Now, as soon as the constraints are brought into the picture, distinctions between "economic" and "social" programs lose much of their significance. For instance, health planning is at least as "economic" as

programs of income maintenance and equalization, a traditional concern of public finance. In the first case, such questions as the elasticity of demand for different health services, and the possibility of replacing the price mechanism by other, equally efficient, methods of rationing the resources of the health system, play a dominant role. In the second case, one of the crucial factors to be considered is the behavioral response of the recipients in terms of work effort and migration, expenditure and saving patterns, family life, etc.

The fact that economic problems may play a larger role in the case of a "social" plan, than for an ostensibly economic program (I am not referring here to levels of expenditure, but to specific mechanisms of implementation) might seem paradoxical only when we think in terms of objectives, and planning commissions are usually organized along such lines. If we look, instead, to the full set of constraints, a unified approach to socioeconomic planning appears as the only possible one. An example may help to clarify this point.

Consider the problem of pollution control. In most countries, responsibility for air, water and solid wastes pollution is entrusted to different local, regional and/or national agencies. However, this separation of responsibilities, according to physical media, does not take into consideration an important fact. The law of conservation of matter implies that treatment of waste residuals cannot reduce their amount, but only change their physical form. Thus, aside from recycling, and changes in the volume and pattern of production, reduction in the level of pollution of one particular medium such as water, can only result in increased pollution of other media (air, land). As soon as this basic constraint is taken into consideration, it becomes clear that the real question is one of choosing the best mix of relative burdens to be placed on the different environmental media.

With respect to the phenomenon of pollution, air, water and land cannot be considered in isolation, just as it is impossible to separate the physical from the biological and socioeconomic aspects of the phenomenon. A unified approach, calling for truly interdisciplinary studies, and a unified system of environmental management, is suggested by the very nature of the problem (Kneese and d'Arge, 1969).

Besides coordination, implementation is another issue which all planning bodies have to face. The difficulties encountered in translating plans and decisions into actual results are at the root of a "crisis of planning" which is rather generally admitted today (UN Economic and Social Council, 1972). It is a matter of common experience, at least in western countries, but probably more generally, that at the stage of program analysis, problems of implementation (i.e., organizational, in-

stitutional and sociopsychological constraints) are often relegated to a position of secondary importance (Schultze, 1969; Williams, 1971). The result is, that quite frequently, the unanticipated difficulties arising in the field, force a revision of the original objectives, even when sufficient financial and technical resources are available. I have argued elsewhere (Majone, 1971; 1973a) that the main reason for this indifference towards problems of implementation can probably be found in the normative approach characteristic of welfare economics and decision theory (in other political systems, the reason could be ideological). Because these disciplines, which form, at present, the most generally accepted logical foundation of policy analysis, give prominence to the moment of choice, analysts have tended to view their task as that of indicating to the political decision maker the correct choice among a given set of alternatives. The determination of the constraints has been taken as unproblematic or, at any rate, as being outside the scope of policy analysis proper; problems of implementation and control become significant only in so far as they give rise to new decision problems.

But, in fact, the selection of a best alternative (on the basis of some criterion of choice which in most policy problems would remain rather arbitrary) is less important than the organization of all available knowledge in a set of constraints. Some of these constraints have to do with administrative knowhow and other skills relevant to the process of implementation; they must be considered, together with all other limitations, at the moment of decision. Subsequent efforts to correct the disfunctions of a program conceived independently of the power of the available organizational tools, are always costly and often impossible.

Before concluding, I would like to stress the fact that the indeterminacy of the policy recommendations which seems to result from our approach, is more apparent than real. First, the larger the number of constraints which are considered, the smaller is the set of feasible alternatives, with a corresponding simplification of the choice problem. Many "bad" decisions are not just suboptimal; they are not even feasible.

Secondly, as Lindblom, among others, has stressed, policy problems are not "solved" once and for all, but repeatedly attacked in a series of meliorative steps. This procedure makes possible a continuous check for feasibility, and the discovery of constraints previously unknown. Because of the adaptive and evolutionary character of the process, it is sufficient that the successive steps move in the right direction. If the concept of optimality has any meaning in this context, it applies to the entire process rather than to any one of its particular phases.

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ABSTRACT

The new discipline of policy analysis applies the specialized knowledge of economics, sociology, organization theory, and all the other social sciences to the task of designing and implementing viable socio-economic programs. This paper is a contribution to the methodology of policy analysis.

Contrary to widely held views, social scientists can usefully participate in the making of public policy not by setting goals or giving expression to the "needs" of particular groups, but rather, by pointing out all the constraints (economic, sociological, organizational, etc.) which effectively limit the set of feasible alternatives. The theoretical explanation of these limitations is a fundamental task of applied social science.

The systematic exploration of the region of feasibility should form the core of all policy analyses. This exploration can be assisted by the proposed distinction between logical, empirical and policy constraints, corresponding, respectively, to impossibility theorems, empirical theories or hypotheses, and preliminary decisions or conventions. The significance of the distinction is indicated by some examples, and the different conditions of testability are noted.

Some methodological problems of socio-economic planning are also examined. It is shown that the nature of a program is determined by the character of the crucial constraints rather than by the ostensible objectives. Questions of program implementation cannot be treated separately from planning and resources allocation. All the constraints, including organizational and administrative ones, must be considered in the moment of decision. An alternative which appears satisfactory in relation to a limited number of conditions may turn out to be quite bad with respect to the complete set of constraints.