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By

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ABSTRACT

A CYBERNETIC MODEL OF THE U.S. DEFENSE EXPENDITURE POLICY-MAKING PROCESS

By

Robin Frank Marra

When focusing on the body of literature which explicitly attempts to explain or develop models of U.S. military expenditures there is an emerging consensus which suggests that the United States does not react to the military expenditure behavior of the Soviet Union. This growing consensus is counterintuitive, particularly when compared with the statements of U.S. defense planners. This dissertation explores possible theoretical and methodological deficiencies which may account for this set of puzzling empirical results.

An Organizational Process approach is adopted, and the defense expenditure process is viewed as consisting of four temporally ordered steps corresponding to the four major decisions made within the process. The four decision-making groups are the Military Services, President, Congress, and the Department of Defense. Their respective defense decision outputs are the: Services' request, the President's recommendation, Congressional appropriation, and actual expenditures.

The actors within this process are viewed as cybernetic decision makers. This approach has the following features: a) decision makers are boundedly rational; b) they respond to a limited number of environmental factors in a hierarchical fashion; and c) the structure of the hierarchy is a function of survival considerations.

Robin Frank Marra

This dissertation develops a multi-actor, multi-stage model of the U.S. defense expenditure policy-making process which is then operationalized and tested for the period of fiscal years 1947-80. A relatively novel approach to the estimation of this model is introduced. Identified as multi-stage residual analysis (MSRA), it involves the use of the residuals from one equation in the system as the dependent variable in the next stage. The results obtained by this approach are compared with those generated by a more traditional, single-equation, multiple regression (MR) procedure.

This study concludes that the hierarchic search structure suggested by the cybernetic approach is a reasonable approximation to the behavior of the major actors in the defense expenditure process. It was found that these actors respond not only to domestic political and economic variables, but also to factors located in the international environment, including the behavior of the Soviet Union.

For my parents who never doubted that I would finish, though they often wondered when.

For Maude and Jackson who continue to delight me each day with their antics and affection.

For Harold who gave me his love, trust, and nuzzles.

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BLUE	Best linear unbiased estimator
CBA	Congressional defense budget appropriations
CBACH	Congressional defense budget appropriation changes
CYBER	Cybernetic (model)
DoD	Department of Defense
EV1	First-order essential variable(s)
EV2	Second-order essential variable(s)
EV3	Third-order essential variable(s)
GLS	Generalized least squares
MEDM	Military expenditure decision-making (process)
MR	Multiple regression
MSRA	Multi-stage residual analysis
OLS	Ordinary least squares
PBR	President's defense budget recommendations
PBRCH	President's defense budget recommendation changes
RLM	Reactive Linkage Model
RMSE	Root mean square error
SIPRI	Stockholm International Peace Research Institute
SOP	Standard operating procedure
SPD	Department of Defense military expenditures
SPDCH	Department of Defense military expenditure changes
SRQ	Military Services' defense budget requests
SRQCH	Military Services' defense budget request changes

CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

For over twenty years considerable effort and attention have been directed toward the study of the build-up of military expenditure levels among nations. As a result, the contemporary researcher in this field is faced with a number of choices: which of several theoretical approaches to adopt; what mix of internal and external factors to include; what methodologies to utilize, etc. This chapter will provide a critical overview of the major options available in each area. By proceeding in such a fashion I will be able to delineate what might be called the conventional wisdom of contemporary research in the area of "arms-building models" (Moll and Luebbert, 1980).

By "conventional wisdom" I am referring to a set of empirical findings, theoretical approaches, and methodologies that have become established by their general usage or acceptance. I do not mean to imply, however, that there is either universal agreement or disagreement over any facet of the research in this field. In articulating this conventional wisdom I will be able to accomplish two distinct, though related, tasks. The first will be to provide a "sense of where we are" in terms of the current understanding of the factors and processes which govern the military expenditure behavior of nations. The second task will be to establish the areas which need further examination. In other words, I will raise a number of questions which suggest where research in this field ought to be directed.

It should be stated at the outset that this chapter will not present a comprehensive review of all of the research which comprises this body of literature. Such a task would be Herculean in scope, and the potential for obscuring major trends in a sea of research would be quite high. Nor is this essential to the task at hand. There are a number of excellent reviews already in existence (e.g., Zinnes, 1976; Moll and Luebbert, 1980; Russett, 1983), and to repeat these efforts would be counterproductive. Instead, this chapter will begin with a survey of the major empirical findings which seem to characterize the research in this area.

Empirical Findings

A complete listing of these findings would reveal that there is more disagreement concerning the major explanatory variables than there is consensus. Moreover, a survey of these findings suggests that there is very little cumulative research being pursued. The empirical results of one study often have little or no influence on subsequent research.

Given the enormity of the literature in this field, some structure needs to be imposed if one is to isolate major trends in the body of empirical research that has been produced. One obvious dichotomy is between international factors and domestic factors. Such a dichotomy, however, may obscure more than it reveals, given the host of different factors which fall under each heading. I would suggest that both international and domestic factors can be subdivided further into categories which permit a more manageable discussion. Specifically, I shall examine the following sets of international factors: those related to the behavior of a nation's major adversary; those which examine the effects of war or combat participation; and those which deal with overall tensions or crises in the international environment. Domestic factors include: macroeconomic variables; political factors; and those associated with bureaucratic forces.

It should also be stated at this point that the focus of this review will be on the body of literature which explicitly attempts to explain or develop models of U.S. military expenditures. This decision reflects not only my own research interests, but also the work on this topic represents the bulk of the research in this field. More importantly, the observations which follow would not be significantly altered if one were to focus on the "arms-building" behavior of some other nation or group of nations. Given this orientation, the next section will examine the current conventional wisdom with respect to the effects which the behavior of the Soviet Union has on U.S. military expenditures.

Reaction to USSR?

There is a growing body of empirical research which suggests that the United States does not react to the military expenditure behavior of the Soviet Union. The following are typical of this emerging consensus:

> . . . the non-process input external threat, measured by Soviet military expenditures, appears to have no effect on the MEDM process. This result, while not unexpected given the results from earlier arms race analyses . . . still appears counterintuitive. However, it adds support to the claim that the inertia for military spending is a function of domestic, non-process factors (Majeski, 1983: 512).

and:

> . . . the principal feature of this model—the presumed reactivity of U.S. military spending to Soviet defense outlays—is not empirically vindicated provides little compelling evidence that an "arms race" embodies the primary dynamic underlying U.S. defense expenditures (Cusack and Ward, 1981:460).

The first observation by Majeski is based upon total or aggregate expenditure levels of the United States and the Soviet Union. Cusack and Ward, on the other hand, are unable to find any relationship between the changes in military expenditures of the U.S. and the USSR.

Nor are these two studies the only ones to have reached this same general conclusion. Others who have been unable to find any action-reaction dynamic between the military expenditure behavior of the U.S. and the Soviet Union include: Domke, Eichenberg and Kelleher (1983); Majeski and Jones (1981); Fischer and Crecine (1981); and Nincic and Cusack (1979). Ostrom (1978a) is one of the few who has been able to demonstrate a significant reaction by the United States to Soviet defense spending.

As Majeski suggests, this growing consensus is counterintuitive, particularly when compared with the statements of U.S. defense planners. Former Secretary of Defense Harold Brown has addressed the issue of the Soviet threat quite clearly:

> The most obvious and most significant of these threats is the global challenge posed by the only nation that rivals us in military power--the Soviet Union (Report of Secretary of Defense to the Congress on the FY 1982 Budget, January 19, 1981).

How is one to evaluate the growing empirical consensus in light of such statements? In addition, how much credence can one give to models which generate such counterintuitive results?

What is more surprising is that, given the above, little research has been initiated which investigates other aspects of Soviet behavior to which the U.S. might be expected to react. Domke, Eichenberg, and Kelleher (1983) find positive effects on military expenditures (measured in percentage changes) associated with a rise in East-West tensions. Except for this finding, reactions to other types of Soviet behavior have not been systematically investigated with respect to U.S. military expenditures.

Effects of War

There is some empirical evidence which suggests that war or active combat activity exerts a positive effect on levels of defense spending. There is less agreement, however, as to how "war" is to be measured. It has been operationalized in terms of: U.S. battle casualties (Ostrom, 1978a); U.S. battle casualties adjusted by a defense price deflator (Fischer and Crecine, 1980); as a war mobilization factor (Nincic and Cusack, 1979; Cusack and Ward, 1981); and as a dichotomous dummy variable (Ostrom, 1978a). With respect to this last conceptualization, however, Ostrom was led to the conclusion that war does not have an impact on any of the policy-making rules (the military services excluded since their request was already found to be a function of a war-related variable).

While the presence of war and its positive effects on U.S. defense spending enjoys both substantive plausibility and empirical support, systematic analyses have been limited largely to the post-Korean era. The reasons for the exclusion of the Korean War period have not always been made clear. There appears to be a general consensus that the period surrounding the Korean War is sufficiently unique, such that any attempts to construct a general model which would encompass this period are not likely to prove successful. It is true that the onset of the Korean and Vietnam conflicts can be distinguished from one another by the sudden, unexpected outbreak of the former and the slower, more gradual involvement in the latter--but there is no compelling *a priori* reason why the Korean War period should be excluded from empirical analyses of U.S. military expenditures.

International Tensions/Crises

Finally, the effects of tensions or crises in the international environment have received scant attention. As such, there is little that can be said at this point, other than that it seems plausible that military spending increases would be desirable and/or necessary during a period of heightened international tensions. Furthermore, it is obvious that Presidents are cognizant of the larger international environment:

> I am recommending a significant increase in defense spending for 1977. . . . My request is based on a careful assessment of the international situation and the contingencies we must be prepared to meet. . . . We dare not do less. (Quoted in The New York Times, January 26, 1976.)

While President Gerald R. Ford was undoubtedly basing part of his assessment on the likely future behavior of the Soviet Union, it should be recalled that 1975 was also a year which posed a number of foreign policy crises to his administration, e.g., Turkish threats to the unity of the NATO alliance, the civil war in Angola, and, of course, the fateful Mayaguez operation.

It can be seen that there is a growing body of empirical evidence which suggests that the primary forces which affect the military expenditure behavior of the United States are not to be found in the international environment. The presence of war appears to be the only external input upon which there is any agreement. The next few sections will examine the domestic (internal) side of the U.S. defense expenditure picture.

Macroeconomic Factors

There is even less agreement among researchers as to which, if any, economic factors should be included in explanations of U.S. defense expenditures. Some models incorporate no such factors directly (e.g., Ostrom, 1978a), while others are almost exclusively built around economic variables (e.g., Fischer and Crecine, 1980).

Perhaps the earliest incorporation of an economic term or variable can be found in the original Richardson equations (cf. Richardson, 1960). Not only did Richardson believe that nations built arms in response to the arms acquisition behavior of an adversary, but he also felt that the cost of existing armament levels imposed an economic constraint on future armaments. Indeed, many of the revisions in the basic Richardson model focused on how to more accurately characterize this economic factor (e.g., Caspary, 1967).

Another, more recent approach to incorporating economic factors can be seen in the work of Fischer and Crecine (1980), who build upon the logic of the "Great Identity" (Huntington, 1961). This identity supposedly highlights the tensions between fiscal policy goals on the one hand, and defense and domestic program goals on the other. Defense and non-defense expenditures in a given year cannot exceed available revenues plus/minus some budget deficit/surplus. Fischer and Crecine suggest that the defense budgeting process takes place within the larger context of decisions concerning both total federal spending and the allocation of that spending between defense and domestic uses. Others have also attempted to incorporate this logic into the study of U.S. defense expenditures (e.g., Fischer and Kamlet, 1981; Domke, Eichenberg, and Kelleher, 1983).

Even researchers who do not directly adopt the logic of the Great Identity are reaching the conclusion that economic factors are the principal forces behind U.S. defense expenditure policy making. Nincic and Cusack argue that variations in U.S. defense spending are related to real and desired conditions within the economy. Their basic conclusion is that

> [I]f one removes the effects of war-time mobilization, it is clear that for the United States the principal driving forces in military spending dynamics were (1) the perceived utility of such spending in stabilizing aggregate demand, (2) the political or electoral value of the perceived economic effects arising out of such spending, and (3) the pressures of institutional-constituency demands (1979:101).

In a similar fashion, Cusack and Ward (1981:460) find that

> . . . U.S. military expenditures may be best explained by the political economic cycles through which the economy is manipulated and support is sought from the populace. . . .

Both studies also raise the interesting notion that defense expenditures may be manipulated not only in response to economic concerns, but also to alter economic conditions for political and electoral motivations. The impact of political factors has not been studied widely, as will be shown in the next section.

Political Factors

Though the use of political factors in the context of U.S. defense expenditure policy making has been relatively limited, there has been some attempt to test hypotheses of this nature. One such hypothesis holds that defense expenditures are manipulated in the sense that they are timed in order to enhance electoral support. The major assumption underlying this work is that

> . . . the knowledge that defense spending can produce short-term improvements in income and employment can be turned to an incumbent administration's advantage through imposition of a cycle in the movement of governmental outlays that corresponds to the salience of major elections (Cusack and Ward, 1981:435).

This hypothesis, which stems from some of the substantive literature dealing with the existence of a political business cycle (e.g., Tufte, 1978), has not met with much empirical support.

Other political factors which have received attention include: public opinion, the party of the President, and the effects of certain administrations. What is most interesting about these three factors is that each was operationalized as a dichotomous dummy variable. The results have been mixed. Fischer and Crecine (1980) were not able to conclude that there was an administration effect. The party of the President appears to have some effect on Presidential defense budget behavior. Specifically, Ostrom (1978a) found that Democratic Presidents tend to impose deeper cuts on the budget requests of the military services while simultaneously being more responsive to the Ratio Goal than their Republican counterparts. Finally, Ostrom (1978a) also found that a high degree of negative public opinion vis-à-vis defense spending tended to have a dampening effect on both the military services' request and the Congressional appropriation. Russett (1972) has also investigated how public opinion is related to military expenditures.

Research on the effects of political factors on U.S. defense expenditures has been sporadic and inconclusive. While many seem to agree that there is a "politics" which underlies U.S. defense expenditure policy making, few seem very sure as to how these political factors might operate--or even what these factors might be.

Bureaucratic/Organizational Factors

With respect to bureaucratic or organizational factors, the major finding is that the base is the primary determinant of U.S. military expenditures. What this base is, however, varies across studies. The base has been characterized as: the previous year's expenditure total; the previous actor's defense expenditure decision; and as a fixed percentage of total expenditures.

Regardless of the base employed there is a growing consensus that much of defense budgeting is inertial, i.e., that defense expenditures at time *t* can be understood as a fixed percentage of some base at time *t-1*. The dominance of this base cannot be explained solely in empirical terms. There are both theoretical and methodological reasons why this result is not unexpected. Each of these points will be considered in more detail in the sections that follow.

Before proceeding to an examination of the major theoretical approaches that have been adopted it seems prudent to try to come to some conclusions about the wealth of empirical findings concerning U.S. military expenditures. First, it seems apparent that there are a number of issues over which no clear consensus exists. Second, it seems equally obvious that the following observation by Moll and Luebbert (1980:178) is not without an empirical basis:

> Domestic political-bureaucratic influences are more important than international rivalries in many cases.

Empirical research which has been published during the subsequent three-year period has done little to alter this basic conclusion. If anything, the observation that U.S. military expenditures are predominantly a function of internal, domestic factors is more firmly entrenched than ever. Part of the reason for this growing consensus can be traced to the theoretical approaches that dominate this literature.

Theoretical Approaches

Existing explanations of the U.S. defense expenditure policy-making process may be categorized along a number of dimensions. One might distinguish between explanations on the basis of their characterization of the relevant environmental stimuli as: primarily international, primarily domestic, or a combination of the two. Such a classification scheme would tend to reinforce the conclusions reached in the previous section.

Another approach would be to examine existing explanations in terms of their conceptualization of the policy-making process. By proceeding in this fashion it would be possible to identify those explanations which characterize the defense expenditure process as unitary, organizational, and bureaucratic. One might also attempt to distinguish among models on the basis of their underlying assumptions about decision makers and the decision-making process.

This section will identify different theoretical approaches on the basis of their conceptualization of the structure of the process and on the basis of their characterization of the decision makers which operate within that process. It will be suggested that, with respect to these two criteria, there is little ground upon which to distinguish one set of explanations from another. Moreover, it will be argued that these basic similarities are impeding progress in this field and are at least partially responsible for the growing body of counterintuitive empirical findings.

Conceptualization of the Process

When speaking of a model's conceptualization of the process it is important to note that there are four interrelated questions which must be addressed. The first has to do with the type of policy-making process which is being offered. Allison (1971) offers three types, and his conceptualization of the options available seems to dominate the literature.

Most of the existing explanations of defense expenditure policy making could be described as falling within one of these three alternative theoretical perspectives: (1) Rational Actor; (2) Organizational Process (Politics); and (3) Bureaucratic Politics. The Rational Actor and Bureaucratic Politics explanations are at the two extremes. The former characterizes the process as if it were the result of the actions of a single decision maker, whereas the latter views the process as consisting of the actions and decisions of a number of individuals. Somewhere between the two lies the Organizational Process approach which views the policy-making process as if it were a "conglomerate of semi-feudal, loosely allied organizations, each with a substantial life of its own," and which sees the resulting decisions "less as deliberate choices and more as the output of large organizations" (Allison, 1971:71).

Of the empirical explanations of U.S. defense expenditure policy making with which I am familiar, all could be described as being either Rational Actor or Organizational Process explanations. Arms race models seem to characterize the former, while more recent explanations (e.g., Ostrom, 1978a; Majeski, 1983) are representative of the latter approach. To date no one has successfully formalized and tested a Bureaucratic Politics Model.

In addition to these three basic characterizations of the process one may distinguish explanations on the basis of the number of major actors or steps which each attempts to model. While arms race models deal with the behavior of a single actor, Ostrom's (1978a) Reactive Linkage explanation models the behavior of four major actors or steps.

Finally, one may wish to consider such multi-step models in terms of the between-steps and within-steps relationships which they specify. One type of between-steps model views the defense expenditure decision from one step as the major input into the next step. An alternative conceptualization would be to view the actors or steps as independent of one another. The Reactive Linkage Model (Ostrom, 1978a) is characteristic of the former, whereas the latter strategy has not been adopted. One possible exception to this observation might be the Great Identity/Constant Shares Model (Fischer and Crecine, 1980) which focuses on the generation of Presidential defense budget requests. Whether this step is truly independent of the other steps in the defense expenditure process is not answerable since Fischer and Crecine do not model any of the other steps.

The Great Identity/Constant Shares Model is relatively unique in that it takes a single step and attempts to model various sub-steps or components which comprise the President's defense budget request. It is one of the few models which attempts to deal with the relationships which operate within steps.

In terms of the conceptualization of the defense expenditure policy-making process it is no longer accurate to say that the number of actors in this process is limited to that of a single, reified actor. The increasing complexity of recent explanations of this process is largely a function of the adoption of an Organizational Process approach which, by its very nature, introduces greater complexity.

The criticism that researchers have largely "black-boxed" the state (Moll and Luebbert, 1980:161) must now be modified. By introducing more steps or actors into the process this "black-box" is slowly being replaced. The logical question, however, is: What is this "black-box" being replaced with? I would suggest that, for the most part, this larger "black-box" has been replaced with a number of smaller "black-boxes." Just as arms race models have tended to reify the state, there appears to be a trend toward the reification of actors comprising the Organizational Process approach. What is lacking in many explanations is an explicit characterization of a set of assumptions about decision making and decision makers. Defense budgets are, ultimately, the product of human minds. As such, some attention should be given to this aspect of U.S. defense expenditure policy making.

Characterization of Human Decision Making

There are three related questions which could be addressed within the context of this topic. I will suggest that: (1) the answer to the first question is usually given, but the question and its implications are seldom considered; (2) rarely has the second question even been asked, much less answered; and (3) preoccupation with this question has all but obscured the first two.

The first question has to do with the type of actors that are involved in the process. Are they individuals, small groups, organizations, etc.? In terms of the decision-making behavior, does it matter whether one is talking about groups or individuals? Organizations? Some attention must be given to the implications of the answers to these questions.

The second question deals with the characterization of decision making itself. Most explanations of the defense expenditure process ignore this question, or else they seem to accept a description of decision makers as being "rational." There are, however, other characterizations which are plausible and should be given consideration. Steinbruner (1974), for example, identifies three conceptualizations of decision making which he terms the Analytic, Cybernetic, and Cognitive Process paradigms. Each makes different assumptions about the abilities and limitations of decision makers, and I think that there are definite implications in terms of the way in which one models the defense expenditure process. The failure of most modelers of this process to explicitly consider the characteristics of decision makers is the single greatest weakness of existing explanations.

Finally, considerable attention has been directed toward the specification of a set of decision rules which describe the behavior of decision makers. Given the failure of most researchers to give consideration to the nature of decision making it is difficult to evaluate whether or not these decision rules are accurate representations of the ways in which decision makers actually behave. In addition, it is often assumed that these decision rules remain constant over time. Only Ostrom (1978a) and Lucier (1979) have explored situations under which these decision rules might be altered, though Lucier's analysis was not concerned with U.S. defense expenditure policy making.

This section has been brief, largely due to the fact that the issues raised here have not received proper attention in the literature in this field. I think it would be accurate to conclude that the study of the U.S. defense expenditure policy-making process has not taken place within the larger framework of the study of human decision making, even though the process is dominated by decision makers. While I would not cite this as the sole reason for the set of inconsistent and counterintuitive empirical findings which characterize this literature, I would suggest that it is a contributing factor. To be sure, some of the problems may be a function of data availability, data reliability, certain methodological concerns that will be addressed below, etc., but the lack of explicit characterizations of decision makers can only exacerbate the intellectual conundrum which modelers of this phenomenon face.

Methodological Issues

In this section I wish to raise a number of concerns which I feel have not received adequate attention in the literature. As most of these concerns are taken up in greater detail in the chapters that follow I shall raise only the major dimensions of these issues at this time. It should also be pointed out that these issues are not exclusively methodological concerns, but also reflect substantive and theoretical considerations.

Dependent Variable

There is no universal agreement even on what it is that researchers are trying to explain, though most focus on aggregate levels of defense expenditures. This characterization of the dependent variable is consistent with the prevailing "black-box" conceptualization of the process. In a few instances the dependent variable has been viewed as the annual change in defense expenditures (e.g., Nincic and Cusack, 1979; Cusack and Ward, 1981) or the percentage change in defense expenditures (e.g., Domke, Eichenberg, and Kelleher, 1983). The substantive and theoretical implications of these various forms, however, have not been explored by the authors who have adopted them. This is essential since it could be that "incrementalism" is a methodological manifestation associated with the use of aggregate levels, rather than a theoretical characterization of decision making. The variance in expenditure levels which can be "explained" by the previous year's expenditure level is considerable, but does this represent a statistical or a substantive explanation?

Method of Analysis

Empirical analyses of U.S. defense expenditures are dominated by traditional multiple regression procedures. Problems of specification error, autocorrelation, multicollinearity, etc., need to be given greater attention, particularly since they may affect the types of substantive explanations which are ultimately produced. Consideration should also be given to other types of estimation procedures or approaches, e.g., non-linear regression, residual analysis, etc. These techniques should be employed, though, if there are substantive or theoretical justifications, rather than just for the sake of experimentation.

Empirical vs. Theoretical Causality

Techniques which infer causal relationships on the basis of statistical associations should be rejected in favor of those which have a sound theoretical basis. Some have concluded, for example, that the United States does not react to the Soviet Union on the basis of "statistical causality analysis" (Majeski and Jones, 1981). In a similar fashion, caution should be exercised in accepting variables as explanatory factors on the grounds of statistical rather than substantive robustness.

I would argue that each of these issues is important to the extent that the types of explanations of the U.S. defense expenditure policy-making process are as much a reflection of the underlying methodologies as they are a result of prior theoretical development. Nor is the list of methodological concerns limited to the three mentioned above. Other issues, such as data reliability, for example, have received more attention than those raised above, and for that reason were not included in this discussion.

At this point it seems reasonable to try to pull together some of the major themes brought out in this chapter. This will be done not by reiterating what has already been said, but rather by suggesting research directions.

What Is To Be Done?

The previous overview of the literature which attempts to explain the processes that govern U.S. military expenditures has demonstrated that there is more disagreement than consensus. The contemporary researcher is faced with a set of empirical results which are inconclusive and, in some cases, counterintuitive. Increasingly, scholars are coming to the conclusion that the United States does not react in any significant manner to the behavior of the Soviet Union, despite the contrary claims of defense policy makers.

While there is a growing trend toward Organizational Process explanations of defense expenditure policy making, unitary or Rational Actor models still enjoy great popularity. The major shortcoming, however, concerns the widespread absence of an explicit characterization of the decision-making process and the attributes of the decision makers who reside within that process. These theoretical deficiencies may account for the observation that:

> [A]lternative models contending to explain a given arms phenomenon usually are based on such divergent assumptions and criteria that they seldom have been reconciled with each other. This situation has hindered validation of all models and their findings and presents a virgin field for secondary research efforts (Moll and Luebbert, 1980:178).

What Moll and Luebbert fail to mention is that with respect to the characterization of decision making the assumptions are seldom made explicit or are entirely lacking. The failure to explicitly incorporate a conceptualization of decision making may, for example, account for Ostrom's (1977a) conclusion that an arms race and an organizational process model were analytically indistinct from one another. Closer inspection would reveal that each shares a similar set of *implicit* assumptions about the characteristics of decision makers.

In the chapters that follow I will offer a model of the U.S. defense expenditure policy-making process based upon an explicit characterization of decision makers. The underlying approach is derived from the literature on cybernetic behavior, and it will be used to develop the aforementioned model. It is anticipated that this model, when operationalized and estimated, will resolve many of the problems identified in this chapter.

CHAPTER II

A CYBERNETIC THEORY OF THE DEFENSE EXPENDITURE POLICY-MAKING PROCESS

It was suggested at the end of the previous chapter that one of the basic problems with the current literature in the area of defense expenditure processes is that most models that have been developed suffer from the lack of an explicit theoretical framework. It will be argued that a complete explanation of the defense expenditure process requires a number of essential components: a conceptualization of the process itself; a view of the individual decision maker residing within that process; and a characterization of the set of relevant environmental stimuli.

Using these three components as a starting point this chapter will develop a model of the U.S. defense expenditure policy-making process that is based upon behavioral organization theory. The individuals who operate within this process will be viewed as "cybernetic" decision makers. The principle features of this characterization of decision-makers are: (1) decision makers are "boundedly rational"; (2) decision makers respond to only a limited number of factors in their environment; (3) the search of the environment proceeds in a hierarchic fashion; and (4) the structure of the hierarchy is a function of "survival" considerations. Both the structure of the process and the view of the individual decision maker will be shown to be quite complementary. The third component, the set of relevant environmental stimuli, will be developed and incorporated into the proposed model.

The Structure of the Process

The underlying structure of the process that will be employed is based on behavioral organization theory (e.g., Simon, 1945; March and Simon, 1958; Lindblom, 1959; Cyert and March, 1963) and has been referred to as an "Organizational Process" explanation (cf. Allison, 1971; Ostrom, 1977a; Ostrom, 1978a). The theoretical framework underlying the Organizational Process approach is largely derived from the work of Herbert Simon and his associates. Two essential components of this behavioral theory are: the cognitive limitations of decision makers and the complexity of the environment within which they operate. At this point the distinction between individual decision makers and groups of decision makers (organizations) starts to blur. Simon's argument is that in order to understand the behavior of organizations we first need to have some comprehension about the individuals which comprise them.

Toward this end Simon takes exception with the classical rational model of behavior. He observes that

> [T]he capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solutions are required for objectively rational behavior in the real world--or even for a reasonable approximation to such objective rationality (1957:198).

If humans are not objectively rational does this mean that they are irrational? Simon does not suggest this, but rather offers a view of rationality which, unlike objective rationality, does not place unreasonable cognitive demands on decision makers. Simon uses the term _boundedly rational_ to describe this "limited" rationality which humans appear to possess.

Even with a conceptualization of bounded or constrained rational behavior it is still possible to observe behavior patterns which are quite complex. For Simon, complex behavior need not preclude the possibility of limited cognitive abilities. The solution lies in discovering the _source_ of the observed complex behavior. In Simon's (1969: 25) view the source is _external_ to the decision maker:

> . . . a man, viewed as a behaving system, is really quite simple. The apparent complexity of his behavior over time is largely a reflection of the _complexity of the environment_ in which he finds himself. (Emphasis added.)

There are a number of ways in which this environmental complexity can be reduced or managed by decision makers. One way is through the development of _rules of thumb_. These are routinized and general solutions to recurring types of problems. In a related manner, the boundedly rational decision maker rarely is able to calculate the best course of action, rather he _satisfices_. In other words, the first acceptable alternative encountered is the one that will be chosen as the solution to the particular problem.

The interaction of these two factors, the complexity of the environment and the limitations of the individual decision maker, has been built into a theory of organizational behavior. Cyert and March (1963) view an organization as a coalition of boundedly rational individuals with diverse goals. In addition, they observe that an organization is

> constrained by the uncertainty of its environment, the problems of maintaining a viable coalition, and the limitations on its capacity as a system for assembling, storing, and utilizing information (1963:99).

Given these constraints, organizations, like their human components, tend to be satisficing rather than maximizing entities. What this means is that the organization makes decisions primarily in response to a limited number of variables in the environment, using fairly simple, well articulated decision rules. These decision rules, sometimes called standard operating procedures (SOPs) or rules of thumb, are reflective of the following basic principles of organizational behavior as articulated by Cyert and March (1963:102):

> (1) Avoid uncertainty: look for procedures that minimize informational needs;
>
> (2) Maintain the rules: having adopted a feasible set of decision procedures, abandon them only under duress; and
>
> (3) Use simple rules: rely on individual judgment to provide flexibility around simple rules.

The combined effect of these three principles is that the complexities and burdens of organizational decision making are reduced considerably. Informational needs are kept to a minimum, decision rules which govern behavioral responses remain stable except under extreme circumstances, and these decision rules are kept simple enough to insure their adaptability to changing environmental demands.

As was mentioned earlier, the theory of organizational behavior developed by Cyert and March portrays organizations as being quite similar to the individuals which comprise them. The limitations of individuals are reflected in the limitations of the organizations they create. One of the primary reasons individuals form organizations is to try to reduce the complexity of the environment which surrounds them. This reduction in uncertainty is achieved by factoring a particular problem into a number of less complex problems. These, in turn, are dealt with by the various subunits within the organization. Each subunit is able to engage a number of standard behavioral patterns in the attempt to solve the subproblem.

The following set of assumptions reflect the key elements of the theory of organizational behavior developed by Simon, Cyert, and March, and is adapted from Ostrom (1978d):

(1) Human decision makers are boundedly rational;

(2) In order to deal more effectively with the complexity in their external environment, boundedly rational decision makers form organizations;

(3) Each complex decision problem is factored into a number of subproblems which are dealt with by the subunits of the organization;

(4) Each subunit has a separate goal or set of goals--these goals reflect the roles of the subunits in the overall decision process;

(5) Decision makers in an organization focus on a small number of decision variables--the environment is simplified and only the most obvious information is gathered;

(6) Organizational decision makers will make use of standard operating procedures to cut down on the burdens of decision making;

(7) The standard operating procedures are simple; and

(8) The standard operating procedures are stable in that they will be changed only if they do not work or in response to a major shift in a key environmental variable.

This set of assumptions represents an explicit theoretical foundation for the conceptualization of the U.S. defense expenditure policy-making process. This Organizational Process approach suggests that there are a number of actors in the process, that each deals with a part of the overall problem, that routine solutions to recurring problems will generally be employed, and that decision makers will carry on a limited search of their environments. Although the theory of organizational behavior presented above is largely based upon a theory of individual behavior, there are still some remaining questions that need to be answered. For example, although we are assuming that decision makers in an organization focus on a limited number of variables in their environments, are there any particular types of factors that they are more or less likely to attend to? What are some of the behavioral implications of bounded rationality? What determines whether or not a major shift has occurred in a key environmental variable? The next section will present a view of decision-making that will provide answers to these questions.

A Cybernetic View of Behavior

Karl Deutsch has called cybernetics ". . . the systemmatic study of communication and control in organizations of all kinds." Moreover, he sees it as a

> . . . shift in the center of interest from drives to steering, and from instincts to systems of decisions, regulation, and control. . . . (1963:76)

Cybernetics can thus be viewed as the study of adaptive behavior, whether by individuals or by groups of individuals, i.e., organizations. The notion of adaptation, however, immediately raises the question: What is it that we are adapting to? Relatedly, one might ask what purpose is served by adaptive behavior. Implicit in the study of adaptation is the study of process and change.

The concept of process is aptly conveyed by Herbert Simon in his distinction between state descriptions and process descriptions.

> The former characterize the world as sensed; they provide the criteria for identifying objects, often by modeling the objects themselves. The latter characterize the world as acted upon; they provide the means for producing or generating the objects having the desired characteristics (1969:111).

In other words, state descriptions are more like blueprints or photographs while process descriptions are like recipes or differential equations. What is more important than the distinction between the two, though, is the way in which they are related to each other. In order for process descriptions to have any meaning they must be linked to certain state descriptions—namely, a problem state description and a goal state description. The former is a characterization of "where we are" whereas the latter is a description of "where we would like to be." Process descriptions can then be viewed as those activities which eliminate the differences between the two state descriptions.

A process model of U.S. defense policy making, for example, should attempt to specify an existing state of affairs, i.e., the current state of our national defense capabilities, as well as our desired level of capabilities. The recent debate as to whether or not a "window of vulnerability" exists between the United States and the Soviet Union, as well as what to do about it, is an example of the relationship between state and process descriptions. Moreover, and this is a crucial aspect in terms of our national defense, a process description should tell us how to respond to the perceived differences between the two states of affairs.

Earlier a question was raised pertaining to the goal of adaptive behavior. Simon provides a very explicit answer--survival.

> The distinction between the world as sensed and the world as acted upon defines the basic condition for the survival of adaptive organisms. . . . [G]iven a desired state of affairs and an existing state of affairs, the task of an adaptive organism is to find the correlating process that will erase the difference (1969:111-112).

To be successful, i.e., to survive, requires a continual translation between state and process descriptions. Much behavior can be understood as a complex means-ends chain which is designed to take one from a particular problem state to a given solution state. Of course, all of this is predicated upon the ability to recognize problems in the first place and, secondly, to be able to design solutions to those problems.

The dominant theme underlying all cybernetic models is that of the decision maker as a boundedly, or adaptively, rational entity. Within the cybernetic decision-making paradigm there are a number of basic premises which guide adaptively rational behavior. The first of these can be termed stability maintenance, and is most closely associated with the work of Ashby (1960, 1964).

The clearest example of this aspect of cybernetic behavior is that of "Ashby's cat" (Ashby, 1960:62). Ashby is trying to account for the behavior of a cat sleeping near a fireplace. Ashby notes that the cat does not appear to try to find the optimal spot near the fire by giving consideration to such factors as the amount of heat energy given off by the fire or the heat conductivity properties of the surrounding atmosphere. Rather, Ashby argues, the cat maintains or monitors a set of "essential variables," changing its position only when those variables move outside of some tolerable range. Thus, in observing Ashby's cat we would see it move away from the fire as more wood is added and the blaze begins to roar. Likewise, as the fire burns down the cat should move towards it.

Underlying this form of adaptive behavior is the notion of stability maintenance. The cat is trying to maintain an external body temperature that lies within a narrow range. Whenever this temperature falls outside this range the cat adjusts its position accordingly. This simple system remains stable only as long as the essential variable, in this instance the external skin temperature of the cat, remains within the tolerable range. The cat's behavior is a function of its attempt to maintain the stability of this system. Another simple cybernetic mechanism with which most people are familiar is the home thermostat. Again there is a monitoring device which attends to a small number of variables, in this case a single one, and which activates a response mechanism whenever the essential variable falls outside of the tolerable range. To develop a defense analogy, it might be argued that military expenditures will remain fairly constant, i.e., within narrow bounds, unless some factor in the environment upsets this "stability." One plausible factor might be the presence of a war. In such a circumstance one would expect defense expenditures to increase to meet this environmental demand, and then to return back to previous levels once the threat had passed. That U.S. military expenditures have never returned to pre-war levels suggests that such a simple conceptualization might not be appropriate.

The problem with such simple cybernetic devices is that they avoid the issue of complexity. The organism merely monitors a few critical factors, and each time one of these falls outside some narrow range a simple behavior pattern is triggered which, in turn, attempts to move the factor back towards an acceptable level. The organism is "blind" to the bulk of the external environment that is not directly connected with the essential variables. While this simple cybernetic mechanism might work quite well in explaining the behavior of a cat or a thermostat, many have suggested that it is not an adequate representation of human decision makers who must continually interact with an extremely complex environment.

Simon is one who has tried to grapple with this problem. As noted in the previous section, Simon views the complexity of human behavior as due to not the complexity of the internal structure and organization of man, but rather the complexity of the external environment in which man must operate. The key question then becomes: How do humans react to and manage complexity? Simon's explanation is that we employ certain design principles which allow us to view the complex in much simpler terms. Chief among these are the principles of hierarchy, near decomposability, and redundancy.

Generally speaking, complex systems are those which consist of a large number of parts that interact nonsimply. Simon provides one key to understanding such systems:

> . . . complexity frequently takes the form of hierarchy and [that] hierarchic systems have some common properties that are independent of their specific content (1969:87).

A way to understand complex systems is to exploit the hierarchic structure of such systems by decomposing them into their component systems.

Near decomposability suggests that the forces or activities within a given subsystem are stronger or more important than the activities between different subsystems. To the extent that this is true it is possible to examine subsystems one by one in virtual isolation from one another. Redundancy can express itself in many forms. Three which Simon identifies are:

> (1) Hierarchic systems are usually composed of only a few different kinds of subsystems in various combinations and arrangements.
>
> (2) Hierarchic systems are . . . often nearly decomposable. Hence only aggregate properties of their parts enter into the description of the interactions of those parts.
>
> (3) By appropriate "recoding," the redundancy that is present but unobvious in the structure of a complex system can often be made patent (1969:110).

What is the relationship between these design principles and adaptively rational behavior? For one thing, it provides a framework for understanding how human beings behave and survive in a complex environment—they strive to view the world in simpler terms. The simplifying tools at their disposal are those which I have just identified: hierarchy, near decomposability, and redundancy. Moreover, these same design principles can aid us in our attempt to understand complex phenomena: we identify the hierarchic structure, note any redundancies which exist, and treat the non-redundant subsystems as single entities. In addition, we are largely freed from having to worry about the potentially large web of interactions which might exist among the various subsystems.

Given this characterization of complexity we can begin to view human decision makers as "active Ashby cats." The "activity" revolves around the attempt to structure a complex environment simply so that we can continue to exist and function within it. We are still somewhat "blind" to large segments of the external environment, but we attempt to provide some organization to it, thereby reducing this complexity. Closely associated with this strategy is the assumption of uncertainty control. Unlike the analytic paradigm, the cybernetic paradigm argues that the decision maker avoids the overwhelming task associated with direct outcome calculations of alternatives. How is this done? Steinbruner offers the following answer:

> Cybernetic mechanisms which achieve uncertainty control do so by focusing the decision process on a few incoming variables while eliminating entirely any serious calculation of probable outcomes. The decision maker is assumed to have a small set of "responses" and decision rules which determine the course of action to take once he has received information to which he is sensitive. That is, decision rules associate a given action with a given range of "values" for the critical variables in focus. The "responses" are action sequences, of the character of a recipe, established by prior experience. They are programs which accept and adjust to very specific and very limited kinds of information (1974:66-67).

The preceding passage suggests that cybernetic decision makers strive to maintain some sort of internal simplicity. How does the complexity of the environment affect this principle? Ashby, for example, argues that the complexity of the environment threatens the survival of the adaptive organism, unless that organism is able to develop a response repertoire which is as varied as the surrounding environment.

It would appear that there are contradictory forces affecting the cybernetic decision maker. On the one hand the requirements of uncertainty control argue for internal simplicity, while on the other hand the survival of such organisms in a complex environment demands fairly elaborate response repertoires. It is the tension between these two demands which forms what Steinbruner calls a ". . . major drama of cybernetic analysis" (1974:69).

The solution to this problem is quite simple: in order to deal more effectively with the complexity in the external environment, boundedly or adaptively rational decision makers form organizations. In so doing each decision maker is able to maintain his or her own internal simplicity by focusing on some limited dimension of the external environment. The organization as a whole has the adaptive capacity sufficiently diverse to match the variety found in the environment by means of an internal complexity which is not a property of the individuals of the organization, but rather a property of the collective. Essentially the response repertoire of the whole is much greater than any single individual repertoire. For that matter, given that these individual behavioral responses can be combined in a variety of ways, it is quite likely that the organization's response repertoire will be far greater than the sum of the individual ones.

It can be seen that there is natural dovetailing between the Organizational Process perspective and the cybernetic view of behavior. It should come as no surprise since there is quite a bit of overlap in terms of the relevant literature. The primary assumptions of the Organizational Process approach have already been enumerated. It would, however, be useful to summarize the major premises underlying the cybernetic paradigm.

(1) Cybernetic decision makers are boundedly or adaptively rational.

(2) Much of the external environment is ignored: cybernetic decision makers conduct only limited searches.

(3) "Survival" is the predominant goal of cybernetic organisms, and it also directs the environmental search.

(4) Given the predominance of survival considerations, cybernetic decision makers react to stimuli in a hierarchic fashion; the nature of this hierarchy is a direct function of the extent to which a given factor or set of factors is "survival threatening."

The notion of limited search, combined with the assumption of bounded rationality, implies that change does not occur merely for the sake of change. Invoking the *ceteris paribus* assumption, one should not expect to witness a marked change in behavior unless one or more of the essential variables is perceived to be outside the tolerable range set by the decision maker. In other words, the behavior at time *t* should be very close to the behavior at time *t-1*. This is to be expected, given the limited cognitive abilities and limited search environments posited by the cybernetic view of decision making.

The range of possible reactions which defense decision makers display is a function of two factors: the spatial proximity of the decision-making unit to the external environment; and the perceived importance or salience of the environmental stimulus to the specific decision-making group. By "spatial proximity" I mean to suggest that some actors in the defense expenditure policy-making process are more isolated from the external environment than other actors are. The differing degrees of isolation are, to a large degree, a function of two factors: the primary roles which each actor or set of actors has adopted; and the size of the specific decision-making group. The salience of different environmental stimuli can also be attributed to the roles of each actor as well as to the "position" of each actor within the overall organizational structure. What emerges from a combination of the concepts of spatial proximity and stimulus salience is what I will call a "funnel of constrained reactivity." It will be argued that the defense expenditure policy-making process is such that the range of possible behavioral responses is successively narrowed as one proceeds through the process.

The next section will present a model of the U.S. defense expenditure policy-making process which incorporates the essential features of both the organizational process perspective and the cybernetic theory of decision making. This model will then be examined in order to note differences and similarities with existing explanations of defense expenditure policy making. It will be argued that the model developed below is a more accurate formalization of the theoretical principles outlined in this chapter.

A Cybernetic Model of Defense Expenditure Policy Making

Before presenting the formal structure of this cybernetic model, hereinafter referred to as the CYBER Model, a brief overview of the defense budgetary process is required. The major work on a defense budget begins approximately fifteen to eighteen months before the start of that budget's fiscal year. Prior to 1976 the federal government used a fiscal year which ran from July 1 through June 30. Then, beginning in 1976 and following a three-month transition period, the federal government changed the onset of the fiscal year to October 1. For example, the fiscal year for 1984 (FY 1984) began on October 1, 1983 and will end on September 30, 1984. This means that the initial work on the FY 1984 defense budget began sometime in July 1982. Although numerous individuals participate in this lengthy budget process, the behavior of only the major actors will be modeled. The conceptualization of the defense budgetary process offered below is not a novel one, and for that reason the discussion of it will be rather brief.

Following Stromberg (1970), Ostrom (1978a), Majeski (1983) and others, the defense expenditure policy-making process will be viewed as consisting of four temporally ordered steps corresponding to the four major decisions made within the process. Each decision and the accompanying decision output is linked with a distinct actor or set of actors within the process. The behavior of each group can be seen as the result of the roles and responsibilities which each possesses. The four decision-making groups or units within the process are:

military services, President, Congress, and the Department of Defense (DoD). Their respective decision outputs are the Services' Request (SRQ), the President's Budget Recommendation (PBR), the Congressional Budget Appropriation (CBA), and the DoD Expenditure (SPD).

Several preliminary points should be made. First, the four actors identified above differ somewhat in terms of their internal composition. The number of participants ranges from a small number (e.g., the President and his key advisers) to potentially several hundred (e.g., the Congress). The number of decision makers responsible for the generation of the Services' Request is not widely known, nor is the size of the decision-making group in the Department of Defense. I would suggest that, in the absence of information to the contrary, one could assume that a reasonably small number of individuals are intimately involved with the generation of the various decision outputs. Moreover, I do not expect that the size of each of these groups varies considerably--either within groups or across groups. Implicit in what I have just said is a conceptualization of the second decision-making unit which contains more than one individual. The President is undoubtedly the primary actor in this group, but given the overall complexity of the annual defense budget it does not seem reasonable that he is solely responsible for its production.

Second, while the size of the four decision-making groups may be taken to be relatively similar, their respective roles are quite different. The implication of this statement is that observed behavioral responses can be expected to differ, given similar environmental stimuli, and that these differences can be attributed for the most part to the roles which each group possesses. In addition, the roles are such that they effectively constrain the range of behavioral responses which each set of actors can be expected to display.

The military services are primarily responsible for seeing that defense spending is kept at a level sufficient to meet the security needs of the United States. This is a rather broad organizational goal, and the latitude in behavior which it suggests for the services is equally broad. Defense requirements as interpreted by the services include the ability to meet various levels of conflict ranging from large-scale war to more limited combat activities. Moreover, the services are expected to maintain a level of defense spending which will deter and/or contain the behavior of the U.S.'s major adversaries. In addition to these overt roles, the services have also adopted the role occupied by agencies in a budgetary context (Wildavsky, 1964). Their position as an agency or group of agencies within the larger federal structure suggests that they have more flexibility to pursue "agency interests," even to the virtual exclusion of the interests of other, non-defense agencies.

Presidents do not, however, enjoy such a luxury. Proposed budget expenditures for defense must be made within the context of the entire federal budget. As such, Presidential latitude is constrained to a greater degree than is that of the military services. As chief executive officer, the President must consider the overall fiscal climate within which his budget proposals must be made. Such a situation imposes additional constraints on the range of reactions which Presidents display. The President also has a conflicting role, that of Commander-in-Chief, which requires that he be able to weigh the trade-offs between fiscal and strategic priorities. This provides him with more flexibility, but still not to the degree of that possessed by the services.

There is some question as to whether Congress adopts a programmatic (Kanter, 1972) or a fiscal (Korb, 1973) role toward defense expenditure policy making. What is important is not whether Congress adopts either of these roles to the exclusion of the other, for examples of both strategies can be found, but rather that Congress has the additional responsibility for setting appropriations levels each year. The constraints imposed by this requirement are such that Congress is able to demonstrate even less variability in its behavioral response repertoire than either of the other two actors.

The Department of Defense is even more constrained given that it has the legal obligation to spend most of its appropriated funds. From a bureaucratic budgetary perspective, there is an additional incentive which suggests that subsequent increases in appropriations will be difficult to justify if the Department starts to amass large budgetary reserves. That DoD has both obligated and unobligated funds in a given fiscal year does provide some discretionary expenditure power, though one should expect this group to be the most constrained by its actual and perceived roles.

Finally, while the groups themselves are temporally ordered, this does not imply that their respective decisions are temporally dependent upon each other. This represents a fundamental shift from the logic of the Reactive Linkage Model. There the decision output from each actor fed directly into the decision calculus of the next actor in the process, e.g., the President's budget recommendation resulted from his application of a cutting rule to the initial Services' request.

Such a conceptualization, while quite plausible, implies a temporal dependence among the various groups such that each is largely restrained from acting until the previous decision maker has completed his or her task. I am not entirely convinced that this is the only plausible interpretation of the defense expenditure policy-making process. Furthermore, it seems equally reasonable to assume that each group begins an independent assessment of defense needs, if only in a rough, crude fashion. The model developed below does not completely reject the logic of the Reactive Linkage Model, but instead suggests a shift in the priority which each actor gives to the decision output of the previous actor in the process.

Based upon the discussion above, the following cybernetic model of the U.S. defense expenditure policy-making process is posited.

$$DEC_{it} = DEC_{it-1} + u^* \qquad (2.1)$$

$$[DEC_{it} - DEC_{it-1}] = u^* \qquad (2.1a)$$

$$u^* = \beta_{i1} EV1_t + v^* \qquad (2.2)$$

$$v^* = \beta_{ij} \Sigma EV2_t + w^* \qquad (2.3)$$

$$w^* = \beta_{ij+1} EV3_t + e^* \qquad (2.4)$$

$$e^* = \text{Idiosyncratic Behavior} \qquad (2.5)$$

$$DEC_{it} = DEC_{it-1} + \beta_{i1} EV1_t + \beta_{ij} \Sigma EV2_t + \beta_{ij+1} EV3_t + e^* \qquad (2.6)$$

Equation (2.1) states that a particular defense expenditure decision at time _t_ should, _ceteris paribus_, be very similar to or in the vicinity of the decision made at time _t-1_. In the absence of additional information one would anticipate that "u*" would be random, i.e., non-systematic. This first equation reflects the notion that decision makers search in the region of their previous behavior for clues as to subsequent responses on their part.

There is a very important theoretical distinction underlying the conceptualizations which appear in equations (2.1) and (2.1a). The focus in (2.1a) is on the change in a defense expenditure decision from one time period to the next. There are several reasons for this shift in attention. The first has to do with the manner in which the previous decision is taken into account, i.e., it is viewed as a base from which decision makers deviate only slightly, except under extraordinary circumstances. Second, given the conceptualization of the decision maker as a boundedly rational individual, one would expect the behavioral search to be in the region of the previous decision. Finally, the complexities of the defense budget are such that decision makers do not possess the cognitive capabilities to "re-think" the budget each year nor do they "re-build" the budget each year starting from zero. The implication of this theoretical shift in attention is that if there are significant deviations in behavior from one time period to the next, then these should be observable in ΔDEC_{it} and attributable to factors contained in u*.

This is a fundamentally different explanation than is offered by those who suggest that budgeting proceeds in an incremental fashion, i.e., the budget at time _t_ is a fixed mean percentage of the budget at t-1. Rather than suggesting that there is an inexorable growth pattern, the CYBER Model posits that, in the absence of mitigating factors, the budget decision should remain relatively unchanged from year to year. Proponents of incrementalism suggest that the base remains relatively unchallenged. There is some face validity to the contention that budgets demonstrate a growth pattern, and that this growth is the result of a behavioral response which applies a simple, stable, linear decision rule. Figure 2.1, which contains the aggregate defense expenditure decisions for the four previously identified actors, suggests that there is a definite upward trend in these decision outputs. The strong trend supports the incrementalist notion of the dominance of the base in budgetary decision making, i.e., an inertial factor is the driving force behind each defense expenditure decision.

There is a substantive trap to be avoided here, namely that the acceptance of an incremental explanation suggests a uniformity of behavior from one year to the next--a uniformity which may not exist. The size of the base relative to the annual changes is such that the changes themselves become masked. Figure 2.2, however, shows that there is a considerable amount of variation in the behaviors of all four actors, with the Services emerging as the most volatile. This is consistent with earlier observations concerning the range of behavioral responses available to each actor. From both a substantive and theoretical perspective the behaviors demonstrated in Figure 2.2 would appear to be the more challenging enterprise. Explanations which account for the annual changes can be used to describe the aggregate series, but the converse is not true.

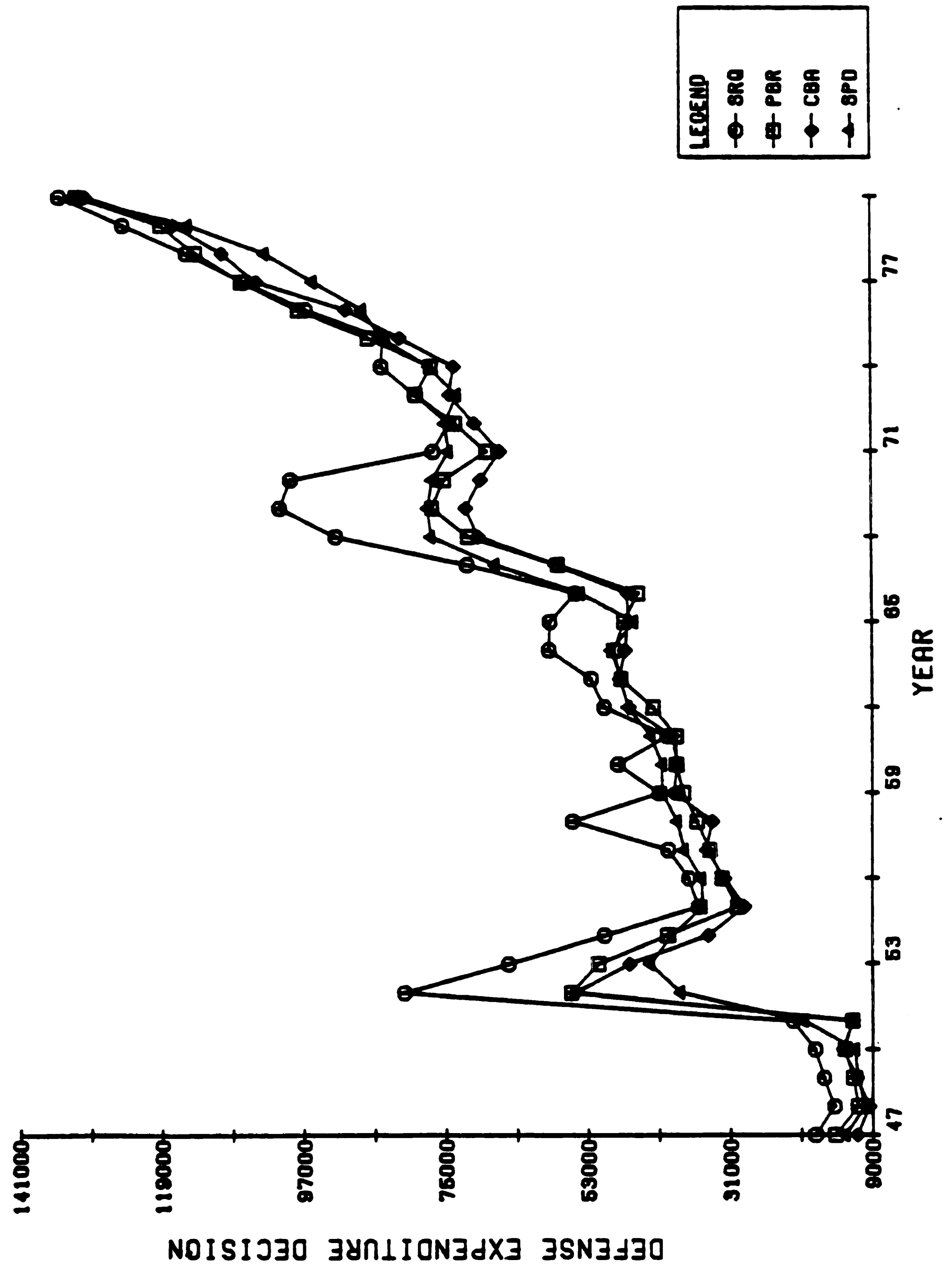


Figure 2.1: Annual Defense Expenditure Decisions

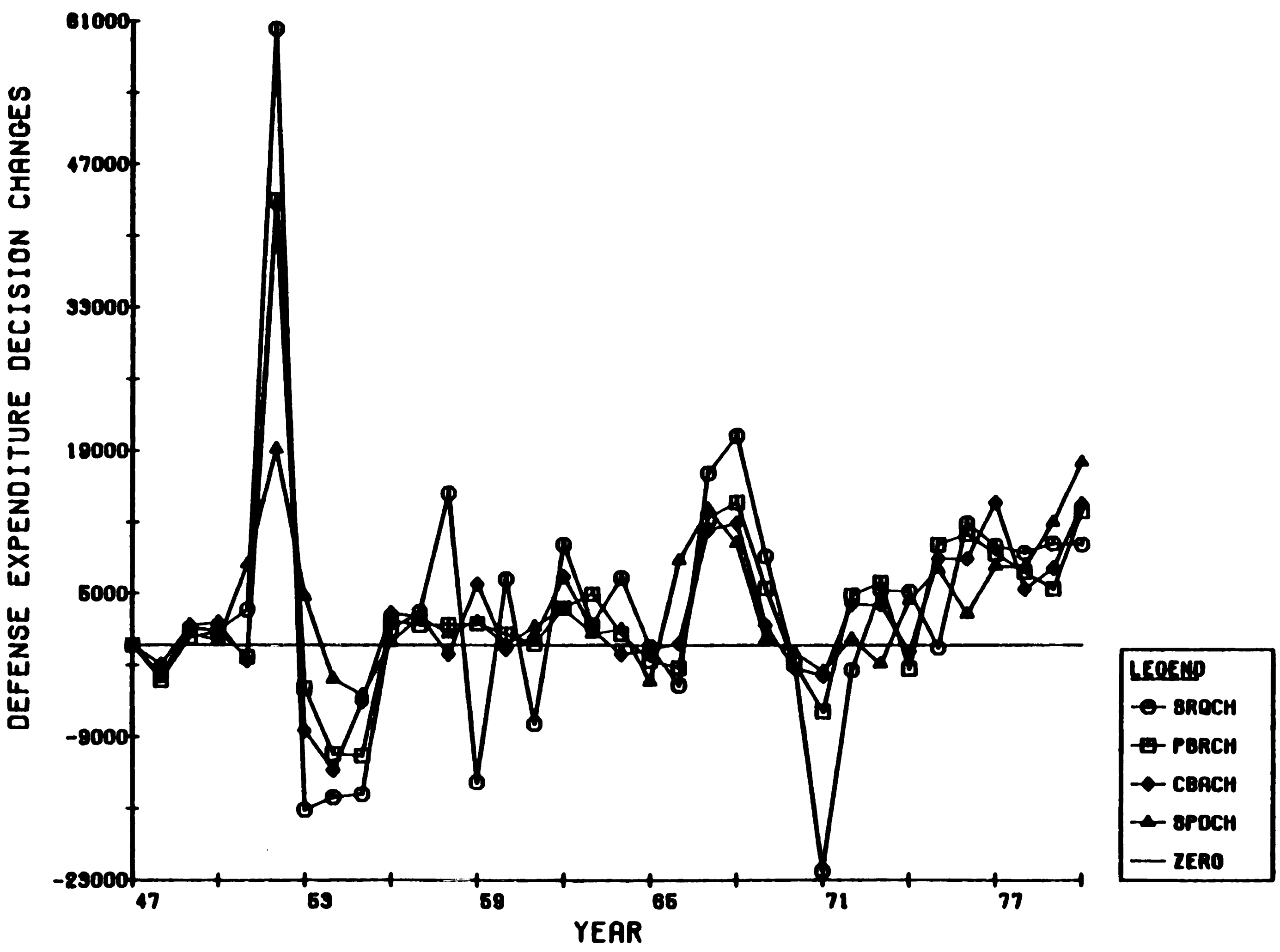


Figure 2.2: Annual Defense Expenditure Decision Changes

The cybernetic view of decision making suggests that changes in behavior are a response to perceived stimuli (essential variables) in the environment. Furthermore, the decision maker, given limited information processing capabilities, attends to only a small portion of this environment. Since survival is the predominant goal of the adaptively rational organism, attention is focused sequentially to those factors which most immediately threaten that survival. It should be possible, therefore, to hierarchically decompose the set of essential variables into subsets which reflect varying degrees of "potential threat" or concern to decision makers.

It should be noted that in the context of the U.S. defense expenditure policy-making process, the concept of "survival" is neither limited to nor primarily concerned with the physical continuation of the various decision-making groups. Survival can and does encompass many different dimensions--national survival, political survival, fiscal survival, survival in a bureaucratic sense, etc. Caution should also be taken in reading the term too literally.

Taken together, equations (2.2) through (2.4) reflect the notion that decision makers sequentially attend to stimuli in their environments. The breakdown of the set of essential variables into first-order (EV1), second-order (EV2), and third-order (EV3) groupings suggests that: a) some factors are perceived as being more important than others; and b) decision makers are able to attend to these factors in a hierarchic fashion. This implies that defense policy makers possess the ability to assign priorities to different sets of stimuli. The operationalizations of the specific factors that are either a first-, second-, or third-order essential variable will be left to

Chapter IV. What is important to note at this point is that the cybernetic view of decision making implies that such a behavioral pattern is not only plausible, but that it, in fact, is an accurate characterization of human decision making.

The logic of the analysis is as follows. First, the strong inertial factor represented by the base is eliminated in that the theoretical focus is on the change in the annual defense expenditure decision. What follows is a hierarchic analysis involving a series of decisions. Figure 2.3 presents a diagram outlining the hypothesized behavioral sequence. Any changes or deviations from the base can be viewed as a series of adjustments, reflecting the decision maker's response to what he deems to be essential variables. Clearly some of these factors demand immediate attention, hence they are dealt with first. Then the next most salient variables are attended to, followed by those at the third level. If one views last year's defense expenditure decision as representing a particular actor's response to the perceived demands imposed by the environment, and if that environment should remain largely unchanged, then it should be expected that the behavior of that actor would also remain essentially the same.

In terms of the empirical analysis that will take place in Chapter IV, at each level I allow each essential variable or set of essential variables to "explain" all that it can before proceeding to the next level. Equation (2.5) states that after the effects of the first three sets of essential variables have been taken into consideration any remaining adjustments can be attributed to idiosyncratic behavior. The ultimate defense expenditure decision, represented by equation

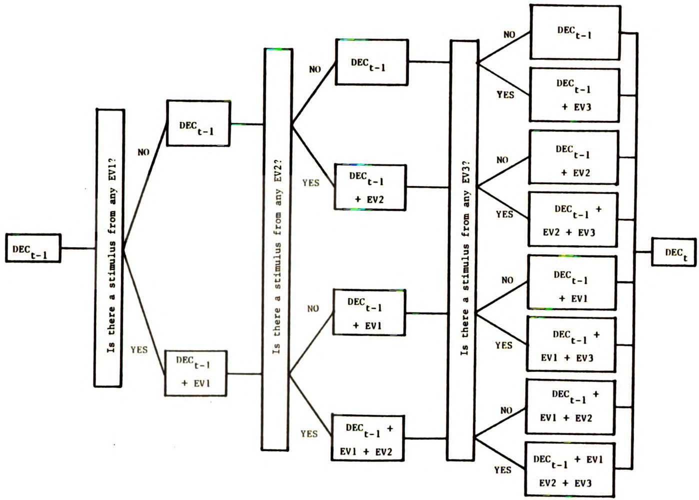


Figure 2.3: Hierarchic Screening Procedure for Actors in the U.S. Defense Expenditure Policy-Making Process

(2.6), can be retrieved through an additive recombination of all levels. The methodology proposed here is rather unique, and Chapter III will be devoted to an exploration of the statistical properties of the model.

CHAPTER III

A METHODOLOGY FOR THE ANALYSIS OF THE CYBER MODEL

This chapter presents a general discussion of the major methodological problems frequently encountered when one is using time-series data. Particular attention will be given to the issues of autocorrelation, multicollinearity, specification error, and seemingly unrelated regressions. After a consideration of the basic causes and consequences of each of these problems, as well as the relationships among them, the CYBER Model of the U.S. defense expenditure policy-making process developed in the previous chapter will be examined to determine the extent to which it avoids these frequently encountered methodological pitfalls.

Methodological Concerns

The multivariate regression model can be represented as:

$$Y_i = \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_\kappa X_{i\kappa} + \varepsilon_i \qquad (3.1)$$

where Y_i and $X_{i\kappa}$ are the dependent and independent variables, respectively, and ε_i represents a stochastic error term. The $\beta_{\kappa s}$ are the regression parameters which one wishes to estimate. The complete specification of this model, however, requires an explicit statement of several rather important assumptions (Kmenta, 1971:348):

(1) ε_i is normally distributed,

(2) $E(\varepsilon_i) = 0$,

(3) $E(\varepsilon_i^2) = \sigma^2$,

(4) $E(\varepsilon_i \varepsilon_j) = 0$ for all $i \neq j$,

(5) Each of the explanatory variables X is nonstochastic,

(6) The number of observations (n) exceeds the number of coefficients (κ) to be estimated, and

(7) None of the explanatory variables can be expressed as a linear combination of the others.

The first four assumptions deal with the specification of the error term, while the remaining three characterize the independent or explanatory variables.

Assumptions (1) and (2) state that the disturbance (stochastic error term) is normally distributed around zero. Furthermore, it is assumed that this distribution is symmetric around its mean. The third assumption, also known as the assumption of homoskedasticity, states that the error term has a constant variance. In other words, one does not expect the disturbances to be greater for higher values of the explanatory variables than for lower values. Assumption (4) implies that the error terms are uncorrelated with each other. When using time-series data this assumption suggests that the disturbance at time t is unrelated to the disturbance at t-1. The assumption of nonstochastic X means that, at least in theory, the values of X are either controllable or fully predictable.

These first five assumptions are necessary, whether one is estimating a simple bivariate relationship or a more complex multivariate model. Assumptions (6) and (7), though, are peculiar only to multivariate regression models. Assumption (6) states that there must be sufficient "degrees of freedom" in order to estimate the regression parameters. In other words, there must be at least one more piece of information than the number of parameters (unknowns) one is trying to estimate. The final assumption requires that the independent variables be independent of each other, i.e., that each explanatory variable provide independent information about the behavior of the dependent variable.

The violation of any of these assumptions can have potentially disastrous consequences for the estimation of a proposed model. In some cases corrective measures are available, but one does not always have this luxury. One problem frequently encountered when using time-series data is autocorrelation; multivariate models are also subject to the problems of multicollinearity. The first of these problems is the result of a violation of assumption (4), while multicollinearity is a problem resulting from the violation of assumption (7). While violations of the other assumptions have very real consequences, they are far less frequently encountered in time-series analysis. Heteroskedasticity (a violation of the third assumption), for example, is much more commonly associated with cross-sectional data. This is because with time-series data, changes in the dependent variable and changes in one or more of the independent variables are likely to be of the same order of magnitude. As such, this methodological problem will not be discussed below. In addition to autocorrelation and multicollinearity a third methodological problem will be considered:

specification error. While not strictly resulting from a failure to meet any of the seven assumptions presented earlier, specification error is still a serious problem. As will be discussed later in this chapter, specification error is the result of an incorrect formulation of the regression model. Three major types of specification error are: the omission of a relevant explanatory variable, the inclusion of an irrelevant explanatory variable, and an incorrect mathematical formulation of the regression equation (Kmenta, 1971:392). The consequences of each of these specification errors, multicollinearity, autocorrelation, and the question of seemingly unrelated regressions will be examined below, followed by a consideration of the trade-offs among them.

Autocorrelation

This problem is frequently associated with the use of time-series data. As previously noted, autocorrelation is a violation of the assumption that the disturbances are mutually independent, i.e., $E(\varepsilon_i \varepsilon_j) \neq 0$ for all $i \neq j$. One explanation for why autocorrelation is often associated with time-series data can be seen if one considers the disturbance term to represent, in part, omitted variables. It then seems quite plausible that if these omitted variables have an impact at time _t_ they also could be expected to have an effect on the dependent variables at time _t-1_ as well. If one has a reason to believe that the omitted variable is trended, then one is in a better position to make some assumptions about the form of the autocorrelation. As it will be demonstrated, this is quite important since the implications for using Ordinary Least Squares (OLS) in the presence of autocorrelation depends, to a large degree, on the form of the autocorrelated disturbances.

While the number of possible error structures is quite large, this discussion by way of illustration will be limited to one of the most frequent forms, that of a first-order autoregressive process.[1] Formally, a regression model with a first-order autoregressive disturbance term can be written as:

$$Y_t = \beta X_t + \varepsilon^* \qquad (3.2)$$

where

$$\varepsilon^* = \rho\varepsilon_{t-1} + \nu_t \qquad (3.3)$$

and ν_t is assumed to meet the basic Gauss-Markov assumptions. In other words, ν_t is normally distributed with a zero mean and constant variance, and $E(\nu_t \nu_s) = 0$ for all $t \neq s$. In addition, one assumes that $E(\nu_t \varepsilon_{t-1}) = 0$ for all <u>t</u> and that $|\rho|<1$. The implications are that the two error terms are uncorrelated with each other and the ε_t is a linear function of only a portion of ε_{t-1} plus a small stochastic disturbance ν_t.

Of central importance to the discussion at hand are the consequences associated with using OLS to estimate a model with autocorrelated disturbances. In general, it can be shown (Johnston, 1972:246 ff.; Kmenta, 1971:273 ff.) that the least squares estimators are <u>unbiased</u>; however, these same estimators are <u>not efficient</u>. It has also been shown that these estimators are <u>not asymptotically efficient</u>, though they are <u>consistent</u>. Turning to the estimated variances of the OLS estimators, it can also be shown that they are biased, and in many cases are seriously underestimated. What all of this means is that while the OLS estimators are unbiased even when the disturbances are autoregressive, there are still serious problems in trying to conduct standard hypothesis tests. Depending upon whether the bias is negative or positive, the calculated acceptance regions will either be narrower or wider than they actually are. A third consequence is that the predictions will be inefficient. Whether or not this is a tolerable state of affairs will be dependent upon what it is that one is trying to say. I shall return to this point later in my discussion of the interrelationships and trade-offs among these various methodological concerns.

Multicollinearity

Multicollinearity is not a problem specific to time-series analysis. As previously noted, multicollinearity is a violation of the assumption that the explanatory variables in a regression model are independent of each other. Many researchers (e.g., Kmenta, 1971; Pindyck and Rubinfeld, 1976; Maddala, 1977) argue that the issue of multicollinearity is not one of existence, but rather one of degree. In the extreme case where one explanatory variable is a perfect linear combination of one or more other explanatory variables

> . . . the sample simply does not give us any information about the response of the dependent variable to changes in one of the explanatory variables while "holding the remaining explanatory variables constant" (Kmenta, 1971:385).

When there is perfect multicollinearity the OLS estimators simply do not exist.

An equally troubling situation is where two or more explanatory variables are highly, though not perfectly, collinear. Johnston (1972:160) has clearly stated the consequences associated with near multicollinearity:

1. The precision of estimation falls so that it becomes very difficult, if not impossible, to disentangle the relative influences of the various X variables. This loss of precision has three aspects: specific estimates may have very large errors; these errors may be highly correlated, one with another; and the sampling variances of the coefficients will be very large.

2. Investigators are sometimes led to drop variables incorrectly from an analysis because their coefficients are not significantly different from zero, but the true situation may be not that a variable has no effect but simply that the set of sample data has not enabled us to pick it up.

3. Estimates of coefficients become very sensitive to particular sets of sample data, and the addition of a few more observations can sometimes produce dramatic shifts in some of the coefficients.

The upshot of all this is that not only is it very difficult, in the presence of near multicollinearity, to disentangle separate effects of explanatory variables, but also the estimated variances for the OLS estimators are likely to be quite large. Under such circumstances the confidence intervals are likely to be quite wide, even to the point of encompassing zero. This is why it is possible that one could erroneously conclude that a particular explanatory variable is insignificant. Once again, the seriousness of this problem is best gauged when viewed in conjunction with other methodological considerations.

Specification Error

Even though specification error is being treated as a methodological concern, the root of this problem is theoretical. As previously mentioned, specification error results when the formulated regression equation differs from the actual theoretical relationship that one is trying to model. In general there are three major types of specification errors. The first type occurs when one includes an irrelevant explanatory variable in a model. Suppose that the true model is given by:

$$Y_i = \beta_1 X_{i1} + \varepsilon_i, \qquad (3.4)$$

but instead the following is estimated:

$$Y_i = \beta_1 X_{i1} + \beta_2 X_{i2} + \varepsilon^*. \qquad (3.5)$$

Kmenta (1971:397-399) shows that by including the irrelevant explanatory variable X_{i2} one actually ignores the restriction that $\beta_2 = 0$. The immediate consequence is a reduction in the efficiency of the estimators, although they will still be unbiased. Furthermore, the estimators of the OLS variances are also unbiased which means that there should be no difficulty conducting valid tests of hypotheses and generating confidence intervals.

A more serious specification error occurs when one excludes a relevant explanatory variable. Suppose that the true model is:

$$Y_i = \beta_1 X_{i1} + \beta_2 X_{i2} + \varepsilon_i, \qquad (3.6)$$

but the following is estimated instead:

$$Y_i = \beta_1 X_{i1} + \varepsilon^*. \qquad (3.7)$$

In this situation, ε^* is actually $\beta_2 X_{i2} + \varepsilon_i$. Note that $E(\varepsilon^*) = \beta_2 X_{i2}$, which generally will not be equal to zero. This in turn will affect the OLS estimator of β_1, since (Johnston, 1972:168)

$$E(\beta_1) = E\ [\beta_1 + (X'X)^{-1}X'\varepsilon^*]$$

$$E(\beta_1) = E\ [\beta_1 + (X'X)^{-1}X'X_2\beta_2 + (X'X)^{-1}X'\varepsilon]$$

$$E(\beta_1) = \beta_1 + (X'X)^{-1}X'X_2\beta_2$$

What this suggests is that the estimator of β_1 will be biased, and the degree of the bias will be a function of the correlation between the included and excluded explanatory variables. In a similar fashion it can be shown that the OLS estimator of the variance of β_1 is both biased and inconsistent. In the case where the omitted variable is uncorrelated with the included variable the estimator of β_1 will be unbiased. Even in this situation, however, the estimator of the variance of β_1 will be biased upward, leading to highly conservative conclusions with respect to hypothesis tests and confidence intervals. These same results can be extended to situations where more than one relevant explanatory variable has been omitted.

The final type of specification error discussed here is that which occurs when the mathematical form of the regression model is incorrectly identified. A frequent example of this is when one estimates a curvilinear relationship using a linear regression model. In other words, the following equation is estimated

$$Y_i = \beta_1 X_{i1} + \varepsilon^* \qquad (3.8)$$

when the correct relationship is actually a parabolic form (Pindyck and Rubinfeld, 1976:191):

$$Y_i = \beta_1 X_{i1} + \beta_2 X^2 + \varepsilon_i, \qquad (3.9)$$

By estimating (3.8) rather than (3.9) one, in effect, excludes a relevant explanatory variable, namely X^2. This being the case, the previous discussion of the exclusion of a relevant explanatory variable also applies to the failure to correctly specify the mathematical form of a model. The OLS estimator of β_1 will be biased and the estimator of its variance will be both biased and inconsistent. The preceding discussion would seem to imply that a researcher should be less willing to abide by Occam's razor and be more willing to specify so-called "kitchen sink" models, i.e., it is better to include irrelevant regressors rather than leave out important ones. Ideally, though, one should strive to develop models which are neither underspecified nor overspecified.

Seemingly Unrelated Regressions

Given a set of equations in which the dependent variables appear only as left-hand side variables, i.e., none of them appear as explanatory variables, it would not be uncommon to assume that the equations were unrelated with each other. Such an assumption, however, may overlook a very subtle connection: namely, that the cross-equation disturbances are correlated with each other. In such a case it could be argued that the equations were only "seemingly unrelated." As Kmenta (1971:517) points out, ignoring these cross-equation connections is a form of specification error in that not all of the relevant information is being utilized.

The consequences of applying OLS to each equation in the system are not as severe as one might expect. The OLS estimators will still be unbiased and consistent. The major problem is that these estimators are no longer efficient, i.e., the OLS estimators are no longer minimum variance estimators. With seemingly unrelated regressions it is more appropriate to employ a generalized least squares estimator. The gain in efficiency obtained by using GLS will be the greatest when the disturbances in the two equations are highly correlated and the explanatory variables are uncorrelated (Kmenta, 1971:524).

There are two general circumstances under which the use of OLS will produce efficient estimators as well. The first is when the equations are not seemingly unrelated but are actually unrelated. The second is when each of the seemingly unrelated equations involves exactly the same variables. In examining the structure of the CYBER Model it would seem that the potential for having a set of seemingly unrelated regressions exists. None of the dependent variables appears as an explanatory variable in a subsequent step, nor is the set of explanatory variables the same for all actors. There is, however, a sense in which the equations in the CYBER Model are related. It will be recalled that the actors in this system, as a last check on their own behavior, look to the behavior of the previous actor in the process. These third-order essential variables, which will be operationalized in the next chapter, represent subtle connections which link one set of equations to another. As such, the question of seemingly unrelated regressions does not appear warranted in the context of the CYBER Model.

To this point in our discussion the problems of autocorrelation, multicollinearity, specification error, and seemingly unrelated regressions have been considered in isolation from one another. These methodological concerns need not, however, be independent of one another, and to consider them in this fashion does not permit an appreciation of the richness of the dilemma. The next section will examine these interrelationships and will speculate on some of the trade-offs that one might wish to consider before deciding on a particular modeling strategy.

Methodological Trade-Offs

In discussing the failure to include a relevant explanatory variable it was noted that the OLS estimators are biased to the extent that the included and excluded regressors are correlated. When they are uncorrelated the estimators will be unbiased, though there will be an upward bias in the variances. By inserting a relevant explanatory variable which is correlated with an existing regressor, though, one is knowingly introducing multicollinearity into the model. The problems resulting from severe multicollinearity are such that the researcher may wish to ask whether the reduction in bias is worth the ensuing increase in imprecision. When there are more than two explanatory variables the correlations among them need not be very large in order to evidence substantial multicollinearity. The decision to include or exclude a potential regressor is not a simple one, and there are no clear-cut rules for helping one to make this decision. As Milton Friedman has eloquently stated:

> The capacity to judge that these are or are not to be disregarded, that they should or should not affect what observable phenomena are to be identified with what entities in the model, is something that cannot be taught; it can be learned but only by experience and exposure in the "right" scientific atmosphere, not by rote. It is at this point that the "amateur" is separated from the "professional" in all sciences and that the thin line is drawn which distinguishes the "crackpot" from the "scientist." (Quoted in: Rao and Miller, 1971:52.)

Friedman is essentially arguing that practical experience be the guide; the careful consideration of two general questions may be more useful. First and foremost of these is: What does the theory suggest? As will be argued later, the theory underlying a model can provide clues as to the structure and specification of the model. The second question concerns the types of inferences one wishes to make. Is the primary inferential target that of "explanation" or "prediction"? The answer should provide guidance as to whether precision or unbiasedness is most desirable. For example, if one is trying to "explain" a given phenomenon in the sense that one is attempting to find out which independent variables account for significant changes in the dependent variable, then the precision of the estimators becomes the central concern. As shown previously, one of the possible consequences of multicollinearity is that one may erroneously delete important regressors. If, on the other hand, the model is to be used largely for predictive purposes, then the accuracy or unbiasedness of the estimators becomes crucial.

One frequent interpretation of autocorrelation is that it is the result of the omission of relevant explanatory variables which are themselves autocorrelated. Such an interpretation can be viewed as a special case of the specification error committed by excluding one or more relevant regressors. As noted earlier, when these excluded variables are uncorrelated with the included ones the OLS estimates are unbiased. This is also the case when the omitted variables are autocorrelated. There is, however, an additional loss in efficiency.

While under certain conditions there appears to be only a minimal trade-off between specification error and autocorrelation, there is a theoretical relationship between the two which needs to be explored. I am referring to the _specification_ of the autocorrelation itself. Autocorrelation results from a violation of the assumption that $E(\varepsilon_i \varepsilon_j) = 0$ for all $i \neq j$. It is important to note that one does not observe the disturbances (ε_is) directly. Instead one observes the residuals ($\hat{e}_i$s), and from them draws inferences about the disturbances. There is more than just a trivial difference between knowing the form of ε _a priori_, on the one hand, and inferring ε from observed $\hat{e}$, on the other. It should be stressed that autocorrelation is a theoretical assumption which one makes beforehand about the unobserved disturbances. It is not inconceivable to have a situation where the _residuals_ display autocorrelation even though the _disturbances_ are not autocorrelated. The issue is first a theoretical one, and second an empirical one, rather than the other way around.

In addition to the theoretical question of whether the disturbances are autocorrelated there is the related issue of the form of the autocorrelation. As noted earlier and presented in equations (3.2) and (3.3), a first-order autoregressive process is most frequently encountered when using time-series data. If one posits a first-order autoregressive process when in fact the disturbances have a more complicated structure, then one may actually generate estimates that are even less efficient than had one gone ahead and used OLS.[2] Returning to (3.3), there is the additional problem that ρ is generally unknown and must be estimated. Rao and Miller (1971:74-76) have shown that if the estimated value $\hat{\rho}$ is different from the true parameter value ρ there can be a fairly large decrease in the precision of the estimates. In other words, mechanical correction procedures may not be the proper panacea, particularly when the existence and form of the autocorrelation are both subject to theoretical debate.

Table 3.1 presents a clearer picture of the trade-offs that I have been discussing. For example, it can be seen that multicollinearity and autocorrelation differ largely in terms of the efficiency of the OLS estimators of β. In terms of the estimator of the variance of β there is a clear trade-off between precision and bias which must be taken into consideration. As mentioned earlier, there are no clear-cut decision rules that one can employ. When such methodological trade-offs exist the researcher will have to decide what it is that he/she wishes to say. Some of these problems can be put into clearer focus by looking at an actual example, the CYBER Model.

Table 3.1: Properties of OLS Estimators in the Presence of Different Methodological Problems

	Multicollinearity	Autocorrelation	Specification Error[a]
$\hat{\beta}$	Unbiased	Unbiased[c]	Biased[d]
	Consistent	Consistent[c]	Inconsistent[d]
	Efficient	Inefficient	
	Asymptotically Efficient	Asymptotically Efficient	
$Var(\hat{\beta})$	Imprecise[b]	Biased	Biased

[a] Specification error is taken to be of a specific form, namely the exclusion of a relevant explanatory variable.

[b] Imprecise in the sense that the estimates of the sampling variances are generally so large as to make them ineffective for the purposes of hypothesis testing, construction of confidence intervals, etc. These estimates are, however, BLUE.

[c] This is not true when the autocorrelation is due to omitted explanatory variables which are themselves serially correlated and which are correlated with the included explanatory variables.

[d] This is not true when the included and excluded explanatory variables are uncorrelated with each other.

The MSRA Methodology

The CYBER Model of the U.S. defense expenditure policy-making process was developed and presented in Chapter II. The general structure of this model is re-presented in equations (3.11) to (3.16):

$$DEC_{it} = DEC_{it-1} + u^* \qquad (3.11)$$

$$[DEC_{it} - DEC_{it-1}] = u^* \qquad (3.11a)$$

$$u^* = \beta_{i1} EV1_t + v^* \qquad (3.12)$$

$$v^* = \beta_{ij} \Sigma \; EV2_t + w^* \qquad (3.13)$$

$$w^* = \beta_{ij+1} EV3_t + e^* \qquad (3.14)$$

$$e^* = \text{Idiosyncratic Behavior} \qquad (3.15)$$

$$DEC_{it} = DEC_{it-1} + \beta_{i1} EV1_t + \beta_{ij} \Sigma \; EV2_t + \beta_{ij+1} EV3_t + e^* \qquad (3.16)$$

where all the variables are as previously identified. The focus of this discussion will be on the methodological characteristics of this model. The structure of the CYBER Model is somewhat unique: the residuals from one equation in the system serve as the dependent variable in the next step. There were only two other models which I could locate in the literature which are of a similar form (Ostrom, 1977b; Rattinger, 1975). I shall call this type of analysis, where residuals from one step feed into the next step as the dependent variable, "multi-stage residual analysis" (MSRA).

Most econometric treatments of residuals are concerned with either their transformation so as to make them conform to the underlying assumptions or their analysis in order to obtain results which are unbiased, more efficient and/or consistent. In a recent article, though, Kugler (1983) examines the use of residuals as proxies for variables that cannot be measured directly. Kugler posits four conditions which must be met in order for residuals to be used in such a fashion:

> a. The impact of the targeted variable must be sufficiently large to dominate the size and variations of the residual term.
>
> b. The hypothesized relationships among the dependent variable, the measured explanatory variables, and the variable associated with the concept to be tested must be accurately specified.
>
> c. The targeted variable must be statistically independent of the measured elements in the estimating equation.
>
> d. The residuals must behave empirically in concordance with the theoretical expectations engendered by the concept to be tested (1983:106).

Even though Kugler is discussing the use of residuals as independent variables, some of the logic underlying their use is still relevant to the MSRA methodology.

Kugler's first condition is based on his observation that the

> main reason residuals are not routinely used as proxies for desired concepts is that other variables, excluded from analysis along with the targeted variable, have equal claim to the variations in ξ^* (1983:110).

In other words, unless the targeted variable is large relative to the other elements which are "inhabiting" the residual term, it is unlikely that one will be able to discern its individual effect. This condition is not as crucial to the MSRA methodology since it is concerned with trying to "explain" the variation within the residuals rather than with using those residuals to explain variations in a dependent variable.

The second and third conditions are directly related to the problems of specification error and multicollinearity that were discussed earlier. The MSRA methodology is also based upon the assumption of a correct specification. The cybernetic theory of decision-making presented in Chapter II, though, argues that decision makers respond in a hierarchical fashion, attending to those factors which are deemed most critical before examining lower-order variables. While one might argue that MSRA is intentionally introducing specification error because relevant explanatory variables are omitted at each stage, the fact that the specification and form of the CYBER Model is fully consistent with a cybernetic theory of decision making obviates this problem.

Whereas Kugler requires that the proxy variable represented by the residuals be unrelated to the other independent variables in the model, the MSRA approach is based on the premise that such a relationship does exist. The difference between the two, of course, is due to the fact that Kugler treats the residuals as independent variables while MSRA views them as dependent variables. This difference, however, obscures the fact that there is substantial agreement between the MSRA approach and Kugler on the question of multicollinearity. Both recognize that multicollinearity can make parameter estimates so imprecise that it becomes difficult, if not impossible, to disentangle the individual effects of multiple explanatory factors. Part of the underlying rationale of the MSRA methodology is that by including all of the relevant explanatory variables in a single equation model one would be introducing substantial multicollinearity. An empirical comparison of these two approaches will be presented in Chapter IV.

Finally, Kugler's fourth condition is a restatement of the notion that there should be some connection between theory and data. Neither should rest independently of the other. Kugler suggests that theory alone is not enough to justify the use of residuals as proxies; rather, independent tests should be set up to provide some empirical corroboration. While the MSRA approach does not disagree with the spirit of this condition, it does give primacy to theoretical development. Following a few concluding observations about the MSRA methodology, the question of empirical support will be addressed directly.

At the beginning of this chapter four methodological concerns were identified and discussed: autocorrelation, multicollinearity, specification error, and seemingly unrelated regressions. To what extent does MSRA avoid, succumb to, or confound these basic problems?

Autocorrelation becomes a problem only if the source or structure of the autocorrelation is ignored. The CYBER Model explicitly posits the source of the systematic behavior of the residuals at each step in the model. Ostrom's (1977b) three-tiered model of defense budgeting is the inspiration for the MSRA approach, and he is not unaware of the potential methodological pitfalls associated with such an approach. With respect to autocorrelation he notes that

> . . . the residuals from equation 1a are expected to be systematic and the cause of the nonrandomness has been posited. Hence there is no need to assume any of the usual error dependency processes are operating (1977b:27).

The same observations are relevant to the CYBER Model and the MSRA approach employed in the estimation.

In the case of the CYBER Model there is substantial collinearity among the independent regressors. While MSRA does not eliminate the multicollinearity, it does alleviate it. What I have in the CYBER Model of the U.S. defense expenditure policy-making process is the superimposition of several marginal considerations. A conventional single-equation model of the process might not be able to separate out the individual marginal calculations which are being made. This is largely an empirical question and will be investigated below.

As was mentioned earlier, the most obvious methodological hazard which the MSRA approach suggests is that of specification error. One argument against this charge has already been offered--namely, that the form and structure of the model are directly derived from an explicit theory of human decision making. Theoretical justifications aside, however, there is the question of whether one is able to tolerate the bias associated with the exclusion of relevant explanatory variables. Recalling the discussion earlier about the trade-offs between specification error and multicollinearity it was argued that the unbiasedness was sacrificed in order to obtain estimates with greater precision. The decision as to which was preferable rested, in part, on what type of inferences one was interested in making. That no guidelines exist to assist in this decision is of little comfort.

In the attempt to determine the appropriateness of the current conventional wisdom of military expenditure models it seems that priority should be given to obtaining estimates which are as precise as possible. Otherwise, I may be led to conclude that some factors are not significant when in fact they really are. If these estimates happen to be somewhat biased, that might be a small price to pay if I am able to demonstrate, for example, that the United States responds in some fashion to the behavior of the Soviet Union.

Finally, I should note a potential methodological problem associated with equation (3.14). From the discussion of the CYBER Model in the previous chapter it was argued that at this stage the decision maker sought information from the previous actor in the process—a final check on one's own assessment of the environmental demands and the appropriate response to them. What is important to this discussion is the fact that decision makers are utilizing information from each other. This connection, however subtle, is important because if no such link existed between the various actors in the process the possibility exists that the disturbances might be correlated across blocks of equations. In such situations OLS produces estimates which are inefficient since not all of the information is being utilized, i.e., information about the mutual correlation of the disturbances is being ignored. These inefficient estimates are still, however, unbiased and consistent providing that none of the other methodological problems exist. The temporal recursivity of the CYBER Model also argues against this potential hazard.

NOTES

[1]For a discussion of this simple form and more complex autoregressive processes, see Hibbs' (1974) "Problems of Statistical Estimation and Causal Inference in Time-series Regression Models."

[2]See, for example, Robert F. Engle, "Specification of the Disturbance for Efficient Estimation," Econometrica, 1973.

CHAPTER IV

OPERATIONALIZATION AND ESTIMATION OF THE CYBER MODEL

Chapter II posited a general form of a cybernetic model of the U.S. defense expenditure policy-making process. This chapter will present the functional form of this model—previously identified as the CYBER Model. A necessary first task will be the operationalization of the variables comprising the subsets of essential factors. Following this exercise several hypotheses concerning the direction and relative magnitude of the parameter coefficients will be derived, the coefficients will be estimated, and the derived hypotheses will be evaluated in light of the empirical evidence. The chapter will conclude with a comparison of the MSRA methodology with a more straightforward multiple regression estimation approach.

Definitions, Operationalizations, and Data Sources

For each variable in the CYBER Model the following strategy is employed. First, each variable is classified according to whether it is a dependent variable or whether it is one of three subsets of independent variables, i.e., the subsets of "essential variables." Within each of these four groupings the variables will be defined and operationalized, and the data sources will be identified for each.

Additional comments pertaining to the operationalized variables will appear at the end of each section when necessary.

Dependent Variables

As noted in Chapter II, the dependent variables of interest are not, as is typical of most research in this area, the aggregate annual defense expenditure decisions. Rather, the focus of this analysis is on the yearly defense decision changes. The theoretical and substantive distinctions between these two forms of the dependent variable have already been noted and will not be repeated here. In the operationalizations below, however, the aggregate form of the variable is presented first, followed by the transformed versions.

DEC_{1t} DEFINITION: proposal by military services for amount of defense expenditure each fiscal year

OPERATIONALIZATION: Joint Chiefs of Staff October 1 submission to the Secretary of Defense

SOURCE: Office of the Assistant Secretary of Defense (Comptroller), Director for Program and Financial Control[1]

ΔDEC_{1t} DEFINITION: proposed annual change (increment or decrement) by military services for defense expenditures

OPERATIONALIZATION: $DEC_{1t} - DEC_{1t-1}$

SOURCE: Office of the Assistant Secretary of Defense (Comptroller), Director for Program and Financial Control

DEC_{2t} DEFINITION: Presidential defense budget request to Congress each fiscal year

OPERATIONALIZATION: budget proposed by the Office of Management and Budget for "Department of Defense - Military"

SOURCE: Congressional Quarterly Almanac (96th Congress, 2nd Session, Vol. 36, p. 186)

ΔDEC_{2t} DEFINITION: President's proposed annual change (increment or decrement) in the budget for "Department of Defense - Military"

OPERATIONALIZATION: $DEC_{2t} - DEC_{2t-1}$

SOURCE: Congressional Quarterly Almanac (96th Congress, 2nd Session, Vol. 36, p. 186)

DEC_{3t} DEFINITION: amount of money appropriated for defense each fiscal year by Congress

OPERATIONALIZATION: Congressional appropriation for "Department of Defense - Military"

SOURCE: Congressional Quarterly Almanac (96th Congress, 2nd Session, Vol. 36, p. 186)

ΔDEC_{3t} DEFINITION: annual change (increment or decrement) in Congressional appropriation for "Department of Defense - Military"

OPERATIONALIZATION: $DEC_{3t} - DEC_{3t-1}$

SOURCE: Congressional Quarterly Almanac (96th Congress, 2nd Session, Vol. 36, p. 186)

DEC_{4t} DEFINITION: total defense expenditures by the U.S. each fiscal year

OPERATIONALIZATION: "Department of Defense - Military" expenditures

SOURCE: The Budget of the United States Government (Washington, D.C.: 1947-1980)

ΔDEC_{4t} DEFINITION: annual change (increment or decrement) in "Department of Defense - Military" expenditures

OPERATIONALIZATION: $DEC_{4t} - DEC_{4t-1}$

SOURCE: The Budget of the United States Government (Washington, D.C.: 1947-1980)

First-Order Essential Variables

First-order essential variables (EV1) consist of the set of factors which most immediately threaten the "survival" of the cybernetic organism. In the context of the U.S. defense expenditure policy-making process this statement should not be taken too literally. "Survival" does not necessarily refer to the physical continuation of the several decision-making groups in the process. It may refer to survival in a narrow bureaucratic budgetary sense, i.e., the budgetary "health" of the actor can be gauged by how well that actor fares in the annual allocation of finite budget resources. Under this conceptualization "survival" may be nothing more than the maintenance of a constant budgetary share from one year to the next.

In order to understand the concept of survival as it is being used here, one must first specify the set of relationships implied by the terms "essential" and "first-order." Essentiality to the cybernetic decision maker is taken to recall the notion that the cognitive limitations of said decision makers are such that they are only able to respond to a subset of all the potentially relevant environmental stimuli. From a theoretical perspective it should be possible to specify a set of general factors *a priori* to which the decision makers can reasonably be expected to attend. The empirical question as to which specific variables precipitate behavioral responses will be addressed in this analysis. Distinguishing between first-, second-, and third-order essential variables implies a hierarchical relationship among the various factors, i.e., some factors are clearly more important than others. Finally, there is the obvious question: Essential to whom? Given my focus on the annual defense expenditure policy-making process, the answer includes the major actors previously identified: the military services, the President, the Congress, and the Department of Defense.

First-order essential variables also can be distinguished from lower-order essential variables by their immediacy. Responses to these factors cannot reasonably be delayed without the decision maker assuming greater risks. In other words, the presence of such first-order factors argues against the defense planner being able to "conduct business as usual." The immediacy of such factors is reflected in the primacy attributed to them by the decision makers themselves.

The literature provides no clear guideposts as to what factor or factors might be included in the decision maker's set of first-order essential variables. A plausible argument may be made that periods of high combat activity, what the layperson might refer to as war, are clearly situations in which defense budget operations can no longer be conducted in a normal fashion. The most salient feature of these combat operations are the casualties to U.S. personnel which may occur. This salience extends not only to the defense decision makers, but also to the general U.S. public. The latter will be discussed in the context of negative public opinion vis-à-vis defense operations.

The salience of U.S. casualties to defense policy makers is actually twofold. In the first place, casualties suffered by U.S. troops serve as a proxy for the magnitude of the combat operations themselves. While other factors may be involved, e.g., the killing prowess of enemy troops, the greater the number of troops that become involved in the field the greater the number of potential casualties. The magnitude of the combat operations has, of course, a direct bearing on the expenditures necessary to maintain those operations. In the second place, the number of casualties gives defense planners some indication of likely replacement costs associated with the loss of men and material. Battle casualties, then, can serve as a reasonable proxy for the costs associated with U.S. combat operations. Although two conceptually distinct costs can be identified ("maintenance costs" vs. "replacement costs"), empirically they are difficult to isolate from each other.[2] The true salience of U.S. battle casualties to defense decision makers is that they provide an indication of the magnitude of an immediate threat—a threat associated with active combat operations.

This first-order essential variable has been termed USE and is defined and operationalized as follows:

USE_{t-1} DEFINITION: intensity of combat operations involving U.S. troops

OPERATIONALIZATION: lagged annual U.S. casualties (in 1000s) which result from enemy action

SOURCE: Statistical Abstract of the United States (Washington, D.C.: U.S. Government Printing Office, 1947-1980)

There is a general consensus in the literature that war is a significant exogenous threat which affects U.S. defense expenditures. It should be stressed that the USE variable is meant to serve as a surrogate for the intensity of U.S. combat operations. In the time period covered by this analysis there are two intervals, corresponding to the Korean and Vietnamese conflicts, in which one observes high levels of U.S. casualties. These are also the two periods of highest combat activity.

Russett (1970) has noted that, following the end of a war, U.S. defense spending has never returned to pre-war levels. The additive form of the USE variable captures this "ratchet effect" during periods of escalating casualties. Two final points concerning this first-order essential variable are in order. First, it has been transformed by dividing each observation by 1,000. This transformation only has the effect of reducing the estimated coefficient by the same factor. Moreover, the USE factor is now expressed in a metric similar to that of the dependent variables, thereby facilitating the substantive interpretation of the estimated coefficients. Second, the USE variable is lagged by one time period. This is done to bring the time frames of the dependent and independent variables into closer agreement with each other. The former is expressed in fiscal years while the latter is reported in calendar years. Even lagging casualties by one time period does not fully synchronize the two variables, but as Fischer and Crecine (1980) have argued, combat activity during one time period can serve as a reasonable expectation for the level of combat in the subsequent time period.

Second-Order Essential Variables

As previously mentioned, second-order essential variables (EV2) elicit behavioral responses, though they are attended to only after decision makers have dealt with questions related to U.S. combat operations. In other words, in the absence of any direct combat activity these factors receive immediate attention from decision makers. In the hierarchy of relevant environmental stimuli these variables occupy the second tier. The immediacy of the response is triggered not so much by the immediacy of the stimulus, but rather by the presence or absence of other factors deemed to be more important by the actors in the defense expenditure policy-making process.

An examination of the defense expenditure policy-making literature has suggested four dimensions relevant to these actors:

(1) Long-term threats posed by major adversaries;

(2) International crises or tensions (short-term threats);

(3) Domestic factors related to economic performance; and

(4) Domestic political support.

Each of these dimensions, along with the variables selected to represent them, will be discussed below.

Long-term threats are those which are posed by one's major adversary. With respect to the United States it is quite clear that the Soviet Union fulfills this role. The American public has been warned consistently of the dangers associated with a failure to remain vigilant in opposing the Soviets. Secretary of Defense Casper Weinberger put the issue in no uncertain terms:

> You're making a terrible mistake if you try to adjust your defense budget to food stamps, harbor dredgings and highways. It's the threat that makes the budget. You've got to build your budget on the Russian budget. (Quoted in the Sunday New York Times Magazine, February 6, 1983.)

This passage suggests that one of the key elements of the Soviet threat is the Soviet defense budget. This notion is certainly consistent with the Arms Race literature which has used, almost without exception, expenditure data to operationalize and test the parameters of a US-USSR action-reaction model.

There are a number of problems, however, associated with the use of Soviet data.[3] In the first place, there is no agreement as to what is actually included in the budget figures released by the Soviet Ministry of Defense. It is felt by some that the declared Soviet defense budget excludes such factors as military R&D, stockpiling, and civil defense. As the SIPRI 1980 Yearbook notes, upward adjustments to include such expenditures are highly speculative. Secondly, Soviet pricing practices are quite different from those in the West (Holzman, 1980). Objectives are set in real terms with no requirement for money prices to coincide with the real costs of goods and services. The implications here are that U.S. decision makers may have consistently underestimated the true defense burden of Soviet military expenditures. A third problem arises when one attempts to convert ruble estimates into dollars, since the chosen exchange rate should reflect the purchasing power of the ruble in the Soviet Union to that of a dollar in the United States. The official exchange rate is considered inadequate for this purpose, and there is no consensus on an alternative.

These technical problems notwithstanding, the major shortcoming of all existing Soviet defense expenditure series is that they reflect "current estimates" of past Soviet behavior, rather than the perceptions of U.S. defense policy makers at the time decisions about our military expenditures were being made. What is sorely needed is such a data set—one which attempts to characterize the "Soviet threat" as perceived by U.S. decision makers at the time their defense budget decisions were made. The construction of such a series is beyond the scope of this analysis. Instead, I incorporate two dimensions of the Soviet threat: military expenditures and relative strategic strength. The former tries to capture the change in the magnitude of the Soviet defense effort, while the latter can be viewed as an indication of the relative danger to the United States posed by Soviet nuclear-capable delivery vehicles.

$SOVCH_t$ DEFINITION: annual change in total military expenditures by the USSR

OPERATIONALIZATION: (military expenditures by USSR in year t) - (military expenditures by USSR in year t-1)

SOURCE: Stockholm International Peace Research Institute, World Armaments and Disarmament, SIPRI Yearbooks, 1968/69, 1979-1982.

The Soviet defense budget is viewed as threatening not only because of its sheer magnitude but also because of what those budgetary funds represent in terms of men and material. There is more than a symbolic threat posed by the vast numbers of Soviet troops, tanks, combat helicopters, strategic nuclear weapons, etc. The threat is also a function of the placement of these forces, their degree of combat readiness, their command structure and quality, and so forth. Our own experience in Vietnam and the Soviet difficulties in Afghanistan serve as reminders that brute strength in numbers and technology alone are no guarantees of battlefield success. And yet, our decision makers cast a wary eye on the growing size of the Soviet military machine.

Of all the various parts of this machine none has generated more concern in the minds of both policy makers and the general public alike than the Soviet strategic arsenal. Since September 1949 when the U.S. confirmed the first Soviet atomic test the perceived threat posed by Soviet nuclear weapons has steadily increased. Today the watchwords are "window of vulnerability"--in the past our attentions were directed toward a "bomber gap" and a "missile gap." Our perceptions of and reactions to Soviet behavior in the area of strategic nuclear forces have been well documented elsewhere (cf., especially, Prados, 1982). Every administration since Truman's has voiced this concern.

> . . . the situation caused by the continuing rapid expansion of Soviet strategic offensive forces is a matter of serious concern. For some time, the Soviet forces which became operational in a given year have often exceeded the previous intelligence projections for that year. (Quoted in Prados, 1982:193.)

This remark appeared in the Fiscal Year 1972 Posture Statement of Secretary of Defense Melvin Laird. It was used, in part, to justify increased funding requests for the modernization of U.S. strategic forces.

At this point, questions of "quality vs. quantity," "launchers vs. warheads," "size vs. accuracy," and "land-based vs. sea-based" enter the debate as to whether the U.S. or the Soviet Union is more powerful in a strategic nuclear sense. This analysis does not attempt to resolve these issues. Following Ostrom and Job (1982) the focus will not be on the absolute levels of Soviet strategic forces, but rather on the relative balance which exists between the United States and the Soviet Union in this area. Moreover, this balance will be examined in terms of the number of missile launchers (land-based, sea-based, and those bombers with intercontinental capabilities) which each side possesses. The periods of greatest concern to U.S. defense planners will be those in which the Soviet Union has caught up with or has passed the United States in numbers of intercontinental missile launchers. This variable, MISSILE, is operationalized below.

$MISSILE_t$ DEFINITION: relative balance of U.S. and Soviet strategic nuclear strength which is based upon a comparison between U.S. delivery vehicles (USDV) or missile launchers and Soviet delivery vehicles (SOVDV) or missile launchers

OPERATIONALIZATION: (USDV - SOVDV)/USDV + SOVDV)

SOURCE: Ostrom and Job, 1982

It should be noted that the above measure of strategic balance also indicates periods of imbalance. Prior to 1955 the Soviet Union was not thought to possess any intercontinental strategic capability. During this era of U.S. dominance the MISSILE ratio takes a value of 1.000 since the number of Soviet missile launchers is zero. During periods of relative equality or parity between the United States and the Soviet Union the MISSILE ratio will be close to 0.000—a period roughly corresponding to the early seventies. Finally, a negative value for the MISSILE ratio is indicative of a situation where Soviet missile launchers outnumber their American counterparts—a period covering 1973 to the present.

The next type of second-order essential variable, international tensions or crises, represents threats which, unlike those posed by Soviet defense spending and strategic strength, tend to be of a less enduring concern to U.S. decision makers. Due to their sporadic and episodic nature these threats or crises do not lend themselves well to any sort of predictability by policy makers. Empirical research has suggested, however, that decision makers react to such events, and that these reactions have budgetary consequences (e.g., Domke, Eichenberg, and Kelleher, 1983). The exact nature and timing of these reactions, though, is less clear. The measure of international tensions/crises employed in this analysis, CRISIS, is defined and operationalized below. A listing of the specific events comprising this data set may be found in Appendix A.

$CRISIS_t$ DEFINITION: a period of increased military management at the national level that is carried on in a sustained manner under conditions of rapid action and response resulting from unexpected events or incidents that have occurred internationally or internally in a foreign country and that have inflicted or threaten to inflict violence or significant damage to the interests, personnel, or facilities of either the United States or the Soviet Union

OPERATIONALIZATION: annual index of the number of events which satisfy the above definition and which are of concern to both the United States and the Soviet Union

SOURCE: Analysis of the U.S. and Soviet Crisis Management Experiences: Technical Report, CACI, Inc. - Federal

Several points concerning the variable CRISIS are worth noting. First, the index consists of events which are of concern to both superpowers. For the period 1946-present CACI has catalogued over 400 Soviet crises and over 300 U.S. crises. The subset of joint crises consists of 95 events and was chosen since those crises involving both superpowers are the most salient in the minds of U.S. decision makers. Second, the index constructed is a simple additive measure of the number of such events each year. Such a measure implicitly assumes that the events are of equal magnitude, importance, salience, etc. Such is clearly not the case. Looking at 1948, the first year in the analysis for which there is more than one joint crisis, one finds the following events:

(1) Communist Party assumes power in Czechoslovakia;

(2) Costa Rica invaded by Nicaraguan-based rebels;

(3) Berlin blockade;

(4) First Arab-Israeli war; and

(5) Cominform expels Yugoslavia.

One would be hard-pressed to successfully argue that the Yugoslav expulsion from Cominform had the same impact on U.S. decision makers as the Berlin blockade. Clearly some type of weighted index would be preferable, but on what basis would such weighting be done? By duration? Intensity? Subjective assessment of event salience? In the absence of any clear criteria such a weighted index, perhaps theoretically more appealing but operationally more difficult to construct, was not developed--opting instead for a simpler additive index.

Finally, there is the question of the proper time frame within which the CRISIS factor produces discernible effects. Some of the crises, e.g., the Berlin blockade and airlift, encompass more than one year while others are of a relatively brief, though intense, duration. The budgetary consequences of these events can also be expected to be spread out over a few years. Within a given year one could expect to see the effects of events from previous years as well as those of the current year. For this reason no lag structure is posited and the CRISIS variable is entered contemporaneously with the dependent variables. CRISIS has been coded, however, on a fiscal year basis.

Part of the conventional wisdom outlined in Chapter I suggests that the major determinants of U.S. defense spending are internal (domestic), bureaucratic, economic, and political factors. The last two types of second-order essential variables are derived directly from this assumption. There are a number of possible measures of economic performance that could be used. Nincic and Cusack (1979), for example, investigated the relationship between military spending and perceived aggregated demand. Fischer and Crecine (1980), however, suggest that the most salient economic factors are those related to the Great Identity, namely the revenue forecast and the projected budget deficit/surplus. The CYBER Model incorporates this same general logic with the variables PIE and BURDEN.

PIE_t DEFINITION: projected rate of increase/decrease in total federal revenues

OPERATIONALIZATION: $(REV_t - REV_{t-1})/(REV_{t-1})$ where REV_t and REV_{t-1} are forecasted revenues for years $\underline{t}$ and $\underline{t-1}$, respectively

SOURCE: Treasury Bulletin, U.S. Department of Treasury, Office of the Secretary

$BURDEN_t$ DEFINITION: anticipated difference between planned current expenditures and forecasted revenues compared with forecasted revenues, i.e., the "burden" which deficits place on the federal budget

OPERATIONALIZATION: $(EXP_t - REV_t)/(REV_t)$ where EXP_t and REV_t are projected total federal expenditures and revenues for year t

SOURCE: Treasury Bulletin, U.S. Department of Treasury, Office of the Secretary

Both of these variables are self-explanatory. PIE, for example, measures the rate at which the "revenue pie" is increasing/decreasing. Other things being equal, defense planners will be expected to seek budget increases which parallel revenue expansions. If revenue decreases are forecast, then we should expect to see contractions in defense requests. Using the absolute level of a budget deficit/surplus is somewhat misleading. In 1952 an anticipated budget deficit of $8.2 billion represented 13% of the revenue forecast, but the deficit figure itself was over $47 billion. The BURDEN variable is included to see whether there is any validity to the argument that defense spending can and has been used in a counter-cyclical fashion, i.e., to lead government spending as a means to combat an economy which is slowing down.

The time frame of these two variables is also particularly important. The basic information pertaining to revenues and expenditures was taken from monthly Treasury Bulletins. Periodically throughout the year the federal government adjusts its estimates of the receipts (revenues) and outlays (expenditures) for the coming fiscal year, as well as for the current and prior fiscal years. Such estimates are known as current estimates and have been employed in the construction of both PIE and BURDEN. Current estimates reflect the information available to decision makers at the time that their decisions are being made.

The final type of second-order essential variable pertains to domestic political support. Support can take many forms. Ostrom and Job (1982) examined the relationship between presidential support (measured in terms of popularity) and the use of force. Rohde and Simon (1983) have noted a relationship between presidential popularity and presidential success in avoiding veto overrides. Others (e.g., Tufte, 1974) have explored the relationship between support and success in Congressional midterm elections. As Ostrom and Simon (1983) have shown, popular support can be an important resource which presidents can draw upon in seeking enactment of their legislative agenda.

The measure of domestic political support employed in this analysis is directly related to public opinion toward U.S. military activity. Based upon Gallup polls, the variable NEGOPIN attempts to tap public sentiment regarding expanded military activity on the part of the United States.

$NEGOPIN_{t-1}$ DEFINITION: negative public opinion toward expansion of U.S. military activity either in terms of spending for defense or in terms of the continuation of specific military policies such as the wars in Vietnam and Korea

OPERATIONALIZATION: yearly index of the percentage of the public which feels that we

are spending too much for defense, or that
we should get out of Vietnam or Korea

SOURCE: Gallup Poll Reports[4]

Two comments are in order regarding NEGOPIN. The first has to do with the time element. This measure of negative public opinion, perhaps best construed as a measure of non-support, has been lagged by one year in the attempt to synchronize public attitudes toward defense with the time horizon of the defense budgetary process. Even so, the time frames are not completely parallel. The second point is perhaps a bit more crucial. It has to do with the fact that the index upon which NEGOPIN is based is actually a composite of two conceptually distinct types of opinion vis-à-vis national defense. For some years the index reflects public sentiment that too much is being spent for defense. For other years the index reflects opposition to continued U.S. presence in either Korea or Vietnam. The two dimensions have been combined largely owing to the infrequent and sporadic nature of the Gallup polls in this area. In years when neither question was asked I had to interpolate in order to arrive at the level of public opinion for those periods. The dimensions can be combined for a substantive reason as well. Both sets of questions tap general public opinion in a negative fashion. Moreover, defense decision makers can see the extent to which the public consensus favors an expansion, contraction, or maintenance of the status quo vis-à-vis defense. Substantial negative opinion is thereby translated into a lack of support. For the President and members of Congress this lack of public support may have electoral consequences. For the groups located in the Department of Defense one would expect less direct effects since they are not dependent upon overt electoral support. One would still expect them, however, to demonstrate some sensitivity to public opinion--if only to maintain their credibility in the eyes of the other actors in the process.

Third-Order Essential Variables

To this point the CYBER Model has been constructed in such a way that the actors in the defense expenditure policy-making process have been treated as if they behaved completely independent of one another. This conceptualization of the process is quite different from that suggested by the Reactive Linkage Model (Ostrom, 1978a). The major stimulus for most actors is the behavior of the previous actor in the process, i.e., the "base" for actor *j* is the decision output from actor *j-1*. The major exception to this general rule occurs at the first step in the process—the services' request. Here the dominant stimulus is external to the process.

The CYBER Model does not entirely disregard the logic of the Reactive Linkage Model. The third-order essential variables (EV3) offered here are in the spirit of the RLM. What is being suggested by the CYBER Model is that each actor looks to the previous actor in the process as a *final* check on one's own behavior. Decision makers take cues from each other, responding to large changes (increases or decreases) in the previous actor's behavior. A failure to do so could, in the long run, be potentially hazardous from a bureaucratic budgeting perspective; it may also reflect that a particular actor has failed to attend to important stimuli from the external environment.

The simplest way to explain the logic underlying these third-order essential variables is to treat them as cues which, in turn, represent each decision maker's perception of the demands of the external environment. Theoretically the effects of the first- and second-order essential variables should be sufficient to determine: a) whether to continue to seek funding at last year's level or whether changes in relevant environmental stimuli warrant a higher/lower funding level; and b) if the latter is the case, how much of an increase or decrease is needed. On some occasions, however, there may be other environmental exigencies not specified by this model, or a combination of environmental effects may act in a non-additive fashion. Such occasions are easily identified--they are those times when a decision maker's response to a particular configuration of essential variables is greater than or lesser than one would normally expect. What this may indicate is a failure of the *ceteris paribus* clause. Viewed in this fashion abnormally large increases or decreases in budget requests can be viewed as a signal that there are additional threats or concerns that should be noted.

The logic and operationalization of the third-order essential variables is quite straightforward, though the actual construction of the variables is somewhat artificial. If the first- and second-order essential variables completely or perfectly "explained" annual defense budget decision changes, then one would expect w^* (see equation 2.3 in Chapter II) to be equal to zero or to differ from zero in a random, non-systematic fashion. Similarly, the presence of systematic variation in w^* would lead one to infer that an actor's defense budget change request was not attributable entirely to the set of first- and second-order essential variables. The third-order essential variables attempt to capture this additional information (cues) which decision makers may convey to each other.

Temporal considerations, the structure of the defense expenditure policy-making process, and the empirical findings of the Reactive Linkage Model suggest the following: the President takes cues from the Military Services; the Congress responds to information supplied by the President; and the expenditure behavior of the Department of Defense is responsive to Congressional activity. The defense budget cycle is such that as Congress is working on the budget for fiscal year _t_, the various agencies and departments are formulating their requests for fiscal year _t+1_. The Military Services, then, can be expected to respond to the previous year's Congressional action rather than the previous DoD expenditure behavior. The latter is rejected since Service requests for fiscal year _t+1_ are made prior to DoD expenditures for fiscal year _t_. This is also consistent with Ostrom's (1978a) empirical observation that the Services respond to the trend in Congressional appropriation. The general form of the third-order essential variables, identified as $CUES_t$, is offered below.

$CUES_t$

DEFINITION: information from previous actor in the defense expenditure policy-making process which suggests that larger increments or decrements in the defense budget change requests are warranted; can be viewed as a "residual threat perception" on the part of the previous actor in the process.

OPERATIONALIZATION: variation in defense budget change requests remaining after the effects of the first- and second-order essential variables have been removed; w* from equation 2.3

SOURCE: constructed from CYBER Model

Data for each of the above variables has been collected or constructed for fiscal years 1947 through 1980. Data for lagged variables have been collected as needed. Budget data for the transition quarter which occurred from July 1 to September 30, 1976 have not been included in the analysis. The next section of the chapter will present a number of hypotheses to be tested by the CYBER Model.

Operational Hypotheses

This section presents a number of general research hypotheses, as well as a number of specific hypotheses as to the direction and relative magnitude of the estimated parameter coefficients. Following this it will be shown that these hypotheses are consistent with the "funnel of constrained reactivity" developed in Chapter II. The central feature of this explanation is that as one moves through the defense expenditure policy-making process each successive actor is increasingly isolated from the external environment, and therefore can be expected to show smaller and fewer reactions to the set of essential variables.

Hypothesis 1a: All actors respond to the first-order essential variable, USE.

Hypothesis 1b: This reaction is directly proportional to the degree of USE, i.e., as battle casualties increase, defense budget change requests will also increase.

Hypothesis 2a: All actors respond to some or all of the second-order essential variables, though it is expected that there will be less reactivity as one moves through the steps of the budget process.

Hypothesis 2b: This decreasing reactivity will be evidenced by fewer significant reactions to the set of second-order essential variables as one moves through the steps of the budget process.

Hypothesis 2c: Where more than one actor responds to the same second-order essential variable there will be a decreasing magnitude of effects as one moves through the process, i.e., the relative magnitude of the estimated parameter coefficients will be decreasing from one step to the next.

Hypothesis 3a: Defense budget change requests are directly proportional to the annual change in Soviet military expenditures, SOVCH, such that increases in Soviet expenditures will produce additions to defense budget change requests and cutbacks in Soviet defense expenditures will lead to reductions in defense budget change requests.

Hypothesis 3b: The reaction to the measure of US-USSR strategic balance, MISSILE, will be as follows: when the ratio is positive, a situation where the U.S. leads in the number of missile launchers, there will be reductions in defense budget change requests; when the ratio is negative, a situation where the USSR leads in the number of missile launchers, there will be increases in defense budget change requests; and when the ratio is zero, a situation of numerical parity between the US and the USSR, there will be no budgetary reaction to the variable MISSILE.

Hypothesis 3c: Reactions to international tensions or crises are directly proportional to the number of annual events in the index CRISIS.

Hypothesis 3d: Defense budget change requests are directly proportional to the measure of the rate of revenue change, PIE, so that projected increases in revenues will produce additions to defense budget change requests and projected decreases in revenues will lead to reductions in defense budget change requests.

Hypothesis 3e: Responses to the measure of deficits as a proportion of revenues, BURDEN, will be negative, i.e., defense budget change requests will be used in a counter-cyclical fashion.

Hypothesis 3f: Defense budget change requests are negatively related to the measure of domestic political support, NEGOPIN, such that increasing opposition to expanding military activity results in reductions in defense budget change requests.

Hypothesis 4: Actors respond to CUES provided by other decision makers regarding the presence of additional environmental concerns. These cues are either positive (suggesting increases to defense budget change requests) or negative (suggesting reductions in defense budget change requests).

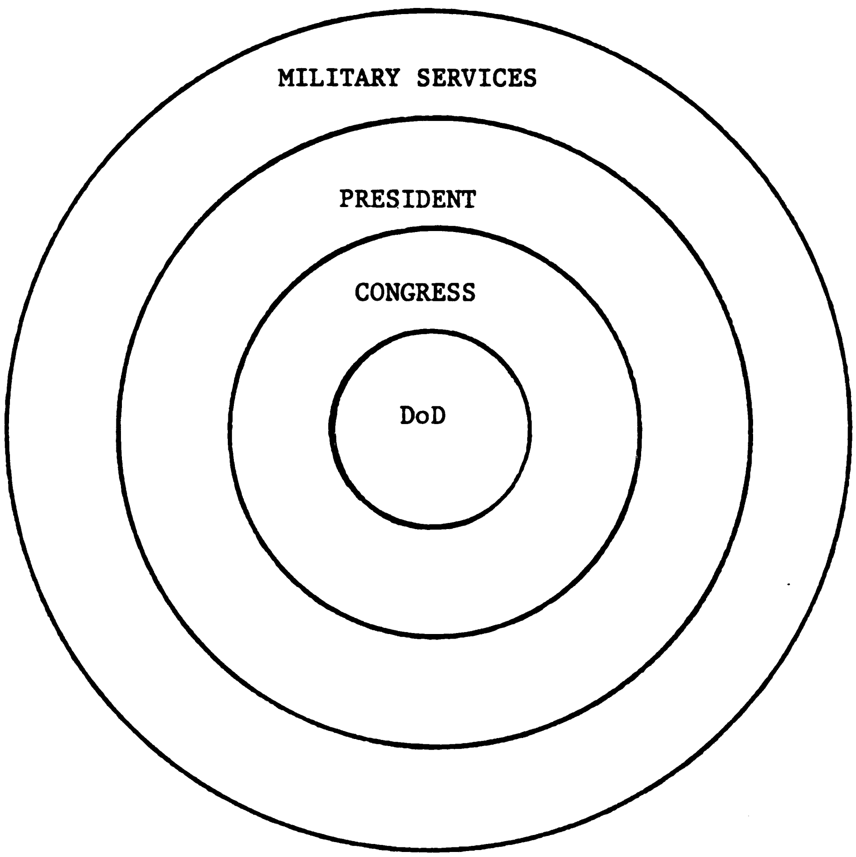
Hypothesis 5: After controlling for the effects of the first-, second-, and third-order essential variables, any remaining variation will be random and can be attributed to the idiosyncratic behavior of decision makers.

This set comprises the research hypotheses that will be tested by the CYBER Model. Several comments are in order. First, given the hierarchic attentions to essential variables suggested by a cybernetic theory of behavior it is not surprising that all actors are hypothesized to respond to the first-order essential variable, USE, since this is the factor which poses the greatest threat. As noted earlier, the presence of active combat operations is a situation which is not "business as usual" and which demands immediate attention by defense policy planners.

Second, the general thrust of hypotheses 2a-c is that, as one moves through the defense expenditure policy-making process, there is a decreasing response or reactivity to the set of second-order essential variables. The explanation for this phenomenon is based on the assertion that, within this policy-making process, there is a buffered inner environment (funnel of constrained reactivity) which increasingly shelters actors from potential stimuli in the external environment. Figure 4.1 visually presents the argument being offered here. It can be seen that the Military Services are most proximate to the external environment and, therefore, are assumed to be the most responsive to this environment. This is precisely the argument made by the Reactive Linkage Model (Ostrom, 1978a) where the initial stimulus from the external environment is mediated by the Services and then filtered throughout the rest of the process.

At the other extreme is the expenditure behavior of the Department of Defense. Represented by the innermost circle in Figure 4.1, DoD is the most isolated from the external environment. Correspondingly, I would expect this actor to be the least responsive, either in terms of the number of variables to which DoD reacts or in terms of the relative magnitude of the coefficients of the variables which DoD reacts to. By the same logic I would expect Congress to be more reactive than DoD, the President to be more reactive than Congress, and the Military Services to be more reactive than the President. Each actor is progressively isolated from these external factors, i.e., each actor in the process acts as a buffer for subsequent actors. Some of this information from the external environment may be passed on to each actor through the third-order essential variables, though this is not their major function. For the most part, the process itself provides a "buffered inner environment" for the actors within the process.

E X T E R N A L   E N V I R O N M E N T



E X T E R N A L   E N V I R O N M E N T

Figure 4.1: Buffered Inner Environment

The next section of this chapter will present and discuss the results of the empirical analysis of the CYBER Model. Of primary importance will be the extent to which the hypotheses outlined previously are supported by this analysis. The substantive implications of the estimated parameter coefficients will also be a topic of the following discussion.

Presentation and Interpretation of Results

It was suggested in previous chapters that many empirical analyses of military expenditure processes focus on the aggregate defense expenditure total. Moreover, the dominance of inertial factors, from both a theoretical and substantive perspective, has already been documented. In Table 4.1 the predominance of the previous year's decision, the inertial factor which many refer to, can be empirically supported. Each of the four aggregate defense expenditure decisions has been correlated with the lagged value of that decision, i.e., the previous year's decision. It can be seen that each of these bivariate correlations is quite large. Squaring each of these bivariate correlations provides a rough estimate of the percent of explained variation, R^2, that would be found by running bivariate regressions between this year's defense expenditure decision and the same decision from the previous year. What emerges is a clear picture that an incredible amount of variation is already accounted for by this expenditure base: the Services, 86%; the President, 90%; Congress, 90%; and DoD, 96%. The implications of this inertial dominance will be made clear later on.

Table 4.1: Bivariate Correlations between DEC_t and DEC_{t-1}

	SRQ_t	PBR_t	CBA_t	SPD_t
SRQ_{t-1}	.86			
PBR_{t-1}		.95		
CBA_{t-1}			.95	
SPD_{t-1}				.98

Hypotheses 1a and 1b suggest that all actors respond to the first-order essential variable, USE, and that this reaction will be positive and directly proportional to the degree of combat activity as measured by battle casualties. Examination of Table 4.2 shows that both of these hypotheses are empirically supported. Not only are the estimated coefficients in the hypothesized direction, but all coefficients are at least twice their standard errors. This last feature supports the inference that the coefficients are significantly different from zero. Note, also, the decreasing magnitude of the estimated coefficients as one moves through the defense expenditure process, suggesting that the Military Services react most sharply to battle casualties, the President less so, etc. In fact, the Services react almost twice as severely as the Department of Defense. For every thousand casualties one would

Table 4.2: Coefficient Estimates for First-Order Essential Variable (USE_{t-1})

Actor	b_{i1} (Standard Error) (t-ratio)
SERVICES	1329.83 (548.12) (2.43)[a]
PRESIDENT	1021.39 (368.11) (2.77)[a]
CONGRESS	865.83 (373.21) (2.32)[a]
DoD	689.50 (255.45) (2.70)[a]

[a]Significantly different from 0.00 at the .05 level.

expect the defense budget change requests for each actor to increase as follows: Services, \$1.33 billion; President, \$1.02 billion; Congress, \$.87 billion; and DoD, \$.69 billion.

The estimation of the second-order essential variables (EV2) was conducted in two stages, though in both stages the residuals from equation 2.2 are the dependent variables. First, these residuals (v*) were regressed on all six of the EV2. Any of the EV2 which were not statistically significant were dropped, and the equations were re-estimated using the reduced set of significant second-order essential variables. A comparison of the two sets of equations shows that there were no major shifts in the size of the estimated parameter coefficients. Table 4.3 summarizes the results of the second set of regressions.

Notice that the coefficients reported in Table 4.3 are both in the predicted direction and quite robust in that they are at least twice their standard errors. The fact that each actor responds to at least two of the set of EV2 provides support for Hypothesis 2a. In addition, these results provide support for Hypotheses 2b and 2c, the hypotheses that deal with the decreasing reactivity as one moves through the process. The Department of Defense reacts to three second-order essential variables, whereas each of the other three actors shows significant reactions to four of these factors. Even more noteworthy is the pattern of coefficients among the Services, President, and Congress. Each of these actors responds to the same subset of EV2: MISSILE, CRISIS, PIE, and NEGOPIN. For each variable I observe a similar pattern: the magnitude of the estimated parameter coefficient

Table 4.3: Coefficient Estimates, Standard Errors, and t-ratios for Second-Order Essential Variables[a]

	SOVCH	MISSILE	CRISIS	PIE	BURDEN	NEGOPIN
SERVICES	-	-7885.20	3599.50	812.60	-	-419.50
		(2922.10)	(871.82)	(188.45)		(82.93)
		(-2.70)	(4.13)	(6.86)		(-5.06)
PRESIDENT	-	-5019.80	1704.30	555.33	-	-191.72
		(2069.30)	(617.36)	(83.88)		(58.72)
		(-2.43)	(2.76)	(6.62)		(-3.26)
CONGRESS	-	-4196.30	1401.40	530.07	-	-159.50
		(2311.30)	(689.58)	(93.69)		(65.59)
		(-1.82)	(2.03)	(5.66)		(-2.43)
DoD	1.01	-	-	191.85	-	-117.71
	(.40)			(74.40)		(54.42)
	(2.55)			(2.58)		(-2.16)

[a]All reported coefficients significantly different from 0.00 at .05 level.

decreases as one moves from the Services to the President to the Congress. In addition, DoD responds to PIE and NEGOPIN. In both cases the estimated parameter coefficients are less than those for the Congress, and this is consistent with the general pattern. The empirical results provide strong support for the "buffered inner environment" explanation developed earlier.

Table 4.3 can also be examined in light of Hypotheses 3a through 3f which deal with the individual factors comprising the set of second-order essential variables. As noted, all of the coefficients are in the hypothesized directions and have decreasing magnitudes relative to each other, also as predicted. There is one anomaly, however, which must be addressed.

Only one actor, the Department of Defense, reacts to changes in Soviet military expenditures ($SOVCH_t$). This result is not entirely consistent with the notion of a buffered inner environment. Logically, one would expect the military services to respond to Soviet expenditure behavior. Indeed, this is precisely the result obtained by Ostrom (1978a): the Services' request was found to be primarily a function of aggregate Soviet military expenditures. This reaction to the external environment was then filtered throughout the rest of the defense expenditure policy-making process in an indirect fashion. That other, more recent empirical analyses have been unable to demonstrate a reaction at any stage to Soviet defense expenditures is of little comfort.

Part of the dilemma is undoubtedly related to the measurement problems outlined earlier. Moreover, given that this analysis employed a measure of the annual <u>change</u> in Soviet military expenditures, one might expect results which vary from those utilizing aggregate defense expenditures. In addition, Cusack and Ward (1981:446) note that which particular data set is used may be quite important.

> Not only are the actual magnitudes quite variant over time, but the manner in which these series change through time is markedly divergent, as evidenced by the low intercorrelation among the first differences.

To the extent that measurement problems plague an aggregate expenditure series, first-differencing will probably exacerbate rather than ameliorate the situation.

One final set of related observations may shed some light on this inconsistent result. Very little is known about the procedures used by SIPRI to generate estimates of Soviet defense expenditures. What seems likely, however, is that they employ some form of growth model, e.g., a first-order autoregressive process. The resulting expenditure series, when differenced, displays a monotonic form, i.e., few extreme changes from year to year. It will be recalled from Figure 2.2 that the annual defense budget change requests by the military services were extremely volatile, and that the DoD expenditure changes showed the smallest variability. In using the aggregate Service Requests, though, much of the volatility of the differenced series is masked by the dominance of the inertial base. That one trended series has been found to vary systematically with another trended series should come as no surprise. Furthermore, given the four different defense budget change series, it seems quite clear that the U.S. expenditure changes most closely "line up" with the Soviet expenditure changes, more so than does any other U.S. change series.[5]

What I am left with is an empirical relationship which, given the data at hand, is not entirely unexpected. Nevertheless, this empirical observation fits neither the theoretical framework being offered nor any intuitive, common sense notion of the perceptions of U.S. defense planners vis-à-vis the military behavior of the Soviet Union. More than anything else, I think that this particular finding points to conceptual inadequacies which haunt existing estimates of the Soviet threat. Some solace can be found in that this result runs counter to the growing body of empirical analyses which find <u>no</u> link between the military expenditure behavior of the United States and the Soviet Union.

While DoD is the only actor which responds to the first measure of long-term Soviet threats, each of the remaining three decision-making groups responds to MISSILE, the comparison of US-Soviet strategic nuclear balance. As predicted by Hypothesis 3b, the coefficient for MISSILE is negative, i.e., when the strategic balance is tipped in favor of the Soviet Union the MISSILE ratio will be negative—thereby producing increments to U.S. defense budget change requests. During periods of U.S. numerical superiority in terms of missile launchers one would expect reductions in defense budget change requests since the MISSILE ratio will be positive. Once again, the Services react most sharply to the strategic balance, followed by the President and then Congress.

These same three actors respond to short-term threats posed by international tensions or crises. Without sounding too repetitious, the same response pattern is observed once again. The Services are more than twice as reactive as either the President or Congress to this index of short-term international threats. The <u>caveats</u> stated earlier, however, bear repeating. This index treats each event as being equivalent—clearly not the case. Knowledge that a crisis produces increments in defense budget change requests of approximately \$3.6 billion for the Services, \$1.7 billion for the President, and \$1.4 billion for the Congress may not be very meaningful given the obvious non-equivalence of events in the index. The fact that significant reactions can be detected, though, is important. The non-reactivity of the expenditure change request decision is also worth noting. Given that the expenditure changes (SPDCH) show the least volatility (see Figure 2.2) in terms of the size of the annual changes, one would expect fewer significant reactions to the second-order essential variables at this step. Furthermore, given that the expenditure stage occurs at the end of the defense budgeting process, one should expect less reactivity to relatively short-term events occurring much earlier. It is also felt by some that at this point in the process there is very little discretionary spending power, i.e., the ability to respond quickly to international events is greatly constrained.

Hypothesis 3d is also supported by this analysis. Each of the four actors in the defense expenditure process makes adjustments in behavior in response to changing revenue conditions. Each actor seeks to increase his defense budget change request in light of projected revenue gains. Similarly, projections of falling revenues should produce reductions in defense budget change requests. The relative size of the coefficients is also important, but their <u>absolute</u> size may seem somewhat artificial. For example, for every one percent increase in projected revenues the Services adjust their budget change request upward by $812 million. For 1980 this represents about 17.6% of a projected revenue increase of $42 billion. For 1953, however, the corresponding figures are 130% of a projected $6 billion increase. For the same year, though, the expenditure change represents 23.5% of this same $6 billion projected increase. This suggests that, while the Services seek more than their share of projected revenue increases, the actual expenditure change represents a more realistic share of the increase.

One of the surprises of this analysis is that there are no significant responses to the variable BURDEN. It was hypothesized that defense budget change requests would be used in a counter-cyclical manner. In other words, as deficits increase and start to cause economic contractions, defense spending could be stepped up to reverse these trends. This argument is essentially the one raised by Cypher (1972) and others who examine the political economy of government spending, particularly military spending.

There are three possible explanations for the inability of the CYBER Model to detect any reactions to this variable. The first is that the variable may be operationalized too crudely. Perhaps a measure of aggregate demand might more accurately reflect periods of expansion or contraction in the economy. Second, there are possible problems, discussed in Chapter III, associated with multicollinearity. A Farrar-Glauber analysis of multicollinearity, found in Appendix B, does not rule out this interpretation. An examination of the matrix of partial correlations finds that BURDEN is correlated with SOVCH at -0.46 with an associated t-value of -2.54, suggesting that multicollinearity is a potential problem. The only other partial correlation which is close to being statistically significant is between BURDEN and MISSILE (-0.39 with a t-value of -1.59). Finally, there simply may not be any counter-cyclical effects associated with military spending. Whatever the case, the present analysis does not provide any support for Hypothesis 3e.

The final second-order essential variable, NEGOPIN, produces significant reactions by all four actors in the model. The coefficients are also in the predicted direction and, once again, one observes a pattern of decreasing reactivity as one proceeds through the steps in the process. Notice, too, that the response of the Military Services is over twice as large as that of any of the other actors. In some ways this result is unusual, even though it is consistent with the buffered inner environment explanation. What is unexpected is that, of these groups, both the Services and DoD do not depend upon the direct electoral support of the public to maintain their position. One explanation, of course, is the general overall greater reactivity of the Services to all factors in the external environment, but the same cannot be said for DoD. Multicollinearity could also present a problem here as NEGOPIN shows significant partial correlations with SOVCH, MISSILE, and CRISIS. The partial correlation between NEGOPIN and MISSILE, for example, is a substantial -0.91 with an associated t-value of -10.46. Finally, it is possible that the Services and DoD act in anticipation of the public pressures that will be brought to bear on the President and Congress and hence, indirectly, on themselves. In any event, the apparent responsiveness to public opinion on the part of both the Services and DoD is certainly noteworthy.

Table 4.4 presents the results of the next stage of the analysis, where the residuals from the regression on the second-order essential variables are regressed on the set of EV3. Hypothesis 4 predicts that each actor in the process responds to information or cues provided by the preceding actor. It can be seen that the results are somewhat mixed. All of the coefficients are in the hypothesized direction, though there is no pattern to the relative size of the estimated coefficients. This latter finding may be due to the fact that the EV3 are stimuli from within the defense expenditure process itself. The buffered inner environment explanation pertained only to factors in the external environment. The results presented in Table 4.4 are also consistent with the notion that the actors in the defense expenditure policy-making process are neither isolated from nor totally independent of each other.

The final stage of the analysis deals with an examination of the residuals from the regressions on the third-order essential variables. These residuals (e^* in equation 2.5) are regressed on their first, second, and third lags and the coefficients are examined to see if they are significantly different from zero. If these coefficients are not different from zero, then one can conclude that these residuals, from a univariate perspective, are random. I can conclude that the residuals are "white noise" and that they can be attributed to the idiosyncratic behavior of decision makers. A summary of these regressions is presented in Table 4.5. While none of the coefficients is statistically significant, it should be reiterated that this procedure only tests for univariate error processes. The possible existence of

Table 4.4: Coefficient Estimates for Third-Order Essential Variables[a] ($CUES_t$)

Actor	b_{i8} (Standard Error) (t-ratio)
SERVICES	0.45 (0.21) (2.12)
PRESIDENT	0.48 (0.10) (5.03)
CONGRESS	1.04 (0.08) (13.17)
DoD	0.48 (0.13) (3.77)

[a]All coefficients significantly different from 0.00 at .05 level.

Table 4.5: Coefficient Estimates for "White Noise" Regressions (e^*_t Regressed on e^*_{t-1}, e^*_{t-2}, and e^*_{t-3})[a]

Actor	e^*_{t-1}: b_{i9} (Standard Error) (t-ratio)	e^*_{t-2}: b_{i10} (Standard Error) (t-ratio)	e^*_{t-3}: b_{i11} (Standard Error) (t-ratio)
SERVICES	-0.011	-0.295	-0.105
	(.186)	(0.179)	(0.191)
	(-0.061)	(-1.646)	(-0.552)
PRESIDENT	-0.252	-0.046	-0.047
	(0.189)	(0.194)	(0.198)
	(-1.336)	(-0.236)	(-0.236)
CONGRESS	-0.267	-0.305	0.161
	(0.179)	(0.184)	(0.193)
	(-1.491)	(-1.655)	(0.835)
DoD	0.210	0.099	-0.053
	(0.217)	(0.232)	(0.236)
	(0.966)	(0.426)	(-0.223)

[a]All coefficients not significantly different from 0.00 at .05 level.

more complex error structures is not eliminated empirically by this analysis. By the same token, however, there is no reason to suspect that such processes exist.

A systematic examination of the hypotheses generated earlier in this chapter finds considerable support for each except for Hypothesis 3e. All of the coefficients are in the hypothesized direction; moreover, the plausibility of a buffered inner environment is given empirical support by this analysis. Part of the test of any model is the extent to which hypotheses derived from that model can be empirically validated. In this regard the CYBER Model of the defense expenditure policy-making process performs quite well. The evaluation of the CYBER Model, though, is only partially complete. Chapter III developed and offered a novel methodology for the analysis of defense budget change requests. The final section of this chapter will compare the results generated by the MSRA methodology against those derived from a traditional multiple regression analysis.

A Comparative Analysis of MSRA and Multiple Regression

The CYBER Model and the accompanying MSRA methodology were developed in response to theoretical and empirical deficiencies in existing explanations of the U.S. defense expenditure policy-making process. It was suggested, for example, that the classic arms race model and organizational process model were indistinguishable from one another in terms of their underlying conceptualizations of the policy-making process and the decision makers who reside therein.

It has been suggested on more than one occasion that the CYBER Model is a more accurate and truer representation of the behavior of cybernetic decision makers. Implicit in this statement is the notion that the CYBER Model offers a better explanation of the behavior of policy makers in the defense expenditure budgetary process. The immediate question arises: Better than what? The answer is twofold. It is argued that the CYBER Model is superior to existing explanations because of its explicit derivation from a body of literature dealing with theories of individual/organizational decision making. Moreover, it has been suggested that the MSRA estimation approach avoids a number of methodological pitfalls associated with a more traditional, single-equation multiple regression (MR) procedure.

This section will compare the results of the MSRA estimation of the CYBER Model with the results generated by a MR approach. While statistical comparisons between the two procedures will be drawn, the focus of this analysis will be on the different substantive explanations offered by each. Before doing so, I would like to note changes in the variable operationalizations that will be made in order to make them more compatible with a MR analysis. Points of difference in the underlying logic of the two estimation approaches will also be noted.

Variable Operationalizations

The operationalizations for the first-order essential variable (USE) and all six of the second-order essential variables (SOVCH, MISSILE, CRISIS, PIE, BURDEN, and NEGOPIN) will remain unchanged. The only alterations that will be made are to the set of dependent variables and to the set of third-order essential variables.

The dependent variables to be examined by the MR approach will not be the annual changes in defense expenditure decisions, but rather the total defense requests, recommendations, appropriations, and expenditures. These variables were previously operationalized as DEC_{1t}, DEC_{2t}, DEC_{3t}, and DEC_{4t}. In addition, the previous year's defense expenditure decisions (DEC_{it-1}) will be incorporated into the model as explanatory variables. These two alterations will make the MR model consistent with most of the empirical analyses of the U.S. defense expenditure policy-making process. This formulation will also enable me to test the proposition that much of the "explanatory power" of plausible, relevant regressors is overshadowed by the dominance of the base (represented as last year's defense budget decision).

Given the artificial construction of the third-order essential variables used in the CYBER Model, it is very difficult to find a direct translation of these factors that can be included in the MR equations. Since the EV3 were designed to represent cues provided by each actor in the process to the next actor, I have decided to operationalize them as the annual defense budget changes (ΔDEC_{it}). In other words, the size of the increase or decrease in defense budget decisions will be viewed as the additional information or cues which decision makers attempt to convey to each other. As with the CYBER Model it is assumed that the services react to the previous years' Congressional change, the President responds to the current change in the Services' Request, etc.

Estimation Procedure

The general form of the equations to be estimated is given as follows:

$$DEC_{it} = \beta_{i1}DEC_{it-1} + \sum_{i=1}^{n} \sum_{j=2}^{k} \beta_{ij} E_{jt} + \beta_{i,j+1} \Delta DEC_{i-1,t} \quad (4.1)$$

where E_{jt} are the set of exogenous factors previously identified as first- and second-order essential variables and all other factors are as before. The only exception to this general form was noted earlier, i.e., the services are expected to respond to the previous year's change in Congressional appropriation (ΔDEC_{3t-1}). There are two aspects of equation 4.1 which will make the use of ordinary least squares (OLS) inappropriate.

The first is the presence of a lagged value of a dependent variable on the right-hand side of the equation. Use of OLS in this situation will produce estimates which are inconsistent. One can no longer make the assumption that the explanatory variables are uncorrelated with the error term. In order to obtain consistent estimates it is necessary to employ a two-stage instrumental variables technique. Second, this problem is attenuated when the disturbances are autocorrelated. Unlike the CYBER Model, where the form of the autocorrelation was specified, the MR model represented in equation 4.1 makes no such specification. For that reason, an iterative maximum likelihood procedure which corrects for first-order autocorrelation will be used in conjunction with the two-stage instrumental variables technique. The resulting estimators will have all of the desirable properties of OLS estimators under normal conditions.

It should be noted that the estimation of equation 4.1 was conducted in two steps. First, the entire equation was estimated using the techniques outlined above. Variables whose estimated parameter coefficients were found not to be significantly different from 0.00 at the .05 level were subsequently dropped from the analysis. The equations, in the second step, were then re-estimated on this reduced set of regressors.

Multiple Regression Estimation Results

Table 4.6 presents the results of the multiple regression estimation of the annual defense budget decisions of the military services, President, Congress, and Department of Defense. Some general comments about the results displayed in Table 4.6 will be offered, followed by a closer examination of the substantive explanation which this analysis produces for each actor.

Overall, it can be seen that the MR approach leads to a much more parsimonious explanation of the U.S. defense expenditure policy-making process. For three of the four actors the MR analysis yields a smaller set of regressors. In such situations it is typical for a researcher to invoke a criterion of parsimony as a means for deciding which of two or more competing explanations of a given phenomenon will be accepted. Parsimony should not, however, be the only criterion employed. Notions of plausibility and relevance to the real world should also be taken into consideration. As I have suggested before, "Occam's razor" should

Table 4.6: Coefficient Estimates, Standard Errors, and t-ratios for Multiple Regression Analysis of U.S. Defense Expenditure Decisions[a]

Actor (DEC_{it})	DEC_{it-1}	USE	SOVCH	MISSILE	CRISIS	PIE	BURDEN	NEGOPIN	ΔDEC_{i-1}[b]
SERVICES (DEC_{1t})	1.09 (0.08) (13.36)	1061.10 (628.19) (-1.69)	-	-6995.80 (4115.60) (-1.70)	3175.40 (1009.50) (3.15)	853.00 (132.58) (6.43)	-	-536.04 (206.95) (-2.59)	-0.47 (0.20) (-2.32)
PRESIDENT (DEC_{2t})	1.01 (0.01) (102.95)	-	-	-	-	203.60 (68.19) (2.99)	-	-	0.47 (0.06) (7.59)
CONGRESS (DEC_{3t})	1.007 (0.01) (160.08)	-173.89 (88.37) (-1.97)	-	-	-	-	-	-	0.98 (0.05) (21.44)
DoD (DEC_{4t})	1.13 (0.03) (34.75)	-	-	-	-	-	-	-197.23 (67.24) (-2.93)	0.41 (0.06) (6.42)

[a]All coefficients significantly different from 0.00 at .05 level (one-tailed test).

[b]For the Services this will be ΔDEC_{3t-1}.

be a guide rather than a firm decision rule to be employed indiscriminantly. Parsimonious models which generate counterintuitive and trivial results are of limited explanatory value.

As a second general observation I would point to the signs (direction) of the estimated coefficients. Applying the operational hypotheses presented earlier in this chapter it becomes apparent that not all of the coefficient estimates are in the hypothesized direction. This would seem to be a necessary condition for a model to meet if it is to have any useful explanatory relevance. Even the magnitude of some of the coefficients is questionable, a third point that will be discussed more fully below. A final observation is the relative robustness of the estimated coefficients associated with the previous year's defense expenditure decision, as evidenced by their large t-ratios.

The MR analysis of the Services' Request yields an explanation very similar to that produced by the MSRA approach. Both find that the services react to the measure of U.S. combat activity (USE) as well as to the same set of previously identified second-order essential variables (MISSILE, CRISIS, PIE, and NEGOPIN). Moreover, the two sets of coefficients are quite similar in terms of their relative size. The coefficient for the previous year's services request, i.e., the base, suggests an average incremental growth of nine percent. This figure might not seem plausible were it not for the presence of the exogenous factors in the model, each of which may produce adjustments to this annual growth pattern.

There are only two aspects of the MR analysis of the services request which are at all disturbing. The first, and more serious, concerns the direction of the estimated coefficient for ΔDEC_{3t-1}, the measure of additional information or cues supplied to the Services by the Congress. The negative sign, implying that the Services cut their requests in response to recent Congressional increases, is both counterintuitive and not consistent with previous empirical results (cf. Ostrom, 1978a). In absolute value, however, this coefficient is almost identical with that associated with the third-order essential variable (CUE) in the CYBER Model. The second feature worth mentioning is the relatively large standard errors associated with the estimated coefficients for USE and MISSILE. These coefficients are only slightly larger than one and one-half times their standard errors. These coefficients are significantly different from zero at the .05 level under a one-tailed hypothesis test. For a corresponding two-tailed test one could not conclude that these coefficients are different from zero. The large standard errors should sensitize one to the potential instability of these estimates.

The results reported in Table 4.6 for the President's defense budget requests are perplexing for a number of reasons. The first is the relatively small incremental growth rate associated with the base (one percent per annum). Almost all of the yearly changes in Presidential defense budget requests can be attributed to projected revenue increases and cues provided by the Services. With respect to the latter finding it should be pointed out that this estimated coefficient is virtually identical to that associated with the President's third-order essential variables.

Perhaps more important than what is included in this model are the factors which are excluded. This MR analysis suggests that the President is unresponsive to U.S. casualties, Soviet spending behavior, the strategic balance between the U.S. and the USSR, as well as to international crises. These results are not consistent with either a common-sense understanding of the President as Commander-in-Chief or with the typical rationale which Presidents have used to justify their sought-after defense budget increases, e.g., the dangers posed by the international environment. The exclusion of public opinion (at least as it is measured here) from the President's decision calculus is also somewhat surprising.

The explanation suggested by Table 4.6 for Congressional defense budget appropriations is also unrealistic in some respects: the incremental growth rate appears to be less than one percent; Congress reduces defense appropriations in response to casualties suffered by U.S. military personnel; and Presidents enjoy almost total success in getting Congressional approval for their proposed defense budget increases or decreases. This last result, when coupled with the almost nonexistent growth rate, is the most plausible aspect of this explanation. Ostrom (1978a), for example, found that Congress cuts Presidential defense budget requests by an average of slightly more than three percent. Most disturbing is the apparent response of Congress to U.S. battle casualties. Moreover, the unresponsiveness of Congress to changing economic conditions seems surprising.

Finally, actual defense expenditures by the Department of Defense demonstrate the highest average annual growth rate—thirteen percent.

This seems reasonably plausible, though it should be stressed that this is an average rate which masks periods of low growth (e.g., 1957-61) and periods of high growth (e.g., 1978-80). Like the CYBER Model, DoD is found to be responsive to negative public opinion. Defense expenditures do not, however, appear to be reactive to Soviet defense expenditures or to U.S. economic conditions. It should be noted that DoD takes cues from recent Congressional action, a result also consistent with the empirical findings of the CYBER Model.

A comparison of the two models, in terms of the explanations they produce, would favor the CYBER Model for a number of reasons. First, some of the coefficient estimates of the MR approach are not in the predicted direction. Second, some of the empirical results of the MR model are counterintuitive and inconsistent with previous empirical analyses. This is true not only in terms of the explanatory factors that are included in the model, but more importantly in terms of the factors that are excluded. Such comparisons, however, tap only one dimension of these two approaches—namely, the explanations which they produce. Another type of comparison, the focus of Chapter V, will examine the forecasting abilities of each model.

NOTES

[1]Data for FY 1948 and FY 1949 were obtained from Congressional testimony by the Services. The FY 1980 Services Request was provided to me by the Services themselves. For FY 1947 only the Air Force and Army supplied the requested data. The entire Services' Request for this year was extrapolated under the assumption that the Navy request was a constant share during this period.

[2]SIPRI (1973) has estimated that the "incremental costs" of the Vietnam War for the period 1965-1973 were in excess of $107 billion. Incremental costs are the additional expenditures above what would have been spent in peacetime for the base-line force.

[3]For an in-depth survey of the problems associated with estimating Soviet defense expenditures, see Cockle (1978) or Burton (1983).

[4]Gallup has asked questions pertaining to defense spending with sporadic frequency. Data on defense spending were obtained from monthly reports #50, 71, 88, 93, 101, 112, 129, 146, 175, and from weekly reports prior to 1965. Gallup polls on public opinion concerning Vietnam were conducted regularly from 1965-71. For years when no opinion data was available a surrogate measure was obtained by interpolating from available data. For clarification and elaboration of the impact of public opinion on defense spending, see Russett (1972).

[5]The zero-order correlations between SOVCH and the defense expenditure changes are: ΔDEC_{1t} (.179); ΔDEC_{2t} (.291); ΔDEC_{3t} (.308); and ΔDEC_{4t} (.333).

CHAPTER V

A FORECAST EVALUATION OF THE CYBER MODEL

The previous chapter initiated an evaluation of the CYBER Model by examining the degree to which the empirical results provided support for a number of hypotheses regarding the direction and relative magnitude of the estimated parameter coefficients. Based upon this preliminary evaluation I concluded that the CYBER Model demonstrated considerable potential as an explanation of the U.S. defense expenditure policy-making process.

The CYBER Model and its underlying MSRA methodology were also evaluated through a direct comparison with a straightforward multiple regression (MR) approach. The MR analysis, while yielding a more parsimonious explanation of defense expenditure policy making, produced some estimates which were not in the hypothesized direction. In addition, the magnitudes of some of the coefficients suggested incremental growth rates which were not plausible in that they were fairly small. As an explanatory device, then, the CYBER Model appears superior to its MR counterpart.

Competing models may be judged, however, on criteria other than the explanations which they yield. The predictive capabilities of individual models may be equally important. It could be argued that a model which generated largely inaccurate forecasts was of limited utility, regardless of the plausibility of its explanation.

This chapter will evaluate the CYBER Model in terms of the historical forecasts which it produces. In addition to the absolute forecasting ability of the CYBER Model, this chapter will explore its relative success as a forecasting tool. As a basis for this comparison, the forecasts of the MR Model and a No-Change Naive Model will be generated. An absolute measure of the accuracy of these forecasts will be employed to conduct this test. As a prelude to this evaluative exercise, the goodness of fit of the CYBER Model will be briefly examined.

Goodness of Fit of the CYBER Model

The most frequently encountered measure used to assess the "fit" of a model represented by a regression line is R^2 (r-square)--the proportion of variation in the dependent variable attributable to the independent variable(s). Unfortunately, the MSRA methodology does not produce R^2s that can be interpreted in the traditional sense. At each step in the analysis the R^2 represents the proportion of explained variance, but of a partitioned set of variance. In other words, an R^2 of 0.80 means that eighty percent of the available unexplained variance can be attributed to the particular set of essential variables.

As a means of summarizing the total explanatory power of the CYBER Model I have generated a surrogate R^2 which is based upon a comparison between the actual defense expenditure decisions and those predicted by the model. These predicted values are correlated with the actual observed values. The square of these bivariate correlations provides an estimate of the proportion of the variance in the dependent variable that can be attributed to the combined subsets of essential variables.

Tables 5.1 and 5.2 present the bivariate correlations and surrogate R^2s for each actor's defense expenditure change decision (ΔDEC_t) and aggregate defense expenditure decision (DEC_t), respectively. Table 5.1 suggests that the CYBER Model meets with considerable success in terms of the amount of explained variation in the defense expenditure change decisions. The range is from 94% for the Congress to 57% for the Department of Defense expenditure change decisions.

Table 5.1: Bivariate Correlations between Actual and Predicted Values of ΔDEC_t with Associated Surrogate R^2s

Actor	Bivariate Correlation	Proportion of Explained Variation[a]
Services	.88	.77
President	.92	.84
Congress	.97	.94
DoD	.75	.57

[a]Derived by squaring the bivariate correlation between actual and predicted values of ΔDEC_t.

Table 5.2, on the other hand, indicates even greater success on the part of the CYBER Model in terms of its ability to predict aggregate defense expenditure decisions. The "poorest" fit is with the Services at 95%; at least 98% of the variation in the other three actors' aggregate defense expenditure decisions can be accounted for.

Table 5.2: Bivariate Correlations between Actual and Predicted Values of DEC_t with Associated Surrogate R^2s

Actor	Bivariate Correlation	Proportion of Explained Variation[a]
Services	.970	.95
President	.992	.98
Congress	.997	.99
DoD	.989	.98

[a]Derived by squaring the bivariate correlation between actual and predicted values of DEC_t.

This phenomenal explanatory success, however, needs to be put into perspective. It should be noted that the previous year's decision (DEC_{t-1}) or base is used in the generation of the predicted values of the aggregate defense expenditure decisions. In the previous chapter it was shown how influential this base is (cf. Table 4.1). This "inertial dominance" makes it very difficult to detect the effects of other factors. In addition, this base all but guarantees the extremely high level of explanatory power typically associated with such incremental models.

Focusing on the Services Request it was demonstrated that the base accounted for 74% of the total variation. As indicated by Table 5.1, this figure is increased to 95% by the inclusion of the first-, second-, and third-order essential variables. While the increase in explained variation is, in an absolute sense, 21%, this figure represents over 80% of the variation not already attributable to the base. Table 5.3 addresses this issue by decomposing the amount of explained variation in the aggregate defense expenditure decisions into two portions: that which can be attributed to the base and that which can be attributed to the combined effects of the essential variables.

Table 5.3: Decomposition of Explained Variation in Aggregate Defense Expenditure Decisions (DEC_t)

Actor	% Variation Attributed to		EV Increase (%)[c]
	Base[a]	Essential Variables[b]	
Services	74	21	81
President	90	8	80
Congress	90	9	90
DoD	96	2	50

[a]Previous year's defense expenditure decision (DEC_{t-1}).

[b]Combined effects of first-, second-, and third-order EVs.

[c](Variation attributed to EVs)/(Total variation not attributable to Base) expressed as a percentage.

Table 5.3 also indicates the proportion of the unexplained variation which the essential variables capture once the effects of the base have been isolated. For example, the increase of 2% in the explained variation in the DoD expenditure series actually represents one-half of the variation not already accounted for by the large, inertial base.

In trying to assess the explanatory power of the CYBER Model, several features emerge. First, in terms of the original dependent variables (ΔDEC_t) the model performs quite well. Across all four actors nearly eighty percent of the total variation can be attributed to the factors comprising the CYBER Model. The poorest fit is with the DoD expenditure change (57%), while 94% of the annual change in Congressional appropriations can be explained by the model. Second, the combination of the essential variables with the previous year's decision is sufficient to explain nearly all of the variation in aggregate defense expenditures decisions for all four actors. Finally, even though the effects of the base appear quite large relative to those of the essential variables, Table 5.3 demonstrates that this comparison is somewhat misleading. Increases associated with the essential variables tend to be fairly small in absolute terms, but are quite large when viewed in relative terms.

Evaluations of the CYBER Model based upon a simple goodness of fit criterion have found this approach to be quite fruitful. When this is coupled with the results of the hypothesis tests conducted in the previous chapter I am quite optimistic about the utility of the CYBER Model as an explanatory and predictive model of the U.S. defense expenditure policy-making process. The estimated parameter coefficients are substantively plausible and empirically robust.

In a comparison between the CYBER Model and a MR Model conducted in the previous chapter it was observed that the latter possesses many shortcomings as an explanatory vehicle. The question has not been addressed, however, as to the forecasting ability of this model. More importantly, the forecasting ability of the CYBER Model must be assessed relative to some other model. The next section will compare the forecasts generated by these two models of defense expenditure policy making. In addition, a No-Change Naive Model will be introduced as an evaluative baseline.

A Comparative Forecast Evaluation

As suggested earlier, the fact that the CYBER Model produces accurate predictions is a statement that cannot be judged in absolute terms alone. If another model yields predictions which are relatively more accurate, then the CYBER Model will have to be found wanting. One obvious candidate is the multiple regression (MR) model estimated in the previous chapter.

First, an absolute measure of the accuracy of these forecasts must be introduced. One possible measure might be the bivariate correlation between the actual and predicted series. While this statistic is indicative of the degree to which the two series are associated with each other, it does not provide a measure of absolute forecast accuracy. For example, a model which consistently yields predictions that are 25% below the actual values will still demonstrate a high bivariate correlation between the two series. This is because one series can be expressed as a linear combination of the other. In absolute terms, however, the model would not fare very well.

As an absolute measure of the accuracy of the forecasts generated by the CYBER and MR Models I shall employ the root mean square error (RMSE). The RMSE is the standard deviation or dispersion around the line of perfect forecasts. The smaller the RMSE, the more accurate the forecasts. The RMSE can be computed as follows:

$$\text{RMSE} = [T^{-1} \Sigma \ (P_t - A_t)^2]^{1/2} \qquad (5.1)$$

where P_t refers to the forecasted or predicted value, A_t is the actual value, and T is the number of forecasts. It can be seen that when the predicted values are identical with the actual values the RMSE will be zero.

As Ostrom (1978b:66) notes:

> Since [the RMSE] is a non-parametric measure, there are no objective standards (e.g., significance levels) with which to assess the forecast accuracy. A determination of the accuracy of the model forecasts can be made, however, by comparing their accuracy to that of a mechanistic alternative—one which requires no prior theorizing (in the sense of having a prior conception of the dynamics of the policy-making process).

One alternative which he suggests is the no-change naive model. This no-change model states that the value of a defense decision at time _t_ is equal to the value of time _t-1_ plus some random disturbance that is normally distributed with a zero mean and a constant but unknown variance, i.e.,

$$DEC_t = DEC_{t-1} + V_{it} \qquad (5.2).$$

Equation (5.2) can also be used to suggest a no-change naive model which accounts for the annual defense expenditure change decisions, i.e.,

$$\Delta DEC_t = \Delta DEC_{t-1} + V_{it} \qquad (5.3).$$

Equation (5.3) says that the annual defense expenditure change decision at time _t_ will differ from the change decision at _t-1_ by only a small, random factor. No-change naive forecasts will be generated using equations (5.2) and (5.3) and will serve as an evaluative baseline.

Tables 5.4 through 5.7 present the actual defense expenditure change decisions for the Services, President, Congress, and DoD, respectively, as well as the predicted values for the CYBER, MR, and No-Change Models. The CYBER Model will be judged to be a more accurate forecasting model if its RMSE is less than the RMSEs of the other two models. In addition to the RMSEs, Tables 5.4 through 5.7 also present the correlations (r_{ap}) between the actual and predicted values for each model. Owing to the manner in which the CYBER Model is estimated the first three observations are lost. As such, forecasts have been generated for the FY 1950-80 period.

It can be seen that the historical forecasts produced by the CYBER Model for the Services' change decisions are more accurate than those of either the MR Model or the No-Change Naive Model. Specifically, they have a smaller RMSE ($6.9 billion to $10.1 billion and $20.5 billion) and are more highly correlated with the actual change requests

Table 5.4: Actual and Forecasted Values of Military Services' Annual Change Requests, 1950-80 ($ Millions)

Fiscal Year	Actual Change Request	Forecasted Change Requests		
		CYBER Model	MR Model	No-Change Naive Model
1950	1415	4889	10013	1625
1951	3410	-1335	-318	1415
1952	60181	55609	64657	3410
1953	-16121	7180	-6727	60181
1954	-14890	-16169	-13137	-16121
1955	-14600	-17659	-19495	-14890
1956	1500	1778	-3755	-14600
1957	3200	-5818	-7382	1500
1958	14800	13949	24890	3200
1959	-1340	-7743	969	14800
1960	6400	16382	-5584	-13400
1961	-7697	-954	1620	6400
1962	9797	2386	-11481	-7697
1963	2000	5675	14925	9797
1964	6544	6834	4552	2000
1965	-160	5448	7992	6544
1966	-3936	-12158	-18577	-160
1967	16735	6849	12106	-3936
1968	20409	16525	21020	16735
1969	8654	16718	22831	20409
1970	-1683	223	322	8654
1971	-22134	-15223	-16334	-1683
1972	-2427	-5655	-18947	-22134
1973	5277	-4540	-1598	-2427
1974	5194	5730	18425	5277
1975	-246	1506	4103	5194
1976	11916	5378	-6909	-246
1977	9691	9455	23266	11916
1978	8988	14895	11010	9691
1979	9887	8880	10549	8988
1980	9832	6690	5981	9887
	RMSE	6873	10062	20490
	r_{ap}	0.879	0.804	-0.022

(.88 to .80 and -0.02). While there is not a statistically significant difference between the CYBER and MR correlations, the smaller RMSE for the CYBER Model indicates that its forecasts are more accurate than those of the MR and No-Change Naive Models. The latter performs especially poorly, a fact borne out by its relatively large RMSE and low correlation between actual and predicted values.

The CYBER Model does just as well in its forecasts of the Presidential change decisions. As presented in Table 5.5, the RMSE for the CYBER Model is less than that of either of the other two models ($3.9 billion to $4.8 billion and $13.1 billion). Moreover, the correlations between actual and predicted values are largest for the CYBER Model (.92 to .87 and .03), though once again the difference between the CYBER and MR Models is not statistically significant. In terms of the magnitude of the RMSEs, the CYBER Model's forecasts are more accurate for the President's change decisions than for those of the Services.

As can be seen from Table 5.6, this forecasting accuracy improves when one examines the Congressional change decisions. More importantly, the CYBER Model's forecasts are more accurate than those of either the MR or No-Change Naive Model. This is evidenced by both the RMSEs ($2.3 billion to $3.3 billion and $13.3 billion) and the correlations between actual and predicted values (.97 to .94 and -.04).

Finally, the CYBER Model yields the most accurate historical forecasts of DoD expenditure changes. This is confirmed in Table 5.7 by its smaller RMSE ($4.1 billion to $4.4 billion and $5.6 billion). The predicted values generated by the MR Model, however, are more closely correlated with actual values (.79 to .75 and .51). This only

Table 5.5: Actual and Forecasted Values of President's Annual Change Requests, 1950-80 ($ Millions)

Fiscal Year	Actual Change Request	Forecasted Change Requests		
		CYBER Model	MR Model	No-Change Naive Model
1950	1316	-624	1505	735
1951	-1192	2864	2640	1316
1952	43490	43265	40706	-1192
1953	-4214	-5421	-5139	43490
1954	-10671	-7387	-5763	-4214
1955	-10833	-9242	-10035	-10671
1956	2346	-29	-1935	-10833
1957	1915	193	928	2346
1958	1980	6699	8818	1915
1959	2069	-6867	-8979	1980
1960	1051	4338	8426	2069
1961	87	-3474	-2184	1051
1962	3607	4437	5015	87
1963	4965	2368	3453	3607
1964	1107	2624	3638	4965
1965	-1543	117	83	1107
1966	-2222	-1346	-3571	-1543
1967	12415	11388	8395	-2222
1968	13920	14626	12443	12415
1969	5490	12378	9888	13920
1970	-1796	4166	652	5490
1971	-6532	-8392	-12177	-1796
1972	4798	1801	2560	-6532
1973	6050	5007	8350	4798
1974	-2343	5274	7377	6050
1975	9806	1825	-2509	-2343
1976	10801	7165	1212	9806
1977	8904	7973	13776	10801
1978	7115	6595	8798	8904
1979	5423	6545	7193	7115
1980	13021	6419	5908	5423
	RMSE	3858	4838	13091
	r_{ap}	0.915	0.868	0.029

Table 5.6: Actual and Forecasted Values of Congressional Annual Change Requests, 1950–80 ($ Millions)

Fiscal Year	Actual Change Request	Forecasted Change Requests		
		CYBER Model	MR Model	No-Change Naive Model
1950	2197	1378	2122	1910
1951	-1554	-1204	-1344	2197
1952	42938	41384	41669	-1554
1953	-8373	-4700	-3005	42938
1954	-12239	-10125	-12764	-8373
1955	-5572	-9941	-12603	-12239
1956	3083	2555	5498	-5572
1957	2774	2801	3909	3083
1958	-897	1263	2829	2774
1959	5913	2928	267	-897
1960	-445	408	3011	5913
1961	769	210	162	-445
1962	6666	3699	3608	769
1963	1473	5409	7340	6666
1964	-916	499	-422	1473
1965	-468	-2078	-3943	-916
1966	135	-1133	-2237	-468
1967	11180	12466	13461	135
1968	11870	12723	12756	11180
1969	1933	3660	2787	11870
1970	-2229	-2910	-4078	1933
1971	-3045	-6006	-6598	-2229
1972	3922	5725	7714	-3045
1973	3855	7122	6706	3922
1974	-658	-2528	-3922	3855
1975	8381	9946	10253	-658
1976	8371	10980	10263	8381
1977	13877	9063	6864	8371
1978	5409	6575	10101	13877
1979	7503	4912	5745	5409
1980	13725	13158	13948	7503
	RMSE	2261	3333	13278
	r_{ap}	0.970	0.939	-0.044

Table 5.7: Actual and Forecasted Values of DoD's Annual Change Requests, 1950–80 ($ Millions)

Fiscal Year	Actual Change Request	Forecasted Change Requests		
		CYBER Model	MR Model	No-Change Naive Model
1950	433	-1421	-4679	1090
1951	7898	5349	5093	433
1952	19144	20055	25999	7898
1953	4694	-1198	800	19144
1954	-3354	-8003	2685	4694
1955	-4887	88	-2849	-3354
1956	227	-1557	-3486	-4887
1957	2702	1795	1942	227
1958	1096	-2834	3130	2702
1959	2273	5139	2907	1096
1960	27	-2588	-1077	2273
1961	1798	4272	187	27
1962	3534	4072	4763	1798
1963	1115	2570	1466	3534
1964	1529	-5044	-322	1115
1965	-3590	-4052	2335	1529
1966	8213	3086	-5809	-3590
1967	13264	8461	16775	8213
1968	9908	11342	14088	13264
1969	520	6832	3719	9908
1970	-715	963	-3259	520
1971	-2598	749	-448	-715
1972	604	2360	-572	-2598
1973	-1853	3367	1428	604
1974	4327	1857	-4723	-1853
1975	7350	6827	11576	4327
1976	2291	4717	8623	7350
1977	7666	8850	4138	2291
1978	7485	5703	8216	7666
1979	11971	6507	9422	7485
1980	17827	5361	17214	11971
	RMSE	4098	4439	5583
	r_{ap}	0.753	0.785	0.508

confirms the observation made earlier which suggested that such correlations were not infallible guidelines for determining the accuracy of a set of predictions.

In terms of its ability to generate relatively accurate historical forecasts the CYBER Model has been shown to do quite well in accounting for defense expenditure change decisions for all four actors. When compared with a MR Model of the defense expenditure policy-making process the differences are not always striking, but for each actor the RMSEs are smaller for the CYBER Model. When compared against a No-Change Naive Model the results are even more impressive. With the exception of the DoD expenditure changes, the RMSEs of the CYBER Model are at least three times more accurate than those of the No-Change Model.

The theoretical focus of the CYBER Model is on the annual change in defense budget requests, recommendations, appropriations, and expenditures, though I realize that considerable scholarly and public attention is usually devoted to aggregate defense expenditure levels. By adding the previous year's defense expenditure decision (DEC_{t-1}) to the change (ΔDEC_t) it is possible to construct the aggregate defense expenditure totals. Tables 5.8 through 5.11 present the historical forecasts for the Services' requests, President's budget recommendations, Congressional appropriations, and DoD expenditures for the FY 1950-80 period. As with Tables 5.4 through 5.7, the actual defense expenditure decisions are compared with forecasted levels generated by the CYBER, MR, and No-Change Naive Models.

Several important points are worth noting. First, with the exception of the Services' request, the MR Model yields historical

Table 5.8: Actual and Forecasted Values of Services Requests, 1950-80 ($ Millions)

Fiscal Year	Actual Request	Forecasted Services Requests		
		CYBER Model	MR Model	No Change Naive Model
1950	17920	21394	15757	16505
1951	21330	16585	15438	17920
1952	81511	76939	80095	21330
1953	65390	88691	73368	81511
1954	50500	49221	60231	65390
1955	35900	32841	40736	50500
1956	37400	37678	36981	35900
1957	40600	31582	29599	37400
1958	55400	54549	54489	40600
1959	42000	47687	55458	55400
1960	48400	58382	49784	42000
1961	40703	47446	51494	48400
1962	50500	43089	40013	40703
1963	52500	56175	54938	50500
1964	59044	59334	59490	52500
1965	58884	64492	67481	59044
1966	54948	46726	48904	58884
1967	71683	61797	61011	54948
1968	92092	88208	82030	71683
1969	100746	108810	104861	92092
1970	99063	100969	105183	100746
1971	76929	83840	88850	99063
1972	74502	71274	69903	76929
1973	79779	69962	68305	74502
1974	84973	85509	86730	79779
1975	84727	86479	90833	84973
1976	96643	90105	83924	84727
1977	106334	106098	107191	96643
1978	115322	121229	118200	106334
1979	125209	124202	128750	115322
1980	135041	131899	134731	125209
	RMSE	6873	7317	14850
	r_{ap}	0.973	0.970	0.875

Table 5.9: Actual and Forecasted Values of President's Recommendations, 1950-80 ($ Millions)

Fiscal Year	Actual Recommendation	Forecasted President's Recommendations		
		CYBER Model	MR Model	No-Change Naive Model
1950	13307	11367	11850	11991
1951	12115	16171	14490	13307
1952	55605	55380	55196	12115
1953	51391	50184	50058	55605
1954	40720	44004	44294	51391
1955	29887	31478	34260	40720
1956	32233	29858	32325	29887
1957	34148	32426	33253	32233
1958	36158	40847	42072	34148
1959	38197	29261	33092	36128
1960	39248	42535	41518	38197
1961	39335	35774	39334	39248
1962	42942	43772	44350	39335
1963	47907	45310	47803	42942
1964	49014	50531	51441	47907
1965	47471	49131	51524	49014
1966	45249	46125	47953	47471
1967	57664	56637	56348	45249
1968	71584	72290	68791	57664
1969	77074	83962	78679	71584
1970	75278	81240	79331	77074
1971	68746	66886	67153	75278
1972	73544	70547	69713	68746
1973	79594	78551	78063	73544
1974	77251	84868	85440	79594
1975	87057	79076	82931	77251
1976	97858	94222	92143	87057
1977	106762	105831	105919	97858
1978	113877	113357	114717	106762
1979	119300	120422	121910	113877
1980	132321	125719	127818	119300
	RMSE	3858	3282	10222
	r_{ap}	0.992	0.994	0.949

Table 5.10: Actual and Forecasted Values of Congressional Appropriations, 1950-80 ($ Millions)

Fiscal Year	Actual Appropriation	Forecasted Congressional Appropriations		
		CYBER Model	MR Model	No-Change Naive Model
1950	13600	12781	12449	11403
1951	12046	12396	11105	13600
1952	54984	53430	52775	12046
1953	46611	50284	49769	54984
1954	34372	36486	37006	46611
1955	28800	24431	24403	34372
1956	31883	31355	29901	28800
1957	34657	34684	33810	31883
1958	33760	35920	36640	34657
1959	39673	36688	36907	33760
1960	39228	40081	39918	39673
1961	39997	39438	40079	39228
1962	46663	43696	43687	39997
1963	48136	52072	51027	46663
1964	47220	48635	50604	48136
1965	46752	45142	46661	47220
1966	46887	45619	44424	46752
1967	58067	59353	57886	46887
1968	69937	70790	70642	58067
1969	71870	73597	73429	69937
1970	69641	68960	69351	71870
1971	66596	63635	62753	69641
1972	70518	72321	70467	66596
1973	74373	77640	77173	70518
1974	73715	71845	73251	74373
1975	82096	83661	83504	73715
1976	90467	93076	93768	82096
1977	104344	99530	100631	90467
1978	109753	110919	110732	104344
1979	117256	114665	116477	109753
1980	130981	130414	130425	117256
	RMSE	2261	2226	10040
	r_{ap}	0.997	0.997	0.946

Table 5.11: Actual and Forecasted Values of DoD Expenditures, 1950-80 ($ Million)

Fiscal Year	Actual Expenditures	Forecasted DoD Expenditures		
		CYBER Model	MR Model	No-Change Naive Model
1950	11674	9820	7511	11241
1951	19572	17023	12604	11674
1952	38716	41627	38603	19572
1953	43410	37518	39403	38716
1954	40056	35407	42088	43410
1955	35169	40144	39239	40056
1956	35396	33612	35754	35169
1957	38098	37191	37696	35396
1958	31194	35264	40825	38098
1959	41467	44333	43732	39194
1960	41494	38879	42655	41467
1961	43292	45766	42842	41494
1962	46826	47364	47605	43292
1963	47941	49396	49071	46826
1964	49470	42897	48748	47941
1965	45880	45418	51083	49470
1966	54093	48966	45275	45880
1967	67357	62554	62050	54093
1968	77265	78699	76138	67357
1969	77785	84097	79857	77265
1970	77070	78748	76598	77785
1971	74472	77819	76150	77070
1972	75076	76832	75578	74472
1973	73223	78443	77006	75076
1974	77550	75080	72283	73223
1975	84900	84377	83859	77550
1976	87891	89617	92482	84900
1977	95557	96741	96620	87891
1978	103042	101260	104835	95557
1979	115013	109549	114258	103042
1980	132840	120374	131472	115013
	RMSE	4098	3250	7054
	r_{ap}	0.989	0.993	0.978

forecasts which are relatively more accurate than those of the CYBER Model. This is evidenced by both the lower RMSEs for the MR Model and its higher correlations between the actual and predicted series. Second, while not intending to deny the MR Model its "victory" over the CYBER Model it should be noted that the differences between the two are not striking. For example, the RMSE of the MR Model is only slightly lower than that of the CYBER Model for the Congressional appropriation series ($2.23 billion to $2.26 billion). When one considers that the average Congressional appropriation for defense during this period is nearly $60 billion, a difference in forecasting ability of $30 million seems relatively inconsequential. This observation, when coupled with the explanatory deficiencies of the MR Model, should not be construed as particularly damning evidence against the CYBER Model. Third, both models easily outperform the No-Change Naive Model. Finally, given the inability of existing models based upon other theoretical approaches (e.g., Rational Actor and Organizational Process) to generate forecasts which are consistently more accurate than those generated by a No-Change Naive Model (Ostrom, 1977a), I conclude that the CYBER Model represents an improvement over such models.

When the substantive plausibility of the CYBER Model is combined with the reported empirical results and the ability of the model to generate accurate historical forecasts of both changes and levels, I think it is reasonable to conclude that this approach represents a significant advance in the study of the U.S. defense expenditure policy-making process. The final chapter of this dissertation will expand on this observation and will offer suggestions for future research.

CHAPTER VI

CONCLUDING OBSERVATIONS

This dissertation began with an overview of the current conventional wisdom suggested by models of the U.S. defense expenditure policy-making process. At this point I would like to review the major findings and features of the CYBER Model within the context of this conventional wisdom. In so doing I shall be able to demonstrate the extent to which the CYBER Model does or does not lend support to previous research efforts in this field.

The CYBER Model and the Conventional Wisdom

Earlier it was shown that there is an emergent consensus which holds that the United States does not, in terms of its defense expenditure policy, react to the behavior of the Soviet Union. Furthermore, it was argued that the conventional wisdom suggested that economic, political, and bureaucratic factors were the primary determinants of U.S. defense expenditure levels. Even those studies which focused on the annual changes in military expenditures tended to reinforce the "primacy of domestic determinants" hypothesis.

The CYBER Model provides little support for such arguments. With respect to the claim that the United States does not respond to the behavior of its major adversary the CYBER Model was able to demonstrate significant reactions by all four actors in the defense expenditure policy-making process. The Military Services, President, and Congress are responsive to the strategic balance which exists between the U.S. and the USSR. Moreover, each of these actors was shown to react to international tensions/crises in which the interests of both superpowers were at stake. The Department of Defense exhibited sensitivity to changes in Soviet expenditure behavior such that these changes were matched on a one-to-one basis.

The CYBER Model is not able to support arguments which suggest the primacy of domestic factors. It will be recalled that each of the four actors was responsive to the first-order essential variable USE, a factor residing in the external, international environment. In addition, three of the four actors (Service, President, Congress) were influenced by four second-order essential variables, two of which are international rather than domestic in nature. The expenditure behavior of DoD was found to be responsive to an additional factor in the external environment. Even if one were to consider the third-order essential variables CUES as reflecting only domestic concerns, eleven of the twenty-three significant reactions in the CYBER Model are to variables in the international environment.

Six types of variables were identified in Chapter I: war, behavior of the USSR, international tensions/crises, macroeconomic factors, political factors, and bureaucratic/organizational factors. Of these six types, the CYBER Model found that defense decision makers were sensitive to all subsets, with the exception of the bureaucratic factors. Given the predominant conceptualization of these factors as an inertial base it was not incorporated into the CYBER Model.

In short, the CYBER Model does not support the trends which were identified as part of the current conventional wisdom. The estimated version of the model provides an accurate representation of changes in defense expenditure decisions for the period 1947 to 1980. On an equation-by-equation basis the CYBER Model explains a large proportion of the total variance. The parameter estimates are not only sharp and plausible, but also are fully consistent with the theoretical argument that the defense expenditure policy-making process takes place within a "funnel of constrained reactivity." The historical forecasts of defense expenditure change decisions generated by the CYBER Model are more accurate than those produced by either a multiple regression model or a no-change naive model. Taken together, the empirical results of the CYBER Model are quite encouraging.

Chapter I also identified a number of theoretical approaches to the study of U.S. defense expenditures. In terms of its characterization of the policy-making process the CYBER Model fits within the tradition of organizational process models. Four actors or steps were identified: the Military Services, President, Congress, and the Department of Defense. Unlike most multi-actor or multi-step models of defense expenditure policy making, the CYBER Model suggests that the steps or decision-making groups are largely independent of one another. Moreover, it was argued that successive actors in the process were increasingly isolated from the external (non-process) environment. The empirical analysis of the CYBER Model supports this theoretical conceptualization.

The major point of departure between the CYBER Model and the conventional wisdom is the explicit characterization of the behavior of decision makers which is integral to the CYBER Model and which is so often absent from other explanations. Underlying the CYBER Model is a view of decision makers which holds that they attend to a limited number of variables in the external environment in a hierarchic fashion. The hierarchy is structured by the importance which decision makers attach to "essential variables" in their environments. "Survival" was identified as a goal which adaptive organisms seek to preserve and which assists them in their determination of which variables are essential.

This approach is distinctive for two reasons. First, a set of assumptions concerning the characteristics of decision makers is used to derive a model of defense expenditure policy making. As pointed out earlier, such explicit characterizations are often absent. Second, those explanations which have addressed the issue of the nature of decision makers have usually done so within a rational actor framework. The cybernetic perspective offered here is relatively unique, both in terms of its conceptualization and its application to the defense expenditure policy-making process. This approach also provided a theoretical basis for focusing on <u>changes</u> in annual defense expenditure decisions, rather than on aggregate <u>levels</u>. Given the relative lack of attention in previous research with respect to this question, such a theoretical basis is both welcomed and necessary.

Finally, a number of methodological concerns have been addressed in this dissertation. The theoretical focus on changes, for example, enabled the CYBER Model to detect reactions to a larger set of variables which otherwise would have been masked or overshadowed by the large, inertial base. The cybernetic approach also suggested a formalization of the model which required a relatively untried methodological strategy. A procedure, identified as multi-stage residual analysis (MSRA), was introduced and employed in the estimation of the CYBER Model. In a comparative analysis between MSRA and a more traditional multiple regression (MR) approach it was shown that the latter yielded a substantive explanation which contained a number of inconsistencies. I would also suggest that strategy followed in this dissertation epitomizes a "theoretical causality analysis" rather than a "statistical causality analysis."

When its theoretical development and focus are combined with the empirical estimation and forecasting results, the CYBER Model emerges as a challenge to much of the current conventional wisdom. The primacy of domestic determinants of U.S. defense spending cannot be supported, nor can the argument that the United States does not react to the behavior of the Soviet Union be substantiated. The CYBER Model also stands as a potentially significant extension to the conventional wisdom; it holds that decision makers and decision making should be the focus of analyses of the defense policy-making process.

There have been costs associated with this enterprise, and I would be remiss if I did not mention some of them. In addition, there are a number of possible areas for extension, revision, and application. The final section will raise these issues as a means of offering suggestions for future research.

Loose Ends: Problems and Prospects

One of the major costs associated with the theoretical perspective adopted in this dissertation is that by focusing on the decision-making process much parsimony is sacrificed. Whether this is inevitable is not entirely clear. My presumption is that a certain amount of relative complexity is unavoidable. While more parsimonious explanations might exist none of these take an explicit decision-making focus. Moreover, given the absolute complexity of the U.S. defense expenditure policy-making process, the CYBER Model developed here is really quite simple. Still, if explanatory completeness could be maintained, then perhaps a more parsimonious formulation would be preferable.

On a more concrete level, there are a number of areas that can be addressed immediately. Some of these are questions of better measurement or operationalization, while others may require a more rigorous theoretical development. The first-order essential variable USE, for example, is not entirely satisfactory. While the CYBER Model performs quite well throughout the entire sample period, it is true that the largest forecast errors are associated with the Korean demobilization period. The model is quite successful in predicting the massive increases connected with both the Korean and Vietnam War eras, but the ability of the model to capture the dynamics of the de-escalation period has not proved successful. Previous attempts to explicitly incorporate a de-escalation factor have been disappointing. Perhaps U.S. battle casualties need to be supplemented with or replaced by data pertaining to the size of U.S. active duty military personnel.

The results obtained for the measure of Soviet expenditure behavior, SOVCH, are also less than satisfying. Given the considerable measurement problems associated with existing estimates of Soviet defense expenditures, perhaps an entirely new approach is called for. An index based upon the perceptions of U.S. defense planners as to the magnitude and dimensions of the Soviet threat would be preferable to existing expenditure series. Such an index, with its emphasis on perceptions, would also be more consistent with the cybernetic framework that is being offered. By moving away from a reliance on expenditure data researchers might enhance their ability to discern a reactive component in U.S. defense expenditure policy making. With respect to the CYBER Model I would suggest that a better measure of the Soviet threat might eliminate the one empirical anomaly uncovered by this analysis, i.e., the reaction to SOVCH at only the DoD expenditure step.

The failure of the CYBER Model to discern reactions to the economic factor BURDEN also represents a problem area. The solution may require better measurement, a different operationalization, or more rigorous theoretical justification as to why reactions to deficit levels should be expected in the first place. Perhaps the willingness of the current administration to tolerate sizable deficit levels in order to finance the expansion of defense programs is not a new phenomenon. Or, it may be that the possible counter-cyclical effects of federal expenditures are not well understood and, therefore, attempts to incorporate such effects into empirical models are doomed to failure. It is even possible that the logic of the Great Identity bears re-examination as it is applied to the study of defense expenditure policy making.

The artificial construction of the third-order essential variable CUES also presents somewhat of a problem. While the argument that decision makers are responsive to information which they provide to each other is both substantively plausible and empirically supported, greater attention should be directed to the exact manner and form in which this information is transmitted and received.

In addition to the concerns raised above, there are several issues which should be explored. The role of supplemental appropriations in the defense expenditure process is neither well understood nor has it been extensively modeled. Ostrom (1978a), for example, treats supplementals as part of an identity relationship and he does not specify an associated policy-making rule. Most analyses, including this one, largely ignore supplementals. Given that supplementals affect the expenditure total, and given that the CYBER Model's "poorest fit" is in its explanation of the DoD expenditure change, this would seem to be a fruitful area for further research.

Greater attention should also be directed toward the number and size of the relevant decision-making groups. This analysis has proceeded on the assumption that the four groups were fairly similar, though this is an assumption which has not been put to any test. Moreover, the implications of group size and group membership composition need to be examined. If it can be demonstrated that aggregate decision-making behavior is a function of the size and composition of group membership, then such considerations will have to be explicitly incorporated into models of this process. While it seems fairly obvious that the President does not prepare his defense budget request by himself, the number of other relevant actors is unclear. By the same token, little is known about who or what in the Department of Defense is responsible for expending defense appropriations. It may be that the "funnel of constrained reactivity" narrows at this point to the extent that little discretionary expenditure power exists. This question cannot be answered properly without further research.

Finally, the cybernetic perspective offered here could be tested to determine its applicability to other fields. If humans are, in fact, cybernetic decision makers, then this approach should be universally applicable wherever and whenever humans are involved. Other budgetary phenomena appear to be the most likely candidates. The possibility exists, however, that the so-called "uncontrollable" portions of the federal budget would not be amenable to this approach. Could other types of foreign policy decisions be understood within a cybernetic perspective? Critics charge that the current administration lacks a coherent Middle East policy and that U.S. policy in Lebanon has been controlled by events in that region. Is this behavior cybernetic? If so, is there a basic incompatibility between long-range planning and adaptive behavior? These are just a few of the questions that could be addressed within the perspective offered here.

The CYBER Model is not being offered as <u>the</u> explanation of the U.S. defense expenditure policy-making process. My goals have been much more modest. I have attempted to imbue this process with an explicit characterization of decision making. I have proceeded in this fashion because I believed that it would address a major shortcoming in this field and that it could help to resolve a number of incongruities that have emerged. To the extent that I have been successful in these efforts the overall understanding of the U.S. defense expenditure process and its participants will have been enhanced.

APPENDICES

APPENDIX A

LIST OF CRISES OF CONCERN TO BOTH SUPERPOWERS, 1946-1980

Crisis Number	Crisis Date	Crisis Name
1	1946	Soviet-Iranian disputes
2	1946	Greek civil war
3	1946	Chinese civil war
4	1946	Turkey rejects USSR demands to join in Dardanelles defense
5	1946	Status of Trieste
6	1946	Palestine—Establishment of State of Israel
7	1947	Italian CP ousted from government role (riots)
8	1948	CP assumes power in Czechoslovakia
9	1948	Costa Rica invaded by Nicaraguan-based rebels
10	1948	Berlin blockade
11	1948	First Arab-Israeli war
12	1948	Cominform expels Yugoslavia
13	1949	Federal Republic of Germany created, Germany divided
14	1950	USSR downs US bomber over USSR airspace - Latvia
15	1950	US backs France in Indochina
16	1950	Korean War
17	1950	US 7th Fleet moves to Taiwan Straits
18	1950	Puerto Rico nationalist uprisings
19	1950	Yugoslavia tensions
20	1952	Burmese operations against KMT forces
21	1953	Workers riot in East Berlin
22	1954	Taiwan Straits crisis
23	1955	Egyptian-Israeli tensions
24	1955	Costa Rica fights Nicaraguan-based rebels
25	1956	Jordanian crisis—continued Arab-Israeli conflict
26	1956	Mideast war; Suez Canal crisis
27	1956	Gomulka assumes power in Poland
28	1956	Hungarian Revolution
29	1957	Jordan survives dismemberment, ousts Egyptians
30	1957	Syria-Turkey dispute—USSR supports Syria
31	1958	US-Venezuelan tensions (Nixon visit)
32	1958	Members of French military join Algerian revolt—deGaulle returns

Crisis Number	Crisis Date	Crisis Name
33	1958	Civil disorders in Lebanon--US Marines sent
34	1958	PRC shells Quemoy-Matsu-Taiwan Straits
35	1958	Berlin Crisis
36	1959	Sino-Indian border clashes
37	1960	U-2 incident
38	1960	Turkish military coup
39	1960	Congo crisis
40	1960	Cuba-US tensions
41	1961	Bay of Pigs
42	1961	Dominican Republic crisis
43	1961	Berlin border crisis
44	1962	US-Cuban tensions
45	1962	US sends troops to Thailand
46	1962	Cuban Missile Crisis
47	1962	PRC-India border war
48	1963	Civil war in Laos; US 7th Fleet sent to Gulf of Siam
49	1963	Haitian crisis; conflict in Dominican Republic
50	1964	Cyprus troubles; Greece-Turkey war threat
51	1964	Panama Canal Zone flag riots
52	1964	British put down African mutinies
53	1964	Coup in Brazil
54	1964	Tonkin Gulf incidents
55	1964	Congo; US airlifts Belgian troops to Stanleyville
56	1965	Indonesia-Malaysia border conflicts
57	1965	India-Pakistan War
58	1965	Southern Rhodesian independence
59	1965	Dominican revolt; US intervention
60	1965	New border incidents between Israel, Jordan, and Syria
61	1967	Sino-Soviet border clash in Ussuri Island
62	1967	Six Day War
63	1968	Czech crisis
64	1968	Seizure of USS Pueblo by North Koreans
65	1968	B-52 with four H-bombs crashes near Thule, Greenland
66	1968	FRG-GDR tension
67	1969	PRC-USSR border clashes
68	1969	Libyan coup
69	1970	Israeli-UAR conflict
70	1970	Jordan-Palestine guerrillas-Syria conflict
71	1970	US general officers accidently land in Armenia
72	1971	India-Pakistani conflict; Bangladesh formed
73	1972	Sadat expels Soviet advisors
74	1973	October Middle East War
75	1974	Ethiopian emperor overthrown
76	1974	Military coup in Portugal
77	1974	Cyprus civil war; Turkish invasion

Crisis Number	Crisis Date	Crisis Name
78	1975	USSR rejects US trade deal
79	1975	US ends aid; Turkey closes US bases
80	1975	US Mayaguez operation
81	1975	Civil war in Angola
82	1976	Lebanese civil war
83	1976	US accused of bombing Siem Reap
84	1976	Egypt abrogates Soviet Treaty
85	1976	The Aegean crisis
86	1977	First Zaire invasion; Western intervention
87	1977	Ethiopian war
88	1978	Nicaraguan civil war
89	1978	Second Zaire invasion; Western intervention
90	1978	Unrest in Iran
91	1979	Somoza regime overthrown in Nicaragua
92	1979	US Embassy seized in Tehran
93	1979	USSR invades Afghanistan
94	1980	Labor unrest in Poland; formation of Solidarity
95	1980	Escalating violence in El Salvador

APPENDIX B

FARRAR-GLAUBER ANALYSIS OF MULTICOLLINEARITY

This appendix presents the results of a Farrar-Glauber analysis of multicollinearity. The problems associated with multicollinearity were detailed in Chapter III and will not be repeated here.

The original Farrar-Glauber procedure for detecting the presence and sources of multicollinearity in a set of independent regressors (variables) consists of three parts.

Part 1 conducts a chi-square test of the hypothesis that the matrix $X'X$ is invertible, i.e., that the determinant (det) of $X'X$ is non-zero. In the instance of perfect multicollinearity this matrix will not be invertible, and estimates of coefficients for the independent regressors cannot be derived.

Part 2 of the analysis involves regressing each of the independent variables on the set of all other independent regressors. Values of R-squared and associated F-statistics are reported for each regression.

Part 3 provides a matrix of the partial correlations between any pair of independent regressors keeping all other variables constant. Thus (r_{ij}) is the partial correlation between X_i and X_j. Associated t-statistics are also provided.

Given the multi-stage character of the CYBER Model, multicollinearity will be a potential problem at only the step where the set of second-order essential variables is introduced. For this reason, the Farrar-Glauber analysis conducted below is limited to this set of regressors. All variables are as defined and operationalized in Chapter IV.

Part 1: Chi-square test of hypothesis that

$\det(X'X) = 0$

Test statistic = 65.898[a]

[a]Significant at .05 level with 15 degrees of freedom.

Part 2: Values of R-squared and Associated F-statistics of Each Independent Variable Regressed on the Others

Independent Variable	R^2	F-statistic
SOVCH	.740	14.798[b]
MISSILE	.866	33.624[b]
CRISIS	.068	0.382
PIE	.128	0.763
BURDEN	.280	2.021
NEGOPIN	.806	21.245[b]

[b]Significant at .05 level with (5, 26) degrees of freedom.

Part 3: Values of Partial Correlation Coefficients and Associated t-statistics of Each Independent Variable on Every Other Independent Variable (All Other Independent Variables Held Constant)

	SOVCH	MISSILE	CRISIS	PIE	BURDEN
MISSILE	-.824				
	(-7.43)[c]				
CRISIS	.191	.199			
	(0.99)	(1.04)			
PIE	.127	.143	-.179		
	(0.65)	(0.73)	(-0.93)		
BURDEN	-.458	-.282	.024	-.151	
	(-2.63)[c]	(-1.50)	(0.12)	(-0.78)	
NEGOPIN	-.719	-.890	.216	.225	-.213
	(-5.28)[c]	(-9.95)[c]	(1.13)	(1.18)	(-1.11)

[c]Significant at .05 level with 26 degrees of freedom.

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