Bounded Rationality in Budgetary Research

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Two bounded rationality theories of federal budgetary decision making are operationalized and tested within a stochastic process framework. Empirical analyses of Eisenhower, Kennedy and Johnson domestic budget data, compiled from internal Office of Management and Budget planning documents, support the theory of serial judgment over the theory of incrementalism proposed by Davis, Dempster and Wildavsky. The new theory highlights both the structure of ordered search through a limited number of discrete alternatives and the importance of informal judgmental evaluations. Serial judgment theory predicts not only that most programs most of the time will receive allocations which are only marginally different from the historical base, but also that occasional radical and even "catastrophic" changes are the normal result of routine federal budgetary decision making. The methodological limitations of linear regression techniques in explanatory budgetary research are also discussed.

The lure of the bounded rationality paradigm for researchers in organizational decision making has been strong because many of the policy problems such researchers are most fascinated by are characterized by a degree of complexity which exceeds human decision makers' cognitive constriants. Whenever this degree of complexity is present, and whenever selection environments are not so restrictive as to impose unique solutions, the paradigm of bounded rationality suggests that we can improve our understanding by examining the decision heuristics or "aids to calculation" which decision makers use to make sense of their difficult problems. First advanced by Simon (1957), the bounded rationality paradigm encompasses those choice "theories which incorporate constraints on the information-processing capacities of the actor" (Simon, 1972, p. 162). More particularly, such theories emphasize limited alternative sets, systematic search routines, and the cognitive difficulty of marginal value tradeoffs in the face of "incommensurable" objectives.

One prominent application of this paradigm in the area of budgetary research has been the theory of incrementalism. This theory was first proposed verbally by Lindblom (1961, 1970), and was subsequently developed in a budgetary context by Wildavsky (1964, 1975) and by Fenno (1966). As operationalized by Davis, Dempster and Wildavsky in 1966, however, the theory of incrementalism posited that budgetary decision makers simplify very complex allocational problems by relying on a few "decision rules," which can be expressed in terms of linear regressions. Since these incrementalist "decision rule" models were first proposed, their influence on quantitative budgetary research has been remarkable. Variations on the basic Davis, Dempster and Wildavsky regressions have been used to analyze and to replicate budgetary decision processes in 56 and then in 116 federal domestic bureaus and in the Congress (Davis et al., 1966, 1971, 1974), in the U.S. Department of Defense (Stromberg, 1970), in U.S. state governments (Sharkansky, 1968), and in municipal governments in the U.S. (Larkey, 1975), in Britain (Danziger, 1974), and in Norway (Cowart, Hansen and Brofoss, 1975). In all of these applications, regression R^2's have been observed to exceed .9.

Despite the diffusion and apparent statistical success of these incrementalist models, a number of researchers have remained skeptical (Natchez and Bupp, 1973; Williamson, 1966; Ripley et al., 1973; Gist, 1974; Wanat, 1974; LeLoup, 1978b). In this same skeptical spirit, the present article has two purposes. First, the methodological foundations of quantitative incrementalist research are examined and criticized. Traditional time series linear regression of the incrementalist variety, I will argue, is a relatively nonfalsifiable approach for distinguishing among plausible decision process models. In its stead, I propose the use of distribu-

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tional tests based on cross-sectional program allocation change data. This alternative testing procedure is grounded in the modeling methodology of stochastic processes.

Secondly, in a more substantive vein, an alternative bounded rationality theory of budgetary decision making, to be labeled "the theory of serial judgment," will be developed. The perspective to be adopted here is that, despite specific problems with the incrementalist models, the paradigm of bounded rationality remains a useful approach to the analysis of budgetary decision making. Bounded rationality has spawned a rich assortment of alternative decision theories,[1] all of which are consistent with behavioral constraints on information processing, alternative sets, value integration, and the ability to predict consequences. And serial judgment is another such theory, which differs from incrementalism in part because of a more explicit and contextually dependent search process, and in part because of the more ambiguous character of its final choice selection.

Both the theory of incrementalism and the theory of serial judgment are operationalized as stochastic process models which predict the distribution of percent allocation change. These two distinct predictions are then evaluated empirically, using domestic program allocation data from the Eisenhower (F.Y. 1957), the Kennedy (F.Y. 1964), and the Johnson (F.Y. 1966) administrations. The empirical emphasis is on various stages within the executive half of the budget planning cycle.

Process versus Outcome Incrementalism

The incrementalist "Theory of the Budgetary Process," first described and applied to federal budget data by Davis, Dempster and Wildavsky in 1966, emphasized the importance of "aids to calculation" in substantively complex, yet institutionally stable problem environments. Institutional stability was said to engender stable mutual expectations, which markedly reduce the burden of calculations for the participants. Given stable expectations, budgetary decision makers treat each others' decisions as reliable information indices. On the basis of such a reliable "base," decision makers were hypothesized to rely on simple decision rules of the form: "Grant to an agency some fixed mean percentage of that agency's base, plus or minus some stochastic adjustment to take account of special circumstances" (p. 532). The cognitive emphasis on fixed mean percentage change imposed a linear structure to such decision rules. This structural framework was postulated to be temporally stable, except for a few discrete "shift points" in which parameters and/or functional forms changed due to pressure from a variety of exogenous events. Percentage parameters, in turn, reflect past learning about the strategic biases inherent in the roles of advocate and guardian.

Within this linear decision rule framework, Davis et al. (1966, p. 537) operationalized a variety of simple regression equations, each of which embodied a different approach to strategic "gaming." But in 87 percent of the bureau cases, the empirically dominant incrementalist model of executive request behavior was

$$\text{REQUEST}_t = \alpha_1 \text{ APPROPRIATION}_{t-1} + \epsilon_t.$$

And in 80 percent of the bureau cases, the empirically dominant model of congressional appropriation behavior was

$$\text{APPROPRIATION}_t = \alpha_2 \text{ REQUEST}_t + \phi_t.$$

This theory of budgetary decision making, while both influential and straightforward in and of itself, has unfortunately been plagued by confusion generated by the multiple uses of the term "incrementalism" (LeLoup, 1978a). The term "incrementalism" in its broadest form has been used to refer to concepts as disparate as marginal change, linear decision rules, fair shares, stability in advocate and guardian rules, and "the strategy of disjointed incrementalism" propounded by Lindblom (1970).

To clarify the meaning of "the theory of incrementalism" to be analyzed in this article, therefore, I will adopt a convention proposed by numerous authors (Wanat, 1974; Bailey and O'Connor, 1975; LeLoup, 1978; Crecine, personal communication). "Incrementalism" in the descriptive sense refers to a pattern of marginal change in final allocation outcome relative to some base, which frequently is the previous year's allocation outcome. Or, as Davis, Dempster, and Wildavsky themselves put it, "This year's budget is based on last year's budget, with special attention given to a narrow range of increases or decreases" (1966, pp. 529–30).

[1]Besides Simon's original pioneering work on satisficing (1957), see, for example, Cyert and March's "adaptive rationality" (1963), Steinbruner's "cybernetic and cognitive process paradigms" (1971), Newell's and Simon's hierarchical search heuristics (1972), Winter's evolutionary theory of the firm (1971), and Radner's "putting out fires" (1975).

This marginal change use can be labeled either as "outcome incrementalism" or as "marginality" and will not be the focus of this article.

Incrementalism in the explanatory sense, on the other hand, refers not just to the fact that some reasons for observed marginality are given (Wanat, 1974), but rather to a particular process of decision making which underlies the observed allocation choices. From this explanatory point of view, the crucial process hypothesis embedded in the Davis, Dempster and Wildavsky models is the linear decision rule hypothesis mentioned above. Other aspects of incrementalist theory, such as institutional stability, mutual expectations and strategic calculations, serve the important theoretical function of increasing the a priori plausibility of this formalization. However, it is the linear decision rule aspect which is tested by quantitative goodness-of-fit measures.[2] This hypothesis, therefore, may be labeled "process incrementalism," and will be the focus of this article's analysis.

Viewed in this manner, the decision process models of Davis, Dempster and Wildavsky have a clear affinity with the broader bounded rationality paradigm. Process incrementalism, in this sense, is simply one particular form of the "simple decision heuristics" or "standard operating procedures" emphasized by Newell and Simon (1972) and by Cyert and March (1963). Alternative formal operationalizations of "standard operating procedure" theory which exist in the budgetary literature include Crecine (1969) and Gerwin (1969).

Even with this context of "process incrementalism," however, Davis', Dempster's and Wildavsky's decision rule interpretation of their empirical regression results have been challenged by a number of their critics. Natchez and Bupp (1973), for example, have argued that aggregate bureau level statistics can tap only "massive administrative stability" and completely miss the purportedly more political policy choices which occur at the program level. Williamson (1966) has derived the identical incrementalist "mark up" functional forms from radically divergent optimization principles. Gist (1974) has alleged that incrementalist patterns are artifacts of uncontrollability in agency allocations. Ripley et al. (1973) have shown that appropriation-expenditure linkages underlie incrementalist regression results. LeLoup (1978b) has pointed out that budgetary decision processes appear quite differently depending upon time period measurement, level of aggregation, and dependent variable format. And, in perhaps the most damaging critique of all, Wanat (1974) has demonstrated that the empirical goodness-of-fits of Davis et al. can also be generated by a purely random decision model in which percent cuts or increases are drawn each time period from a Uniform [0, .1] distribution.

Taken individually, the significance of these disparate critiques can be challenged (Padgett, 1978). However, at least two more general themes underlie these arguments. First is the methodological point, to be developed in a later section, that the incrementalist regression findings are very susceptible to multiple process interpretations. Second is a more substantive concern with the rigidity implicit in the temporally fixed, linear decision rule formulation. Linear rules appear to relegate the impact of bureaucratic, political and technical dynamics either to annual "stochastic adjustments" to fixed percent changes or to very rare "shift point" alterations in fundamental program parameters. The dominant image of incrementalist theory is one of a very inertial and buffered bureaucratic system which extrapolates deterministically from t to t+1. For many researchers, an "as if" justification of formal models built upon this image is sufficient. For others, however, the image seems unacceptably far removed from qualitative accounts of what actually transpires within the federal budgetary process (Natchez and Bupp, 1973).[3]

One particular qualitative observation motivating the present research is based upon the Office of Management and Budget and the Department of Housing and Urban Development internal budget memoranda which were available to me.[4] The contextually rich infor-

[2]Of course, this is not to imply that other aspects of incrementalist theory cannot be investigated within the regression framework. For example, estimated regression coefficients can be interpreted in terms of "strategic calculations."

[3]The question of appropriate criteria for the evaluation of formal models is of course complex and subject to dispute. However, for one articulation of the position that plausible process correspondence is one such criterion, see Simon (1968). For the opposing viewpoint, see Friedman (1953).

[4]The Crecine archive is a rich collection of internal OMB budgetary planning documents and memoranda, focusing primarily on the OMB Office of Budget Review. This archive spans the period from the Truman through the Nixon administrations, and is described in greater detail in Crecine (1977). The Crecine archive was assembled by J. P. Crecine, G. Galloway, M. Kamlet, D. Mowery, J. F. Padgett, and C. Stolp. The Padgett archive was assembled from the

mation detail alluded to by Davis et al. does not appear to play, on an annual basis, only the subsidiary role of "stochastic adjustments to take into account special circumstances." Rather, complex information on a wide variety of substantive, administrative, political and economic dimensions appears to be the heart of decision making and of disputes over program allocations. Indeed, in the executive branch at least, one never observes literally a two-stage decision process in which first fixed percentages of base are calculated and then "special adjustments" made.[5]

Despite this apparent absence of literal incrementalist decision rules, Davis, Dempster and Wildavsky are justified in their emphasis on the cognitive limitations of budgetary decision makers faced with exceedingly complex and voluminous information. Executive budgetary decision makers do experience great difficulty when confronted with the task of making omnisciently rational tradeoffs across a wide variety of issues and programs, as is indicated by the demise of PPBS. And use of "base" figures as comparative reference points is widespread.

The Theory of Serial Judgment

The theory of serial judgment is an alternative hypothesis about the behavioral structure of program or bureau level federal domestic budgetary decision making. Like process incrementalism, the theory of serial judgment remains in the bounded rationality tradition; however, it implies greater temporal flexibility than the linear decision rule formulation. This alternative theory derives its name from two distinctive features: (1) a sequential search through an ordered set of discrete budgetary alternatives, and (2) a non-deterministic final selection based upon the slightly ambiguous application of "informed judgment."

Like the incrementalist decision maker, the serial judgment decision maker begins the choice process with a fixed reference point or base, which is historically given in the form of prior budget estimates. From this historical starting point, however, the serial judgment decision maker next makes a conscious choice about "direction of search"—namely, whether to search for alternatives representing increased budget levels or whether to search for alternatives representing decreased budget levels. Propensities to search in one direction or the other may be influenced by institutionalized role biases, by aggregate fiscal policy "climate," and by decision makers' opinions about the substantive merits of the program in question. Once serial judgment decision makers start searching, they perceive a number of salient discrete budgetary alternatives, based upon their knowledge of a wide variety of program-specific contextual detail.[6] The distribution of alternatives so perceived will of course be influenced by the program's legal and technical constraints, which are often discussed in the budgetary literature under the rubric of "controllability."

Within this salient alternative framework, the serial judgment process of choice is simple—one just starts cycling sequentially through alternatives encountered along the direction of search, either adding discrete increases or subtracting discrete decreases, until an alternative is encountered which is deemed acceptable both on the grounds of program merit and within the context of fiscal policy constraints.[7] These serial accept/reject decisions are based on the application of informal "judgment," which is the mixture of cognitive predisposition and contextual sensitivity to a variety of disparate programmatic detail. In other words, each

files of the HUD budget office, and spans the fiscal years 1957–1970.

[5]The only cases of executive decision behavior I know of which might be interpreted within this framework are occasional across-the-board percent cutting exercises, used to generate a list of alternatives for further evaluation. These exercises were observed during the Eisenhower administration, and also during the very last year of the Johnson administration.

[6]The contextual determinants of such salient alternatives are almost too large to enumerate. However, examples include the following: the size of Boston's latest Urban Renewal application, the amount of unobligated balance carry-over from the previous year, the remaining dollars left in congressional authorization, the sizes of new construction starts which could be deferred, the amount of mortgage assets which could be sold at a discount, the dollar implications of inflation in per unit costs, the budgetary cost of projected demographic change in populations eligible for transfer payments, the dollar implications of new presidential or agency proposed legislation, and so forth. The diversity of these contextual cues is one major reason for a stochastic formal representation.

[7]The role of "fiscal climate" is specifically singled out because of the Crecine (1975) finding that aggregate constraints on the overall size of the federal budget are crucial to the structure of OMB and executive budgetary decision making. "Merit" considerations, moreover, are meant to be interpreted broadly to include political, strategic and administrative evaluations as well as substantive policy preferences.

accept/reject decision may be justified by reference to a number of incommensurable and frequently unmeasurable issues which are attached to the program. However on average, the probability of accepting salient alternatives is determined by the decision maker's cognitive predisposition towards the merits of the program and by the decision maker's evaluation of the aggregate fiscal climate. These probabilities can be interpreted as stochastic analogues of "aspiration levels." Final choice is treated as non-deterministic in part because of an assumption that no unambiguously correct budgetary alternative is perceived to exist.

Serial judgment decision theory has its roots in three broader behavioral choice traditions. First, the affinity of this decision process with Simon's theory of satisficing (1957) is obvious. Serial judgment theory presumes that only a limited number of alternatives are considered; it postulates that the first "acceptable" alternative encountered is chosen; and it highlights the notions of search and, implicitly, aspiration levels. Secondly, serial judgment theory is consistent with one of the three heuristics of Tversky and Kahneman for "judgment under uncertainty" (1974)—namely, the heuristic of "anchoring and adjustment." The serial judgment decision maker starts with an historically given initial value, in the form of prior budget estimates, and then systematically adjusts this initial value by cycling through neighboring alternatives, which are taken here to be discrete in character. Finally, the theory of serial judgment builds upon March's and Olsen's emphasis (1976) on ambiguity in organizational choice. Informal judgment is required because omnisciently rational calculations are infeasible. Serial judgment, I argue, is not an unreasonable way for decision makers to cope with federal policy complexities.

In qualitative OMB and HUD budget planning memoranda, serial judgment frequently is manifest either in the form of HUD "priority bands" of program cuts or in the form of itemized OMB listings of program increases and decreases, which are then cycled through and tabulated until some aggregate fiscal target is achieved.

Linear Models in Decision Making Research

In the empirical analyses which follow, I will evaluate the two theories of process incrementalism and of serial judgment primarily upon the basis of cross-sectional program or bureau level budgetary data which have been transformed into a percent change format. The goal of the modeling sections which follow will be to use the methodology of stochastic processes to derive competing probability distribution predictions. Since this approach and the methodology upon which it is based are unorthodox for budgetary decision research, a few words of justification are in order.

As Wanat (1974) and others have already argued, a linear decision rule interpretation of the Davis et al. regression results is open to dispute. Incrementalist regressions certainly demonstrate that federal budgetary decisions usually differ in only a marginal, temporally stable, and approximately linear manner from earlier decisions. Whether such descriptive patterns have actually been generated by the application of incrementalist decision rules is more problematic.

To appreciate the potential severity of this methodological issue, consider the following list of conceivable alternative decision processes:

1. an economic cost-benefit process in which the measurements of benefits and costs change in a marginal and stable manner over time (classical public finance approach);
2. an overt bargaining process in which non-incrementally motivated decision makers in conflict jointly determine budgetary allocations within a system in which "power relationships" remain approximately stable (political conflict of interest approach);
3. a decomposition process in which aggregate fiscal policy based totals, which themselves change only marginally, are sequentially suballocated into smaller and smaller sets of categories in an at least approximately proportional manner (Simon's "nearly decomposable systems" approach);
4. a selection process in which randomly generated proposals are rejected by hostile political environments which do not change radically in composition or selection criteria over time (evolutionary approach);
5. an exogenous determinants process in which "service levels" are set in response to clientele pressures which build and diminish relatively smoothly over time (municipal finance's public expenditure determinants approach); or even
6. a null model in which nothing but inflation drives the system.

All of these schematically described processes *could,* under plausible circumstances, generate allocational decisions which differed in only a marginal, temporally stable, and approximately linear manner from earlier decisions. Of course, this is not to say that all of these processes *necessarily* lead to patterns of decisions which would be well tracked by the Davis et al. models, nor that one cannot imagine circumstances in which these processes would lead to differing predictions. However, the examples illustrate the point that process interpretation of incrementalist regression results is not straightforward.

I would suggest, however, not only that this problem of multiple process consistency with incrementalist empirical results is severe, but also that this problem is exacerbated by reliance on linear regression methodology. While to some extent such multiple process consistency problems are inevitable for any formal model, linear regression analysis of raw-dollar, time-series allocation data seems a peculiarly insensitive strategy for making "critical test" empirical distinctions among competing decision process theories.

My pessimism in this regard stems in part from the experience of the discipline of psychology with linear models of behavioral choice theories (Dawes and Corrigan, 1974). There, a number of simulations have been performed which show that a wide variety of nonlinear decision process models can generate final choices which are well tracked by simple linear regressions of those choices on information inputs. For example, Rorer (1971) has simulated graduate school admissions choices by ten different nonlinear decision rule models, ranging from quadratic models to multiplicative models to various sequential branching models to categorical or pattern recognition models to lexicographic models. Multiple regressions of simulated candidate ratings on information inputs, however, produced an average correlation coefficient of .85, with a maximum of .96 and a minimum of .71. Thus, even though the "true" underlying decision processes were radically nonlinear in character, the general linear model tracked aggregate patterns of final choices fairly well.

One can draw one of two conclusions from this type of result. On the one hand, linear functional forms are often quite useful for modeling and predicting final decision outcomes even when the underlying choice process is not understood. In the context of estimation, moreover, linear regression models are valuable (as long as prescribed precautions are taken against standard econometric problems such as heteroscedasticity, etc.) for investigating relative magnitudes of "net causal effects" of some independent variables on some dependent variable of interest. Such relative assessment of "net causal effects" can be made whether or not one understands the detailed mechanisms by which such effects are transmitted.

On the other hand, the very adaptability which makes linear models useful in these predictive and estimation contexts makes linear models indiscriminant in an explanatory context in which the goal is to understand the underlying process mechanisms by which final decision outcomes are produced. General linear models are all too robust in such a context for essentially two reasons. First, as Dawes and Corrigan (1974) demonstrate through simulation, linear models are quite robust in goodness-of-fit under deviations from optimal regression coefficient estimates. This appears to explain thg high R^2's obtained in Wanat's "uniformly distributed percent cuts" simulation exercise. Perhaps more importantly, however, behavioral decision data are very commonly characterized by conditionally monotone relationships between information inputs and choice outputs, for the simple reason that information is a cue for dimensions of value. These relationships insure that such data will to a first approximation have strong linear components, especially if the range of dependent variable variation is not great. In the face of competing process explanations, however, the demonstration of such linear components is frequently not very discriminating (Green, 1968). Instead of a futile search for marginal improvements to already high R^2's, therefore, I recommend a change in methodological focus—a reaffirmation of the "critical test" philosophy, in which the goal is to identify dimensions of data in which the predictions of competing theories differ markedly.

Stochastic Process Methodology

The alternative stochastic process approach to be employed in this article is designed to alleviate some of these methodological problems. The primary justification for a focus on predicted probability densities of cross-sectional percent allocation change is the fact that such predictions are clearly distinguishable and, hence, falsifiable relative to one another.

Focusing explicitly on the analysis of changes in allocations rather than on the analysis of absolute dollar levels is one straightforward first step towards the elimination of dominant but indiscriminant monotonic patterns from data. Models which predict change obviously predict absolute levels as well, but such models are more likely to diverge in statistical evaluation due to typically lowered goodness-of-fits. Standardization of changes in terms of percentages insures comparability of programs of various sizes within a cross-sectional grouping framework.

Cross-sectional grouping of programs at single points in time offers some promise for decision process research because it tends to bring into focus the object of study better than grouping across time for individual programs. Cross-sectional grouping of data across programs tends to hold constant sets of actors and organizational procedures, even as it increases the diversity of the program information cues being evaluated within the system. Time-series grouping, on the other hand, tends to hold constant the types of information cues being focused on, even as it increases variability in actors and organizational procedures. However, while cross-sectional budgetary analysis is arguably superior to time-series analysis for largely methodological reasons, simulation techniques also will be used in this article to compare the time-series behavior of serial judgment with process incrementalism.

Proper level of data aggregation is a complex issue for budgetary analysis, since quite different considerations may govern decision making at the various levels of overall budget total, departmental (e.g., HEW) allocations, and program (e.g., Vocational Rehabilitation) allocations. Indeed, as pointed out by Crecine (1975, 1977), in the executive branch higher-level fiscal policy outcomes may successively constrain less aggregate levels of budgetary decision making.

Formally, this hierarchical decision structure presents no problem, since it may be represented by a decomposable model in which the parameters of one level of analysis are taken as deriving in part from more aggregate considerations. In this article, however, parameters will be taken as exogenously fixed, and the focus of attention will remain on the program level of analysis for three reasons: (1) Theoretically, the primary concern here is with behavioral decision theory, which corresponds most naturally to the more micro level of budgetary decision making. (2) This program level corresponds to the Davis et al. bureau level of aggregation.[8] (3) This level of analysis mitigates "compositional effect" problems, which stem from the possibility that departmental totals reflect in aggregate the mixed outcomes of radically different program decision processes.

As stated above, the objective of the stochastic process technique is to derive probability density predictions for observable phenomena such as percent allocation change. The use of this technique will be illustrated in the following sections, but one introductory comment is in order. Stochastic process derivations of predicted program choice distrib'' ions can be carried out under two different assumptions—density parameters are homogeneous across programs, and density parameters are heterogeneous across programs. The heterogeneity assumption is clearly the more plausible of the two, since it permits decision makers to hold various substantive opinions about the merits of different programs. Heterogeneity, therefore, will be introduced into the following deviations via the technical device of postulating mixing distributions of parameters across programs. Both the homogeneous and the heterogeneous versions of the two process models, however, will be evaluated empirically.

The actual data to be analyzed here were drawn from the Crecine archive of internal Office of Management and Budget (OMB) planning documents and memoranda, and from the Padgett archive of internal Department of Housing and Urban Development (HUD) planning documents and memoranda. These executive branch data were supplemented with congressional data drawn from the Senate Appropriations Committee publication *Appropriations, Budget Estimates, Etc.*

Budget stages coded included the following:

CE_i = OMB's current estimate,[9] at the time of

[8]Semantic ambiguities sometimes confuse aggregation descriptions in budgeting. For example, the term "agencies" refers in some instances to departments (e.g., HEW) and in others to bureaus (e.g., Bureau of Indian Affairs). Likewise, the term "programs" sometimes refers to entities very comparable to bureaus (e.g., HUD's Urban Renewal program, HEW's Family Services or AFDC program) and sometimes to subbureau entities, such as PPBS categories. In this article, the term "program" refers operationally to that set of sub-departmental units which appears in OMB internal planning tabulations. Typically, these units are equivalent to what Davis et al. refer to as "agencies" or bureaus. However, occasionally but consistently OMB will group small budget line items together into categories such as HEW's Community Health program(s). A listing of the "program allocation" data employed here can be found in Padgett (1978).

[9]The "Current Estimate" is the most recent OMB evaluation of the NOA and Expenditure implications of congressional appropriations, after taking into account supplementals and uncontrollable adjustments.

Preview ceilings, of the previous year's New Obligational Authority (NOA) for program i;

$\tilde{B}_i$ = OMB's spring or summer Preview NOA ceiling for program i;

A_i = Domestic agencies' NOA fall submission or request to OMB for program i;

$\bar{B}_i$ = OMB's Director's Review NOA allowance for program i;

P_i = Presidential NOA budget submission to Congress for program i;

C_i = Congressional NOA appropriation for program i.

These raw-dollar budget data were then transformed into the following "percentage change" formats:

$$\Delta\tilde{b}_i = \frac{\tilde{B}_i - CE_i}{CE_i}\,; \Delta a_i = \frac{A_i - \tilde{B}_i}{\tilde{B}_i}\,; \Delta\bar{b}_i = \frac{\bar{B}_i - \tilde{B}_i}{\tilde{B}_i}\,;$$

$$\Delta p_i = \frac{P_i - \bar{B}_i}{\bar{B}_i}\,; \Delta c_i = \frac{C_i - P_i}{P_i}.$$

More complete institutional descriptions of the federal budgetary planning cycle can be found in Crecine (1977), LeLoup (1977), and Padgett (1978).

The Process Incrementalism Model

To operationalize the theory of process incrementalism within a stochastic process framework, we first have to specify linear "decision rules" for each of the above budget stages. This specification involves both a choice about the relevant "base" and a choice about appropriate incrementalist functional forms.

Here, the "base" will be taken in most cases to be simply the most recent prior decision. The only ambiguity in this operationalization comes in the case of the OMB allowance stage, where it is unclear whether the "base" should be the most recent decision made by agencies—agency requests—or the most recent decision made by OMB itself—preview ceilings. Here, the preview ceiling will be the allowance "base" under the assumption that this choice is more likely to be closer to OMB's allowance preferences than is the typically higher agency request.

The decision rule functional form to be examined will be the simple linear specification with one independent variable. This was the specification which Davis, Dempster and Wildavsky found to be empirically dominant. In fact, however, it will be seen that the distributional implications of incrementalist theory are independent of which particular linear "decision rule" is chosen for analysis.

Under these assumptions, the process incremental hypothesis that allocation decisions are produced "as if" they were generated by the application of simple and temporally stable linear decision rules may be operationalized as follows:

$$\tilde{B}_i = \alpha_{1i} \cdot CE_i + \epsilon_i$$
$$A_i = \alpha_{2i} \cdot \tilde{B}_i + \phi_i$$
$$\bar{B}_i = \alpha_{3i} \cdot \tilde{B}_i + \theta_i$$
$$P_i = \alpha_{4i} \cdot \bar{B}_i + \eta_i$$
and $$C_i = \alpha_{5i} \cdot P_i + \nu_i.$$

A simple transformation yields:

$$\Delta\tilde{b}_i = \alpha_{1i} - 1 + \epsilon_i/CE_i$$
$$\Delta a_i = \alpha_{2i} - 1 + \phi_i/\tilde{B}_i$$
$$\Delta\bar{b}_i = \alpha_{3i} - 1 + \theta_i/\tilde{B}_i$$
$$\Delta p_i = \alpha_{4i} - 1 + \eta_i/\bar{B}_i$$
and $$\Delta c_i = \alpha_{5i} - 1 + \nu_i/P_i.$$

Therefore, under incrementalist decision rule specifications, the problem of finding the predicted distribution of standardized change reduces to the problem of finding the distribution of decision rule parameters and the distribution of the standardized error terms. The latter of these two distributions is straightforward—since all previous decisions are fixed at the time of choice and hence are not random variables themselves, the Davis et al. hypothesis that stochastic disturbances are Normally distributed implies that the distributions of standardized stochastic disturbances are also Normal.

The main theoretical question, therefore, centers around the distribution of α_i's which is implicit in incrementalist theory. Davis, Dempster and Wildavsky said little in their original 1966 paper about the determination of such parameters, except to note that they should change only occasionally during "shift points." A later (1974) paper, however, presents a more explicit exogeneous determinants theory about how decision rule parameters are fixed during shift points. That theory may be labeled a "cumulative pressure" theory. Hence,

> While the incremental behavior specified by these models ... appeared to be the general rule, a major finding concerned the nature of the exceptions. For many agencies, epochs in which the underlying relationships appeared to change were identified statistically.... We investigated a subset of these epochs by docu-

> mentary analysis and classified the major influences at work. ... Although some of these influences were essentially random and nonrecurring, most could be seen to be due to specific political, or general economic or social events. This suggests that, although it is basically incremental, the budget process does respond to the needs of the economy and society, but only after sufficient pressure has built up to cause abrupt changes precipitated by these events (1974, p. 3).

Thus, the process image which Davis et al. present regarding "shift point" changes in decision rules is one in which a variety of exogeneous events influencing "the needs of the economy and society" exert pressure on the internal operation of the budgetary process. This pressure in turn cumulates, without immediate effect, until decision makers recognize or are forced to recognize the need for change, at which point an abrupt transformation of decision rules occurs which reflects the aggregate level of all of this cumulated pressure. This budgetary theory is consistent with more general standard operating procedure theory (Cyert and March, 1963; Steinbruner, 1974), which presumes that simple decision heuristics shift abruptly only when a sufficiently severe "problem" forces the updating and revision of past learning.

Davis, Dempster and Wildavsky (1974, p. 9) operationalize this verbal image of cumulated pressure caused by exogenous events in the following manner:

$$\alpha_i = \beta_{0i} + \beta_{1i}z_1 + \beta_{2i}z_2 + \ldots + \beta_{mi}z_m.$$

The z's here represent all those political, economic and social events or variables which determine the perceived "need" for a program and which, hence, put pressure on the budgetary process regarding that program. Davis et al. actually studied 18 such variables, but they leave little doubt that an even larger number of variables are likely to be operative. The joint effect of excluded variables was grouped into Normal regression "error" terms.

This cumulative pressure theory of "shift point" changes, therefore, states that (a) there exists a wide variety of possible exogenous event determinants of the α_i's, and that (b) these determinants are cumulative or additive in their effects.

Given these two substantive hypotheses, one of two approaches can be taken to generate the desired predicted distribution of α_i. Both, however, lead to the same answer. If one presumes the z's to be nonstochastic, as is implicit in the regression framework which Davis, Dempster and Wildavsky themselves adopt, then the distribution of α_i is identical to the distribution of the regression stochastic disturbance term, which of course is Normal. If, on the other hand, one presumes the z's to be stochastic, then, under the supplementary assumption that the z's are independent, the Central Limit Theorem implies that α_i again approaches Normality, regardless of the distribution of the z's.

Two comments can be made about the supplementary independence assumption required to make the Central Limit Theorem argument hold in the stochastic z approach. First, Davis et al. themselves implicitly adopt this very common methodological assumption in their stochastic disturbance representation of excluded variables. More importantly, however, advanced versions of the Central Limit Theorem (Loève, 1955, p. 377) have shown that even sums of dependent random variables converge to Normals under certain technical conditions.[10] In less precise terms, these advanced results imply that the sum of even dependent random variables will converge to a Normal distribution as long as one one summand is "dominant" in the presence of an infinite number of other summands. This fact appears to account for the robustness of Normal approximations of sums even when common independence assumptions are violated.

Hence, under at least two different interpretations, the Davis, Dempster and Wildavsky "shift point" theory implies that all of their decision rule parameters should be at least approximately Normally distributed. For example,

$$p(\alpha_{1i}) = \Phi[\mu_{1i}, \sigma^2_{1i}].$$

This result in turn, coupled with the linear decision rule specification listed above, implies that the density of standardized allocation choices predicted by process incrementalism should also be Normal, since the convolution of any number of Normals remains Normal. For example,

[10]These technical conditions are (a) that the expected differences between finite conditional and finite unconditional means and variances of z_m's approach zero as $m \to \infty$, and (b) that the so-called Lindeberg-Feller condition holds. This last condition implies that the ratio of any z's variance to the variance of the sum approaches zero as $m \to \infty$ (Woodroofe, 1975, p. 256).

$$p(\Delta\tilde{b}_i) = \Phi[\mu'_{1i}, \sigma'^2_{1i}],$$

where

$$\mu'_{1i} = [\mu_{1i} - 1 + (\mu_{\epsilon_i}/CE_i)],$$

and

$$\sigma'^2_{1i} = [\sigma^2_{1i} + (\sigma_{\epsilon_i}/CE_i)^2].$$

This convolution property accounts for the earlier remark that distributional implications of process incrementalism are independent of the particular linear decision rule specification. Increasing the number of terms in a linear decision rule simply increases the number of Normally distributed standardized parameters terms which must be convoluted. But such an increase in no way affects the final distributional form.

This distributional result holds for individual programs. That is, process incrementalism implies that the probability density of allocation choice for any program at a fixed point in time is Normal. This individual program prediction, however, will be identical to the prediction that observable cross-program distributions are Normal only under the supplementary assumption that all program density parameters are constant across programs. In fact, however, a heterogeneity assumption, reflecting different information inputs and substantive policy priorities, is more plausible.

Incorporating heterogeneity into the analysis requires the postulation of mixing distributions of parameters across programs. Particular such hypotheses are hard to justify on theoretical grounds, so I will simply adopt the strategy of presuming mixing distributions which are tractable but which also are sufficiently malleable to at least approximate virtually any unimodal reality. The only constraints in this Normal case, of course, are that μ parameters lie between $-\infty$ and $+\infty$ and that σ^2 parameters lie between 0 and $+\infty$.

Two mixing distributions which appear reasonable under this strategy are the following: (a) The distribution of means across programs is Normal ($\bar{\mu}$, $\bar{\sigma}^2$). (b) The distribution of the inverse of variances across programs is Gamma (α, β). The first of these two heterogeneity assumptions is straightforward in the absence of any theoretical reasons to the contrary. The second of these two assumptions is convenient since Gammas are sufficiently malleable under different (α, β) selections to at least approximate most unimodal patterns.[11]

The implications of these two heterogeneity assumptions, taken one at a time for the illustrative case of $\Delta\tilde{b}_i$, are as follows: (a) A Normal distribution of μ_{1i}'s across programs, with σ^2_{1i}'s temporarily held constant, implies the following Normal distribution of $\Delta\tilde{b}_i$'s:

$$p(\Delta\tilde{b}_i) = \Phi[\bar{\mu}, \sigma^{*2}_i],$$

where

$$\sigma^{*2}_i = [\bar{\sigma}^2 + \sigma^2_{1i} + (\sigma_{\epsilon_i}/CE_i)^2].$$

(b) However, if $(\sigma^{*2}_i)^{-1}$ in turn is assumed to be distributed as Gamma (α, β) across programs, then the predicted distribution of percent change program choices becomes a type of Student's t distribution:

$$p(\Delta\tilde{b}_i) = \frac{(2\beta)^{-1/2}}{B(1/2,\alpha)}\left[1 + \frac{(\Delta\tilde{b}_i - \bar{\mu})^2}{2\beta}\right]^{-(\alpha+1/2)},$$

where $B(1/2, \alpha)$ is the symbol for the beta function.

Thus under an assumption of parameter homogeneity, process incrementalism implies a Normal distribution of appropriately standardized allocation change. However, under the more plausible assumption of parameter heterogeneity, process incrementalism implies approximately a Student's t distribution of standardized allocation change. Not surprisingly, these two distributions are not qualitatively very different from one another, the main difference being the slightly "fatter tails" of the Student's t.

The Serial Judgment Model

To operationalize the competing serial judgment theory of budgetary decision making, first posit that the historical "starting points" required for each budgetary stage are identical to the "bases" specified for the process incrementalism model. Given these fixed historical referents, however, the serial judgment decision maker then decides upon a direction of search —namely, upon whether some increase or some decrease is warranted both "on the merits" and

[11]For example, Gammas can assume a J pattern with peak at 0, or unimodal patterns with peak anywhere from 0 to ∞. Moreover, this class subsumes within it the Chi-Square and Negative Exponential distributions as special cases.

"under the current fiscal climate."

This first "direction of search" phase can be represented, for the illustrative case of OMB ceilings, as a binary choice between the two alternative sets $\Delta\tilde{b}_i > 0$ and $\Delta\tilde{b}_i < 0$. This binary choice is based upon the following two judgmental propensities:

p_i = the probability of deciding that some allocation increase for program i is justified "on the merits," and

$\bar{p}$ = the probability of deciding that an allocation increase for any program is justified "under the current fiscal climate."

Assuming that these two judgments are independent, the "direction of search" choice can be modeled as

$$P[\Delta\tilde{b}_i > 0] = \bar{p} \cdot p_i$$
$$P[\Delta\tilde{b}_i < 0] = 1 - \bar{p} \cdot p_i.$$

Given search, the serial judgment decision maker next perceives discrete salient alternatives in an essentially "unbiased" or random manner over the continuous space of all conceivable allocation alternatives. More specifically, hypothesize that information is such that the probability of perceiving a salient alternative in any small interval of allocation dollars (or percentages) is constant over all possible small intervals, be they located among large or among small allocation alternatives. In other words, again for the illustrative case of OMB ceilings:

I. The probability of perceiving at least one salient alternative in the small allocation interval $d\Delta b_i$ is

$$P(d\Delta\tilde{b}_i) = \lambda_i d\Delta\tilde{b}_i + o(d\Delta\tilde{b}_i);\ d\Delta\tilde{b}_i \to 0, \lambda_i > 0.$$

II. The probability of perceiving two or more salient alternatives in the interval $d\Delta\tilde{b}_i$ is $o(d\Delta\tilde{b}_i)$, where $o(d\Delta\tilde{b}_i)$ is a technical term which can be interpreted as "negligible probability."

It is shown in many probability tests (e.g., Feller, 1968, pp. 446–48), that these two hypotheses are sufficient to imply that the resultant full distribution of perceived salient alternatives over the large interval $[0, \Delta\tilde{b}_i)$ is Poisson. That is,

$$P[X_i = k] = \frac{\lambda_i^k}{k!} e^{-\lambda_i \Delta\tilde{b}_i}.$$

Here, X_i is the random variable "number of salient alternatives perceived in the interval $[0, \Delta\tilde{b}_i)$," and k represents particular integer sample outcomes of X_i. λ_i is a parameter which equals the expected value of X_i. This measure of how "fine-grained" decision makers' perceptions of alternatives are is inversely correlated with the program's "degree of controllability."[12]

For purposes of parsimony, the simplifying assumption will be adopted that this same λ_i is also applicable for the case of $\Delta\tilde{b}_i < 0$. This symmetry simplification, however, will be reexamined in light of later data analysis.

Choice under the serial judgment decision strategy is simply a matter of cycling through the salient alternatives encountered along the direction of search until one of them is deemed acceptable both on the merits and under the current fiscal climate. Let

β_i = the probability of deciding that a salient alternative is acceptable, based "on the merits," and

$\bar{\beta}$ = the probability of deciding that a salient alternative is acceptable "under the current fiscal climate."

Then, the probability of accepting a salient alternative as adequate is $\bar{\beta} \cdot \beta_i$, and the probability of rejecting a salient alternative as inadequate is $1 - \bar{\beta} \cdot \beta_i$. Under this specification, $1 - \bar{\beta} \cdot \beta_i$ may be thought of as a stochastic analogue to Simon's more deterministic notion of "aspiration level," since probability of rejection increases the higher the aspiration level.

To derive the predicted density of percent change allocation choice from this model, all that is necessary is to notice that, for a fixed direction of search, final choice will be the sum of all of the salient alternatives added to the base. In other words,

$$\Delta\tilde{b}_i = \sum_{j=0}^{n} \Delta\tilde{b}_{ij},$$

where the $\Delta\tilde{b}_{ij}$'s represent the successive sizes of salient alternatives considered, and n represents the total number of alternatives accepted. Both $\Delta\tilde{b}_{ij}$ and n are random variables. Hence, the desired $p(\Delta\tilde{b}_i)$ is a compound distribution of $p(\Delta\tilde{b}_{ij})$ and $p(n)$.

[12]That is, the more controllable the program, the larger, on average, discrete dollar or percent alternatives are likely to be. Moreover, the larger the average size of individual alternatives, the fewer of them are likely to be perceived within any fixed interval.

The distribution $p(\Delta\tilde{b}_{ij})$ follows from the above Poisson "unbiased" perception of salient alternatives hypothesis. For it can be shown (Karlin and Taylor, 1975, p. 121) that the distribution of distances between Poisson events is Exponential (λ_i), and n-fold convolutions of such Exponentials are Gamma (n, λ_i). Moreover, it can be shown (Feller, 1968, pp. 164–68) that the distribution of number of evaluations until the first acceptance "stopping point" is Geometric ($\bar{\beta}\cdot\beta_i$). Therefore, fixing the direction of search to be positive, and using the notation $p(\Delta\tilde{b}_{ij})^{n*}$ to represent the n-fold convolution of $p(\Delta\tilde{b}_{ij})$ with itself, the serial judgment prediction for the distribution of percent allocation change is Exponential $[\lambda_i(1-\bar{\beta}\beta_i)]$ with a singularity at $\Delta\tilde{b}_i=0$, as is demonstrated in Figure 1.

Coupling this result with first "direction of search" stage is straightforward:

$$p(\Delta\tilde{b}_i) = \begin{cases} (1-p_i^*)\beta_i^*\lambda_i^* e^{\lambda_i^*\Delta\tilde{b}_i}, & \Delta\tilde{b}_i<0 \\ (1-\beta_i^*) & , \Delta\tilde{b}_i=0 \\ p_i^*\beta_i^*\lambda_i^* e^{-\lambda_i^*\Delta\tilde{b}_i} & , \Delta b_i>0, \end{cases}$$

where $p_i^* \equiv \bar{p}p_i$, $\beta_i^* \equiv \bar{\beta}\beta_i$ and $\lambda_i^* \equiv \lambda_i(1-\bar{\beta}\beta_i)$. This Double Exponential prediction is analogous to the process incrementalism prediction of a Normal Density of allocation choice for any one individual program.

As was the case in the last section, however, I also wish to explore the implications of the plausible assumption that parameters are heterogeneous across programs. Using the same strategy of exploring mixing distributions which are both tractable and malleable, the following hypotheses seem reasonable, given that $\bar{p}p_i$ and $\bar{\beta}\beta_i$ are constrained to lie between 0 and 1 and that λ_i is constrained to lie between 0 and $+\infty$:

(a) p_i^* is distributed as Beta (u,v).[13]

(b) β_i^* is distributed as Beta (υ,ν).

(c) λ_i is distributed as Gamma (α,δ).

Under these heterogeneity assumptions, with the added constraint that $\alpha = \upsilon+\nu$, it can be shown that the cross-program empirical distribution of choices produced by a serial judgment maker will be a Double Pareto:

$$p(\Delta\tilde{b}_i) = \begin{cases} (1-u_1^*)u_2^*(\frac{\nu}{\delta})[1-(\frac{1}{\delta})\Delta\tilde{b}_i]^{-(\nu+1)}, & \Delta\tilde{b}_i<0 \\ (1-u_2^*), & \Delta\tilde{b}_i=0 \\ u_1^*u_2^*(\frac{\nu}{\delta})[1+(\frac{1}{\delta})\Delta\tilde{b}_i]^{-(\nu+1)}, & \Delta\tilde{b}_i>0. \end{cases}$$

In this case $u_1^* \equiv \dfrac{\mathrm{u}}{\mathrm{u+v}}$ and $u_2^* \equiv \dfrac{\upsilon}{\upsilon+\nu}$.

Thus, the serial judgment process produces a Double Exponential empirical distribution of

[13]The Beta distribution is very malleable since, under various selections of u and v parameters, this distribution can assume J shapes with peak at either 0 or 1, U shapes with peaks at 0 and 1, unimodal shapes, triangular shapes, or even the rectangular shape of the Uniform distribution.

$$\begin{aligned} p(\Delta\tilde{b}_i) &= \sum_{n=0}^{\infty} p(n)p(\Delta\tilde{b}_{ij}\,|\,n) \\ &= p(n{=}0)p(\Delta\tilde{b}_{ij}\,|\,n{=}0) + \sum_{n=1}^{\infty} p(n)p(\Delta\tilde{b}_{ij})^{n*} \\ &= (1-\bar{\beta}\beta_i)\begin{Bmatrix} 1, \Delta\tilde{b}_i=0 \\ 0, \Delta\tilde{b}_i>0 \end{Bmatrix} + \sum_{n=1}^{\infty}(1-\bar{\beta}\beta_i)(\bar{\beta}\beta_i)^n \begin{Bmatrix} 0 & , \Delta\tilde{b}_i=0 \\ \dfrac{\lambda_i^n}{(n-1)!}(\Delta\tilde{b}_i)^{n-1}e^{-\lambda_i\Delta\tilde{b}_i} & , \Delta\tilde{b}_i>0 \end{Bmatrix} \\ &= \begin{cases} (1-\bar{\beta}\beta_i) & , \Delta\tilde{b}_i=0 \\ (\bar{\beta}\beta_i)\lambda_i(1-\bar{\beta}\beta_i)e^{-\lambda_i(1-\bar{\beta}\beta_i)\Delta\tilde{b}_i} & , \Delta\tilde{b}_i>0 \end{cases} \end{aligned}$$

Source: Compiled by the author.

Figure 1. Serial Judgment Derivation for the Individual Program Level

percent change allocation choices for the case of homogeneous programs. And it produces a Double Pareto empirical distribution of percent change allocation choices for the more plausible case of heterogeneous programs.

Graphically, the competing distributional predictions of process incrementalism and serial judgment are illustrated in Figure 2.

Substantively, the characteristic sharp peak near zero of the Double Pareto implies that most programs most of the time receive budget allocations which are only marginally different from the historical referent or base. The equally characteristic "fat tails" of the Double Pareto, however, imply the occasional occurrence of very radical changes. What Davis, Dempster and Wildavsky describe as a "shift point," induced by exogenous intervention into a routinized budget system, the serial judgment strategy generates as the normal outcome of its more flexible decision process.

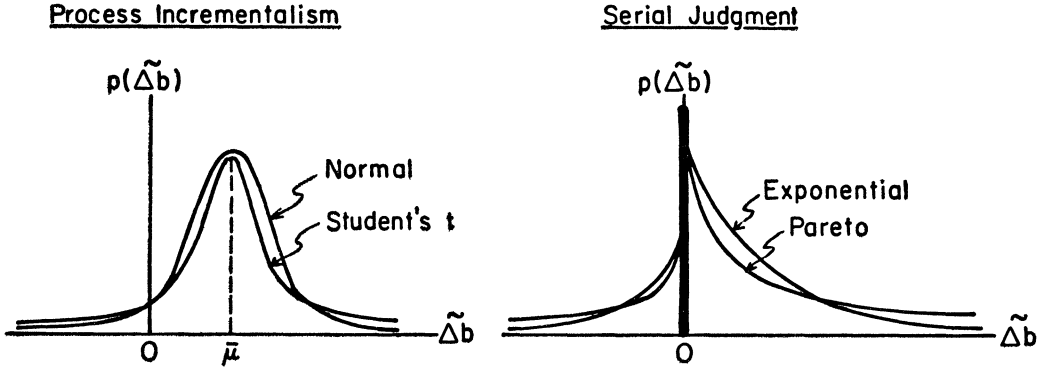
Data Analysis

As mentioned above, the program allocation data to be analyzed here were drawn from the Crecine OMB and the Padgett HUD archives, and were supplemented with publically available congressional data. The years chosen for analysis were fiscal years 1957, 1964, and 1966. These three particular years were selected within data availability constraints to represent one year each from the Eisenhower, the Kennedy, and the Johnson administrations. Only domestic program data were coded because of the Crecine (1975) finding that allocational decision making for National Security programs is relatively autonomous, institutionally, from decision making for domestic programs. Also, very small programs, whose Preview Current Estimate totalled less than \$1 million, were excluded from the analysis. In all, complete data series for 62, 98 and 94 domestic programs could be reconstructed for FYs 1957, 1964, and 1966, respectively. These programs represented 83, 91, and 86 percent of the total NOA domestic[14] President's budget for FYs 1957, 1964, and 1966. A more complete description and listing of the program allocation data analyzed can be found elsewhere (Padgett, 1978).

In particular, the "major budget stages" coded are listed in Table 1. More than the usual number of stages were coded for FY 1957 because of the greater emphasis placed on these early planning figures by the Eisenhower administration. An additional FY 1964 ceiling revision stage was coded because of Kennedy's unanticipated midyear decision to cut the budget total by \$2 billion in order to increase the chances of congressional passage of the first major Keynesian tax-cut measure.

As has already been discussed, the data were first standardized into a percent change format. Besides the $\Delta\tilde{b}$, Δa, $\Delta\bar{b}$, Δp, and Δc transformations already mentioned, the standardizations employed were the following:

[14]The term "domestic" is meant to exclude the Department of Defense-Military, the Atomic Energy Commission, the National Aeronautics and Space Administration, and Foreign Military Assistance.



Source: Compiled by the author.

Figure 2. Graphical Display of Incrementalism versus Serial Judgment Distributional Predictions

$$\Delta\tilde{b}_p = \left(\frac{\text{1957 Projection} - \text{1956 Current Estimate}}{\text{1956 Current Estimate}}\right)$$

$$\Delta a_p = \left(\frac{\text{1957 Preview Request} - \text{1957 Projection}}{\text{1957 Projection}}\right)$$

$$\Delta\tilde{b}' = \left(\frac{\text{1957 Ceiling} - \text{1957 Projection}}{\text{1957 Projection}}\right)$$

$$\Delta\tilde{b}_r = \left(\frac{\text{1964 ``Ratcheted'' Ceiling} - \text{1964 Ceiling}}{\text{1964 Ceiling}}\right).$$

The primary statistical procedure employed for the relative evaluation of the process incrementalism and the serial judgment theories was the Kolmogorov-Smirnov one-sample test. The Kolmogorov-Smirnov statistic is the maximum deviation over all cases of the empirical cumulative distribution from the predicted cumulative probability distribution (Bickel and Doksum, 1977). Hence, the lower the statistic, the better the goodness-of-fit.

One problem with the direct calculation of Kolmogorov-Smirnov statistics in the present research context is the fact that the full serial judgment models, as developed above, possess one extra free parameter than do the corresponding process incrementalism models. This problem was solved by constraining Exponential β_i^* and Pareto u_2^* parameters to equal 1.0. With or without this comparability constraint, however, all relevant density parameters were estimated by the method of maximum likelihood, except for Student's t parameters which were estimated by the method of moments.[15]

Table 2 reports finally derived Kolmogorov-Smirnov goodness-of-fit statistics, along with critical values for the .05 level of significance. Results for both constrained and unconstrained versions of the serial judgment model are given. The critical values reported are the Monte Carlo values cited by Bickel and Doksum (1977, p. 381), which are exact for the Normal case with parameters estimated and which are approximations otherwise.[16]

The results are remarkably consistent over all years and over all budget stages. In 17 out of the 18 budget stages analyzed, serial judgment predictions are superior to process incrementalism predictions when numbers of parameters are constrained to be comparable. Moreover, even this one discrepant $\Delta\tilde{b}_r$ stage vanishes when the unconstrained serial judgment model is estimated, since almost half of the program cases in this stage were observed to equal zero percent change. When the full serial judgment model is estimated, all Double Pareto statistics drop below the critical values cited. It is shown elsewhere (Padgett, 1978) that these general comparative findings are not altered if one employs average absolute error, sum of squared errors, or χ^2 as alternative goodness-of-fit measures.

Thus on the basis of more refined cross-sectional analysis of percentage allocation change, the theory of serial judgment appears more consistent with program-level federal budgetary decision making than does the Davis, Dempster and Wildavsky theory of process incrementalism. It can be shown, moreover, that this superiority is not an artifact of uncontrollability in the budget process (Padgett, 1978).

One oversimplification of the serial judg-

[15]Maximum likelihood estimation for the Normal, Exponential and Pareto distributions is described in Johnson and Kotz (1970, Vol. 1). The method of moments (Johnson and Kotz, 1970, Vol. 2, p. 116) was employed for the Student's t due to convergence difficulties experienced in the numerical analysis of the three relevant log likelihood derivative functions.

[16]The standard Kolmogorov-Smirnov critical values reported in many statistics text tables are not appropriate here due to parameter estimation. Unfortunately, relevant Monte Carlo simulations for non-Normal cases could not be found in the literature.

Table 1. Budget Stages Coded

FY 1957	FY 1964	FY 1966
OMB Preview Current Estimates	OMB Preview Current Estimates	OMB Preview Current Estimates
OMB May Projections	OMB Preview Ceilings	OMB Preview Ceilings
Agency Preview Requests	OMB "Ratcheted" Ceilings	Agency Requests
OMB Preview Ceilings	Agency Requests	OMB Director's Review Allowances
Agency Regular Requests	OMB Director's Review Allowances	President's Budget
OMB Director's Review Allowances	President's Budget	Congressional Appropriations
President's Budget	Congressional Appropriations	
Congressional Appropriations		

Source: Compiled by the author.

ment model, however, should be noted. It is apparent from visual inspection of Double Pareto residuals that, over the range of typically less common decrease choices, Double Pareto predictions for agency requests are higher than observed cumulative distributions, and that, over the same range, Double Pareto predictions for OMB ceilings and allowances are lower than observed distributions. This suggests that the simplifying assumption that λ_i^* parameters are symmetric for both increase and decrease directions of search is somewhat in error. Apparently, once agencies decide that some decrease from ceiling is necessary, they are much more reluctant to grant sizable decreases than they are to grant comparable-size increases. On the other hand, once OMB decides that some decrease for a program is warranted, OMB appears much more eager to make such a decrease sizable than it does to grant comparable increases. These two observed biases, of course, are quite consistent with our substantive preconceptions about agencies' and OMB's respective roles in the budgetary process.

Despite the observed superiority of serial judgment's distributional predictions over process incrementalism's distributional predictions, it is of course always possible that the Double Pareto distribution could also be consistent with some other decision process theory not yet examined.[17] While no definitive answer to this problem exists, some suggestive information can be generated by examining the more "fine-grained" predictions of serial judgment

[17]In fact, I report elsewhere (1978) that the serial judgment model is also superior in its distributional predictions to two other stochastic models of budgetary decision making—a tacit bargaining model, which is a member of the rational choice tradition, and an information bombardment model, which is a member of the recent "organized anarchy" tradition of Cohen, March, and Olsen (1972). The fact remains, however, that possible alternative process consistency is a serious issue.

Table 2. Kolmogorov-Smirnov Statistics

		Serial Judgment				Incrementalism	
		(Unconstrained)		(Constrained)			
		Double Expon.	Double Pareto	Double Expon.	Double Pareto	Normal	Student's t
1957 (n=62)							
OMB Projections	($\Delta\tilde{b}_p$)	.1938	.1029	.2104	.1003	.2366	.2307
Preview Requests	(Δa_p)	.1572	.0547	.1891	.0596	.3148	.3020
OMB Ceilings	($\Delta b'$)	.1460	.0544	.1510	.0691	.2310	.2292
Regular Requests	($\Delta\underline{a}$)	.1502	.0474	.1530	.0441	.2821	.2703
OMB D.R. Allowances	($\Delta\bar{b}$)	.1147	.0597	.1174	.0637	.2448	.2115
President's Budget	(Δp)	.1342	.0723	.2674	.2452	.4329	.4271
Congressional Approp.	(Δc)	.0936	.0528	.2198	.1850	.2513	.2572
Critical K-S value at p=.05				.1123			
1964 (n=98)							
Regular OMB Ceilings	($\Delta\tilde{\underline{b}}$)	.0794	.0611	.0812	.0547	.1666	.1472
Ratcheted Ceilings	($\Delta\tilde{b}_r$)	.0566	.0564	.4490	.4490	.2539	.2733
Agency Requests	($\Delta\underline{a}$)	.1439	.0682	.1547	.0711	.2571	.2422
OMB D.R. Allowances	($\Delta\bar{b}$)	.1010	.0559	.1134	.0575	.2398	.2267
President's Budget	(Δp)	.1638	.0667	.2037	.1392	.3111	.2817
Congressional Approp.	(Δc)	.1209	.0671	.1473	.0767	.2574	.2210
Critical K-S value at p=.05				.0897			
1966 (n=94)							
OMB Ceilings	($\Delta\tilde{b}$)	.1900	.0787	.1945	.0745	.2771	.2680
Agency Requests	($\Delta\underline{a}$)	.1535	.0772	.1725	.0867	.2781	.2596
OMB D.R. Allowances	($\Delta\bar{b}$)	.1118	.0366	.1368	.0515	.2271	.2128
President's Budget	(Δp)	.1972	.0472	.2327	.0642	.3414	.3297
Congressional Approp.	(Δc)	.1783	.0514	.2170	.0785	.3484	.3410
Critical K-S value at p=.05				.0916			

Source: Data coded from Crecine OMB archive and Padgett HUD archive of U.S. government internal memoranda and budgetary planning documents.

theory. Perhaps one of the most critical of such predictions is that observed Double Pareto distributions in fact derive from a mixture of Double Exponential distributions. This expectation suggests that if one could somehow group programs, on an a priori basis, into relatively more homogeneous parameter subsets, the observed distributions should be close to the more fundamental Double Exponential.

One obvious such grouping procedure is to subset programs according to their departmental memberships. It is at least plausible to speculate that, because of organizational structure, strategic or other reasons, program parameters are more homogeneous within departments than they are across departments. If this were the case, then the distributions of allocation choices for only HUD or HEW programs, for example, could be examined separately, via the Kolomogorov-Smirnov test or some other procedure, to see if such distributions are consistent with Double Exponential predictions.

Unfortunately, for the data analyzed here, this straightforward procedure is unreliable due to the small sample sizes of programs within departments. (The data set used here had an average of only eight programs within departments.) Under this situation, therefore, a χ^2 significance test of the more complicated compound hypothesis that all departments' distributions are Exponential simultaneously was constructed along the lines suggested by Bickel and Doksum (1977, p. 320). The procedure employed was the following: Using absolute value choices, individual department λ_i^* parameters first were estimated using the Newton iterative procedure suggested by Bickel and Doksum.[18] The χ^2statistic was then calculated for each budget stage over all departments on the basis of the four fixed-interval groupings $[.00, .05)$, $[.05, .10)$, $[.10, .20)$ and $[.20, \infty)$.

The results are reported in Table 3, along with the critical χ^2 (p=.05) appropriate for m-s-1 degrees of freedom. (s here is the number of parameters estimated, equal to the number of departments in each stage; and m=4·s is the total number of intervals over which the χ^2 statistics were calculated.) As can be seen, the compound hypothesis that all departments' distributions are Exponential cannot be rejected for any budget stage. These results give some support to the serial judgment "fine-grained" expectation that observed Double Pareto distributions actually derive from a heterogeneous mixture of underlying Double Exponentials.

Table 3. χ^2 Test of Compound Hypothesis that All Individual Departments' Distributions are Exponential

1957 (n=53)		
OMB Projections	$(\Delta\tilde{b}_p)$	19.144
Preview Requests	(Δa_p)	23.898
OMB Ceilings	$(\Delta\tilde{b}')$	25.723
Regular Requests	(Δa)	13.289
OMB D.R. Allowances	(Δb)	16.724
President's Budget	(Δp)	16.649
Congr. Appropriations	(Δc)	9.024
Critical χ^2_{23} at p=.05		35.172
1964 (n=93)		
OMB Regular Ceilings	$(\Delta\tilde{b})$	30.866
Ratcheted Ceilings	$(\Delta\tilde{b}_r)$	38.984
Agency Requests	(Δa)	21.221
OMB D.R. Allowances	$(\Delta\bar{b})$	35.873
President's Budget	(Δp)	27.136
Congr. Appropriations	(Δc)	26.569
Critical χ^2_{35} at p=.05		49.802
1966 (n=91)		
OMB Ceilings	$(\Delta\tilde{b})$	40.790
Agency Requests	(Δa)	28.513
OMB D.R. Allowances	$(\Delta\bar{b})$	21.663
President's Budget	(Δp)	31.199
Congr. Appropriations	(Δc)	26.511
Critical χ^2_{35} at p=.05		49.802

Source: Data coded from Crecine OMB archive and Padgett HUD archive of U.S. government internal memoranda and budgetary planning documents.

One final empirical point is worthy of note. The consistency of serial judgment theory with the high regression R^2's reported by Davis et al. is easily demonstrated. Monte Carlo simulations of a sequence of Double Exponential choices have been performed, and incrementalist "decision rule" regressions have been run on the reconstructed time series dollar outcomes. For purposes of illustration, 56 program allocation "cases" were generated over 17 years[19] using p_i^*, β_i^* and λ_i^* parameters which were randomly selected from Beta and Gamma mixing distributions. The parameters of these mixing distributions, in turn, were taken to equal the average, over the three years studied, of the unconstrained parameters estimated for each $\Delta\tilde{b}$, $\Delta\bar{b}$,

[18] β_i^* was constrained to equal 1, and departments with only three programs or less were excluded from the analysis. I am grateful to Mark Kamlet for bringing this procedure to my attention.

[19] These were the number of bureaus and years studied by Davis et al. (1966).

Δp, and Δc budget stage. Dollar time-series data were reconstructed from simulated percent change choices by means of the identities

$$\text{PRES. BUDGET}_{i,t} = \text{CONG. APPROP.}_{i,t-1}(1+\Delta\tilde{b}_{i,t})(1+\Delta\bar{b}_{i,t})(1+\Delta p_{i,t}),$$

$$\text{CONG. APPROP.}_{i,t} = \text{PRES. BUDGET}_{i,t}(1+\Delta c_{i,t}),$$

where the Preview Current Estimate here is taken to equal the simulated congressional appropriation. The incrementalist regressions run were of the simple form listed in the beginning of this article, without using any "shift points."

The resulting simulated distributions of R's are reported in Table 4, along with the analogous distributions reported by Davis, Dempster and Wildavsky (1966, p. 537). It is apparent that the distribution of serial judgment simulation R's is not substantially different from the distribution of actually estimated R's. Hence, serial judgment theory is consistent with gross time-series patterns of federal budgetary data, as well as with more refined cross-sectional patterns. However, these simulation results also illustrate concretely the methodological argument presented above about the insensitivity of regression analysis in process-oriented budgetary decision-making research.

Conclusions

This article has examined the methodological foundations of incrementalist quantitative research and has proposed a new bounded rationality theory of budgetary decision making. The empirical results support the relative superiority of this serial judgment theory over the competing Davis, Dempster and Wildavsky theory of process incrementalism.

In some respects, these results support both the incrementalists and their critics. Certainly, the importance of the bounded rationality paradigm's emphasis on cognitive constraints and simplifying decision heuristics, which the incrementalists share, has been reaffirmed. In addition, the incrementalist notion of "base" has been given support in the context of serial judgment's reinterpretation of that concept as a "reference point." However, when the focus shifts from absolute dollar levels to the analysis of allocational change, the rigidity implicit in the incrementalist temporally fixed decision rule formulation is undercut. In its stead, serial judgment theory substitutes a systematic, yet very contextually dependent process of search through and informal evaluation of a limited number of salient alternatives.

This serial judgment process of decision making generates budgetary outcomes in which most program allocations most of the time differ in only a marginal, but temporally variable, manner from the historical base. However, occasionally, as the normal outcome of serial judgment decision making, more radical and "catastrophic" changes are also produced. Serial judgment theory implies that the federal budgetary system is much more responsive to political, bureaucratic and technical dynamics, on a routine even if constrained basis, than the theory of process incrementalism would lead one to believe.

Somewhat paradoxically, this formal serial judgment theory is quite consistent with Wildavsky's verbal description of *The Politics of*

Table 4. Frequencies of Regression Correlation Coefficients

A. Serial Judgment Simulation R's (n=56)

	1 – .995	– .99	– .98	– .97	– .96	– .95	– .94	– .93	– .90	– .85	– 0
Executive	3	5	8	6	4	5	3	4	6	3	9
Congressional	28	8	7	1	2	2	2	1	3	1	1

B. Davis, Dempster and Wildavsky Reported R's (Exec. n=61; Cong. n=67)

	1 – .995	– .99	– .98	– .97	– .96	– .95	– .94	– .93	– .90	– .85	– 0
Executive	9	2	2	8	5	2	4	3	5	11	10
Congressional	21	8	15	4	5	2	2	1	5	2	2

Source: Compiled by the author; Otto A. Davis, M. A. H. Dempster, and Aaron Wildavsky (1966), "A Theory of the Budgetary Process," *American Political Science Review* 60: 529–47.

the *Budgetary Process.* Certainly, Wildavsky's generalizations that "budgeting is experiential; . . . budgeting is simplified; . . . budgeting officials 'satisfice'; . . . budgeting is [frequently outcome] incremental" are embedded in the serial judgment formalization. Also the numerous strategic cues itemized by Wildavsky may be important components of the contextual information detail which lies behind serial judgment parameters. Indeed, one implication of the serial judgment model is that Wildavsky's original highly contextual and political emphasis need not be abandoned in the search for bounded rationality process regularities.

Future research should be directed toward an analysis of the actual substantive issue content which flows through this serial judgment process. In model terms, this suggests an investigation into the cross-program structure of estimated serial judgment parameters. One such extension which seems promising is to model serial judgment parameters in terms of the hierarchical organizational structure emphasized by Crecine. Indeed, it can be shown that formally embedding the serial judgment program-level process into a departmental-level attention-focusing process, in which salient alternatives are sequentially allocated to various programs according to a stationary probability "strategy vector" until a fixed aggregate fiscal target is reached, is also consistent with the empirically confirmed Double Pareto distribution (Padgett, 1979). This type of extension might be one approach to reconciling bounded rationality theories, such as serial judgment, with more aggregate organization theory and with historically oriented studies of budgetary management strategies.

Work in this direction is currently in progress. Serial judgment theory as it now stands, however, permits such organizational and political extensions to proceed on a more firm behavioral decision theory foundation than has previously existed.

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