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A central issue for fiscal sociology is the articulation between state and society. Operationally, what is required is the embedding of bureaucratic decision making in history. This article proposes the concepts of hierarchy and ecological control as one possible bridge between organization theorists and macro sociologists. A stochastic process model of federal budgetary decision making within the executive branch is developed and tested using HUD program allocation data from the Johnson administration. The model emphasizes that budgets emerge from the interaction of three levels of organizational decision making, each of which is embedded in a distinct cultural context. Historical application focuses on the impact of the Vietnam War on domestic antipoverty and housing programs.

INTRODUCTION

In 1918, Joseph Schumpeter observed,

> The fiscal history of a people is above all an essential part of its general history. An enormous influence on the fate of nations emanates from the economic bleeding which the needs of the state necessitate, and from the use to which its results are put. . . . Fiscal measures have created and destroyed industries, industrial forms and industrial regions even where this was not their intent, and have in this manner contributed directly to the construction (and distortion) of the edifice of the modern economy and through it of the modern spirit. But even greater than the *causal* is the *symptomatic* significance of fiscal history. The spirit of a people, its cultural level, its social structure, the deeds its policy may prepare—all this and more is written in its fiscal history, stripped of all phrases. He who knows how to listen to its message here discerns the thunder of world history more clearly than anywhere else. . . .
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> The public finances [therefore] are one of the best starting points for an investigation of society, especially though not exclusively of its political life. . . . Notwithstanding all the qualifications which always have to be made in such a case, we may surely speak of a special set of facts, a special set of problems, and of a special approach—in short, of a special field: fiscal sociology, of which much may be expected. [1954, pp. 6–7]

This statement has a history which goes back to Jean Bodin ("Financial means are the nerves of the state" [1583]) and to Rudolf Goldscheid ("The budget is the skeleton of the state stripped of all misleading ideologies" [1917]). More recently, the tradition is alive in writers as diverse as James O'Connor (1973) and Daniel Bell (1976). Despite this history, however, it seems safe to conclude, along with O'Connor, that the field of fiscal sociology has been largely stillborn: "The budget remains, in [Schumpeter's] words, a 'collection of hard, naked facts' not yet 'drawn into the realm of sociology' " (1973, p. 4). Most sociologists persist in seeing federal budgetary decision making as a dry, technocratic matter unrelated to their basic concerns.

Fiscal sociology, if ever it comes into existence, should above all be concerned with the articulation between state and society. Embedding organizational decision making in history is the operational objective. Three rather large tasks are involved: (a) an institutional analysis of the structure of governmental expenditure and/or taxation policymaking, along with a historical description of its operation and development; (b) a "symptomatic" analysis of mechanisms for the representation of external group and/or class interests within the system; and (c) a "causal" analysis of the impact of expenditure and taxation policies on a wide variety of social phenomena, such as economic growth, income distribution, the regulation of intergroup and economic relations, and the changing structure of the polity itself.

This article is concerned primarily with the first, secondarily with the second, and not at all with the third of these tasks. I present and test a stochastic process model of U.S. federal budgetary decision making within the executive branch. This model draws heavily on concepts from organization theory and from hierarchy theory. But it also identifies three "ecological control" mechanisms for the routine representation of external interests within the federal budgetary bureaucratic system. Empirical testing focuses on allocational decision making within HUD (the Department of Housing and Urban Development) and within OMB (the Office of Management and Budget) during the Johnson administration. Historical application is to the impact of the Vietnam War on domestic housing and antipoverty programs.

Theoretical Background

Contending theorists have posed the fundamental issue as the relative autonomy of the state. The broadest cleavage within the budgetary literature of political science and economics is between the two metaphors of state as manager and state as reactor. The guiding image of public finance economists is that of a central authority rationally allocating relatively pliant resources in accordance with macroeconomic policy, program policy priorities, and efficiency criteria (Musgrave and Musgrave 1976). Institutionally oriented political scientists, on the other hand, led by the incre-

mentalists, emphasize the structural rigidities induced by bureaucratic politics and standard operating procedures (Lindblom 1961; Wildavsky 1964; Davis, Dempster, and Wildavsky 1966, 1974; Crecine 1969). Despite radical disagreement about the significance of cognitive limitations in the face of budgetary complexity, both schools tacitly agree that the primary focus of analysis should be on dynamics located *within* the governmental system.

Writers in the pluralist and Marxist traditions, on the other hand, have emphasized the dependence of state expenditures on external interest group or class demands. The dominant image of the pluralists, of course, is that of state as broker among competing interests (Bentley 1949), whereas the dominant Marxist image is that of state as instrument for class domination (O'Connor 1973). Despite major disagreement about the locus and structure of political power, both traditions tacitly agree that the primary focus of analysis should be on dynamics located *outside* the governmental system. Each school, however, has struggled for a way to represent more autonomous actions of state decision makers within their formulations (Frohlich, Oppenheimer, and Young 1971; Skocpol 1979).

Within the budgetary literature, debates among these schools have been structured by the fact that quantitative empirical studies to date appear to support the institutionalists' position more strongly than any other. The statistical results of Davis et al. (1966, 1974), in which R^2s in excess of .9 are obtained simply by regressing federal allocation decisions on earlier decisions (the "base"), are well known. Their interpretation emphasized the importance of incrementalist decision rules or "aids to calculation" which induce temporal stability in a structured institutional context of advocate versus guardian roles. Crecine (1969, 1975) has improved on this interpretation by insisting upon the constraining role of macroeconomic fiscal policy, as implemented through a lexicographically ordered set of cutting rules. On the state governmental level, the complementary regression finding is the relative dominance of economic and demographic determinants over political determinants of state allocation outcomes (Dye 1966; Hofferbert 1966; Dawson 1967; Sharkansky 1969). Additional comparative support is alleged by the finding of broad organizational similarities in the budgetary systems of many different nation-states (Wildavsky 1964, 1975; Lord 1973; Campbell 1977).

The dominant image which emerges from this line of research is that of a very inertial and buffered institutional system which extrapolates deterministically from t to $t + 1$ because of organizational stability and bureaucratic standard operating procedures, with perhaps some modification due to aggregate fiscal policy. This overall image does not square well with Schumpeter's vision. At the risk of considerable oversimplification, one could conclude that the answer to the issue of the articulation between state and society is that there is none. The state, in the realm of budgeting at least,

is such a buffered and inertial bureaucratic system that external political demands are reflected within it at best only at the time of legislative birth of new programs and at the extreme margins of discretionary expenditure growth.

Current Research Issues

Part of the problem with this conclusion, I have argued elsewhere (Padgett 1980), is methodological. Regression analyses too often contain an implicit "black box" conception either of the governmental system as a whole or of various stages and actors within the system. Inputs are correlated with outputs, and inferences are sought about the internal structure of decision making within the system. In the area of budgeting, however, many alternative decision processes are at least plausibly consistent with the broad patterns revealed by traditional incrementalist regressions (Padgett 1980). This fact gives rise to a discrepancy between the rigid, bureaucratic image presented in quantitative analyses and the more contextual image presented by qualitative observers who stress the intense disputes and gaming, the ambiguity, and sometimes even the confusion and volatility afflicting the budgetary system (Natchez and Bupp 1973).

Earlier research (Padgett 1980), moreover, revealed the relative superiority of the "serial judgment" model over the incrementalist model of federal budgetary decision making, once the empirical focus shifted away from the time-series regression analysis of absolute expenditure levels into the cross-sectional stochastic process analysis of distributions of allocation change. This behavioral decision model, a member of the bounded rationality tradition (Simon 1957, 1972), emphasized the importance both of ordered search through a limited number of budgetary alternatives and of stochastic "informed judgment" selection of final budget choice. Serial judgment theory presumes contextual sensitivity and temporal flexibility, and it implies the occasional occurrence, on a routine basis, of radical and "catastrophic" change.

Apart from methodological problems, however, a more difficult conceptual issue confronts anyone who is interested in implementing Schumpeter's program. The problem is simply put: on the one hand, state expenditure decisions are made largely by and implemented through formal organizations. This point, so obvious once stated, is recognized but has been insufficiently appreciated by public finance economists, by pluralists, and by Marxists alike, who treat organizations as fairly pliable instruments. On the other hand, by adopting a more historical vantage point, we can perhaps also agree to take as a truism that state expenditures are embedded in the legal, economic, and political structures of society. This point, while recognized, has been insufficiently appreciated by the institutionalists, who emphasize the fairly buffered and self-enclosed character of federal budget-

ing. The problem, of course, is how to meld the organizational and the historical perspectives. Put another way, the problem is the classic sociological one of how to integrate conceptually distinct levels of analysis.

THEORY

To address this problem, first I consider the federal budgetary system from the internal point of view—that is, from the perspective of organization and hierarchy theory (Simon 1969, 1973). In the next subsection, I reexamine the same federal budgetary system from the external point of view—that is, from the perspective of ecological control.

Hierarchy

The necessary anatomical background is as follows. Within the executive branch, there are three major institutional clusters: (a) the President, along with his "troika" of economic advisers (the Chairman of the Council of Economic Advisers, the Secretary of the Department of the Treasury, and the Director of OMB), (b) the Office of Management and Budget, and (c) numerous major domestic[2] departments (e.g., HEW, HUD, Interior, etc.). For budgetary purposes, OMB and domestic departments are internally arrayed roughly in parallel. The OMB is composed of a Director and Deputy Director (along with supporting Office of Budget Review staff), a series of Division Chiefs in charge of broad functional areas (such as the Human Resources division and the Natural Resources division), and a large number (approximately 200) of budget examiners assigned to specific programs. Domestic departments are composed of a Secretary and Under Secretary (along with supporting budget office staff), Assistant Secretaries in charge of program clusters (such as the Renewal and Housing Assistance division and the Metropolitan Development division within HUD), and numerous program chiefs administratively in charge of operational programs (such as the Urban Renewal, Elderly Housing, Model Cities, and Water and Sewer programs within HUD).

Within this organizational complex, one can distinguish at least three functional levels of budgetary decision making. At the most aggregate presidential level, decision making centers on the macroeconomic determination of total federal spending.[3] Fiscal policy and defense or war-related

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[2] The institutional budgetary system for the Department of Defense is somewhat different from that on the domestic side. In particular, OMB does not occupy as salient a position (Crecine 1975).

[3] The President himself gets involved in more detailed program allocation decisions only in two circumstances: a few "pet programs" or high saliency cases and annual end-of-year departmental appeals of OMB allowances. While Presidents do differ in their propensities to get involved in such detail (with Johnson being relatively active, and Nixon being exceedingly reluctant), the dollar amounts involved in such direct intervention are trifling in federal budget terms. Cognitive limitations in the face of the complexity of the U.S. federal budget provide one obvious reason for this state of affairs.

issues reign; the outcome is a total domestic spending target, which may change during the course of the planning year.[4] At the intermediate level of OMB and domestic department higher echelons, decision making centers on the distributional determination of relative spending priorities among programs. Political and tactical as well as substantive policy issues reign; the outcome is a set of budget policy guidelines, which structure the inevitable cuts necessary to reach total targets. At the most micro level of budget examiners and program chiefs, decision making centers on the administrative determination of "proper" allocations necessary to fund individual program "needs." Technical, legal, administrative, and efficiency issues reign; the outcome is a set of program funding requests or recommendations which program chiefs and budget examiners each make within their respective organizations.

Bureaucratic conflict exists at each level. Economic advisers differ over fiscal policy, and foreign policy advisers differ over the proper level of defense. The upper echelons of OMB and domestic departments struggle over relative priorities and over the proper interpretation of ambiguous "presidential commitments." The OMB and departmental budget staffs disagree over the proper definition and measurement of program "need." The overall image which emerges from this bureaucratic politics perspective is more that of many different institutional actors pulling simultaneously in many different directions than it is that of the budget as a rational instrument for central planning and control.

From a hierarchical point of view, however, the details of what occurs within each level across thousands of programs and issues are less revealing than the character of the interfaces between levels. Presidential decision making about fiscal policy and defense may be exceedingly complicated and convoluted. However, from the point of view of OMB, all that is produced from this within-level conflict is a single number—either of the form "your overall expenditure target is $500 billion" or of the form "cut $2 billion." The very top echelons of OMB may have some idea about where this number came from, but whether they do or do not is largely irrelevant to their task. Politics has been compressed into a single piece of information.

A similar phenomenon occurs at the very bottom of the hierarchy. Program "needs" are usually assessed and justified in terms of quantitative measures, such as "projected application rates." Applications, for example from mayors interested in initiating new Urban Renewal projects, may be the outcome of highly complicated community decision making. But from the point of view of the federal budgetary system itself, all such politics (and/or demographics and economics) have been aggregated and com-

[4] In addition to overall fiscal policy target decisions, defense/domestic "split" decisions are also made by the President, in conjunction with the National Security adviser and the Secretary of the Department of Defense, with some input from the State Department Secretary and the OMB Director (see Crecine 1975).

pressed into a single piece of information. Lower budgetary officials can adopt a bureaucratic approach precisely because they have no need to pierce beneath the veneer of these inputs.[5]

Hierarchical interfaces also have implications for the structure of alternatives perceived at each level. Starting at the micro program level, individual and discrete cutting alternatives, which lower-level budget officers perceive, are difficult to characterize in general, because they depend contextually on information inputs which are extremely diverse across programs. However, the *distribution* of alternatives that budget officials will perceive, once they start looking, will be heavily dependent on the legal and technical constraints on the program. The dollar sizes of cutting alternatives perceived will be much higher, on average, for the FNMA Special Assistance program, which allows one the option of selling off mortgage portfolio assets, than for the Public Housing program, which requires chipping away at housing units for which contracts have already been let. "Uncontrollability" does not mean that nothing can be done to inhibit expenditure growth;[6] however, such legal constraints on the discretion of the executive are no accident. What on one level appears to be a technical budgetary concept, on another represents the hidden hand of Congress at work. Legislative history and conflict are compressed into a legal structure which shapes, without predetermining, the feasible alternatives perceived by lower-level executive budgetary officials.

Moving now to interfaces within the executive complex proper, the alternatives perceived by upper echelons within departments and OMB are constrained by the decisions of lower levels. Upper echelons are capable of shaping the mix of priorities which are embedded in any department's set of program allocations, both by their promulgation of budget policy guidance to lower budget officials and by their judicious selection from among the cutting alternatives confronting them. However, cutting alternatives per se are generated by the judgment of lower budget levels about what is "feasible." Higher officials are capable of piercing beneath the detailed composition of such alternatives to only a limited degree.

At the presidential level as well, such organizational constraints are operative. Final selections of fiscal policy targets and defense/domestic splits, while based primarily on macroeconomic and foreign policy grounds, are not necessarily made in a complete budgetary vacuum. A limited number of overall federal expenditure "packages" are presented to the President by OMB, and he chooses from among this limited set. Presidential awareness

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[5] This is not to argue that budgetary officials are completely blind. Outside knowledge may shape the biases with which such officials approach the evaluation of their information. However, budgetary decision makers' ability to understand exactly what they are dealing with is certainly no greater than that of sociologists.

[6] Most obviously, legal constraints can be altered at any time "simply" by a change in legislation. However, even the executive branch itself can and does cut uncontrollables when it wishes via the device of "reestimating projections" (Crecine et al. 1981).

of the programmatic consequences of this macro choice can be only exceedingly cursory, given the complexity of the federal budget as a whole.

The structural image I have been developing is that of a hierarchically organized, nearly decomposable system (Simon 1969, 1973; Ando, Fisher, and Simon 1963; Crecine 1977). Bureaucratic politics, of the direct interpersonal variety, takes place laterally on three different levels simultaneously. Levels interface within this organizational complex through aggregate targets going down and through alternative-set menus coming up. The deceptively simple reason that these three organizational levels, encompassing such different relevant issues and such different political dynamics, have to relate at all is numerical aggregation—program budget totals add to department budget totals, which add to the overall federal budget total. The meaning of the term "hierarchy" here is much closer to Simon's conception (1973) of a "Chinese boxes" ordering of aggregation levels than it is to Weber's conception of a linear tree of authority relations.

Ecological Control

This internal organizational decision structure gives us a clue about the articulation between state and society and about the possible simultaneous truth of the statements that "the state is a relatively autonomous bureaucratic system" and that "the state is embedded in the legal, economic and political structures of society." That clue is *ecological control*, which may be defined as indirect control over the underlying premises of choice (such as information, alternative sets, targets, and the definition of issues deemed "relevant") rather than direct control over the process of selection itself (Cartwright 1965; March and Simon 1958).[7]

Each aggregation level of organizational decision making is embedded within a distinct cultural context. In the short run, these contexts define the formats of compressed cybernetic inputs. In the long run, they are the historical residues of past political struggles and structural relationships. If we now reexamine the budgetary system from the perspective of the outside looking in, we find that ecological control of the premises of organizational decision making takes three forms. At the micro program level of aggregation, the perception of feasible budgetary alternatives is affected by a program's controllability, which is rooted in the legal structure. At the intermediate departmental level of aggregation, selection from among budgetary cutting alternatives is guided by central organizational authorities' relative program priorities, which are rooted in institutional "missions" and constituency relations. At the macro presidential level of aggregation, both the total size and the distribution of cutting effort demanded from

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[7] The term "ecological" is meant to connote the "terrain" of policy choice rather than population biology.

various organizations are controlled by fiscal targets, which are rooted in macroeconomic and defense considerations.

Thus, "culture" at the micro program level is equivalent to the legal structure. In terms of short-term decision making, the legal system affects not the content of the compressed information which organizations perceive (e.g., the level of "projected application rates") but the format of such aggregated inputs (e.g., the fact that they are examining projected application rates in the first place). Speaking metaphorically, culture in this sense defines the window out of which one is looking rather than the detailed image that one sees. Selective perception or "uncertainty absorption" (March and Simon 1958) is one consequence. In the long run, of course, this form of ecological control is rooted in past political struggles within the Congress.

At the intermediate departmental level, "culture" means organizational ideologies or "missions" (Halperin 1974). In the short run, such ideologies affect the definition of what policy issues are deemed "relevant." Bureaucratic conflict between organizations is in large part a struggle over the ideological baseline of "what are the most important issues in the choice at hand?" In the long run, such organizational missions are rooted, at least in part, in constituency relations.

At the presidential level, "culture" in our era means Keynesian economics on the macroeconomic front and "balance of power" or Cold War ideology on the foreign policy front. Keynesian economics not only defines the set of cybernetic economic indicators to monitor but also provides econometric computer simulations to legitimate and to control presidential interpretation of these indicators. Some theorists have contended that an ideological emphasis on macroeconomic stabilization and growth is consistent with the class composition of dominant parties (Hibbs 1977). In this article, however, these three forms of ecological control are not assumed to work in mutually consistent directions.

The Implication of Time

To meld operationally this external ecological control perspective with the internal hierarchical perspective, one has to appreciate the implications of real time for framing conceptually distinct levels of analysis. Program budget decisions are made repeatedly in a time frame of weeks, or even days; fiscal policy targets are set annually in the best of circumstances or, more typically, a few times each year; substantive policy priorities within the executive change on the order of every few years (usually during changes in administration); legal controllability constraints change only after many years; and truly major institutional or ideological shifts occur in a time frame of decades. What in one time frame appears as an ecological premise in another appears as a discretionary choice. Within the context of any one

time frame, moreover, corresponding decisions change discontinuously, not smoothly.

Of course, the federal budgetary system is the residue of historical forces operating in many different dynamic frames. However, both correlational studies of budgetary allocations and qualitative case accounts of specific budget choices will tend to uncover only the most proximate of causes— usually the compacted information inputs which decision makers themselves perceive. The theoretical implications of this are to overstrengthen the image of the state as a highly self-enclosed bureaucratic system, governed exclusively by standard operating procedures and internal bureaucratic gaming, and to undercut the development of Schumpeter's call for a "fiscal sociology."

To make analytic progress, the researcher must self-consciously select a particular historical time frame (along with its implicit definition of the "dependent variable"), thereby consigning lower-frequency dynamics to the role of structural parameters (i.e., ecological premises of decision) and higher-frequency dynamics to the role of stochastic variation.[8] "We will, of course, want to select the [analytic] boundaries so as to make that [dynamic] separation as sharp as possible" (Simon 1973, p. 10).

MODELS AND PREDICTIONS

I now implement my hierarchy and ecological control approach by focusing on the middle level of organizational aggregation—decision making within the higher echelons of domestic departments and OMB. That is, fiscal policy decisions and total targets are taken as exogenously given, and the informational determinants of micro-level cutting alternatives will be subsumed within probability distributions. The issue, then, is the structure of OMB and departmental authorities' attempts to shape departmental budgets to reflect their own substantive or strategic priorities, primarily through the means of central cuts to lower-level requests for increases.

I hypothesize that this decision structure is sequential search. That is, once program priorities and total targets have been determined, central authorities cut the set of program budgets confronting them by focusing their attention first on one program and then on another, cutting each in turn until the aggregate target is achieved. There are two key ingredients. (1) The probabilities of focusing attention on different programs are not equal because of the "mix of priorities" embodied in budget policy guidances (reflected in θ_i below). (2) The expected dollar sizes of cuts to different

[8] The physical science terminology is intentional. "As Melvin Calvin has put it: 'This is one of the most fundamental things we have to teach freshmen: What is the difference between an atom and a molecule? An atom interacts at one energy level and molecules interact at the other, and that is how we tell the difference'" (Simon 1973, p. 9). Statistical mechanics, with its aggregation of molecular interactions through probability distributions and its reconstruction of gaseous dynamics through structural parameters such as temperature, provides the formal prototype.

programs, once attention has been focused on them, are not equal because of heterogeneous legal constraints (reflected in β_i below). Both of these elements—central attention focus and lower-level generation of feasible cutting alternatives—will be modeled as stochastic processes.

Following a brief sketch of the annual planning cycle, analysis proceeds in four parts: (a) a formal overview of the decision structure within each cutting stage; (b) mathematical specification of propositions regarding attention focus and alternative generation; (c) structurally oriented predictions about cross-sectional distributions, for individual budget stages, of both allocation change and numbers of cuts; and (d) historically oriented predictions about the time-series cumulation of program-budget means and variances across internal executive stages and about actual values of distributional parameters.

The Planning Cycle Context

Detailed institutional anatomies of the stages in the annual planning cycle for the executive budget are presented in many places elsewhere (Crecine 1977; LeLoup 1977; Padgett 1978), so only the most abbreviated of descriptions will be given here. In the preview stage (May–August), two things happen: (a) program chiefs and budget offices within domestic departments formulate a set of requested budget increases (over the previous year's "current estimate"), which are then sent to OMB, usually with only minor central departmental modification; and (b) OMB budget examiners, in consultation with their division chief superiors, formulate a set of total departmental budget "ceilings," which are transmitted back to the departments as guidance for the development of their regular fall submissions.[9] These ceiling totals are designed to be consistent with current fiscal policy. At the end of September, departments submit to OMB their formal agency requests. Two types of central cuts may be in evidence here: (a) regular, usually modest, cuts from the earlier preview submission to the current fall submission; and (b) a progressively more stringent series of "band" cuts, illustrating the manner by which departments would get their budget total below ceiling, if that should prove necessary.[10]

The OMB Director's Review stage[11] occupies October, November, and

[9] The program composition underlying these departmental ceiling totals is usually also transmitted, but on a much more informal basis between OMB examiners and departmental budget officers. Ceiling totals are sent more formally from the OMB Director to the Departmental Secretary.

[10] Departments, of course, frequently resist strenuously the actual implementation of these more severe "band" cuts. This addendum to the regular agency request was a reform of the Johnson administration and, in particular, of OMB Director Charles Schultze.

[11] The Director's Review derives its name from a quasi-judicial hearing in which examiners formally defend their allowance recommendations to the OMB Director and Deputy Director. These central authorities, however, typically make very few modifications.

early December. Examiners cut agency requests in order to derive OMB Director's Review allowances or marks. These program-by-program allowances are constrained to be consistent with the perhaps updated fiscal policy, departmental total, and budget policy guidance instructions which examiners receive from their superiors. After the Director's Review, departments are allowed to appeal some subset of their allowances, first to the OMB director and then, in a smaller number of cases, to the President himself. The proportion of the budget involved in such appeals, however, is typically very small. In addition, in late December OMB may also be confronted with the need to make fairly frantic, last-second "ratchet" cuts. These are triggered by major economic or war uncertainties at the presidential level. The cycle concludes with the submission to Congress of the "President's Budget" in mid or late January.

A sample overview of the history of one program's budgetary changes, over the course of an executive planning cycle, is presented in figure 1.

Focus for now on the two central cutting stages—the departmental fall submission and the OMB Director's Review. An excellent qualitative flavor of the decision problem in the first of these stages is contained in the following quotation from an internal HUD memorandum, entitled "HUD's Budget Priorities for 1969," written by Deputy Under Secretary W. R. Ross on August 8, 1967:

> For the 1969 budget, the general nature of the budget requests prepared by the program offices can best be characterized as the "demand" level. That is, with few exceptions, the totals suggested for each program are closer to the expected application level less an estimated "tolerable" backlog.
>
> The Problem:
>
> 1. To select, for current and anticipated conditions [e.g., Vietnam], the mix of priorities which will persuade the President that his 1969 budget for urban affairs can and must be larger than he will initially believe possible within total budget constraints as he perceives them.
>
> 2. To apply the priorities established to the budget proposals to illuminate the specific policy choices involved in successive reductions from the program manager-proposed levels. [Ross 1967]
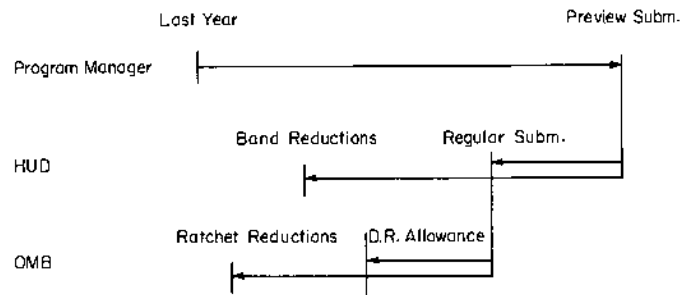

Fig. 1.—Sample structure of annual budgetary change (scale in $)

A Sequential Attention Model of Hierarchical Control

As hypothesized above, the choice structure within which both domestic department and OMB decision makers go about solving such cutting problems is sequential search. Consider the representation of the cutting process given in figure 2. The scheme can refer either to departmental cuts of program-manager requested budgets or to OMB examiner cuts in formal agency submissions. For illustrative purposes only, I shall write primarily in terms of the latter case. Notation is introduced in the order of the actual OMB cutting process. (1) Programs i refer to the constituent elements of a department, the total of which is n (e.g., for HUD, programs are such entities as Urban Renewal, Elderly Housing, Model Cities, Water and Sewer Grants, etc.). (2) The set $\{a_i\}$ is the agency budget submission received by OMB, the departmental total of which is A. (3) B is the total departmental target given to OMB examiners. (4) This departmental target defines the total size of the required OMB cut: $\Gamma = A - B$. (5) The set $\{\gamma_{ik}\}$ is the array of individual dollar cuts which examiners make in order to reach the cutting target, Γ. (6) There is a stochastic number, K, of such cuts necessary to achieve this target objective, c_i of which fall on the individual program i (hence, $K = \Sigma_{i=1}^{n} c_i$). Most important, (7) the existence of only one nonzero entry in each "cutting round" column, k, models sequential cutting, the dollar size of cut in each round being defined

Cut #

Program		1	2	3	4	5		k		K	
Program 1	a_1	$-\gamma_{11}$	0	0	0	$-\gamma_{15}$	$\cdots$	0	$\cdots$	0	b_1
Program 2	a_2	0	0	0	0	0	$\cdots$	0	$\cdots$	0	b_2
Program 3	a_3	0	0	$-\gamma_{33}$	0	0	$\cdots$	0	$\cdots$	0	b_3
Program 4	a_4	0	$-\gamma_{42}$	0	0	0	$\cdots$	0	$\cdots$	0	b_4
$\vdots$		$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$	$\vdots$
Program i	a_i	0	0	0	0	0	$\cdots$	$-\gamma_{ik}$	$\cdots$	0	b_i
$\vdots$		$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$	$\vdots$
Program n	a_n	0	0	0	$-\gamma_{n4}$	0	$\cdots$	0	$\cdots$	$-\gamma_{nk}$	b_n

$$A = \sum_{i=1}^{n} a_i \qquad \Gamma = A - B = \sum_{i=1}^{n} \sum_{k=1}^{K} \gamma_{ik} \qquad B = \sum_{i=1}^{n} b_i$$

$$K = \sum_{i=1}^{n} c_i$$

$$\Gamma_k = \sum_{i=1}^{n} \gamma_{ik}$$

$$\gamma_i = \sum_{k=1}^{K} \gamma_{ik} = a_i - b_i$$

FIG. 2.—Hypothesized structure of cutting within stages

as Γ_k (hence, $\Gamma = \Sigma_{k=1}^{K}\Gamma_k$). (8) The final program budget change produced by this OMB cutting process is $\gamma_i = \Sigma_{k=1}^{K}\gamma_{ik} = a_i - b_i$.

In the next subsection, this framework is implemented first by hypothesizing a particular structure of attention focus across programs, in terms of a set of attention probabilities $\{\theta_i\}$, and then by hypothesizing a particular structure to the process of generating cutting alternatives $\{\gamma_{ik}\}$, in terms of program-distinctive parameters $\{\beta_i\}$ which define "relative controllability."

Before proceeding directly to this task, however, I should highlight that all three levels of budgetary decision making are embedded in the figure 2 formulation. The micro program level is embodied in the generation of cutting alternatives, $\{\gamma_{ik}\}$. View the matrix solely from the perspective of a given row. Descriptively, this perspective corresponds to the development of one program's budget over time. Theoretically, this perspective corresponds to behavioral decision theory. The process is identical to the serial judgment model (Padgett 1980). Discrete "salient" alternatives are encountered sequentially and accepted until an unacceptable state ensues, which is controlled by aggregate fiscal targets. Perceptions of the size of each individual γ_{ik} alternative depend on a variety of contextual detail (such as the dollar size of Boston's Urban Renewal application, unobligated balance carryovers from the previous year, etc.), and hence γ_{ik} can be represented as a random variable (Woodroofe 1975). The parameters governing these perceptual densities are distinctive to each program i because of size and controllability considerations. Such parameters $\{\beta_i\}$ reflect legal, technical, and administrative constraints on the budgetary system.

Now view the matrix solely from the perspective of its columns. Descriptively, this perspective corresponds to the implementation of relative program priorities, at the intermediate departmental level of decision making. Theoretically, organizational control theory is relevant; here this means sequential attention focus (Cyert and March 1963; March and Olsen 1976). Budgetary attention focus is governed, ambiguously and stochastically, by the policy guidance produced by upper echelons in the organization. Political and tactical considerations, as well as substantive preferences, may underlie the short-run determination of these policy guidances, represented by the attention probability vector $\{\theta_i\}$.[12]

Finally, consider only the overall number of columns in the matrix, which describes the number of cuts necessary to achieve the total departmental target. This is where the role of presidential macroeconomic fiscal policy comes in. Targets (B) are received from on high,[13] which in conjunc-

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[12] Of course, higher cutting attention probability means lower substantive priority, and $\Sigma_{i=1}^{n}\theta_i = 1$.

[13] More specifically, as outlined above, the chain of causation runs from presidential selection of the total federal expenditure target, on macroeconomic and/or political

tion with the total agency request (A) define the aggregate cutting task (Γ). Given such a fixed "stopping point" (Γ), the number of cuts necessary (K) will be a random variable, since the micro level $\{\gamma_{ik}\}$ and intermediate level $\{\theta_i\}$ are also stochastic. The parameters of the distribution of K, however, will clearly be a function of aggregate totals $(B, A,$ and thus $\Gamma)$. The "tighter" the fiscal year, the more columns in the matrix, and conversely. Fiscal policy controls how long and hard the system is forced to work rather than the details of what it does.

Figure 2 describes the history of one particular budget stage (e.g., OMB Director's Review), but the concatenation of numerous budget stages within each planning cycle can be represented formally simply by "stacking" analogous matrices onto the ends of one another. Policy conflicts between OMB and HUD can be represented by discrepancies between their two attention probability sets $\{\theta_{Oi}\}$ and $\{\theta_{Hi}\}$.

In this model, fiscal policy affects housing policy not directly or self-consciously but indirectly as it is filtered through the concatenation of many such stages. Speaking colloquially, the relative sizes of the program-manager request total, the departmental request total (A), and the OMB allowance total (B) affect the distribution of "how often the ball is in whose court" and hence the relative degree to which different organizational actors' priorities are reflected in the final president's budget. This consequence of macro-level context for micro-level allocation is one example of ecological control in action.

Mathematical Specification

Only five propositions are required to specify the model completely. The first two of these hypotheses have received support in earlier research (Padgett 1980):

I. Cutting alternatives, γ_{ik}, are generated by a Poisson process (Feller 1968; Coleman 1964). Thus

$$p(\gamma_{ik}) = \text{Exponential}[\beta_i] = \beta_i e^{-\beta_i \gamma_{ik}} .$$

The expectation of this probability distribution is $E(\gamma_{ik}) = (1/\beta_i)$, and β_i is further hypothesized to be the same for both OMB and HUD.

Budgeteers' perception of how much a given program can be cut, once attention has been focused on it, is "unbiased" in the following sense: the probability of perceiving any fixed dollar cut as feasible is independent of how much has been cut from the program in the past.[14] Once departmental

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grounds, through the presidential determination of the aggregate defense/domestic split, through the OMB Office of Budget Review decomposition of the resulting domestic total into departmental targets (Crecine 1975).

[14] More technically, for any very small allocation interval $d\gamma_{ik}$, the probability of perceiving one feasible cutting alternative is $p(d\gamma_{ik}) = \beta_i d\gamma_{ik} + o(d\gamma_{ik})$, where $o(d\gamma_{ik})$ means "negligible probability" (Karlin and Taylor 1975).

budget offices or OMB examiners determine that a given program should or has to be cut, they rely only on the contextual programmatic details of what they observe. These highly diverse (and compressed) informational inputs can be considered, from the point of view of the budgetary system itself, essentially as random bombardments from the outside world.

Different programs, however, will differ systematically in the average size (= $1/\beta_i$) of the cuts so perceived, because each program is subject to different controllability constraints. Such controllability parameters, β_i, will be the same for both OMB and HUD decision makers because they are both confronted with the same legal structure.

II. Controllability parameters β_i are distributed heterogeneously across programs. In particular,

$$p(\beta_i) = \text{Gamma}[\alpha, \delta] = \frac{\delta^\alpha}{\Gamma(\alpha)} \beta_i^{\alpha-1} e^{-\delta\beta_i}.$$

This particular distributional form was selected because of its mathematical tractability and because it can approximate virtually any unimodal reality which exists. It is, therefore, a flexible technical device which allows for realistic legal heterogeneity and which permits more central structural analysis to go forward while postponing investigation into the determinants of the β_i's.

III. Attention focus is structured as a heterogeneous, stationary process. Thus,

$$p(c_i = 1 \mid k) = \theta_i, \quad \text{for all } k.$$

(Here, the event $(c_i = 1 \mid k)$ means "attention is focused on the ith program in cutting round k.")

This is the core hypothesis about attention focusing. It asserts that there exists a fixed set $\{\theta_i\}$ of attention probabilities which is applied over and over again across all the K cuts within any one budget stage. Central budget policy guidance, for each set of $\{\gamma_i\}$ cuts, is the reason. Because of the "mix of priorities" defined by organizational upper echelons, θ_i's are presumed heterogeneous across programs. As described above, however, the relative priorities of HUD and OMB may not be the same. (Hence HUD's set $\{\theta_{Hi}\}$ may differ from OMB's set $\{\theta_{Oi}\}$.)

Heterogeneity of attention probability can be represented by a sample vector drawn from the following multivariate distribution:

IV. $p(\theta_1, \ldots, \theta_i, \ldots, \theta_n) = \text{Dirichlet}[\nu_1, \ldots, \nu_i, \ldots, \nu_n].$
    If, further, $\nu_1 = \nu_2 = \ldots = \nu_i = \ldots = \nu_n = \nu$, then all marginal distributions are:

$$p(\theta_i) = \text{Beta}[\nu, (n-1)\nu] = \frac{\Gamma(n\nu)}{\Gamma(\nu)\Gamma((n-1)\nu)} (\theta_i)^{\nu-1}(1 - \theta_i)^{(n-1)\nu-1}.$$

The details of this heterogeneity hypothesis need not detain us, for the reasons discussed under proposition II. The constant ν constraint is necessary in order to avoid the empirical proliferation of ν_i parameters.

The parameter ν has a particular substantive meaning—it represents a type of social norm. The $\nu = 1$ special case can be taken as a random base-line,[15] which can be interpreted thus: "higher-echelon decision makers in every time period reexamine their priorities from scratch, without cross-sectional preconceptions." In contrast, the $\nu > 1$ case represents a distinct normative bias toward equity. Variance of θ_i's goes down continuously with increasing ν, out to the extreme limit of $\nu = \infty$, at which complete homogeneity prevails (i.e., all θ_i's are identical and collapse to $1/n$). The opposite $\nu < 1$ case, on the other hand, represents an extremely selective approach to budgetary decision making, in which some programs are highly favored and others, as a result, are forced to absorb most of the aggregate shock.

Thus the abstract parameter ν can be said to reflect a social norm of selectivity versus equity or, alternatively, an aggressive versus a conservative approach to budgetary decision making. John Campbell (1977) has argued that such budgetary norms are rooted in broader cultural traditions. He found that the Japanese budgetary system was highly skewed in the "balance" or equity direction.

A final, empirically innocuous assumption will be useful in deriving the asymptotic limiting behavior of the system:

V. n and K are both large.

The foregoing sequential attention model of federal executive budgetary control applies (with different parameters) to any OMB cutting stage[16] and to any departmental cutting stage (see fig. 1). The stage ignored so far is the very first program-manager stage, in which (usually substantial) budgetary increases over the previous year are requested.[17] This stage, however, is structurally very simple, as indicated in the quotation above from HUD Deputy Under Secretary Ross. Both top-down fiscal constraints and cross-program considerations of relative priorities are completely absent. Program-manager preview requests are independent of one another and are based simply on what such lower managers feel they will need for the upcoming budget year.

I will, therefore, model this stage (using the notation γ_{P_i} = requested preview increase over the previous year's current estimate) very simply by a set of n independent Poisson processes. Preview-requested increases

represent a pure case of monitoring diverse, program-specific informational inputs from the outside world. There is no particular reason for expecting that preview-increase controllability parameters will be identical to HUD and OMB central-cutting controllability parameters. However, it will be seen empirically that, to a remarkably close approximation,

$$(1/\beta_i)_{\text{Preview increase}} \simeq 2(1/\beta_i)_{\text{HUD/OMB cut}}.$$

With this last preview-increase stage included, the entire federal executive planning cycle, at the intermediate level of aggregation, has been modeled in stochastic process form.

Stochastic Predictions

I now report the more structurally oriented predictions of the ecological control model—cross-sectional distributions for individual budget stages, both of dollar allocation change (theorems 1, 4a, 4b, 5a, and 5b) and of numbers of cuts (theorems 2, 3a, and 3b). All predictions are presented in abbreviated format as theorems. The mathematical derivations of theorems 1-6 from the five propositions above are confined to the Appendix.

Substantive discussion and interpretation of the theorems are postponed until the empirical and the historical sections of the article. To aid understanding in the meantime, the reader may find it helpful to recall how the three aggregation levels of budgetary decision making are reflected in notation: (1) The micro program level generation of cutting alternatives— $\{\gamma_{ik}\}$ or, cross-sectionally, $\{\Gamma_k\}$—is governed by controllability, $\{\beta_i\}$. The two higher-order parameters, α and δ, summarize legal variation in controllability, β_i, across programs. (2) Intermediate departmental level attention focus—reflected in numbers of cuts, $\{c_i\}$—is governed by budget policy guidance, $\{\theta_i\}$. Here, ν is the higher-order parameter (the equity/ selectivity social norm) which summarizes "mix of priority" variation in attention focus, θ_i, across programs. (3) Macro presidential level control is reflected in the aggregate departmental cutting target, Γ. The final set of program budgetary changes generated at each stage, $\{\gamma_i\}$, emerges from the interaction of all three levels.

Theorem 1: The probability distribution of all individual cuts *across all programs* (Γ_k), for both OMB and domestic departments, is Pareto. In particular,

$$p(\Gamma_k) = (\alpha/\delta)[1 + \Gamma_k/\delta]^{-(\alpha+1)}.$$

As long as $\alpha > 1$, the average size of all cuts is $E(\Gamma_k) \equiv \bar{\delta} = \delta/(\alpha - 1)$.

Theorem 2: The probability distribution of total number of cuts required (K) approaches a Normal as Γ becomes large, for the case of $\alpha > 2$. In particular,

$$\lim_{\Gamma \to \infty} p(K \mid \Gamma) = \text{Normal}\left[(\Gamma/\bar{\delta}), \left(\frac{\alpha}{\alpha - 2}\right)(\Gamma/\bar{\delta}) \right].$$

In the case of $1 < \alpha < 2$, the probability distribution of K approaches a Stable distribution:[18]

$$\lim_{\Gamma \to \infty} p(K \mid \Gamma) = \text{Stable}[\alpha] .$$

For all $\alpha > 1$, $E(K \mid \Gamma) = (\Gamma/\bar{\delta})$.

Theorem 3a: Given a large number of programs (n) and knowledge of relative priority (θ_i), the probability distribution of numbers of cuts (c_i) received by *any one individual program* is a Poisson. In particular,

$$\lim_{n \to \infty} p(c_i \mid \Gamma, \theta_i) = \frac{(\theta_i \Gamma/\bar{\delta})^{c_i}}{c_i!} e^{-(\theta_i \Gamma/\bar{\delta})} ,$$

where $E(c_i \mid \Gamma, \theta_i) = \text{Var}(c_i \mid \Gamma, \theta_i) = (\theta_i \Gamma/\bar{\delta})$.

Theorem 3b: Again for large n, the unconditional probability distribution of numbers of program cuts received (c_i), *across all programs*, is Negative Binomial. In particular,[19]

$$\lim_{n \to \infty} p(c_i \mid \Gamma) = \frac{\Gamma(c_i + \nu)}{c_i!\Gamma(\nu)} \phi^\nu (1 - \phi)^{c_i} .$$

The parameter ϕ is a notational simplification of the following: $\phi \equiv (n - 1)/[\Gamma/\nu\bar{\delta} + (n - 1)]$. The first moment is $E(c_i \mid \Gamma) = \nu(1 - \phi)/\phi$.

Theorem 4a: The probability distribution of *any one program's* allocational change during a cutting stage ($\gamma_i = \Sigma_{k=1}^K \gamma_{ik} = a_i - b_i$ in the example above), given knowledge of that program's controllability (β_i) and of its relative priority (θ_i), is the following intractable Compound Poisson, with singularity at the point of no change:

$$p(\gamma_i \mid \Gamma, \beta_i, \theta_i) = \begin{cases} e^{-(\theta_i \Gamma/\bar{\delta})} & , \quad \gamma_i = 0 \\ \sum_{c_i=1}^{\infty} \frac{\beta_i^{c_i}}{\Gamma(c_i)} \gamma_i^{c_i-1} e^{-\beta_i \gamma_i} \frac{(\theta_i \Gamma/\bar{\delta})^{c_i}}{c_i!} e^{-(\theta_i \Gamma/\bar{\delta})} & , \quad \gamma_i > 0 . \end{cases}$$

The moments of this distribution, however, are simple:

$$E(\gamma_i \mid \Gamma, \beta_i, \theta_i) = (\theta_i/\beta_i)(\Gamma/\bar{\delta}) ;$$

$$\text{Var}(\gamma_i \mid \Gamma, \beta_i, \theta_i) = (2\theta_i/\beta_i^2)(\Gamma/\bar{\delta}) .$$

Theorem 4b: The probability distribution of allocational change during a cutting stage, *across all programs*, is exactly a Pareto distribution with singularity at the origin, for the baseline case of $\nu = 1$:

$$p(\gamma_i \mid \Gamma) = \begin{cases} \phi & , \quad \gamma_i = 0 \\ (1 - \phi)(\alpha/\delta)\phi[1 + (\phi/\delta)\gamma_i]^{-(\alpha+1)} & , \quad \gamma_i > 0 . \end{cases}$$

[18] The Stable distribution has no closed-form representation, except in a few special cases, so that it cannot be written out here. In the case of $\alpha = 2$, the Stable is the Normal; in the case of $\alpha = 1$, the Stable is the Cauchy (see Feller 1971).

[19] Unfortunately, notation here is potentially confusing: $\Gamma(\nu)$ means the gamma function, which is a continuous form of the factorial (Taylor and Mann 1972), whereas Γ is our aggregate fiscal target variable.

The expectation of this distribution is $[\Gamma/(n-1)]$, and the variance is infinite whenever $\alpha < 2$.

For more general ν, a closed-form solution does not exist. However, an excellent Pareto approximation, which preserves the correct expectation and singularity, is as follows:

$$p(\gamma_i | \Gamma) = \begin{cases} \phi^\nu & , \quad \gamma_i = 0 \\ (1 - \phi^\nu)(\alpha/\delta)\Lambda(\phi/\nu)[1 + \Lambda(\phi/\nu\delta)\gamma_i]^{-(\alpha+1)} , & \gamma_i > 0 . \end{cases}$$

The parameter Λ is a notational simplification of the following: $\Lambda \equiv (1 - \phi^\nu)/(1 - \phi)$.

Theorem 5a: In the far simpler preview case of program-manager requested increases over the previous year (γ_{Pi}), the probability distribution for *any one program* is the following Exponential:[20]

$$p(\gamma_{Pi} | \beta_i) = (\beta_i/2)e^{-(\beta_i/2)\gamma_{Pi}} .$$

Theorem 5b: The *cross-sectional* preview-increase result is a Pareto:

$$p(\gamma_{Pi}) = (\alpha/2\delta)[1 + \gamma_{Pi}/2\delta]^{-(\alpha+1)} .$$

Moment and Parameter Predictions

The foregoing predictions about cross-sectional distributions of allocation change and of number of cuts will be most useful in assessing the structural validity of the model. It remains to be shown, however, how the various budget stages fit together over time. There are two sides: (*a*) On the micro program level, means and variances of individual program budget changes over the entire annual planning cycle are presented (theorem 6). (*b*) On the intermediate departmental level, the actual parameter values implied in the allocation change distributions are highlighted (theorem 7). Theorem 6, in other words, embeds annual program budgets in the higher departmental and presidential levels of decision making. Theorem 7 embeds departmental budgets in the higher presidential level of decision making.

Theorem 6: The entire executive planning cycle, including preview increases, departmental cuts, and OMB cuts (see fig. 1), can be summarized for individual programs i in terms of moments. The following notation is required: $\gamma_{Fi} \equiv$ final President's Budget change for program i relative to the previous year; $\theta_{Hi} \equiv$ departmental (e.g., HUD) priority for program i; $\theta_{Oi} \equiv$ OMB's priority for program i; $\Gamma_H \equiv$ departmental aggregate cut of preview increases; and $\Gamma_O \equiv$ OMB aggregate cut of departmental requests.

The moment results, presented in terms of aggregate changes,[21] are as

[20] Here I anticipate the empirical result cited above.

[21] The same results, presented in terms of OMB totals (B), departmental totals (A), and previous year totals (CE), are as follows:

$$E(\gamma_{Pi}) = [2(1 - n\theta_{Hi}) + \theta_{Hi}(A - CE)/\delta - \theta_{Oi}(A - B)/\delta](1/\beta_i)$$

$$\mathrm{Var}(\gamma_{Pi}) = 2[2(1 + n\theta_{Hi}) - \theta_{Hi}(A - CE)/\delta + \theta_{Oi}(A - B)/\delta](1/\beta_i)^2 .$$

follows:

$$E(\gamma_{Fi}) = [2 - \theta_{Hi}(\Gamma_H/\tilde{\delta}) - \theta_{Oi}(\Gamma_O/\tilde{\delta})](1/\beta_i) \, ,$$

$$\mathrm{Var}(\gamma_{Fi}) = 2[2 + \theta_{Hi}(\Gamma_H/\tilde{\delta}) + \theta_{Oi}(\Gamma_O/\tilde{\delta})](1/\beta_i)^2 \, .$$

Theorem 7: The Pareto distribution implied by theorem 4b is most simply expressed in its empirically estimable form:

$$p(\gamma_i|\Gamma) = \begin{cases} S & , \quad \gamma_i = 0 \\ (1 - S)\alpha D[1 + D\gamma_i]^{-(\alpha+1)}, & \gamma_i > 0 \, . \end{cases}$$

However, the following parameter predictions are also embedded in the ecological control model:

a) $\quad S = \phi^v = \left[\dfrac{(n - 1)}{\Gamma/v\tilde{\delta} + (n - 1)} \right]^v$;

b) $\quad D = \Lambda(\phi/v\delta) = \left\{ 1 - \left[\dfrac{(n - 1)}{(\Gamma/v\tilde{\delta}) + (n - 1)} \right]^v \right\} \left[\dfrac{(n - 1)\delta}{\Gamma\delta} \right]$;

and

c) the α's estimated from data on distributions of allocation choice by budget stage, $\{\gamma_i\}$, are constant across stages and equal to the α estimated from micro-level data on the distribution of individual cuts, $\{\gamma_{ik}\}$.

The reader interested solely in the historical and policy implications of these results is encouraged to skip directly to the last section of this article. Empirical analysis is next.

TESTING AND INSTITUTIONAL INTERPRETATION

After a brief description of the data, empirical testing of the ecological control model proceeds in four parts. First, predictions about the overall cross-sectional pattern of dollar allocation change by stage (theorems 4b and 5b) are assessed.[22] The subsequent two parts focus on underlying structural components of the model: probability predictions about the micro-level generation of cutting alternatives (theorem 1) and about the intermediate level of attention focus (theorem 3b). Finally, historical data on fiscal targets are used to generate point predictions about the parameters governing the distributions of allocation change (theorem 7).

Data Description

The model is tested using data on the allocation decisions for HUD programs, made within OMB and HUD during the Johnson administration

[22] A methodological justification for the empirical analysis of allocation change, rather than of absolute budget level, is presented in Padgett (1980).

(i.e., fiscal years 1967–70, the executive planning for which occurred in calendar years 1965–68). Since this information is not available in the public record, data were coded from internal governmental planning documents, contained in the Crecine OMB archive[23] and in the Padgett HUD archive,[24] and compiled under the legal auspices of the Freedom of Information Act.

The full list of budget stages analyzed in this article is presented in table 1. Each item on the list corresponds to a vector of from 22 to 47 HUD program allocations. Allocations were measured in terms of new obligational authority (NOA), which is the executive-branch equivalent of congressional appropriations. Cross-sectional predictions about fiscal allocation change (theorems 4b and 5b) are assessed in terms of the "change from base" format illustrated in figure 1. More disaggregate theorems 1 and 3b predictions rely on the entire set of table 1 allocation vectors. The level of disaggregation in the full data set, from which the table 1 items were drawn, is unusual in that virtually a week-by-week reconstruction of the evolution of internal executive-branch decision making regarding HUD over a 14-year period (FY 1957–70) is feasible.[25]

One preliminary note about the definition of "programs": All theorems are evaluated using data in their pristine, disaggregate format—that is, "programs" are operationally equivalent to all line items in which the "base" is nonzero, exactly as they appear in formal planning documents. Even within one year, the number of HUD programs facing OMB may be smaller than the number of HUD programs facing HUD, since HUD may have already eliminated some line items. Across years, the number of HUD programs, so defined, fluctuates considerably owing to birth and death both of proposals and of actually operative programs. For purposes of $\{\beta_i\}$ and $\{\theta_i\}$ parameter estimation only, therefore, a more consistently aggregated

TABLE 1

BUDGET DATA ANALYZED

Budget Stage	FY 1967	FY 1968	FY 1969	FY 1970
HUD preview..............	Preview current estimate HUD preview submission	Preview current estimate HUD preview submission	Preview current estimate Assistant Secretary "B" recommendation	Preview current estimate Proposed preview estimate
HUD regular submission ..	HUD regular submission	HUD regular submission	High BRC alternative HUD regular submission (middle BRC alternative)	Revised BRC estimate HUD regular submission
HUD band reduction......	Lower priority band Second priority band Third priority band Fourth priority band	Band I Band II Band III Band IV/V	First approximation to OMB planning figure Adjusted to planning figure (low BRC alternative)	Possible additional reductions to reach planning figure
OMB Director's Review...	OMB division recommendation OMB allowance ("A" mark) OMB "B" mark	OMB division recommendation OMB DR allowance Possible OMB reductions below allowance	OMB division recommendation OMB DR allowance Possible major reductions	OMB DR allowance
OMB ratchets............				

NOTE.—DR = Director's Review, BRC = budget review committee.

set of 25 "standard" programs was constructed to enable meaningful time-series pooling across the four years studied.[26]

One modification of the disaggregate program data proved necessary to remove "spillovers" from the preview-increase stage to the HUD regular submission stage. Occasionally, events occur within this two-month period which necessitate an upward revision in the program-manager requests. These last-minute upward revisions are folded into the very beginning of the HUD cutting process. Such revisions were treated for purposes of analysis as having occurred during the immediately preceding preview stage. Therefore, "HUD central cuts" data sets consist only of the actual budgetary reductions observed.

Cross-sectional Patterns of Allocation Change

The most basic prediction of the ecological control model is theorem 4b, which aggregates into allocation choices the interaction of all three levels of federal budgetary decision making. Theorem 4b posits that the cross-sectional distribution of HUD or of OMB cuts will be Pareto, with singularity at the point of no change. Mathematically and graphically, this probability distribution prediction can be expressed either in density or in cumulative format, as is illustrated in figure 3. In these graphs the more familiar Exponential distribution is also presented for visual calibration.

$$p(\gamma_i) = \begin{cases} S & , \; \gamma_i = 0 \\ (1-S) \cdot D[1 + D\gamma_i]^{-(a+1)} & , \; \gamma_i > 0 \end{cases}$$

$$P(\gamma_i) = 1 - (1-S)[1 + D\gamma_i]^{-a}$$
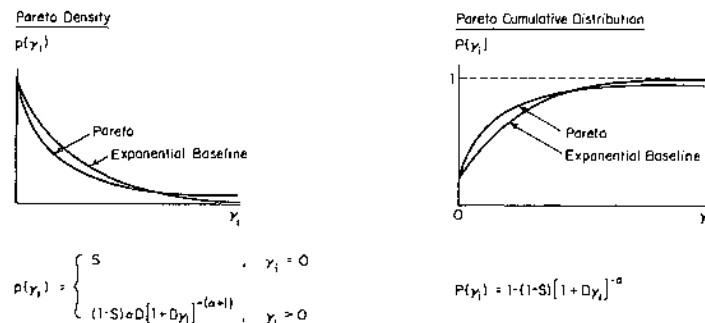
FIG. 3.—Theorem 4b hypothesis about the cross-sectional distribution of HUD or OMB cuts; S and D are defined in theorem 7.

[26] The procedures I employed in constructing these 25 aggregated programs were as follows. (a) Proposed legislation supplements to existing programs were folded into the programs themselves (e.g., the aggregated "Urban Renewal" program consists of the Urban Renewal regular budget estimate plus any proposed Urban Renewal legislation). (b) Small line items clearly derivative of larger existing programs were aggregated (e.g., Urban Fellowships was clustered with the Community Development Training program). (c) All Administrative Expense line items were grouped together. (d) All unaccounted for items of proposed legislation were aggregated into a residual Minor/Miscellaneous legislation category. An effort was made to maintain as many programs as was possible, consistent with the constraint of having nonzero data across all years. The final set of aggregated programs is presented in tables 5, 7, and 8.

The Pareto distribution has embedded within it two qualitative observations. (a) Most programs most of the time receive fairly small cuts. As noted in Padgett (1980), this prevalence of marginal change is consistent with the regression results of the incrementalists (Davis et al. 1966, 1974). (b) The equally characteristic "fat tail" of the Pareto, however, describes the less frequent, but nonetheless routine, generation of radical and even "catastrophic" change. This more volatile pattern is the structural consequence of controllability and policy priority heterogeneity, which induces differential sensitivity among programs to aggregate fiscal and foreign policy events. The graphical effects of more restrictive or tighter fiscal targets are two: the program-level Pareto distribution is spread out to the right, and the size of the "no cut" singularity is decreased.

Goodness of fit was measured with the Kolmogorov-Smirnov statistic, which is the maximum absolute deviation or error of the empirical cumulative distribution from the theoretical cumulative distribution (Bickel and Doksum 1977). Hence, the lower the statistic, the better the goodness of fit. (The alternative χ^2 statistic was not employed since this approach loses information through grouping.) The parameters α, D, and S were estimated using maximum-likelihood procedures, the algorithms of which are available upon request.

The results are reported in table 2. At least three different approaches can be taken to assess the accuracy of the fits.

a) An orthodox but not very powerful approach (Simon 1968) is to rely on significance tests. Significance levels were calculated, for the case of distributions with estimated parameters, using the Monte Carlo results reported in Bickel and Doksum (1977, p. 381).[27] The Pareto hypothesis could never be rejected, at the .05 level, for any stage either in the case of HUD cuts or in the case of OMB cuts.

b) A "critical test" approach is to compare the model explicitly against a competing null alternative. The competing incrementalist model has already been rejected (Padgett 1980). In the present analysis, therefore, the competing null alternative selected was the Exponential distribution, with singularity at the origin. This null distribution is a strenuous one, in the light of the strong graphical similarity of the Exponential and the Pareto. The two-parameter Exponential was also estimated using maximum-likelihood techniques. Table 2 reveals that the Pareto prediction is superior in all cases.

c) A final contextual method is simple visual inspection. The budgetary stage possessing the largest number of program observations is presented in figure 4. The data are graphed in cumulative step-function form, and

[27] These significance values are exact for the case of the Normal distribution, but are approximations otherwise. Unfortunately, no Kolmogorov-Smirnov Monte Carlo simulation results for the case of the Pareto could be located in the literature.

TABLE 2

TEST OF THEOREM 4b: KOLMOGOROV-SMIRNOV STATISTICS

	Pareto Prediction	Exponential Null
HUD Cuts		
1967:		
Regular (25)	.07117*	.15782*
Bands (25)	.08937*	.18261
1968:		
Regular (42)	.04071*	.09148*
Bands (42)	.06864*	.16190
1969:		
Regular (47)	.04236*	.27655
Bands (47)	.05999*	.24709
1970:		
Regular (41)	.06995*	.19710
Bands (41)	.04965*	.18631
OMB Cuts		
1967:		
Director's Review (22)	.06459*	.17742*
Ratchet (22)	.08244*	.32316
1968:		
Director's Review (41)	.08738*	.20483
Ratchet (41)	.08259*	.26521
1969:		
Director's Review (38)	.07173*	.16731
Ratchet (38)	.06791*	.19500
1970:		
Director's Review (38)	.05369*	.29019

NOTE.—N's in parentheses.
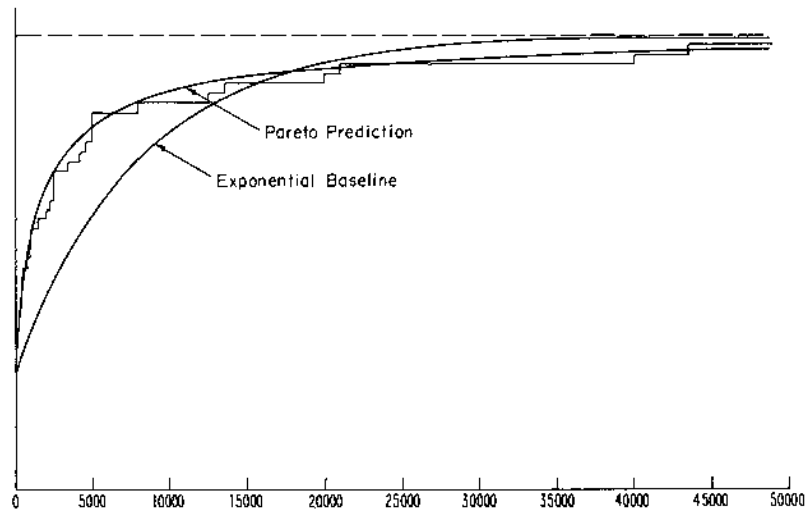* Hypothesis cannot be rejected at .05 level of significance.

FIG. 4.—Sample data set: 1969 HUD band reductions ($N = 47$; scale in units of $10,000).

continuous theoretical predictions are indicated. Visually, the accuracy is clear.

Therefore, even though density parameters vary considerably over time, (as will be shown in another section), the Pareto structural form predicted by the ecological control model is remarkably consistent across both years and organizations. Elsewhere (Padgett 1980) I present results which indicate that these HUD program findings generalize both to all domestic departments and to the Eisenhower and Kennedy administrations.[28]

The allocation change prediction for the first preview stage (program-manager requested increases over the previous year) is also a Pareto but without singularity (theorem 5b). Program managers independently develop projections of program "need," unconstrained by aggregate fiscal policy or relative priority considerations. The empirical implication is that Pareto parameters, for this stage only, should be constant across years.

Kolmogorov-Smirnov statistics and maximum-likelihood parameters for the preview stage are presented in table 3. There was a slight but persistent tendency for no increase to be requested; therefore, goodness-of-fit statistics are presented for both the singularity and the no-singularity cases. Except for this observed but unpredicted singularity,[29] the hypothesis is confirmed. Nonzero preview increases are distributed as Pareto, and preview parameters appear to be roughly constant, within sample fluctuation, across the four years studied.

The ecological control model is, therefore, confirmed at the level of allocation choice. I now look beneath these decision outcome results at underlying structural components of the model.

Cross-sectional Patterns of Cutting Alternatives

Cutting alternatives perceived by central organizational authorities are generated by lower budgetary personnel (examiners in OMB and budget officers in HUD). The decision structure operative at this lower level is hypothesized to be serial judgment (Padgett 1980). The consequence of this hypothesis (theorem 1) is that the probability distribution of all individual cuts across all programs is Pareto, for both HUD and OMB. The HUD and OMB parameters, moreover, should be identical because the legal structure confronting both organizations is the same.

Kolmogorov-Smirnov statistics and maximum-likelihood parameters are presented in table 4. The data underlying this analysis are all the individual program cuts (γ_{it}) observed over the entire time period, disaggregated by

[28] In Padgett (1980), empirical analysis was performed on program data in percentage change format, rather than in the dollar change format employed here. Consistency of results across these formats is to be expected, since all that is involved is a rescaling of the β_i parameters.

[29] One possible explanation of this error is that program managers are behaving like unconstrained serial judgment decision makers (Padgett 1980).

TABLE 3

TEST OF THEOREM 5b: KOLMOGOROV-SMIRNOV (K-S) STATISTICS AND PARAMETER ESTIMATES

PREVIEW INCREASES	K-S Statistics				Parameter Estimates		
	Pareto without Singularity	Pareto with Singularity	Exponential Null	Fraction in Singularity	$\hat{\alpha}$	$\widehat{1/2b}$	Sample Mean (in Units of $10,000)
1967 (25)........	.12000*	.12566*	.34052	.12000	.56483	.0014603	9,857.719
1968 (42)........	.14286	.08556*	.32811	.14286	.72843	.0011948	6,417.617
1969 (47)........	.13873	.08244*	.31825	.12766	.63404	.0015435	6,980.211
1970 (41)........	.10768*	.09425*	.28583	.09756	.80216	.0007782	7,617.559

NOTE.—N's in parentheses.
* Hypothesis cannot be rejected at .05 level.

TABLE 4

TEST OF THEOREM 1: KOLMOGOROV-SMIRNOV (K-S)
STATISTICS AND PARAMETER ESTIMATES

DISAGGREGATED CUTS	K-S STATISTICS	PARAMETER ESTIMATES		
		$\hat{a}$	$\widehat{1/\beta}$	$\hat{s}$
HUD cuts: FY 1967–70 (162)	.05928*	1.13734	.0005960	4,803.207
OMB cuts: FY 1967–69 (101)	.06786*	1.15124	.0005647	4,896.344
Pooled HUD and OMB cuts (263) . .	.06189	1.14271	.0005837	4,838.977

NOTE.—N's in parentheses.
* Hypothesis cannot be rejected at .05 level.

the cutting rounds listed in table 1. (The FY 1970 OMB Director's Review data could not be used in this analysis, since my documentary sources did not decompose these final choices into a series of successive iterations.)

The alternative generation prediction of theorem 1 is confirmed. Disaggregated cutting alternatives are distributed as Pareto, and HUD parameters are identical to OMB parameters. Because of this last identity, the HUD and OMB data sets were merged in order to generate a set of final parameter estimates, which will figure in the aggregate parameter predictions to come.

These micro-level findings about cutting alternatives help to explain the cross-sectional patterns of allocation change observed in the previous subsection. Final budgetary decisions made by higher organizational authorities are distributed as Pareto because the alternatives being presented to them by lower budgetary officials are distributed as Pareto, because of the serial judgment structure of alternative generation. The ecological terrain of one organizational level's decision problem is shaped in part by the choices of the next level down.

To probe further into the structure of cutting alternatives, information about the controllability parameters (β_i) governing each program is required. Given the Exponential proposition I and given micro-level cuts disaggregated by cutting round, maximum-likelihood estimation (MLE) of such parameters is straightforward: MLE $(1/\hat{\beta}_i)$ is simply the sample average of program i's cuts over the entire four-year period (assuming that the legal structure for program i has not changed during this period).

The final set of $(1/\beta_i)$ parameters, based on the aggregated program definitions described above (n. 26) and on pooled OMB and HUD cuts, is presented in table 5. Programs in the table are rank ordered according to their relative degree of controllability: the larger the average size cut, the more controllable the program, measured in raw dollar terms. Put another way, programs are rank ordered according to the relative sensitivity of their budget estimates to aggregate macroeconomic or foreign policy events

TABLE 5

CONTROLLABILITY PARAMETERS

Programs	$(1/\hat{\beta}_i) =$ Average Size Cut (in Units of $10,000)	Observed Cuts (N)
Urban Renewal (including Urban Renewal legislation)	35,000	4
Federal National Mortgage Association	28,689	9
Model Cities Supplemental Grants	28,333	6
College Housing	25,000	6
Model Cities Urban Renewal Addon	22,500	4
Water and Sewer Grants	10,095	21
Open Space	5,363	11
Urban Transportation	4,454	13
Elderly Housing	3,960	20
Minor/Miscellaneous Legislation	3,107	7
Metropolitan Development Incentives	2,632	9
Neighborhood Facilities	2,216	16
Rehabilitation Loans	1,856	16
Participation Sales Insufficiencies	1,565	1
Urban Planning	1,507	18
Rent Supplements	1,350	8
Model Cities Planning	1,300	4
Public Works Planning	1,142	12
Public Housing Annual Contributions	1,100	5
Research	997	11
Community Development Training	683	9
Advance Acquisition	671	7
Urban Information and Technical Assistance	379	7
Administrative Expenses	359	12
Alaska Housing	200	5

(in the absence of any explicit policy intervention to the contrary). Further interpretation is provided in the historical section.

One empirical regularity is worthy of note. The controllability parameters reported in table 5, which are based on HUD and OMB central cuts, relate in a very simple way to the analogous parameters governing preview increases. When the average size of program-manager requested increases is regressed on the average size of central authority cuts for all 25 programs (with zero intercept constraint), the result is as follows:

$$(1/\hat{\beta}_i)_{\text{increase}} = 1.8215 \cdot (1/\hat{\beta}_i)_{\text{cut}} ; \quad R^2 = .9299 .$$

When the one outlier, Urban Renewal, is excluded,[30] the result is:

$$(1/\hat{\beta}_i)_{\text{increase}} = 1.9841 \cdot (1/\hat{\beta}_i)_{\text{cut}} ; \quad R^2 = .9481 .$$

I therefore simplify the model by $(1/\hat{\beta}_i)_{\text{increase}} = 2 \cdot (1/\hat{\beta}_i)_{\text{cut}}.$

[30] Historically, the fact that Urban Renewal is an outlier is not surprising. Although there was not as strong a push for preview increases as would be expected from the regression alone, most of Urban Renewal's increase during this period was obtained "backdoor" through the Model Cities Urban Renewal Addon program. Such large quantities of funds were being received indirectly that less was required in the older mainline program.

Cross-sectional Patterns of Attention Focus

At the intermediate departmental level of aggregation, the model hypothesizes that hierarchical control is structured by a process of sequential search. Cutting attention shifts successively from one program to another until fixed fiscal targets are attained. Attention focus is structured, but only stochastically, by a set of budgetary policy guidelines, which are operationalized as a heterogeneous set of attention probabilities $\{\theta_i\}$.

The relevant probabilistic prediction is theorem 3b, which posits that the distribution of observed numbers of cuts across programs will be a Negative Binomial. As indicated above, ν is the equity/selectivity social norm which governs the degree of heterogeneity in policy discrimination pursued by decision makers. When $\nu = \infty$, all θ_i variation collapses into homogeneity (i.e., all $\theta_i = 1/n$), and the Negative Binomial heterogeneous prediction is transformed into the following Poisson:

$$p(c_i \mid \Gamma) = \frac{(\Gamma/n\delta)^{c_i}}{c_i!} e^{-(\Gamma/n\delta)} .$$

Data are presented in the form of histogram arrays, one for each year by organization, of numbers of programs receiving c_i cuts. These arrays are feasible because, as predicted, most of the time most program budget estimates do not change within organizations from one cutting round vector to another. The maximum number of program cuts observable is the number of cutting round vectors listed in table 1. Since ν was presumed constant within administrations, because of institutional and personnel stability, maximum-likelihood estimation of ν parameters (one each for OMB and HUD) was based on cross-year pooled data sets. That is, for ν estimation only, HUD histogram arrays across FY 1967–70 and OMB histogram arrays across available FY 1967–69 were collapsed. The results are: HUD $\hat{\nu} = 5.9$, OMB $\hat{\nu} = \infty$. Thus, from the aggregate perspective of numbers-of-cuts data alone, OMB appears to adopt such an extreme equity stance that policy priorities are hard to perceive. In its approach to central cutting, HUD is more clearly selective.

Table 6 reports the observed histogram arrays along with Negative Binomial (HUD) and Poisson (OMB) fits. These fits are based on only the one year-by-year free parameter: $\mu \equiv E(c_i \mid \Gamma)$. The goodness-of-fit statistic employed is χ^2, which was calculated only over the truncated space of feasible observations.

On the basis of χ^2 significance tests, the theorem 3b prediction can be rejected in only one of the seven cases—OMB cuts during FY 1968. Virtually all of the OMB cuts observed in this year were clustered in one cutting round (division recommendations), which created a severely peaked distribution. This anomaly frustrated my observational capacity to perceive 1968 OMB cuts in their most pristine disaggregate form.

The puzzle about why OMB appears so much more egalitarian ($\hat{\nu} = \infty$)

TABLE 6

TEST OF THEOREM 3b: NEGATIVE BINOMIAL (HUD) AND POISSON (OMB) HISTOGRAMS OF CUTS

A. HUD: $p(c_i|F)$ IS NEGATIVE BINOMIAL[a]

Cuts (c_i)	1967 Actual	1967 Predicted	1968 Actual	1968 Predicted	1969 Actual	1969 Predicted	1970 Actual	1970 Predicted
0.........	10	9.9256	18	19.6696	13	12.8867	18	16.9738
1.........	10	8.4871	17	14.0018	13	14.9729	11	13.9042
2.........	2	4.2436	4	5.8283	11	10.1727	8	6.6600
3.........	1	1.6195	3	1.8518	7	5.2254	4	2.4350
4.........	2	.5222	0	.4971	3	2.3115	....	.7522
5.........	0	.1499	0	.1188	....	.9013	....	.2068
6.........	0	.0395		.0260	....	.3225	....	.0522
	$\hat{\mu}=1.0000$	$\chi^2=6.0649^*$	$\hat{\mu}=.8095$	$\chi^2=2.6851^*$	$\hat{\mu}=1.4468$	$\chi^2=1.0971^*$	$\hat{\mu}=.9512$	$\chi^2=1.9441^*$

B. OMB: $p(c_i|F)$ IS POISSON[b]

Cuts (c_i)	1967 Actual	1967 Predicted	1968 Actual	1968 Predicted	1969 Actual	1969 Predicted
0.........	5	5.8877	9	16.2281	16	16.8070
1.........	6	7.7610	27	15.0407	16	13.7110
2.........	10	5.1152	4	6.9701	3	5.5926
3.........	1	2.2476	1	2.1534	3	1.5208
4.........		.7407		.4989	....	.3102
5.........		.1953		.0925	....	.0506
	$\hat{\mu}=1.1318$	$\chi^2=5.5658^*$	$\hat{\mu}=.9268$	$\chi^2=14.6120$	$\hat{\mu}=.8158$	$\chi^2=3.0615^*$

a With fixed $\nu = 5.9$, and $\hat{\phi} = \nu/(\nu + \mu)$.

b With fixed $\nu = \infty$, and $\mu = (Y/n\delta)$.

* Hypothesis cannot be rejected at the .05 level.

in its cutting approach than the more selective HUD can be explained with the aid of θ_i parameter estimates. Maximum-likelihood estimation of $\{\theta_i\}$, based on proposition III and on the set of 25 "standard" programs (n. 26 above), is simple: $MLE(\hat{\theta}_i)$ equals the number of cuts received by program i, over the entire four-year (HUD) or three-year (OMB) period, divided by the total number of HUD or OMB cuts observed over these periods. The results for both HUD and OMB, rank ordered from highest to lowest priority, are presented in the first columns of tables 7 and 8, respectively.

One null explanation for these organizational priorities can be dismissed immediately: budgetary attention focus is not guided by controllability. For HUD, the correlation between $(1/\hat{\beta}_i)$ and $\hat{\theta}_{Hi}$ is $r^2 = .0540$. For OMB, the correlation between $(1/\hat{\beta}_i)$ and $\hat{\theta}_{Oi}$ is $r^2 = .1117$.

A more fruitful clue about the structure underlying these organizational priorities can be found through a qualitative examination of budgetary guidance memoranda and planning documents. The HUD documents cluster programs in terms of functional areas, which are highly correlated with breakdowns by organizational division within HUD. These program clusters are: (1) housing programs, located primarily in the Renewal and Housing Assistance division; (2) nonhousing programs in the Metropolitan Development division; (3) research, training, and administrative programs; and (4) market support programs in the Mortgage Credit division. On the other hand, OMB documents organize programs on a more technocratic basis, but with one important exception for presidential initiatives: (1) Administration Commitments, (2) Uncontrollable or Mandatory Expenditure programs, (3) Financial Asset programs, and (4) a rather broad and amorphous "Other" category. The Administration Commitments category is OMB's bureaucratic device for protecting the President's "pet programs" (e.g., Model Cities under LBJ) from more routine budgetary scrutiny.

Once HUD and OMB θ_i parameter estimates are organized into these qualitative categories, the lexicographic order apparent in tables 7 and 8 emerges. With the exception of Rehabilitation Loans and Elderly Housing,[31]

[31] These two exceptions to the dominant HUD pattern are due to the following: (1) Robert Weaver, Secretary of HUD under Kennedy and Johnson, viewed the Elderly Housing program partially as a gimmick which local communities used to circumvent the provision of low-income housing for blacks. Local governments generally prefer elderly housing to public housing, and it was Weaver's opinion that municipalities used elderly housing units to inflate their "low-income" housing statistics. (2) Deemphasis of the Rehabilitation Loan program by HUD under LBJ stemmed from a number of causes. Most obvious was the fact that this was a congressionally imposed, rather than LBJ initiated, program which aided moderate-income, owner-occupied units in borderline "tipping" neighborhoods, rather than in ghettos. In detailed program memoranda, however, the most recurrent justification for Rehabilitation Loan cuts was the low "need," as measured by application rates. Lower-level HUD program personnel speculated that this poor application rate performance could be attributed to two possible causes: (a) HUD regional offices were administratively set up to deal with municipal governments instead of individual personal loans; (b) members of the banking community sat on the boards of local housing authorities (an alternative administrative outlet) since flotation of bonds is crucial to Public Housing construction. Rehabilitation Loans were a direct competitor to the ongoing operations of Savings and Loan Associations.

TABLE 7

HUD PRIORITY STRUCTURE, 1967–70

$\hat{\theta}_i$	Renewal and Housing Assistance, plus Model Cities	Research, Training, and Administration	Mortgage Credit	Metropolitan Development
.00000	Participation Sales Insufficiencies			
.01449	Urban Renewal			
.01449	Public Housing			
.01449	College Housing			
.01724	Model Cities Planning			
.02586	Alaska Housing			
.02586	(Minor/Miscellaneous Legislation)ᵃ			
.02899	Rent Supplements	Community Development Training		
.02899				
.03448	Model Cities Supplemental Grants			
.03448	Model Cities Urban Renewal Addon			
.03623			FNMA	Advance Acquisition
.03623				Metropolitan Development Incentives
.04310		Urban Information and Technical Assistance		
.04348		Administrative Expenses		
.05072		Research		Public Works Planning
.05072				Urban Transportation
.06034				Open Space
.06522				Neighborhood Facilities
.07246				Urban Planning
.07971	Rehabilitation Loans			
.08696	Elderly Housing			
.08696				Water and Sewer Grants

NOTE.—The sum of $\hat{\theta}_i$'s does not equal one exactly, since not all programs existed all four years.

ᵃ Minor/Miscellaneous Legislation is listed in parentheses because it is actually an amalgam from all divisions.

TABLE 8

OMB PRIORITY STRUCTURE, 1967–69

$\hat{\theta}_i$	Administration Commitments	Uncontrollable Programs	Financial	Other
.00000	Model Cities Urban Renewal Addon			
.01176				Urban Renewal
.01724	Model Cities Supplemental Grants			
.01724		Participation Sales Insufficiencies		
.01724		Alaska Housing		
.01724				Urban Information and Technical Assistance
.03449	Model Cities Planning			
.03529		Public Housing		
.03529		Rent Supplements		
.03529				Research
.04706			FNMA	
.04706			College Housing	
.04706				Rehabilitation Loans
.04706				Public Works Planning
.04706				Community Development Training
.05172				Open Space
.05172				Metropolitan Development Incentives
.05172				Minor/Miscellaneous Legislation
.05882				Urban Transportation
.05882				Administrative Expenses
.07059				Neighborhood Facilities
.07407				Advance Acquisition
.08235				Urban Planning
.08235				Elderly Housing
.00412				Water and Sewer Grants

NOTE.—The sum of $\hat{\theta}_i$'s does not equal one exactly, since not all programs existed all three years.

HUD, at least during the Johnson administration, clearly preferred Renewal and Housing Assistance programs to Metropolitan Development programs. In the terminology of Halperin (1974), low-income housing programs are HUD's "essence," and nonhousing and suburban programs are more peripheral to HUD's primary concerns. Research, training, and mortgage support programs are intermediate in priority. This lexicographic preference structure is arguably rooted in HUD's primary bases of constituency support—minority groups, and mayors and other politicians from large urban areas.

In the case of OMB, the buffered position of the Administration Commitments category clearly reflects OMB's constituency, which is the President himself. Programs in the Uncontrollable category can be and are cut by the simple expedient of "reestimating projections," but the data reveal that OMB resorts to this gimmick fairly rarely. The Financial Asset category includes highly controllable programs, which either are not cut at all by OMB or else are cut very severely, frequently at the tail end of the year. With the exception of Urban Renewal and two research programs,[32] the large bulk of OMB cutting effort centers on the undifferentiated "Other" category. Thus, "Other" cuts are OMB's bread and butter; and Financial Asset cuts (i.e., selling off mortgage portfolios at a discount) are non-substantive "shock absorbers," which OMB very self-consciously holds in reserve to cover unanticipated contingencies. The OMB's aggregate emphasis on equity (high v) is attributable, in large part, to the scope of its undifferentiated "Other" schema.

The images which emerge from these statistical analyses are consistent with the ideologies or "missions" of the two organizations. On the one hand, HUD considers itself an activist organization, with a fairly clear vision of the desegregated and orderly urban society it would like to see (though not so clear a vision of how to achieve this). Consequently HUD organizational leaders tend to think in substantive policy schema rather than in technocratic terms. On the other hand, OMB envisions itself as an unbiased presidential assistant, charged specifically with the task of improving efficiency and economic rationality. Unless explicit presidential initiatives are at stake, OMB submits programs more equally to its scrutiny and justifies its cuts more typically on administrative, technical, and efficiency grounds.

Short-run organizational lexicographic preference structures, I argue, are rooted in longer-term institutional roles and constituency relations.

[32] Again, Urban Renewal is an outlier because of its intimate association with the Model Cities Urban Renewal Addon effort. Also (as mentioned in n. 30), preview increases for the mainline Urban Renewal program were not as large as expected statistically. Research programs ranked surprisingly high in OMB's priorities, but this may be due to the fact that OMB hoped such applied research would lead to new methods of administration and of cutting other programs' costs.

Parameter Predictions

To operationalize the parameter predictions of theorem 7, the structural components ν, α, δ, and $\bar{\delta}$ already presented in tables 4 and 6 will be used. Thus, the only exogenous piece of historical information required is Γ, the aggregate fiscal cutting target. With only this one historical input, ultimately rooted in macroeconomic and/or defense issues, the ecological control model can predict how this aggregate change will be distributed among domestic programs. Historically observed Γ's and resulting parameter predictions are reported in table 9 for HUD and in table 10 for OMB. Only two systematic patterns of deviation are observed:

1. Observed α's for allocation choices are slightly below the disaggregate prediction of $\hat{\alpha} = 1.14271$. The actual average α, across all stages, is $\hat{\alpha} = 1.03705$. I suspect that the structural parameter is in fact $\alpha = 1$. This result implies that the model can be simplified in a parsimonious direction: (*a*) the very general proposition II (i.e., $p(\beta_i) = \text{Gamma}[\alpha, \delta]$) can be replaced by $p(\beta_i) = \text{Exponential}[\delta]$; (*b*) the general theorem 2 conclusion that $p(K|\Gamma) = \text{Stable}[\alpha]$ can be replaced by $p(K|\Gamma) = \text{Cauchy}$.

2. In the OMB table 10, both $(1 - S)$, the percentage of nonzero cases, and D, a parameter governing the expected severity of nonzero cuts, are underpredicted. These two errors are related, since they imply that OMB tends to cut more programs more gently than the ecological control model predicts. The source of the error is traceable to $\hat{\nu} = \infty$: OMB, due to its "unbiased" and technocratic institutional role, is more equitable in its cutting strategy than would be the case under the more heterogeneous policy guidance presumed by the model.

In table 11, the expectations underlying "numbers of cuts" distributions in theorem 2 and theorem 3b are predicted. No systematic errors are observed.

The foregoing empirical analysis can be summarized in the following fashion. First, it was demonstrated that all three levels of decision making in the model could be aggregated to yield correct predictions about outcomes (i.e., the distribution of program allocation choices). Then the two main structural components of the model (alternative generation and attention focus) were confirmed as being accurate in essentials. Institutional differences between OMB and HUD were highlighted. The final prediction of parameters showed that the model, in addition to accounting for structural regularities, is robust across historical variation.

HISTORICAL AND POLICY INTERPRETATION

These statistical analyses, designed to test the structural validity of the ecological control model, have a clear historical context. From the point of view of HUD, two large-scale but contradictory political developments

TABLE 9

HUD Pareto Parameter Predictions

	Fiscal Target	Actually Estimated			Theoretically Predicted*		
	Γ_M	$(1-\hat{S})$	$\hat{\alpha}$	$\hat{D}$†	$(1-\phi'')$	α	$\Delta\phi/_{M}\delta$
1967 (25):							
Regular submission	40,581	.44000	1.22447	.0006393	.28785	1.14271	.0004809
Bands	112,781	.76000	1.68068	.0003415	.59303	1.14271	.0003565
1968 (42):							
Regular submission	56,300	.19048	.77780	.0004729	.24207	1.14271	.0004979
Bands	200,750	.57143	.91034	.0003099	.60698	1.14271	.0003502
1969 (47):							
Regular submission	195,290	.61702	.62220	.0007694	.53866	1.14271	.0003717
Bands	280,230	.74468	.79743	.0004556	.68054	1.14271	.0003155
1970 (41):							
Regular submission	168,220	.53659	.99295	.0003850	.55547	1.14271	.0003731
Bands	240,920	.63415	.82640	.0003800	.67676	1.14271	.0003174

NOTE.—N's in parentheses.

* Predictions employ the following fixed parameter estimates derived from earlier analyses: (α) from micro-level alternative generation (table 4)—α = 1.14271; $\hat{\delta}$ = 4838.977, and $\hat{b}$ = 1713.156; and (b) from intermediate-level attention focus (table 6)—ν = 5.9.

† Reported maximum-likelihood estimates of D are based on fixed α = 1.14271. Since under simultaneous estimation, MLE $\hat{D}$ is not independent of MLE $\hat{\alpha}$, this procedure permits error in predicted D's to be assessed independently of error in predicted α's.

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TABLE 10

OMB PARETO PARAMETER PREDICTIONS

	FISCAL TARGET T_D	ACTUALLY ESTIMATED			THEORETICALLY PREDICTED*		
		$(1-\hat{S})$	$\hat{\alpha}$	$\hat{D}$†	$(1-\phi^*)$	α	$\Delta\phi/\nu\delta$
1967 (22):							
Director's Review............	47,778	.59091	1.25470	.0006509	.37510	1.14271	.0004657
Ratchets..............	136,823	.77273	.67423	.0004933	.73983	1.14271	.0003207
1968 (41):							
Director's Review............	83,915	.70732	1.38383	.0008660	.35179	1.14271	.0004736
Ratchets..............	168,215	.78049	.92137	.0006792	.58065	1.14271	.0003900
1969 (38):							
Director's Review............	83,080	.52632	1.49022	.0005409	.37125	1.14271	.0004670
Ratchets..............	150,780	.57895	1.11963	.0003680	.56921	1.14271	.0003945
1970 (38):							
Director's Review............	146,660	.73684	.87945	.0007489	.55919	1.14271	.0003985

NOTE.—N's in parentheses.

* Predictions employ the following fixed parameter estimates derived from earlier analyses: (α) from micro-level alternative generation (table 4)— $\alpha = 1.14271$, $\hat{\delta} = 4838.977$, and $\delta = 1713.156$; and (b) from intermediate-level attention focus (table 6)—$\nu = 100,000 \cong \infty$.

† Reported maximum-likelihood estimates of D are based on fixed $\alpha = 1.14271$. Since under simultaneous estimation, MLE $\hat{D}$ is not independent of MLE $\hat{\alpha}$, this procedure permits error in predicted D's to be assessed independently of error in predicted α's.

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TABLE 11

THEOREMS 2 AND 3b EXPECTATION PREDICTIONS

A. HUD

	ACTUAL		PREDICTED	
	K	$E(c_i)$	Γ/δ	$\nu(1-\phi)/\phi$
1967 (25).......	25	1.0000	23.31	.9771
1968 (42).......	34	.8095	37.35	.9111
1969 (47).......	68	1.4468	57.91	1.2589
1970 (41).......	39	.9512	49.79	1.2447

B. OMB

	ACTUAL		PREDICTED	
	K	$E(c_i)$	Γ/δ	$\Gamma/n\delta$
1967 (22).......	29	1.1318	28.28	1.2852
1968 (41).......	38	.9268	34.76	.8479
1969 (38).......	31	.8158	31.16	.8200

NOTE.—N's in parentheses.

characterized the 1965 through 1968 period. On the one hand, this was the era of Johnson's Great Society and of black urban riots. The direct effect was the creation of new HUD programs, such as Model Cities and Rent Supplements. The indirect effect was a high executive-branch priority on inner city housing and urban programs in general, and hence upward budgetary pressure on HUD. A contradictory historical development was the massive escalation of the Vietnam War. Defense expenditures rose precipitously, but in a volatile and uncertain manner. The net effect was downward budgetary pressure on the domestic side, as efforts were made to offset partially the rising costs of Vietnam.

The central historical question to be addressed with the aid of the ecological control model, therefore, is, What were the unintended domestic budgetary and policy consequences of the Vietnam War?

Domestic policy consequences are unintended because resource allocation in the executive branch emerges from the interaction of decision making at three levels of budgetary aggregation rather than from the domination of any one. The Weberian image of a unified central command system, in which policy is set on high and is then implemented below, is highly misleading. In the relatively short annual time frame of budgetary decision making, the state appears to be a relatively autonomous bureaucratic system with its own internal dynamic—the analysis of which is crucial for understanding the discretionary translation of social inputs into resource outputs.

In a longer historical time frame, however, the determination and interaction of parameter premises are of central concern. In the model above,

ecological control of the premises of budgetary decision making has three forms. At the micro program level of aggregation, the perception of feasible budgetary alternatives (γ_{ik}) is affected by a program's relative controllability (β_i), which is rooted in the legal structure. At the intermediate departmental level of aggregation, selection from among budgetary cutting alternatives is guided by central organizational authorities' policy priorities (θ_i), which are rooted in institutional roles and constituency relations. At the macro presidential level of aggregation, both the amount and the distribution of cutting effort demanded from the system are controlled by fiscal targets (Γ_H and Γ_O), which are grounded in macroeconomic and defense considerations.

To analyze the historical question of this section, therefore, one must "unpack" the separate implications of each ecological level and then reassemble these parts into the interactive whole. The technical tool for this task is theorem 6, which cumulates the results of all budget stages into predictions about the expectation and variance of program i's budgetary growth or decline (γ_{Fi}), as reflected in the final President's Budget, relative to the previous year. This theorem is operationalized with the $\{\beta_i\}$, $\{\theta_{Hi}\}$, $\{\theta_{Oi}\}$, Γ_H, and Γ_O parameters reported in tables 5, 7, 8, 9, and 10.

Controllability and Fiscal Targets

Consider now the interaction of controllability and fiscal targets alone. All effects from the intermediate policy level of aggregation are temporarily suppressed by $\theta_{Hi} = \theta_{Oi} = 1/n$. The expectation half of theorem 6 collapses into the simple form: $E(\gamma_{Fi}) = 2(1/\beta_i) - (\Gamma/n\bar{\delta})(1/\beta_i)$, where $\Gamma \equiv \Gamma_H + \Gamma_O$. This expression is graphed in figure 5 using the empirical $\{\beta_i\}$ parameters in table 5. The image is that of a purely mechanical budgetary system, guided by no policy priorities whatsoever. This image is useful as a baseline from which to evaluate the impact of organizational preferences.

On a general level, it is clear that controllable programs (high $1/\beta_i$) shrink more drastically than uncontrollable programs (low $1/\beta_i$) as a function of stringent fiscal constraint (high Γ). Controllability (and thus the legal structure) controls the differential sensitivity of programs to external macroeconomic or defense events. It is as one's intuition might expect: uncontrollable programs are highly buffered from influence by upper executive echelons, and conversely.

The variance result in theorem 6—in particular, the $(1/\beta_i)^2$ term—implies in addition that the volatility of growth around expected values may be quite extreme for highly controllable programs. Uncontrollable programs, on the other hand, exhibit a more glacial and apparently deterministic pattern. The incrementalist models of Davis et al. (1966, 1974), therefore, fit better the more uncontrollable the program.[33]

[33] This conclusion is supported by the empirical findings of Gist (1974).

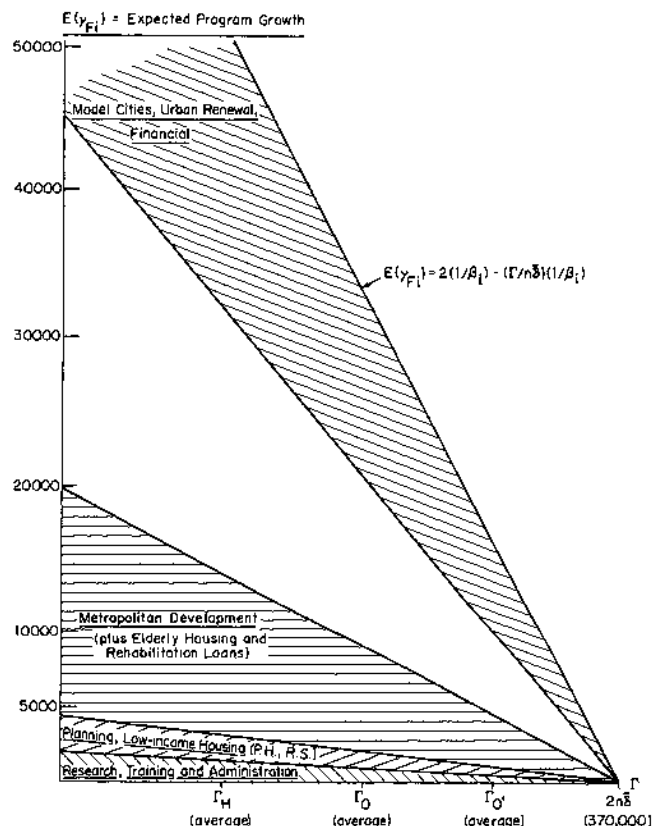FIG. 5.—Interaction of fiscal policy and controllability alone

Historically, it is clear that as the Vietnam War drives aggregate cutting targets (Γ) up, it is the Model Cities, the Urban Renewal, and the financial programs which are structurally the most vulnerable to large dollar cuts, in the absence of explicit policy intervention to the contrary. Metropolitan Development programs are the second most vulnerable; and low-income housing, planning, and various administrative support programs are least vulnerable, from the controllability point of view. The structural contradiction between Johnson's Vietnam and antipoverty efforts is immediately apparent.[34]

[34] This analysis suggests that, in the absence of explicit policy intervention to the contrary, the routine operation of the budgetary system in response to a shock such as the Vietnam War would tend to cripple the Great Society Model Cities program, which was just beginning to get off the ground. Under Johnson, this explicit policy intervention was very much forthcoming. The model, however, does shed some light on the bureaucratic aspects of Model Cities' demise under Nixon. While Nixon sought to dismantle the Great Society for reasons having little to do with budgetary decision making, the model suggests that by this explicit negative policy Nixon may have only accelerated a tendency which was

Visual calibration of the relative magnitudes of various fiscal effects is presented on the Γ-axis in figure 5. The Γ_H presented is the average aggregate HUD regular submission cut observed over this four-year period; Γ_O adds the average aggregate OMB Director's Review cut observed; and $\Gamma_{O'}$ adds the average aggregate OMB ratchet cut observed. The magnitude ($\Gamma_{O'}$ − Γ_O) is directly traceable to the war in Vietnam: as annual defense expenditures become more clear at the end of each year, Johnson demanded final, last-second rounds of domestic cutbacks (Padgett 1979a, 1979b). At least a portion of the more traditional Γ_H and (Γ_O − Γ_H) cutbacks, moreover, indirectly reflected the impact of the Vietnam War, as both HUD and OMB tried to anticipate likely but uncertain war demands.[36]

Organizational Priorities and Fiscal Targets

Consider now the interaction of organizational policy priorities and fiscal targets alone, holding constant the impact of controllability. Figure 6 illustrates this interaction, using the empirical parameters from tables 7 and 8, within the "priority space" of $\theta_{Hi} \times \theta_{Oi}$. Interpretation is as follows. (a) Programs closer to the origin are of higher priority; programs farther from the origin are of lower priority. (b) Programs closer to the 45° line are programs where OMB and HUD agree on relative priority; programs farthest from the 45° line are programs of greatest priority disagreement.

With controllability suppressed, it is impossible to speak of absolute dollar levels of budget growth or decline, but it is possible to demarcate "winners" (programs for which budget growth is expected) from "losers" (programs whose expected budgets decline) as a function of aggregate fiscal targets (Γ_H and Γ_O). Technically, this is achieved by setting $E(\gamma_{Fi}) = 0$ in theorem 6, which produces the "break-even" or demarcation line (i.e., $\theta_{Hi} = 2(\bar{\delta}/\Gamma_H) - (\Gamma_O/\Gamma_H)\theta_{Oi}$) illustrated in figure 6. As overall fiscal "tightness" ($\Gamma \equiv \Gamma_H + \Gamma_O$) is increased, holding constant distribution of cutting effort (i.e., $\Gamma_H = \Gamma_O$), the break-even line is shifted in parallel out from the origin. As distribution of aggregate cutting effort changes, holding constant fiscal tightness, the break-even line rotates in accordance with the slope (Γ_O/Γ_H).

On a general level, the substantive implications are straightforward. Not surprisingly, a tighter fiscal year makes for fewer "winners" among programs than a looser fiscal year. When we remember the quantitative sizes of expected gains and losses, however, an additional implication becomes

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already embedded in the routine operation of the budgetary system. Given the generally conservative fiscal and domestic stance of the Nixon administration, coupled with the continued pressure of the war in Vietnam, a policy of omission as well as commission toward Model Cities would probably have been sufficient over a slightly longer time to cripple the program.

[36] Through no fault of its own, however, OMB chronically underestimated Vietnam War expenditure projections through this period, necessitating numerous supplementals.
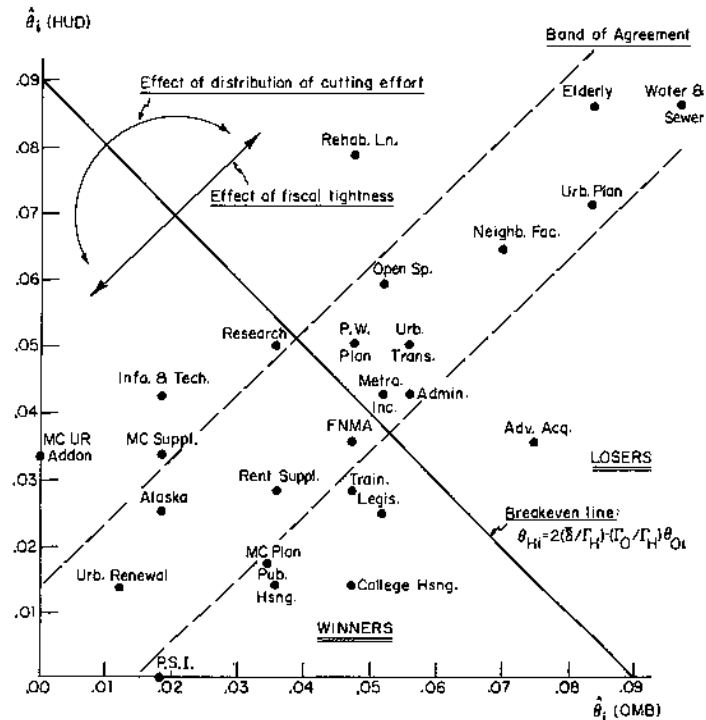
FIG. 6.—Interaction of fiscal policy and organizational priorities alone

apparent: "Winner" programs of high priority to both OMB and HUD are not greatly affected by whether the fiscal year is, in aggregate, tight or loose. Implicit "protective barriers" are thrown up around such programs by central organizational authorities. "Loser" programs of low priority to both OMB and HUD, on the other hand, are affected drastically by restrictive fiscal policy shifts. In addition to reasons of legal controllability, therefore, the interaction of presidential fiscal policy and organizational priorities causes most of the aggregate "shock" to be absorbed by such programs.

The ecological distribution of cutting effort between OMB and HUD, reflected graphically in rotations of the demarcation line, affects most radically high-conflict programs involving greatest priority disagreement. Whichever organization holds the cutting initiative "controls" the allocation outcome for such programs.

Empirically during the Johnson administration, OMB and HUD both placed a low priority on the suburban Metropolitan Development programs. Model Cities, Urban Renewal, and low-income housing enjoyed high priority. Various financial, research, and administrative support programs were intermediate in joint preference. In terms of policy conflict, OMB

placed a higher priority on Model Cities, Rehabilitation Loans, and research programs than did HUD; HUD preferred College and Public Housing, administration and training, and new legislation more than did OMB.

Therefore, the fiscal "shock" of the Vietnam War was absorbed in HUD largely by the Metropolitan Development sector. These programs were structurally vulnerable because of controllability and were also of low organizational priority. The highly controllable and intermediate preference financial programs (FNMA and College Housing) experienced wild fluctuations in budgetary allocation. Low-income housing, research, and administrative support programs, being of intermediate priority and of fairly low controllability, were on average not greatly affected by the Vietnam War. However, since OMB tended to have an edge in cutting initiative during this period, research and Model Cities programs fared better, while training, College Housing, and proposed legislation fared worse than they otherwise would have.

Of particular interest are the Model Cities and Urban Renewal programs, because they experienced contradictory pressures during this era. On the one hand, they were very vulnerable structurally. On the other hand, they were of very high priority. The net effect was that, while expansion was definitely inhibited, the executive branch under Johnson succeeded in sheltering these programs from some of the potentially more catastrophic consequences of the Vietnam War, insofar as doing so was within the executive's power.

Historically, of course, the antipoverty effort did experience serious financial difficulties, even during the Johnson era. But, on the direct choice level, the largest Model Cities cuts came from the Congress, not from the executive. On the more indirect ecological level, however, the distribution of cutting effort between the Congress and the executive as a whole shifted markedly in the direction of the Congress, once Johnson submitted his 10% tax surcharge proposal to fund the war in 1967 (Padgett 1979a, 1979b). In other words, while Johnson, OMB, and HUD in fact struggled strenuously to save the highly vulnerable Model Cities program from the impact of the Vietnam War, the executive's traditionally strong political control over the federal budget deteriorated rapidly once new taxes became an issue—with obvious negative consequences for the antipoverty effort.

Three-way Interaction: Controllability, Organizational Priorities, and Fiscal Targets

The interaction of all three ecological premises—controllability, organizational priorities, and fiscal targets—can now be reconstructed with the aid of figure 7, which illustrates theorem 6 in graphical form. Interpretation is as follows. The vertical axis measures expected allocation change, from one year to the next, for program i in the final President's Budget. This change
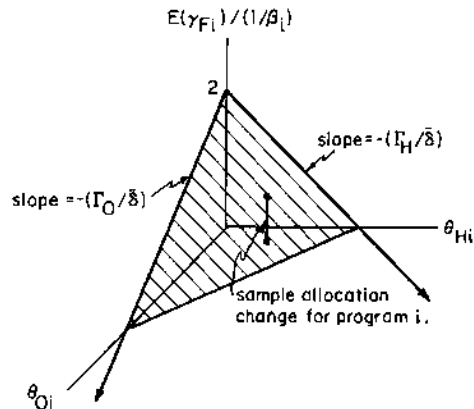
FIG. 7.—Interaction of fiscal policy, controllability, and organizational priorities

is standardized in terms of the program's controllability—$(1/\beta_i)$, which is the average size of program cut. The two horizontal axes define the same $\theta_{Hi} \times \theta_{Oi}$ "priority space" as was presented in figure 6. The tilted "fiscal plane" is controlled, as illustrated, by the aggregate fiscal targets, Γ_H and Γ_O, which are standardized here in terms of average cross-sectional cut ($\bar{\delta}$). The intersection of this "fiscal plane" with the horizontal "priority space" is the break-even line presented in figure 6.

This figure can be used, even without knowledge of underlying equations, in order to generate the expected value or mean allocation change for any HUD program i. First locate program i in the horizontal priority space of $\theta_{Hi} \times \theta_{Oi}$ (see fig. 6). Then the vertical distance between this point and the corresponding point in the fiscal plane is the predicted standardized mean allocation change for program i. Predicted dollar allocation change is generated simply by multiplying this vertical distance by $(1/\beta_i)$. The set of all n such vertical projections defines the expected budget changes for all programs within HUD.

The fiscal plane compactly summarizes final allocation changes, from one year to the next, across all HUD programs simultaneously. The impact of various macro fiscal shifts on domestic housing policy is thereby highlighted. The effect of "tightness" of fiscal year is simply to expand or to contract the fiscal plane outward or inward from the origin (holding constant the fixed point $\{E(\gamma_{Fi})/(1/\beta_i), \theta_{Hi}, \theta_{Oi}\} = \{2, 0, 0\}$). The effect of distribution of cutting effort, on the other hand, is to rotate or swing the fiscal plane around from left to right. Figure 7 presents the case of equal distribution of cutting effort.

Substantively, these macro fiscal shifts (be they due to the war in Vietnam or to some other source) ecologically control the distribution of which institutional actor's preferences are more saliently represented in the final

President's Budget. Fiscal tightness controls the *vertical* distribution of bureaucratic "power," so defined. In looser fiscal years, the fiscal plane's slopes are more gentle. That is, programs receive, in standardized terms, more egalitarian budget growth, largely independent of central policy priorities. Unstandardized program growth is driven primarily by program-manager requests (which are affected by controllability alone), and central authorities simply do not kick into action much under such circumstances.

On the *horizontal* dimension of OMB versus HUD, it is the distribution of aggregate cutting effort which is crucial. Take the extreme cases first: If HUD central authorities do not cut their program-manager requests at all, thus shifting the entire burden to OMB, then OMB's priorities will be reflected and HUD's central priorities will not. On the other hand, if HUD central authorities take the initiative and cut all that is required (either by choice or as a result of OMB preview ceiling pressure), then OMB's program priorities will be irrelevant and HUD will control the relative allocation result. The more typical in-between cases have already been discussed. The ecological distribution of cutting effort between OMB and HUD affects high-conflict programs of greatest priority disagreement the most.

Thus macro fiscal targets, derived on grounds having little to do with detailed programmatic priorities, tip the lower-level bureaucratic politics "balance of power" between organizations and among institutional levels. Once again, this is the theme of ecological control in action: outcomes from one level of aggregation shape without predetermining decision processes operating at other levels of aggregation. In an autonomous bureaucratic system, like the state, social control of expenditures operates not directly or self-consciously but indirectly through structural parameters or underlying premises of organizational decision making.

CONCLUSION

Schumpeter's challenge for a fiscal sociology, in which the central issue is the articulation between state and society, has not been accepted. Institutional political scientists, public finance economists, pluralists, and Marxists remain split into different camps with very little cross-fertilization. I propose one route of integration through the concepts of hierarchy and of ecological control. From an internal perspective, federal executive budgets emerge from the interaction of three levels of organizational and expenditure aggregation. The structure of decision making within this bureaucratic complex must be taken seriously for any understanding of the translation of political, economic, and social inputs into state expenditure outputs. From an external perspective, however, each level of organizational aggregation is embedded in a distinctive cultural context of "ecological control" premises which reflect, in highly compressed form, the historical residues of past political struggles—program controllability, whose roots lie in the

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legal structure; organizational priorities, whose roots lie in institutional roles and constituency relations; and presidential fiscal targets, whose roots lie in macroeconomic and defense issues. Such ecological control premises change on different historical time frames. This hierarchy and ecological control approach is one possible bridge between organization theorists and macro sociologists.

A stochastic process model of budgetary decision making within the federal executive branch has been developed to make the arguments more precise. Seven probabilistic theorems were derived and tested. Empirical analyses, using HUD and OMB allocation data from the Johnson administration, strongly supported the hierarchy and ecological control model. On a more applied level, the model provides a systematic framework for exploration into historical issues, such as the impact of the Vietnam War on domestic housing and antipoverty policy.

MATHEMATICAL APPENDIX

Theorem Proofs

Overall, theorems 1–6 have the schematic structure (with theorem numbers encircled) shown in the unnumbered figure below.
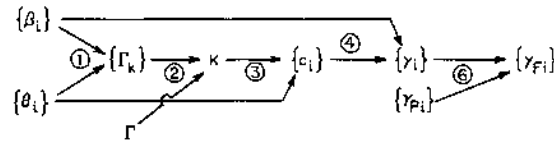
Theorem 1: $p(\Gamma_k) = (\alpha/\delta)[1 + \Gamma_k/\delta]^{-(\alpha+1)}$, where Γ_k is the column sum: $\Gamma_k \equiv \Sigma_{i=1}^n \gamma_{ik}$.

Proof: From propositions I and III and the definition of Γ_k, it follows that $p(\Gamma_k | \theta_i, \beta_i)$ is the following mixture: $p(\Gamma_k | \theta_i, \beta_i) = \Sigma_{i=1}^n \theta_i \beta_i e^{-\beta_i \Gamma_k}$. To find unconditional $p(\Gamma_k)$, we utilize the law of total probability:

$$p(\Gamma_k) = \int_0^\infty \int_0^1 p(\Gamma_k | \theta_i, \beta_i) p(\theta_i) p(\beta_i) d\theta_i d\beta_i ,$$

where $p(\theta_i)$ and $p(\beta_i)$ are given by heterogeneity propositions II and IV, respectively.

Thus, integrating out θ_i first:

$$p(\Gamma_k | \beta_i) = \int_0^1 \sum_{i=1}^n \theta_i \beta_i e^{-\beta_i \Gamma_k} \left\{ \frac{\Gamma(n\nu)}{\Gamma(\nu)\Gamma((n-1)\nu)} (\theta_i)^{\nu-1}(1-\theta_i)^{(n-1)\nu-1} \right\} d\theta_i$$

$$= \sum_{i=1}^n \beta_i e^{-\beta_i \Gamma_k} \left[\frac{\nu}{(\nu)+(n-1)\nu} \right]$$

$$= \frac{1}{n} \sum_{i=1}^n \beta_i e^{-\beta_i \Gamma_k} .$$

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And, integrating out β_i next:

$$p(\Gamma_k) = \int_0^\infty \frac{1}{n} \sum_{i=1}^n \beta_i e^{-\beta_i \Gamma_k} \left\{ \frac{\delta^\alpha}{\Gamma(\alpha)} \beta_i^{\alpha-1} e^{-\delta\beta_i} \right\} d\beta_i$$

$$= \frac{1}{n} \frac{\delta^\alpha}{(\delta + \Gamma_k)^\alpha} \sum_{i=1}^n \int_0^\infty \beta_i \frac{(\delta + \Gamma_k)^\alpha}{\Gamma(\alpha)} \beta_i^{\alpha-1} e^{-(\delta + \Gamma_k)\beta_i} d\beta_i$$

$$= (\alpha/\delta)[1 + \Gamma_k/\delta]^{-(\alpha+1)}$$

Theorem 2:

For $\alpha > 2, \lim_{\Gamma \to \infty} p(K|\Gamma) = \text{Normal}\left[(\Gamma/\delta), \left(\frac{\alpha}{\alpha - 2} \right) (\Gamma/\delta) \right]$.

For $1 < \alpha < 2, \lim_{\Gamma \to \infty} p(K|\Gamma) = \text{Stable}[\alpha]$.

Proof: At the aggregate level of analysis, the superposed sequence Γ_k forms a Renewal Process (Feller 1971), with Γ_k playing the role of a "waiting time." Thus, for the case of $\alpha > 2$, where finite mean and variance exist, the Renewal Central Limit theorem (Feller 1971, p. 372) implies that

$$\lim_{\Gamma \to \infty} p(K|\Gamma) = \text{Normal}\left[(\Gamma/\delta), \left(\frac{\alpha}{\alpha - 2} \right) (\Gamma/\delta) \right].$$

For the case of $1 < \alpha < 2$, finite variance of Γ_k does not exist, and the Renewal Central Limit theorem does not hold. However, Feller (1949) proves through generating functions, for conditions which are satisfied by the Pareto, that

$$\lim_{\Gamma \to \infty} p(K|\Gamma) = \text{Stable}[\alpha].$$

For finite expectation ($\alpha > 1$), the basic Renewal theorem itself (Feller 1971, p. 360) implies that

$$\lim_{\Gamma \to \infty} E(K|\Gamma) = (\Gamma/\delta).$$

Theorem 3a:

$$\lim_{n \to \infty} p(c_i|\Gamma, \theta_i) = \frac{(\theta_i \Gamma/\delta)^{c_i}}{c_i!} e^{-(\theta_i \Gamma/\delta)}.$$

Proof: The characteristic property of the Poisson is that $E(c_i)$ equals $\text{Var}(c_i)$. It is the only commonly recognized discrete distribution which has this property. Furthermore, for *fixed* K, micro-level cutting of each individual program is a Bernoulli Process (Feller 1968, p. 196). Therefore (see Karlin and Taylor 1975, p. 8),

$$E(c_i) = E_K[E(c_i|K)] = E_K[\theta_i K] = \theta_i E(K)$$

$$= \theta_i (\Gamma/\delta).$$

Also,

$$\text{Var}(c_i) = E_K[\text{Var}(c_i|K)] + \text{Var}_K[E(c_i|K)]$$

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$$= E_K[\theta_i(1 - \theta_i)K] + \mathrm{Var}_K[\theta_i K]$$

$$= \theta_i E(K) + \theta_i^2[\mathrm{Var}(K) - E(K)]$$

$$= \theta_i(\Gamma/\delta) + \theta_i^2[\mathrm{Var}(K) - (\Gamma/\delta)] ,$$

where if $\alpha > 2$, $\mathrm{Var}(K)$ is given above, and if $1 < \alpha < 2$, finite $\mathrm{Var}(K)$ is given in Feller (1949). For large n, $\theta_i^2 \ll \theta_i$, so that

$$\lim_{n \to \infty} \mathrm{Var}(c_i) = E(c_i) .$$

Theorem 3b:

$$\lim_{n \to \infty} p(c_i | \Gamma) = \frac{\Gamma(c_i + \nu)}{c_i! \Gamma(\nu)} \phi^\nu (1 - \phi)^{c_i} , \quad \text{where } \phi \equiv \left[\frac{(n-1)}{\Gamma/\nu\delta + (n-1)} \right] .$$

Proof: Once again, we need to rely on the law of total probability and on heterogeneity proposition IV:

$$p(c_i | \Gamma) = \int_0^1 p(c_i | \Gamma, \theta_i) p(\theta_i) d\theta_i$$

$$= \int_0^1 \left\{ \frac{(\theta_i \Gamma/\delta)^{c_i}}{c_i!} e^{-(\theta_i \Gamma/\delta)} \right\}$$

$$\left\{ \frac{\Gamma(n\nu)}{\Gamma(\nu)\Gamma((n-1)\nu)} (\theta_i)^{\nu-1}(1 - \theta_i)^{(n-1)\nu-1} \right\} d\theta_i .$$

As it stands, this expression is not tractable. However, for large n, we can rely on the following

Lemma:

$$\lim_{\substack{n \to \infty \\ \theta_i \to 0}} \mathrm{Beta}[\nu, (n-1)\nu] = \mathrm{Gamma}[\nu, (n-1)\nu] .$$

Proof: Let $n \to \infty$ and $\theta_i \to 0$, so that $\nu\theta_i(n-1) \to t_i$. Then

$$p(t_i) = \frac{\Gamma(n\nu)}{\Gamma(\nu)\Gamma((n-1)\nu)} \left[\frac{t_i}{\nu(n-1)} \right]^{\nu-1} \left[1 - \frac{t_i}{\nu(n-1)} \right]^{(n-1)\nu-1} ,$$

$$\lim_{n \to \infty} p(t_i) = \frac{1}{\Gamma(\nu)} [(n-1)\nu]^\nu [\nu(n-1)]^{-(\nu-1)} t_i^{\nu-1} e^{-t_i}$$

$$= \frac{\nu(n-1)}{\Gamma(\nu)} t_i^{\nu-1} e^{-t_i} .$$

Therefore,

$$\lim_{n \to \infty} p(\theta_i) = \frac{[\nu(n-1)]^\nu}{\Gamma(\nu)} \theta_i^{\nu-1} e^{-\nu(n-1)\theta_i} .$$

Given this lemma, the theorem above follows directly:

$$p(c_i | \Gamma) = \int_0^\infty \left\{ \frac{(\theta_i \Gamma/\delta)^{c_i}}{c_i!} e^{-(\theta_i \Gamma/\delta)} \right\} \left\{ \frac{[\nu(n-1)]^\nu}{\Gamma(\nu)} \theta_i^{\nu-1} e^{-\nu(n-1)\theta_i} \right\} d\theta_i$$

$$= \frac{(\Gamma/\delta)^{c_i}}{c_i!} \frac{[\nu(n-1)]^{\nu}}{\Gamma(\nu)} \int_0^{\infty} \theta_i^{c_i+\nu-1} e^{-[\Gamma/\delta+\nu(n-1)]\theta_i} d\theta_i$$

$$= \frac{\Gamma(c_i+\nu)}{c_i!\Gamma(\nu)} \left[\frac{\nu(n-1)}{\Gamma/\delta+\nu(n-1)}\right]^{\nu} \left[\frac{\Gamma/\delta}{\Gamma/\delta+\nu(n-1)}\right]^{c_i}$$

$$= \frac{\Gamma(c_i+\nu)}{c_i!\Gamma(\nu)} \phi^{\nu}(1-\phi)^{c_i} .$$

Theorem 4a:

$$p(\gamma_i|\Gamma,\theta_i,\beta_i) = \begin{cases} e^{-(\theta_i\Gamma/\delta)} & , \quad \gamma_i = 0 \\ \sum_{c_i=1}^{\infty} \frac{\beta_i}{\Gamma(c_i)} \gamma_i^{c_i-1} e^{-\beta_i\gamma_i} \frac{(\theta_i\Gamma/\delta)^{c_i}}{c_i!} e^{-(\theta_i\Gamma/\delta)} & , \quad \gamma_i > 0 . \end{cases}$$

Proof: Again, because of the law of total probability

$$p(\gamma_i|\Gamma,\theta_i,\beta_i) = \sum_{c_i=0}^{\infty} p(\gamma_i|\beta_i, c_i) p(c_i|\Gamma,\theta_i)$$

$$= p(\gamma_i|\beta_i, c_i = 0) p(c_i = 0|\Gamma,\theta_i)$$

$$+ \sum_{c_i=1}^{\infty} p(\gamma_i|\beta_i, c_i) p(c_i|\Gamma,\theta_i)$$

$$= \begin{Bmatrix} 1, \gamma_i = 0 \\ 0, \gamma_i > 0 \end{Bmatrix} e^{-(\theta_i\Gamma/\delta)}$$

$$+ \sum_{c_i=1}^{\infty} \begin{Bmatrix} 0 & , \quad \gamma_i = 0 \\ \frac{\beta_i^{c_i}}{\Gamma(c_i)} \gamma_i^{c_i-1} e^{-\beta_i\gamma_i}, & \gamma_i > 0 \end{Bmatrix} \cdot \frac{(\theta_i\Gamma/\delta)^{c_i}}{c_i!} e^{-(\theta_i\Gamma/\delta)}$$

$$= \begin{cases} e^{-(\theta_i\Gamma/\delta)} & , \quad \gamma_i = 0 \\ \sum_{c_i=1}^{\infty} \frac{\beta_i}{\Gamma(c_i)} \gamma_i^{c_i-1} e^{-\theta_i\beta_i} \frac{(\theta_i\Gamma/\delta)^{c_i}}{c_i!} e^{-(\theta_i\Gamma/\delta)} & , \quad \gamma_i > 0 . \end{cases}$$

This follows both from proposition I and from the fact that c_i-fold convolutions of identically distributed Exponentials(β_i) are Gamma(c_i, β_i) (see Feller 1971, p. 11).

Theorem 4b(1): For the case of $\nu = 1$,

$$p(\gamma_i|\Gamma) = \begin{cases} \phi & , \quad \gamma_i = 0 \\ (1-\phi)(\alpha/\delta)\phi[1 + (\phi/\delta)\gamma_i]^{-(\alpha+1)}, & \gamma_i > 0 . \end{cases}$$

Proof: Here, we begin with

$$p(\gamma_i|\Gamma,\beta_i) = \sum_{c_i=0}^{\infty} p(\gamma_i|\beta_i, c_i) p(c_i|\Gamma)$$

$$= p(\gamma_i | \beta_i, c_i = 0) p(c_i = 0 | \Gamma) + \sum_{c_i=1}^{\infty} p(\Gamma_i | \beta_i, c_i) p(c_i | \Gamma)$$

$$= \begin{Bmatrix} 1, & \gamma_i = 0 \\ 0, & \gamma_i > 0 \end{Bmatrix} \phi$$

$$+ \sum_{c_i=1}^{\infty} \begin{Bmatrix} 0 & , & \gamma_i = 0 \\ \dfrac{\beta_i^{c_i}}{\Gamma(c_i)} \gamma_i^{c_i-1} e^{-\beta_i \gamma_i}, & \gamma_i > 0 \end{Bmatrix} \phi(1 - \phi)^{c_i} .$$

This last expression simplifies, with the aid of the power-series expansion of an exponential. Therefore,

$$p(\gamma_i | \Gamma, \beta_i) = \begin{cases} \phi & , & \gamma_i = 0 \\ (1 - \phi)\beta_i \phi e^{-\beta_i \phi \gamma_i}, & \gamma_i > 0 . \end{cases}$$

Finally, we integrate out β_i, using proposition II, to get the unconditional distribution:

$$p(\gamma_i > 0 | \Gamma) = \int_0^{\infty} p(\gamma_i > 0 | \Gamma, \beta_i) p(\beta_i) d\beta_i$$

$$= \int_0^{\infty} (1 - \phi)\beta_i \phi e^{-\beta_i \phi \gamma_i} \left\{ \frac{\delta^{\alpha}}{\Gamma(\alpha)} \beta_i^{\alpha-1} e^{-\delta\beta_i} \right\} d\beta_i$$

$$= (1 - \phi)\phi \frac{\delta^{\alpha}}{(\delta + \phi\gamma_i)^{\alpha}} \int_0^{\infty} \beta_i \frac{(\delta + \phi\gamma_i)^{\alpha}}{\Gamma(\alpha)} \beta_i^{\alpha-1} e^{-(\delta+\phi\gamma_i)\beta_i} d\beta_i$$

$$= (1 - \phi)\phi(\alpha/\delta)[1 + (\phi/\delta)\gamma_i]^{-(\alpha+1)} .$$

Theorem 4b(2): For the more general case of $\nu \neq 1$, the following Pareto approximation has the correct expectation and singularity:

$$p(\gamma_i | \Gamma) = \begin{cases} \phi^{\nu} & , & \gamma_i = 0 \\ (1 - \phi^{\nu})(\alpha/\delta)\Lambda(\phi/\nu)[1 + \Lambda(\phi/\nu\delta)\gamma_i]^{-(\alpha+1)}, & \gamma_i > 0 , \end{cases}$$

where $\Lambda \equiv (1 - \phi^{\nu})/(1 - \phi)$.

Proof: For the general case of $\nu \neq 1$, the simplification mentioned in the proof of theorem 4b(1) does not work. However, the exact expectation can be derived by the method of Laplace transforms (Feller 1971, p. 429), even without knowledge of the probability distribution in closed form. Laplace transforms are defined as follows:

$$\psi(\lambda) = \int_0^{\infty} e^{-\lambda x} p(x) dx .$$

In our case, $p(x)$ is the following:

$$p(\gamma_i | \Gamma, \beta_i) = \begin{cases} \phi^{\nu} & , & \gamma_i = 0 \\ \displaystyle\sum_{c_i=1}^{\infty} \frac{\beta_i^{c_i}}{\Gamma(c_i)} \gamma_i^{c_i-1} e^{-\beta_i \gamma_i} \frac{\Gamma(c_i + \nu)}{c_i!\Gamma(\nu)} \phi^{\nu}(1 - \phi)^{c_i}, & \gamma_i > 0 . \end{cases}$$

Therefore,

$$\psi(\lambda) = \int_0^\infty e^{-\lambda\gamma_i}\phi^\nu d\gamma_i + \int_0^\infty e^{-\lambda\gamma_i}\left\{\sum_{c_i=1}^\infty \frac{\beta_i{}^{c_i}}{\Gamma(c_i)}\gamma_i{}^{c_i-1}e^{-\beta_i\gamma_i}\right.$$

$$\left.\times\frac{\Gamma(c_i+\nu)}{c_i!\Gamma(\nu)}\phi^\nu(1-\phi)^{c_i}\right\}d\gamma_i$$

$$= \phi^\nu\left(\frac{1}{\lambda}\right) + \sum_{c_i=1}^\infty\left[\frac{\Gamma(c_i+\nu)}{c_i!\Gamma(\nu)}\right]\phi^\nu(1-\phi)^{c_i}\left(\frac{\beta_i}{\beta_i+\lambda}\right)^{c_i}$$

$$= \phi^\nu\left(\frac{1}{\lambda}\right) + \phi^\nu\left\{\left(\frac{\beta_i+\lambda}{\beta_i\phi+\lambda}\right)^\nu - 1\right\}.$$

The binomial expansion was employed in the above.

Expectations are calculated from Laplace transforms as follows:

$$E(x) = -\frac{d}{dx}\psi(\lambda=0).$$

In our case, this yields $E(\gamma_i|\Gamma,\beta_i) = \nu(1-\phi)/\beta_i\phi$. The unconditional expectation, therefore, is

$$E(\gamma_i|\Gamma) = \int_0^\infty E(\gamma_i|\Gamma,\beta_i)p(\beta_i)d\beta_i$$

$$= \int_0^\infty \nu(1-\phi)\left(\frac{1}{\beta_i\phi}\right)\left\{\frac{\delta^\alpha}{\Gamma(\alpha)}\beta_i{}^{\alpha-1}e^{-\delta\beta_i}\right\}d\beta_i$$

$$= \nu\left(\frac{1-\phi}{\phi}\right)\bar\delta = \Gamma/(n-1).$$

Direct calculation of the expectation of the theorem's Pareto approximation also yields this answer. The functional form was chosen to be identical to the $\nu = 1$ case in theorem 4b(1), which was derived exactly.

Theorem 5: For the case of program-manager requested increases (γ_{Pi}),

and

$$p(\gamma_{Pi}|\beta_i) = (\beta_i/2)e^{-(\beta_i/2)\gamma_{Pi}},$$

$$p(\gamma_{Pi}) = (\alpha/2\delta)[1 + \gamma_{Pi}/2\delta]^{-(\alpha+1)}.$$

Proof: Proof follows along the lines of theorem 1. Here, as stated in the text, I anticipate the simplifying empirical result that $(1/\beta_i)_{increase} \doteq 2(1/\beta_i)_{cuts}$.

Theorem 6: For the final allocational change (γ_{Fi}) of the President's Budget, relative to the previous year,

$$E(\gamma_{Fi}) = [2 - \theta_{Hi}(\Gamma_H/\delta) - \theta_{Oi}(\Gamma_O/\delta)](1/\beta_i)$$

$$\text{Var}(\gamma_{Fi}) = 2[2 + \theta_{Hi}(\Gamma_H/\delta) + \theta_{Oi}(\Gamma_O/\delta)](1/\beta_i)^2.$$

Proof: Here we simply cumulate the moments which are contained in the probability distributions of theorems 4a and 5.

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