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Preferred Policies When There is a Concern for Probability of Adoption

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A theory of effective policy choice is developed that recognizes that the probability that a policy is adopted depends on who gains from it, who loses, and by how much. Ten pieces of recent environmental legislation are assessed to see how mechanisms such as coupling with other legislation, phased implementation, and the manipulation of uncertainty can spread benefits and costs. Several optimizing models are presented that explicitly incorporate the probability of adoption.

1. INTRODUCTION

Efficiency benefits stand at the center of conceptual work in environmental economics. They are the measuring rod against which performance is judged. Thus, one policy for pollution control is preferred to another because it offers greater efficiency benefits. These are the grounds, for instance, on which the use of effluent charges has been urged.

In practice, adopted regulatory policies for the environment differ markedly from the ones prescribed by economists' models. Most policies fall far short of maximizing benefits. The primary reason, I would argue, is not that policymakers are ignorant or ill informed about these matters, though assuredly some of them are. Rather, policymaker's concerns, quite appropriately, go beyond choosing the policy alternative that offers the greatest level of efficiency benefits.

The distribution of the costs and benefits of a regulatory policy is a major additional concern of policymakers; indeed it is almost a preoccupation. Therefore, it is to be expected that this distribution strongly affects the likelihood that a policy will be proposed, amended, enacted, and implemented.

This paper explores a theory of effective policy choice that recognizes that the probability that a policy is adopted depends on who gains from it, who loses, and by how much. Examples are drawn from recent federal experience with environmental regulation, though the analysis probably applies as well to such decisions as how to formulate public works programs or design an energy policy.

2. A REVIEW OF TEN PIECES OF ENVIRONMENTAL LEGISLATION

Ten major pieces of environmental legislation proposed from 1970 through the first half of 1977 were examined to see which were adopted, which were defeated, and what efforts to redistribute costs were associated with all ten. Table 1 gives some critical characteristics of the proposals as of May 1978.

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TABLE 1

Mechanisms to Spread Benefits and Costs of Ten Pieces of Environmental Legislation

Clean Air Act Amendments of 1970 (P.L. 91-604)

No explicit benefit distribution provisions; benefits accrue to those valuing clean air and those affected by respiratory ailments. Strict auto emission limitations, and requires establishment of National Ambient Air Quality Standards. Cost-distributing mechanisms; *uncertainty* in specifying standards (only constraint on NAAQS is standards set low enough to protect public health). *Compliance and implementation schedules stepped*—leading to NAAQS attainment by 1975. *Flexible deadlines*: 1975 deadline for NAAQS moved to 1977 (state-by-state) basis, by Administrator; could grant 1-year extension of 1975 auto emissions deadline if technically impossible. President can grant 2-year extensions and renewals of 1975 deadline for hazardous substances emissions standards if technically impossible, and national security required continued operation of pollution source. Determination of standards left to *Administrator's discretion*, susceptible to pressures from industries and Administration. *Emissions standards* and *nondegradation* for stationary sources not clearly required. *Enforcement* of Ambient Air Standards difficult.

1970 Tax on Lead DEAD

No explicit provisions for benefits distribution. *Benefits dispersed and ambiguous*: lead-free air and achievement of 1975 Ambient standards (otherwise impossible); revenue-raising a benefit that cuts two ways. Meant Ways and Means saw bill as tax on petroleum industry, not antipollution. Industry warned *costs to public*: inflation, higher gas prices. *Costs fall directly on industry*, *unfairly concentrated* on small refiners and lead manufacturers. This despite *stepped implementation* for small refiners, allowing exemption of 1 million lbs. lead first year, decreasing by 200,000 lbs./yr. until all lead taxable in 1976. Killed in committee after petroleum industry assurance: reduce lead in gasoline.

Water Quality Improvement Act of 1970 (P.L. 91-224)

Established total liability petroleum companies for oil spills damage and clean-up costs. *Ceiling on cost* from liability lowered to assure availability of insurance for ship-operators. Fixed future liability; *no immediate costs*. Other provisions (vessel sewage, hazardous substances, pesticides, thermal pollution) *vague, and restrictions indirect*—costs from these very uncertain. Benefits accrue only seacoast states; explicit additional benefits added: funds water-quality demonstration projects, Alaska, and Great Lakes pollution research and demonstration projects. Late '69 *oil spills impetus to pass bill* despite concerted oil industry opposition.

Federal Water Pollution Control Act of 1972 (P.L. 92-500)

Relied heavily on massively distributed municipal *grants*, special projects grants for particular legislators, *major uncertainties* regarding level and distribution of eventual costs. *Stepped implementation*, *de facto flexibility implementation deadlines* announced. Standards left to the *administrator's discretion*: BPT and BAT imply consideration of industries' costs. Administrator partially dependent on industries' information and claims. 1981 BAT compromised for new sources depending on costs. President's power to *limit federal government costs* augmented. Authority of EPA over states decreased to win state support.

Federal Environmental Pesticide Control Act of 1972 (P.L. 92-516)

Industry wanted bill now, in lieu of more stringent one later. Offers *financial indemnities* for bearing imposed costs. If existing pesticides registration withdrawn, manufacturers or farmers with acquired stockpiles of it reimbursed at fair market value (obtained before withdrawal registration). Elaborate *stepped implementation* plan. *Uncertainty in cost distribution* because EPA determines which are registered or banned. *Limits on costs*: penalty held down to $1,000 and export provision modified to remove restrictions on exported pesticides.

TABLE 1—*Continued*

Noise Control Act of 1972 (P.L. 92-514)

Industry favored bill since preferable to varied state, regional regulations or to stiffer Federal bill in future. EPA determined level of noise for industrial tools and machinery, taking into consideration *cost of compliance*. For aircraft: resolved by *uncertainty of regulatory process*. Compromise between airlines and environmentalists: EPA provides standards; FAA could change or veto them, if publishes reasons and holds hearings. Final authority enforcement rests with FAA. Leaves standards set by regulatory maneuvering, hence *uncertainty* weighted on the side of industry (FAA control). *Costs limited* when retrofitting idea dropped.

SO_2 Emissions Tax Proposals of 1973 DEAD

H.R. 5334 (by Administration): No special provisions for distribution of benefits; *concentrated costs* borne by copper, iron, steel and electric utility industries. Benefits dispersed; going to those who value clean air or have respiratory ailments. Modest *stepped implementation plan*; attempt to distribute cost impacts. Lacked explicitly targeted benefits.

H.R. 10890 (environmental and public interest lobbies): *Costs to all firms* regardless of air quality; *stepped fee schedule. Costs highly concentrated* on few industries, no targeted distribution of benefits.

Toxic Substances Act of 1976 (P.L. 94-469)

To prevent potentially dangerous chemicals from reaching market. Requires extensive pretesting; costs borne by company introducing substance. *Viewed as inevitable*, almost improvement over unpredictable, erratic regulations. *Targeted distribution of benefits*: legislators from industrial states, with chemical firms in their districts, for local research projects and studies of toxic substances and health problems. Uncertainty of costs result of agency discretion in exemptions, standards, all regulations (to be determined with cost–benefit analysis). Major uncertainty from possible exemption from testing standards if court rules against EPA decision to require company to do testing.

Stripmining Proposals of 1976 and P.L. 95-87 of 1977

H.R. 9725 and H.R. 13950 were killed by Rules Committee despite general support for the bill in Congress, stretched compliance schedules, stepped implementation plans and loosened geographical restrictions.

P.L. 95-87 passed in new context: Administration favored it, and since it was the fourth attempt, industry *accepted as inevitable*. Also substantial *benefit distribution*: Mine Reclamation fund for ravaged lands, grants to states for own regulatory programs and research, grants to education. *Cost–burden distribution narrowed* when application limited to coal mining; copper opposition dissolved. *Cost limitations* through major concessions to mining industry on geographical restrictions and types of mining, also *stepped implementation* for small operators—exemption of small operators from restrictions until January 1, 1979. *Cost uncertainty* because regulatory process undefined and identity of regulator uncertain. Also *discretion of regulator* in regulations and enforcement.

National Materials Policy Act of 1977 (S. 1281)

Alleviated burden to municipalities of solid waste disposal; encourages materials recycling on wide distribution benefits: all fees collected go to municipalities on revenue sharing basis to defray local (solid waste disposal (SWD)) and management costs. Level fees indexed to costs: distributed cost impacts over time so costs to firms rise when costs SWD are more expensive. *Uncertainty cost distribution*: EPA allowed wide latitude deciding who pays what charge. Extended stepped schedule for fees (11-year implementation plan). Wide distribution of benefits and slow phase-in of charges will be key factor if bill is accepted.[a]

[a]As of May 1978 bill still alive: has been proposed every year since 1971; is still being studied by RECRA commission. Has had EPA hearings, much publicity.

Lessons

Four critical findings emerge from a review of the experience summarized in Table 1. First, a wide variety of mechanisms were employed to redistribute costs and benefits in these proposals. Few of these mechanisms could be justified on efficiency grounds. Second, the redistribution efforts concentrated on reducing the costs to constituencies that would be significantly hurt by the legislation. Third, the eventual fate of these measures—passage or defeat—was by no means clear before final legislative action was taken. Measures that were seriously supported and hoped for were defeated. This suggests that the frequently heard assertion that a measure is politically feasible or infeasible, implying probabilities of passage of 1 or 0, is too simple. Probabilistic estimates often are appropriate. Fourth, the proposals that failed on average made less of an effort to reduce cost impositions.

These observations suggest a conclusion: The political process recoils from the "let the chips fall where they may" nature of traditional efficiency maximization. In particular, it attempts conscientiously to redistribute resources so that cost impositions are reduced, even if this can only be achieved at the expense of substantially greater reductions in benefits.

This pattern of choice is in sharp contrast with the dictates of benefit-cost analysis, which focuses exclusively on efficiency and considers not at all the distribution of chips. Alterations in policies to achieve predominantly redistributional objectives are rejected.

Benefit-cost analysis has traditionally been criticized for ignoring distributional concerns. It has been considered amoral, insensitive, or at least in conflict with important goals of society in that it pays no heed to the income levels of those who receive benefits or on whom costs are imposed.[1] That is, it does nothing to promote a more favorable distribution of income

In the case of environmental legislation, we suggest that the political system goes much further than benefit-cost analysis in enshrining the status quo. It focuses on benefits and costs as measured from present positions, and these gains and losses become the primary basis for judgment. Recognizing this, quite a different, more pragmatic criticism might be leveled at benefit-cost analysis: By ignoring distributional concerns it severely limits its relevance for policy decision.[2]

Mechanisms to Spread Costs

Our review of legislative proposals suggests that the political system is most responsive to levels of costs and that, to secure passage of legislation, conscientious

[1]There are, not surprisingly, good reasons why economists have been reluctant to pontificate on distributional matters. Their underlying theories tell them little on how to identify one distribution as preferable to another, or even how to measure income or welfare in a manner that is comparable from one individual to another. The practical world has less difficulty with these issues, for the most part it ignores philosophical underpinnings, and makes such judgments all the time.

[2]Economists and policy analysts, somewhat ironically, are particularly well equipped to estimate the type of distributional outcomes on which the political process focuses. The more refined methods of these professionals are required when the ultimate incidence of a tax must be measured, or the effects on various interest groups of tightened environmental regulations must be predicted. In many instances it is easier to judge the aggregate efficiency consequences of a policy than its distributional effects. This suggests that the comparative advantage of economists may be the greater the more the size and sign of changes from the status quo must be taken into effect in the formulation of policy.

efforts must often be made to reduce heavy imposition. Accordingly, we shall direct most of our attention to the losers' side of the ledger.

The ten environmental policies we reviewed employed a remarkable number of schemes to spread costs and benefits. Indeed, every one of the bills that passed made some effort to soften cost impacts. (Proposals that failed were less attentive to these considerations.) The mechanisms that were used for cost spreading fall into three general categories: (1) coupling with additional provisions or legislation that conveys benefits on constituencies that were otherwise hurt—compensating benefits or indemnities, (2) delayed or phased implementation—stepped introduction of fees, stepped implementation, or flexible deadlines, and (3) manipulation of uncertainty —clouding the identity of losers, and in some instances leaving the form of ultimate impositions in doubt.[3]

Compensating Benefits. The provision of compensating benefits is one favorite way to transform the benefits vector. Public works, research and demonstration grants were the principal methods employed in the pieces of legislation reviewed. A supplement to the Noise Control Act, for example, provided $22.5 million to local governments for noise research, planning and control projects. The Water Quality Improvement Act—basically a bill to compensate states for oil spills, and thus primarily a bill to benefit seacoast states —provided additional funds for research and demonstration projects in Alaska and the Great Lakes, water-related areas not otherwise benefiting. The Toxic Substances Act provided funds directly to compensate suffering regions. It specifies that research funds be spend "in states such as New Jersey, or in other heavy industrial states."

Indemnities. Parties that stand to suffer as a consequence of a piece of environmental legislation may be paid for some or all of their losses, transferring this burden to the taxpayers at large. The Pesticide Control Act gave manufacturers and farmers with existing stockpiles fair market value for these stockpiles.[4]

Stepped Introduction of Fees. The Lead Act proposed starting by imposing its tax on the largest refiners, a common phasing ploy. The SO_2 Control Act proposed gradual increments in the fees it charged, as does the Materials Policy Act, versions of which are still under consideration. (Since charges seem more readily accepted in the solid waste arena, the ultimate form and phasing of charges under a materials policy act may prove significant in introducing the incentives approach to environmental policy making.)

Flexible Deadlines. Even though a bill may mandate deadlines for compliance, there may be provisions for stretching deadlines under particular circumstances. The expectation is that the administrator will respond favorably should costs prove unexpectedly high. This may be a particular concern when there is substantial technological uncertainty. The mobile source emissions portion of the Clean Air Act contains provisions for this type of flexibility.

Purposeful Uncertainty. This mechanism is worthy of particular mention, for it conflicts at first glance with economists' traditional assumptions about risk aversion.

[3]Indexing is an additional mechanism proposed under the National Materials Policy Act. It imposes fees designed to reduce solid waste in relations to assessments of solid waste disposal costs at that time. Though indexing may spread costs, the objective is to assess appropriate charges.

[4]In practice, we are told, manufacturers and farmers were allowed to use up existing stockpiles and indemnities were avoided.

Purposeful uncertainty, however, can be of value in two ways. First, if there is a significant lack of knowledge about the costs of an imposition, an agreement that the imposition will be variable depending upon future cost may act to diminish expected costs. This will occur if the policy's stringency will be greatest when the expected costs of achieving any level of performance are lowest. Effluent limits, for example, could be formulated to vary negatively with future assessments of the marginal cost of meeting any particular limit. Flexible deadlines, in a parallel fashion, would be moved forward when costs turned out low, pushed backwards when costs proved high. If purposeful uncertainty is to prove beneficial, all parties must believe that the assessments on which future actions will depend will be fairly made. (This will be impossible to the extent that companies can camouflage low costs or government administrators can successfully overlook high ones.)

The attractiveness of the purposeful uncertainty strategy will be magnified if, despite commonly confronted uncertainties, the affected parties disagree about future costs. Assuming, as seems mostly to be the case in the real world, that those who forecast high costs are those to be imposed upon, an agreement to scale the size of the imposition to discovered future costs may be a way to secure agreement on action when no agreement on facts is achievable.

Suppose, for instance, that EPA believes a new standard for a factory will cost $1 million, while an affected company thinks it will cost $5 million. They may both agree to a plan which assures relaxation of the standard should it turn out to cost $3 million or more. Indeed, the two parties together, assuming that each believes its own initial estimates, would find this outcome preferable to a number of certain impositions.

A second, quite different, form of benefit may return to uncertainty. It can enhance the probability that certain kinds of legislation will be passed. Consider a situation in which no firm will mount a major lobbying effort against a piece of legislation if its expected imposition is below $100,000. Obviously, the legislation is more likely to pass if each of three firms believes that there is a one-third chance that it will suffer an imposition of $200,000, than if it is defined in advance which firm will be the loser.

Purposeful uncertainty has been a factor, perhaps not always intended as such, in a number of the pieces of legislation in our sample. In the Materials and Noise Acts, EPA was given authority to decide at what state in the manufacturing or distribution process to levy charges. The Clean Air Act and the Federal Water Pollution Control Act (FWPCA) left the standards to the discretion of the agency. Under the Toxic Substances Control Act, affected companies have been granted the right to challenge the pretesting requirement in court whenever they felt sufficient evidence was available to obviate its need. Finally, the FWPCA allowed for alteration of standards if suggested by a benefit–cost study.

The variety of cost-spreading mechanism employed in the environmental legislation under review testifies to the importance of distributional concerns in the political process.

3. A MODEL INCORPORATING PROBABILITY OF ADOPTION

We shall first develop an exceedingly simple model that explains why it may be beneficial to pay attention to distributional considerations in general, and to possibilities for reducing cost imposition in particular. We shall then review the mechanisms that were actually employed to spread costs in the pieces of legislation under consideration. Finally, we shall turn to models that elaborate principles of optimal policy choice in dynamic contexts.

Benefits Structure

The kernel of our argument can be expressed with the aid of a simple model. Let B_j be the vector of individual benefits that policy j confers,

$$B_j = (b_{1j}, \dots, b_{ij}, \dots b_{nj}),$$

where some of the b_{ij}'s may be negative. For the moment we shall not focus on any differences between expected and received benefits. Where there is uncertainty, it is probably most appropriate to assume that the certainty equivalent of the perceived benefits an individual receives is his b_{ij} value.

The naive maximizer among decisionmakers will merely search for the policy that offers the highest total benefits. These total benefits for policy j are

$$T_j = \sum_i b_{ij}.$$

The naive maximization process is the fundamental principle behind benefit-cost analysis.

It is frequently objected that this approach weighs benefits going to all individuals equally. In some cases, this is a normative objection; that is, it is felt that equitable decisions require unequal weightings. In other cases, the argument is simply that in actual practice, benefits are not weighted equally, and a useful model must reflect reality more accurately. A preferential maximizer values benefits going to some groups above those going to others. He seeks to maximize

$$\lambda_j = \sum_i \lambda_i b_{ij},$$

where λ reflects the relative weight assigned to an individual's benefits.[5] The remainder of our analysis will assume that all the λ's equal 1, i.e., equal weighting. The models are readily adapted to unequal weightings, or indeed situations where weights depend on the magnitudes of the b_{ij}'s.

The Probability of Passage

The central argument behind this analysis is that there is a probability function $P(B)$ that indicates the probability of passage of any measure. (Since B is the only argument, it is viewed as being solely related to the size distribution of the gains and losses it generates.) Much of political science is associated with describing the shape

[5] There is a not inconsiderable literature within economics which investigates political decisions and attempts to infer the implicit weights placed on the interests of different groups. The implication of the analysis below would be that this could only be done accurately with a knowledge of $P(B)$, as well as a knowledge of the opportunity set. Obviously, this formula might have to be modified if the b_{ij}'s were large and weights might vary with levels of benefits.

of $P(B)$, an issue to which economics and benefit-cost analysis have paid little attention.

What more can we say about the shape of $P(B)$? The evidence of the environmental legislation reviewed makes it clear that this function can take on values other than 1 or 0. That is, policies are proposed and seriously supported, yet ultimately defeated, with every evidence that the supporters thought that they had some a priori prospect of success. Beyond this, we can make a number of general points.

1. Nonadditive—There is no simple way to tally up the total of net benefits, that is the sum of the gains and losses of all participants, T_j, to determine whether a policy will be selected.

2. Lack of Anonymity—The $P(B)$ function is not anonymous. It matters who receives which payoff. Much discussion within political science boils down to such questions as: What are the advantages of having the gainers from a policy be the members of organized constituencies? Which individuals in which constituencies are more important than others?

3. Positive Responsiveness—Though we may not know the general shape of $P(B)$, we can be a bit more venturesome in discussing partial derivatives. Usually, we would suspect that holding other b_i's equal, raising one individual's benefits will increase the probability of adoption. That is,

$$\partial P/\partial b_i \geq 0.$$[6]

4. Extra Attention to Negative Benefits—The environmental policies cited all undertook efforts to reduce the costs on severely affected parties. Many of these efforts took the form of providing some identifiable positive benefits to political jurisdictions that would suffer losses should the legislation be adopted.

This observation could be formalized into a conjecture about the shape of $P(B)$. Consider individuals k and $k+1$ who play equivalent roles in the political process. For a proposed policy, b_k is positive and b_{k+1} is negative. Say that $P(B)$ increases by 1% if we added \$1,000 to b_k. Then this would suggest that $P(B)$ would increase by more than 1% if b_k were left unchanged and b_{k+1} were increased by \$1,000. Reducing the negative payoff has more effect on the probability of passage than increasing the positive payoff.[7]

5. The Effect of Further Increases in b_i on $P(B)$—Second derivatives are a bit more troubling, and in general it seems impossible to say, for example, whether a policy offering individual's i and j benefits of 100 or 200 has more or less chance of passage than another policy offering them each 150.

[6]If envy is a political factor, as it is, alas, too often, even this simple relationship may not hold. Other things being equal, for instance, the provision of further benefits to a large profitable industry may hurt a proposal's chances.

[7]Robert Dorfman has undertaken some work that relates to this subject. He focuses attention on exactions, that is all the negative benefits. He proposes that policymakers should investigate the shape of the frontier relating total expected benefits, T, and the sum of exactions, $E = \Sigma_{b_i<0} b_i$. If it were assumed that the sum of negative benefits were a sufficient statistic to determine the probability of passage, then we would surely wish to select a policy from among those on this frontier. Moreover, and this is Dorfman's point I believe, we would not in general select the point that offers the maximum value T. R. Dorfman Incidence of benefits and costs of environmental programs, *Amer. Econ. Rev.*, 330–340 (February 1977).

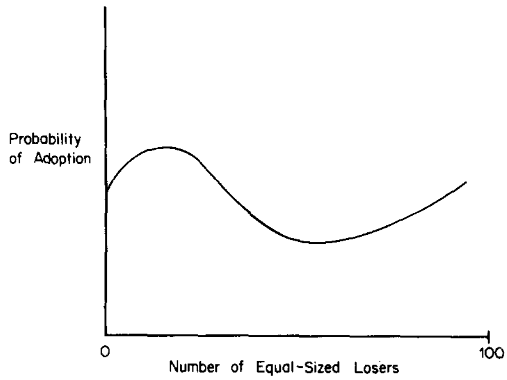

FIG. 1. Probability of adoption as a function of the number of losers with total losses and the distribution gains held fixed.

It is an interesting question, given a fixed distribution of gains in a population, how the distribution of a given total amount of losses would affect probability of passage, given various hypotheses about the political system. Say there were 100 potential losers, and a total loss of $100,000. Concentrating all of the loss on one party, the other 99 receiving 0, would probably strike against perceived equity. It might be harder to close a tax loophole that presently benefits one individual than one that benefits a dozen. Similarly, it might be difficult to secure passage for environmental legislation that would have the effect of closing down a single firm. Over a certain range, the losses are divided up among larger numbers of individuals, perceived inequity may diminish, and probability of passage may rise. After a point, however, the number of parties suffering a severe loss may become large enough that, as they choose to exercise their political weight, the probability of passage will fall. Then, as the losses spread further, say to all 100 losers, they may be small enough that no loser will exert any effort to defeat the legislation; the free-rider phenomenon predominates and passage becomes more likely. The total curve would be not unlike Fig. 1. Other stories would produce other pictures.

Future research should explore the shapes of $P(B)$ function in different circumstances. We have mentioned three factors that may play a role, perceived benefit, political influence and perceived equity. A concern for equity may reflect either an altruistic strain within society, or a pragmatic recognition of the need to protect minority interests. (The latter may come from adherence to constitutional guidelines.)

For the remainder of this paper, we shall assume that the shape of the $P(B)$ function is known, or can be derived from available information. (In a model we shall see later, individual's efforts for and against a proposal determine likelihood of passage. Such efforts are chosen to maximize expected personal utilities.) The critical question we consider is how to formulate optimal policies when the form of $P(B)$ is known.

Strategic Maximization

Our interest then is in strategic maximizing behavior. That is, we wish to select or formulate policies in a manner that takes explicit account of the probability that the

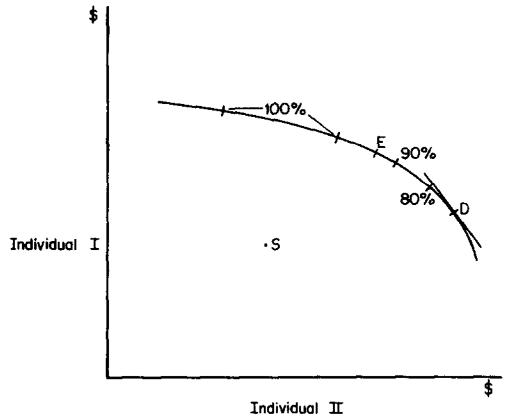

FIG. 2. Strategic maximization taking account of the probability of adoption.

policy will be adopted. The objective we shall employ is to maximize expected net benefits, that is to select the alternative j that yields the maximum value of

$$R_j = P(B_j)T_j.^8$$

The essence of the argument we are making can be conveyed with a simple geometric diagram (Fig. 2) that reveals the alternative levels of net benefits that are available. Except where stipulations are made to the contrary, we assume that there is agreement on the consequences of alternative policies, i.e., the location of the feasibility frontier is not in dispute. Since $P(B)$ is known, the probability that any particular proposal will succeed is readily determined.

Assume that this is a one-time only proposal, and that if it is defeated the status quo, S, will persist. The curve gives the feasibility frontier for benefits. The hatch marks indicate probabilities of passage at particular points on that frontier. One portion of the curve—designated 100%—offers outcomes that can be secured with 100% probability. This may even be the case where a range of Pareto improvements is possible, for individuals receiving positive benefits may commit themselves to vote against a measure if they feel or assert that their share of total gains is unsatisfac-

[8]A strategic maximizer could also have preferences or weightings attached to different benefits, in which case T_j would be replaced by λ_j. Further generalization could allow for nonlinear weights on the benefits going to different parties. Expected net benefits might appeal to an idealistically motivated politician or policy maker. (This assumes that benefits are not so large that recipient risk aversions should come into play.) Many policymakers, of course, will have somewhat different objective functions, perhaps maximizing the probability of an "acceptable" outcome. Whatever that function might be, they would still take $P(B)$ into account. Take the case of a politician concerned only with his probability of reelection. He would then attach his estimated probability of reelection as a function of the benefits vector. Denote this as $v(B)$. He would choose the policy that offers the highest value of $P(B)v(B) + (1 - P(B))v(B^0)$, where B^0 is the status quo vector of benefits that results when the policy is defeated. (Conceivably his probability of election could even depend on his defeated proposal.) Then $v(B^0)$ would be replaced with $\bar{v}(B)$, the probability of election when B is proposed but defeated. If there is uncertainty about benefits, then $v(B)$ would be a conventional von Neumann–Morgenstern utility function.

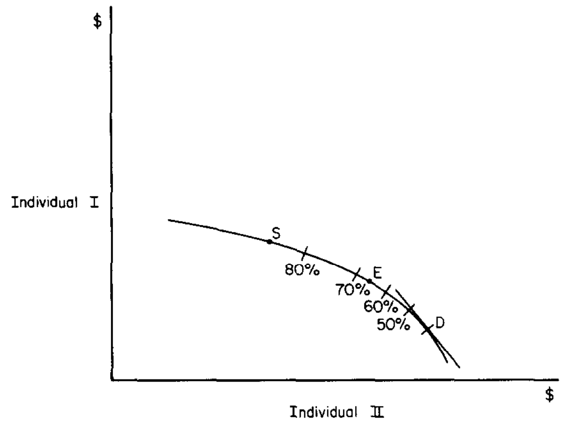

FIG. 3. Strategic maximization with non-Pareto improvements.

tory. In the diagram shown, the highest level of total net benefits, as indicated by a slope of -1, is at point D. However, point E offers the greatest *expected* net benefits, where the expectation takes into account probability of passage.[9]

Movements from the status quo will not in general be Pareto improvements; rather they will help some parties at the expense of others. The situation might be the one shown in Fig. 3. Given that the political system abhors identified losers, it will sacrifice substantial net benefits to reduce cost impositions. In the diagram, expected net benefits are maximized at point E; net benefits are at a maximum at D.

The diagrams implicitly assume the possibility of making continuous tradeoffs among the benefits going to different parties. In some circumstances, of course, only discrete choices will be available. In other instances, there will be opportunities to transform the benefits offered by disjoint alternatives; the feasibility frontier will be a series of curved segments.

Consider the type of transformation that should be undertaken in the neighborhood of the optimum, whether the frontier is continuous or merely composed of continuous segments. The optimal policy, for a two-individual world, will maximize $P(b_1, b_2)\cdot(b_1 + b_2)$. Assume that $\partial P/\partial b_1 > \partial P/\partial b_2$. Resources would be transferred towards individual 1 if a costless transfer could be made. However, a \$1 sacrifice of b_2 will only yield \$$\beta$ in increased benefits to individual 1. Optimality is achieved where

$$\left(\beta\frac{\partial P}{\partial b_1} - \frac{\partial P}{\partial b_2}\right)\cdot(b_1 + b_2) = P(b_1, b_2)\cdot(1 - \beta),$$

where β and b_1 should be understood to be implicit functions of b_2. The left hand

[9]Most of the models in this paper maximize expected net benefits. If individuals are risk-averse, then it might well be appropriate to maximize the sum of certainty equivalents. If utility functions are identical across individuals, this is the same as maximizing expected total utilities. (Conceivably some other aggregating function for utilities could be employed.)

side of the equation represents the gain in expected net benefits due to an increase in probability; the right hand side gives the loss due to a lower level of total benefits.[10]

A Model in Which Probability of Passage is Endogenous

In the remainder of this paper we shall assume that the shape of $P(B)$ is known. In this section we delve one step deeper and see how a $P(B)$ function might develop.

Basically, $P(B)$ derives from the efforts that citizens undertake to influence the outcome of the political process. The more influence exerted on a side of an issue, the more likely that side is to triumph. We assume that citizens exert their efforts to secure benefits. (In this first paradigmatic analysis, we shall consider only the actions of citizens as individuals influencing the process. The analysis would work equally well if interest groups were included.) The benefits, which could be tangible goods, aesthetics values or health, self-interested or other-regarding, will be expressed in the form of a monetary equivalent. Each citizen is assumed to pick that level of effort that maximizes his expected utility given the efforts of other individuals. The outcome then is a Nash equilibrium.

For purposes of illustration, we shall assume that all consumers have a common utility function $U(W, E)$ with wealth, W_1 and effort, E, as arguments. The proposal is assumed to convey a net benefit, possibly negative or zero, to each individual.

The probability that a measure passes depends on the efforts made for it and against it. Indicate efforts for as $X = x_1, x_2, \ldots, x_m$. Efforts against will be denoted $Y = y_1, y_2, \ldots, y_n$. The probability of successful passage is taken to be:

$$P(X, Y) = \frac{x_1^\gamma + x_2^\gamma + \cdots x_m^\gamma}{x_1^\gamma + x_2^\gamma + \cdots x_m^\gamma + y_1^\delta + y_2^\delta + \cdots y_n^\delta},$$

where γ and δ represent the responsiveness of the system to the efforts of individuals pro and con. (Having δ greater than γ would favor the status quo.) Consider the symmetrical case where $\gamma = \delta$.

An individual with initial wealth W_0 receiving positive benefit should the proposal succeed would choose his level of effort, x, to maximize

$$P(X, Y)U(W_0 + b, x) + (1 - P(X, Y))U(W_0, x),$$

where it must be remembered that x is a component of X. We shall deal with the case where there is simultaneous maximization. All participants act as naive maximizers; i.e. they do not consider the effect their input of effort has on the effort input by others.

To derive illustrative numerical results, we shall need a specific form for the utility functions. Let it be

$$U(W, E) = \ln(W) - \propto E.$$

[10]If transfers are not costless, then at each point representing a discrete policy choice before any transformation, the feasibility frontier will have a kink, i.e., a discontinuous derivative. This in turn implies that there is a good likelihood that no transformation will prove beneficial. In such cases, the equation in the text will produce an inequality showing the undesirability of movements in either direction.

The individual's optimal expenditure is now computed by solving the equation

$$\frac{\partial U}{\partial x_i} = \frac{\partial P}{\partial x_i}\ln(W + b) - \frac{\partial P}{\partial x_i}\ln(M) - \alpha = 0.$$

Define

$$G_i = \ln(W_0 + b_i) - \ln(W_0),$$

the utility gain a winner reaps when the bill goes through, and

$$L_j = \ln(W_0 + b_j) - \ln(W_0),$$

the utility loss a loser entails. For the case where all gainers gain the same and losers lose the same, some algebraic manipulation shows that the probability of passage is:

$$\frac{1}{1 + \left(\frac{m}{n}\right)^{1-\delta}\left(\frac{1}{g}\right)^{\delta}}.$$

Even a model this simple can yield properties that are worth noting. First note that risk aversion in the monetary argument will work against passage of a bill that yields the same vector of negative as of positive benefits. For example, with $\gamma = \delta = 0.8$, and $\alpha = 1$, if initial endowments are 200, two people gain 100 from the proposal and two others lose 100 then the optimal individual for and against efforts will be $x = 3.874$, and $y = 6.622$. The probability of passage is 0.3944.

Second, the values of γ and δ vitally affect the behavior of the model. As their values approach 1, we observe the free-rider phenomenon: those who gain or lose relatively little stand by to let big gainers and losers make all the effort. Small positive values of γ and δ might be thought to represent some variant of perfect democracy. Each individual can make his voice felt without great effort. Indeed, for $\gamma = \delta = 0$ the probability of passage will depend solely on the ratio of the numbers of individuals for and against the proposal.

We can see how $P(B)$ achieves its form given the structure of the underlying political mechanism $P = f(X, Y)$ and the utility functions of individuals. For $\gamma = \delta = 0.8$, and $M = 200$ for all individuals, we get the following outcomes:

1. Unequal Gains, Equal Losses

Benefit Level	150	50	−100	
Number of Individuals at that Level	1	1	2	
Optimal Per Capita Effort	10.667	0.108	6.773	
Probability of Passage				$P(B) = 0.4244$

2. Concentrated Gains, Diffuse Losses

Benefit Level	100	−2	
Number of Individuals at that Level	2	100	
Optimal Per Capita Effort	1.485	0.001	
Probability of Passage			$P(B) = 0.8980$

The comparisons with the example in the text are instructive. If gains are unequal, the free-rider phenomenon, well known from the economic theory of alliances, comes into play.[11] The large gainer pays far more than his proportional share. The underprovision of the public good—efforts in this model— is understandably less extreme when the benefits are concentrated on one individual. In the limit, he is the sole beneficiary and there is no underprovision.

4. STRATEGIC MAXIMIZATION IN A DYNAMIC CONTEXT

Our discussion of mechanisms for spreading costs showed the importance of dynamic considerations when probability of adoption is a concern. Static models offer simplicity. This simplicity is bought at the expense of omitting from consideration one of the strategies most frequently used to boost probability of adoption: journeying rather than leaping to the optimum.

Many policies have a phased implementation period. Even so, if the policy is announced all at once, each participant can compute his stream of future costs and benefits and arrive at a number giving his present value. If once the policy is accepted it will surely go forward, then the situation is no different from one of static maximization. This is not to suggest, however, that announced phased implementation may not offer advantages, for it can still bring down expected costs.

Indeed, phased implementation may even offer a means for bringing about Pareto-superior outcomes, assuming that there are market imperfections elsewhere in the system. It is frequently observed that corporations have discount rates in the neighborhood of 15%. Environmentalists, by contrast, with their strong concern for the future, may have a discount rate no higher than 3%. This suggests that both groups would prefer a strict policy implemented ten years hence to a moderate policy implemented immediately.

The dynamic implementation problem acquires both analytic and policy interest when there is a probability that an effort will be stopped at any number of stages. This problem arises naturally when there are many stages in implementing a policy, as there frequently are. Multiple states can arise for a variety of reasons. We consider three: (1) There may be a natural division of responsibility for implementing legislation, for example, between the courts, the regulatory agency, and the legislature. (2) The proposals may be natural competitors, perhaps different uses for the same geographic area. If one proposal is defeated, another can be tried. (3) The legislature, with attention to the probability of adoption, may seek to enact modest measures at the outset. With success, it may continue to push further in the same direction. We consider these problems under the mnemonic headings Stages of Adoption, Try and Try Again, and Optimal Speed.

Stages of Adoption

The adoption of legislation is a multistage process. At the outset, a policy must be proposed. After proceeding through possible revisions in the legislature it is then

[11] M. Olson and R. Zeckhauser, An economic theory of alliances, Rev. Econ. Statist. **48**, No. 3, 266–279 (August 1966).

defeated or voted into law. Assuming no executive veto, the next stage of most regulatory legislation is implementation by an administrative agency. Finally, there is the period of possible court challenge. These stages need not fall neatly in chronological order; they may overlap, and some may be encountered more than once.

For expositional simplicity, the models of this analysis collapse these stages into one stage of acceptance or rejection. Since the illustrative examples deal mostly with the design of legislation, it may be natural to think of this stage as drafting and voting on legislation. This would be a fully general interpretation either if (1) once legislation was passed it was automatically implemented, or if (2) the decisionmaker cared only about the outcome of the legislative process.

If the decisionmaker, however, is concerned with the consequences of the policy, then he should study each of the many stages from proposing legislation to implementing it. Attention to the multistage problem might reveal in some instances that legislation that was more likely to get passed would be less likely to be implemented. If the ultimate outcome was the concern, and if, say, there were a three-stage process, then we might have

$$P(B) = R(B)\cdot S(B)\cdot T(B),$$

where $R(B)$ is the probability that the legislation gets passed, $S(B)$ is the probability that it is implemented and $T(B)$ is the probability that it is sustained in the courts. The next order of complexity would introduce a conceivable time delay until implementation, along with the probability of implementation.

The potential areas for research are vast. This paper concentrates on some relatively simple models and shows that they have the potential to highlight the operation of some rather complex processes. Investigation of the way the structure of legislation affects its success in later stages of the implementation process should prove particularly helpful. So too should analyses of the differential response of the implementation process to the structure of the benefits vector.

Try and Try Again

In some policy situations it may be possible to propose one policy, if it is not successful, go to another, and so forth until a success is achieved. Here the problem is one of ordering. Should project k be attempted before project m? For this analysis, and those that follow, we shall assume that the objective is to maximize the sum of expected discounted benefits. Let the discount factor be ρ, and to simplify exposition, write $P(B_k)$ as P_k. The objective then is to find the sequence that maximizes

$$P_kT_k + \rho(1 - P_k)(P_mT_m).$$

To see whether project k should come ahead of m, try out both orderings and subtract the one from the other. This gives

$$(1 - \rho)(P_kT_k - P_mT_m) - \rho(P_kP_m(T_m - T_k)).$$

If this quantity is greater than 0, k should precede m.

Note that if ρ is close to 1 (i.e., the discount rate is low or the trials come sufficiently close together) that discounting is not an important consideration, only the second term is of consequence. Then project k should be tried ahead of project m if $T_k > T_m$. Alternatively, if $\rho = 0$, which would be the case if there will be only one trial, or if the time between trials is so great that follow-up attempts contribute very little to value, only the first term matters, and optimality is achieved by using one-time-only strategic maximizing behavior.

It is interesting to note that, in a case in which project k should come ahead of m if these are the only competing possibilities, the inclusion of still a third project, which would end up in between the two, will shift the value of ρ, and may make it desirable to put m ahead of k.

Optimal Speed

In many situations, after the enactment of an initial policy, a second, more ambitious policy is proposed in the same area. Return to Fig. 3, where the maximum total net benefits was available if a move were made successfully from S to D. We noted earlier that if a single step were contemplated, expected benefits would be maximized through the proposal of policy E.

Of course, there may be no reason to stop at E. Once that gain is secured, assuming that there would be no back-sliding, it would be worthwhile to try the additional move to D.

Recognizing that more than one move can be taken, the decisionmaker is thrust into a dynamic optimization context. What first move should he take, given that if it succeeds he will take a second move as well, and then a third, etc.? We would expect that the orientation towards a second (or further) move would make the optimal first move more modest than the preferred move when only one step is feasible.[12]

In considering multiple-stage strategies, the formulation of the problem is highly important. Once a point is achieved, does it become the status quo? How long would it take for it to become established as such? Might a failure in a further move push us back towards the initial status quo? Does the fact that further moves may be attempted change the probability of success on any intermediate move? These questions address the nature of our political process. It is essential that they be understood if analytic techniques are to be used to help identify preferred policies.

In the models below, we assume that a stepped process of implementation involves moving from one status quo point to another candidate for that role, that once a point is achieved it is secure, and that the probability of moving from one point to the next depends only on the benefits and costs that moves offers to affected parties; i.e., there is no looking ahead.

We also confine our attention to movements along the efficiency frontier. Although this may not appear to be a limitation, it could be. A detour inside the frontier could be worthwhile. Any proposed move that would take us to a point off the frontier, in contrast to a frontier point that dominates it, would sacrifice both success probability and payoff. These losses, however, could be more than compensated because the success probability for further moves from the dominated point will be greater.

[12]It is conceivable that the optimal first step will be larger, if, for example, the probability of successful second moves is significantly increased when they are smaller.

To formulate an optimal strategy in a multiple-stage problem there are two considerations: the number of steps and the size of each step. The algorithms discussed below, for example, compare the expected payoff from the optimal two-move plan with that of the optimal three-move plan, etc. This all assumes that the length of a period is fixed.

The multiple-stage problem in its most general form is one of optimum speed. The solution to the continuous problem can be approximated as closely as is desired by shrinking the length of periods. We shall treat the optimum speed problem below in discrete form. If there were no problems in securing net benefits, it would be optimal to undertake the program that offers maximum net benefits in a single gulp. However, as with our previous formulations, the probability of successfully implementing a change will in general decrease with the size of the change. Some moderation in the optimal speed of implementation is the result.

Consider a discrete time problem where there is a total of T of net benefits available. The objective is to find the sequence $s_1, s_2, \dots s_n$ that maximizes discounted expected value. Once stopped at a particular benefits level, no further benefits are secured, though the level already achieved is maintained. The probability that a program is stopped in period j may depend on both the level of benefits to date, $\Sigma_{i=1}^{j-1} s_i$, and the speed in period j, s_j. For simplicity, we shall consider cases in which the speed in period j is of concern, but not the level of benefits to date. This formulation would most likely apply when imposed costs were linearly related to benefits. Define the probability of not being stopped in j as $p(s_j)$. As an accounting formulation, assume that no benefits are received for the period in which one is stopped. The probability that one secures the benefits offered by s_j is then

$$P_j = \prod_{i=1}^{j} p(s_i).$$

Assuming that the net benefits s_j are secured successfully, they will be reaped in each subsequent period. With a discount rate of r, the benefits returning from this success discounted to period j will be s_j/r. To maximize total discounted benefits, we are searching for the sequence

$$S = (s_1, s_2, \dots, s_n)$$

that maximizes

$$\sum_{j=1}^{n} P_j(s_j/r)/(1+r)^j,$$

subject to $\Sigma_{i=1}^{n} s_i \leq T$. In some circumstances there may be an additional constraint on the value of n.

Linear Relationship between Benefits and Cost

This problem is far too complex to be solved in general form, though numerical solutions are available for specific functional forms. To illustrate, let us assume that

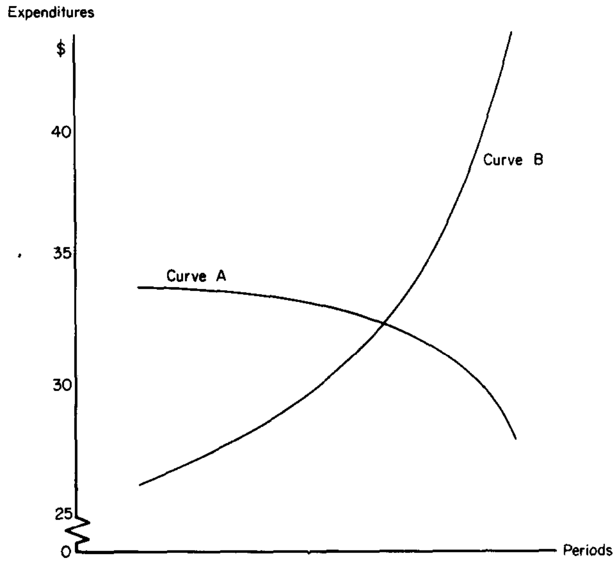

FIG. 4. Shapes of two optimal expenditure paths. 2.247 million dollars in total benefits available to expend, $k = 1$. Curve A: $r = 0.2$; Curve B: $r = 0.05$; periods constrained ≤ 7.

the function $p(s_j)$ is of the form $1 - ks_j^2$. As the speed of implementation doubles, the probability that the program is stopped in any period decreases fourfold.[13] If costs were linearly related to benefits, this formula for probability of stopping would be the reduced form of the structural formula

$$P(B, C) = 1 - q(C^2 - \propto B^2).$$

Figure 4 above shows two optimal time paths assuming that a fixed amount in net benefits is available. Two conflicting factors are at work. Discounting makes it worthwhile to get benefits earlier. However, the size of the potential loss of future benefits is much greater in the early periods of implementation. The various paths reflect the differential impacts of these factors for different parameter values.

Note that for some sets of conditions we observe the interesting phenomenon of an upward swoop in speed. In these cases, the desire to avoid the loss of future benefits, much greater in early periods, more than outweighs discounting considerations.

The nature of the optimal path depends on whether the total number of time periods and/or the total available benefits are constrained. If neither constraint is binding, then the optimization decision for each period, looking forward, is precisely the same. The recursive form of the problem makes solution easy.[14] For example,

[13] Note that if the probability of stoppage were only proportional to the speed, then it would be desirable to adopt the whole program at once. By direct analogy, if the probability of getting a speeding ticket, per unit of time, is proportional to speed, then one is just as likely to get a speeding ticket on a 100 mile journey if he goes 10 miles per hour as if he goes 100—this fact can be camouflaged if we make the simplifying assumption of working with discrete time periods.

[14] The optimal expenditure is $[-(3r + 1) \pm \sqrt{9r^2 + 10r + 1}\,/2k]^{1/2}$.

TABLE 2
Shapes of Optimal Expenditure Paths

Resources	Years for expenditure: Constrained	Years for expenditure: Unconstrained
Constrained	Swoop or droop	Droop[15]
Unconstrained	Swoop	Constant expenditure

with $r = 0.05$ and $k = 1$, with s_j measured in million dollar units, the optimal expenditure in each period is 0.2048.

For a maximization over any finite period of time, if the constraint on total available net benefits is not binding, the level of optimal expenditure will rise over time, i.e., the optimal path is an upward swoop.[16] In the last period, obviously, the optimal expenditure is what would be spent in a one-period strategic optimization. These properties hold true independent of the discount rate, which can easily be seen by looking at the second to last period. It is optimal to spend slightly less then than in the last period, for, in contrast to the last period, there is a future whose survival probability is driven down by expenditure. In this optimized sequence of expenditures, the discounted expected value of the future cannot decrease as periods move backwards towards the origin. Otherwise it would be optimal to substitute the string of planned expenditures starting in period $n + 1$ in period n.

The problem takes its most intriguing and most realistic form when the constraint on total available benefits is binding. Then when the number of time periods is limited, the optimal path may swoop or droop. Curve A in Fig. 4 shows the optimal path for a total of available net benefits of 2.247 million dollars for a discount rate of 0.2, and with $k = 1$ assuming that there is no binding constraint on the number of time periods. As expected, the higher discount rate yields an optimal expenditure path that concentrates advances more heavily in the early years. Curve B in Fig. 4 shows the optimal expenditure path with the same total benefits and k value, but with a discount rate of 0.05 and the constraint that all expenditures be undertaken in seven time periods. (If there were no constraint on time periods, the optimal expenditure curve for the high discount rate would also droop.) In general, the shapes of optimal expenditure paths are as shown in Table 2.

Nonlinear Relationship between Benefits and Costs

In practice, costs may not be proportional to the level of net benefits that is secured. Rather, many programs can and should be ordered so that the ratio of benefits to costs is highest in the phases of the program implemented first. The program should be adopted in an order so that this ratio declines monotonically over time. The spirit of this rule is extrapolated from a traditional rule in benefit–cost analysis, where efficiency benefits are the only concern.

The justification, however, is quite different. If the probability of successfully adopting an additional step depends positively on benefits and negatively on costs,

[15] We think it may be possible to have a swooping optimal expenditure path in this case. The computer program is available on request.

[16] If there is a finite period of time, it is quite likely that the resource constraint will not be binding, since there is an internal maximum for expenditure in any particular period.

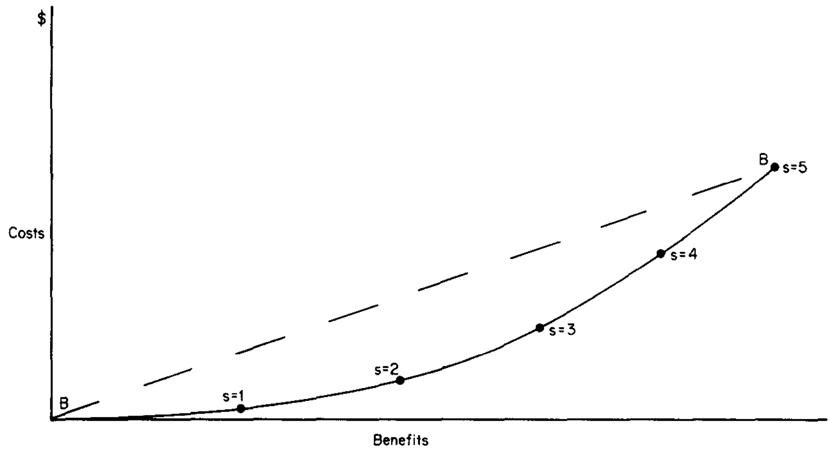

FIG. 5. Total costs and benefits as an environmental standard is raised.

then ordering phases on the basis of the benefit/cost ratio will maximize the probability that any particular level of net benefits is achieved. Quite evidently, this also maximizes the expected net benefits from the whole project. With a nonlinear relationship between benefits and costs, the optimal ordering of undertakings is an important consideration along with the speed with which they are undertaken.

There are at least two possible areas of complication. First, the phases may be indivisible; whole chunks may have to be undertaken at the same time. Then, unless the function giving the probability of successful adoption is homogeneous of degree zero, i.e., doubling the benefits and costs does not change the probability of successful adoption, it may be preferable not to implement according to the ordering provided by the benefit/cost ratio.

Second, the nature of the problem may rule out certain orderings. As one possibility, the levels of benefits and costs may depend on the sequence in which the project is phased. A ban on burning solid waste will be less costly if the more accessible dump is purchased before the ban goes into effect.

Frequently in the environmental area, a policy will be fully described by the value of some policy instrument. Such an instrument could be a price, say the level of an effluent charge, or a standard, perhaps the permissible amount of a pollutant to discharge. In such cases, only adoption patterns that follow monotonic orderings (e.g., an effluent charge that never declines) make sense. Fortunately, in a number of environmental problems such orderings coincidentally follow the prescription of implementing according to the benefit/cost ratio. This is true with both effluent charges and environmental standards so long as the cost and benefit functions have the traditionally assumed properties.

Consider a standard, S, where the marginal cost curve is $MC = 10 - S$, and the marginal benefit curve is $MB = S$. The optimum level for the standard is 5. Presently there is no standard, and 10 units of pollutant are generated. The relationship between costs and benefits over the relevant range for the standard, between 0 and 5, is shown in Fig. 5. This situation is much more favorable than one offering the same total level of benefits and costs, but a linear relationship between the two. The linear situation is indicated by the dashed line BB in the diagram. The nonlinear plan has a substantially shallower slope at the beginning, and one that is steeper towards the end. This suggests that in contrast to the linear situation, the optimal implementation plan will decelerate more quickly (accelerate more slowly).

These examples are meant solely to be illustrative. The critical point is that both the ordering and the time phasing of benefits and costs can be matters of great significance, not only for promoting efficiency, but also for maximizing the probability of adoption.

5. CONCLUSIONS

The purpose of this analysis was to stimulate thinking. No theorems are proved here. The analyses of the costs are benefits associated with particular pieces of environmental legislation, and of the mechanisms that were used to transform costs and benefits, we hope will prove uncontroversial. The major points that are made here relate to the vital link between the operation of the political process and of procedures for effective policy choice. (1) Effective policy choice attends to both the net benefits a policy offers and the probability that the policy will be adopted. (2) The probability that the policy will be adopted depends on the distribution of benefits and costs it confers to organized and unorganized constituencies. (3) Simple analytic models provide a framework that not only should prove helpful prescriptively, but also helps explain some observed aspects of the policy formulation process that might otherwise appear puzzling.

The examples in this paper employ numerical values for costs and benefits. In practical circumstances these numbers will be somewhat elusive; rarely will they be subject to discovery through scientific processes. This suggests a further strategy to influence the legislative process: Estimate benefits or costs in a manner that is favorable to a particular set of views or selected individuals. This ploy is utilized regularly when the costs of various projects are estimated by the proposers. A substantial underestimate would be appropriate, for instance, if it is unlikely that the legislature will continue to fund the project, once initiated, despite cost overruns. Companies that are to be subjected to new environmental legislation are eager to foresee all possible costs, and can be expected to turn up particularly healthy estimates of magnitudes such as job losses incurred. All of these endeavors are designed to turn the next part of the process, the redistribution of benefits and costs, in directions beneficial for the estimating parties. There may also be the thought of driving down $P(B)$.

Every major piece of environmental legislation that we reviewed made some effort to spread costs, to soften their impact. Some of the schemes were remarkably inventive. Generally they fall into three categories: provision of identified benefits, purposeful uncertainty, or phased implementation of a policy. The first strategy, for example, the distribution of research funds to severely affected states under the FWPCA or the Toxic Substances Control Act, converts a small imposition on a diffused many into a large benefits for an identified few, the latter not incidentally including the legislators representing particular geographic districts. The second strategy, phased implementation, has additional advantages if the discount rate for the losers greatly exceeds that of the winners. This might seem an unlikely situation. However, if environmentalists truly value highly the far future, as they often suggest they do, and if corporations are very present oriented, then phased implementation of tougher environmental standards may be a good compromise strategy for both parties.

The purposeful use of uncertainty, we asserted above, can be a useful tool for implementing policies. Not only may it prevent any party from recognizing the extent to which its welfare is threatened, but recognizing that at every juncture the system will respond to excessive or unfair burdens may provide some reassurance about ultimate levels of imposition. Companies know, for example, that even once legislation is passed, losses may well prove too big to enforce, in which case litigation can always provide an avenue of relief. Not only does this assure delay, but in cases of reasonable imposition it can lead to reversals.

When the world is seen as an arena in which legislators attempt (and should attempt) to formulate policies with an eye to the distribution of benefits and costs, and in which the system on the whole responds dramatically to limit cost impositions, some possibly confusing aspects of the policy process become clear. We may then see, for example, that regulatory delay, far from marking the failure of a policy, may be an essential ingredient of it. Indeed, if we wished to ascribe a high degree of perception of legislators, we might suggest that they see themselves operating in an interactive environment where the other participants are affected parties, regulatory agencies, the courts, etc. Few legislators can be naive about the likely speed of implementation for regulatory policies once legislation is enacted. Clearly legislation is defined, at least in part, with an understanding of the likely performance by regulatory agencies. (Of course legislators do not necessarily advertise this fact to their constituents, particularly those who may find it easier to monitor the form of a policy than its actual impacts.) Moreover, legislators are undoubtedly aware of the ability of affected parties to hold up the implementation of environmental legislation through court action. This suggests that part of the phasing problem is handled automatically. If impositions are too severe, even if successfully passed within the legislature, they may provoke attempts to stop or slow them.

The world we sketch then is much richer than the one that economists traditionally consider. The choice of an optimal policy depends rather little on tallying up costs and benefits, and choosing the one that offers the highest excess of the second over the first. Rather, it requires picking the policy that offers the highest expected value, taking account of its likelihood of adoption and implementation. Because frequently only a portion of a policy will be implemented, time phasing may also be a matter of critical import.

Analysts, it is frequently asserted, should provide the raw materials for policy decisions, but leave the value judgments to the decision makers themselves. For our analysis this might suggest that the decision maker would attach the weights for any group's benefits or expected benefits. But what about the assessment of the $P(B)$ function? In any particular instance, that process would seem to be a predominantly political matter, more accessible to a well-placed senator than his leading staffer, much less an academic. We are not suggesting that on a day-to-day basis such assessments be taken over by analysts, but neither is this an area the analyst-economist should avoid. His task should be a general one, attempting to look at broad classes of legislation and to decipher the general shapes of $P(B)$ functions, to determine what makes possible the enactment of legislation.[17]

Once analyses begin to pay attention to the distribution of costs, they will become more useful to decisionmakers. Moreover, those who traditionally stand apart from

[17]There are contributions by Olson, Downs, Riker, and others that bear on this subject. Unfortunately, these studies tend to disagree when put to the test in describing the critical shape of the function.

the political process will be less puzzled by the happenings in the world at large. Perhaps our major prescriptions will start making more sense to policy-makers. In the field of environmental quality, for example, it is startling that effluent charges, although recommended by economists for years, have hardly had a trial in the United States. A conjecture at least worth exploring is that that form of uniform tax system, particularly if it is to have bite in reducing pollution, will prevent the working of many of our tried and true methods of spreading costs. For example, firms, the primary injured parties, not only will have to clean up some pollution, but will have to pay for what they do not clean up. Moreover, there is no way to avoid the really major imposition on the particular firm that may go out of business and indeed, following efficiency dictates, that *should* go out of business because the social cost of the pollution exceeds the value it allows to be generated. However, if we have a political system that abhors big losers, such a scheme will be extraordinarily difficult to get adopted. If this form of incentive mechanism is to be adopted, economists may have to be more inventive in designing schemes. Perhaps the schemes should have positive benchmarks, a starting point from which charges are assessed. Certainly they should be proposed on a phased-implementation basis.

In the politically attuned world in which we live, positive net benefits is hardly a sufficient criterion to assure that a policy will be adopted. The appropriate design of regulatory schemes in such a setting is a question of great import. Analytic training may be particularly helpful in undertaking this task, for it may provide a distinctive competence to go beyond estimates of net benefits to society to a breakdown into benefits and costs going to particular parties. It is this distribution of benefits and costs, we have argued, that vitally affects the probability a measure will be adopted. Our brief review of ten pieces of environmental legislation suggests that numerous mechanisms are available and have been employed to spread the benefits and costs of policies in an effort to enhance their probability of adoption. The models in this paper, inspired by real-world practices, show why the spreading of costs is of vital concern to policymakers.