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Armaments, Detente, and Bureaucracy

THE CASE OF THE ARMS RACE IN EUROPE

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This study explores the extent to which defense spending of the European nations of NATO and of the Warsaw Pact since 1950 can be characterized as an action-reaction process. Since the level of armament expenditures in any state is an outcome of organizational processes, a model is introduced that represents the "normal" growth of defense spending as a function of bureaucratic momentum. Deviations from these expected levels are then treated as reactions to the potential adversary's pattern of military spending and/or to the fluctuations of tension in Europe. The most important findings are (a) the comparatively low influence of action-reaction and international tension—as opposed to that of bureaucratic momentum, and (b) the differential impact of the hostile alliance's armament expenditures and of tension on, respectively, the NATO nations and the Warsaw Pact countries.

Since Lewis Fry Richardson wrote his path-breaking piece on "Generalized Foreign Politics" in 1919 under the impression of the First World War, a tremendous wealth of literature on the problems of arms races has been produced. Arms race models, by now, have become one of the favorite examples to illustrate the utility of formalized theory construction in political science. The mathematical tools employed in these models range from wave theory (Smoker, 1966) to systems of difference, or

AUTHOR'S NOTE: Most of the research for this article was carried out during my time as a Kennedy Fellow at Harvard University's Program for Science and International Affairs. A number of colleagues at PSIA, at the Harvard Center for International Affairs, and at the MIT Center for International Studies helped me a great deal by their comments at various stages of the enterprise. In particular I would

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differential, equations, and from decision and game theory to the most advanced contributions of mathematical control theory (Zinnes and Gillespie, 1974). This proliferation of arms race studies has not been confined to mathematical modeling alone. The more traditionally oriented field has experienced a simultaneous growth of historical and conceptual studies of the arms race syndrome and its alleged determinants and effects (Gray, 1971). The main preoccupation here has been with the current strategic arms competition between the United States and the Soviet Union and the interaction of quantitative and qualitative aspects of this process (Wohlstetter, 1974a, 1974b).

Compared to this prodigious amount of creative thinking that has gone into theorizing on and modeling of arms races, there is an amazing dearth of empirical research, which is aggravated by the familiar "two culture" problem. In the camp of those who have subscribed to a more "scientific" approach to the interactive armament behavior of nations and/or alliances, the predominant relationship between theorists and empiricists seems to be one of mutual neglect. This in part is due to the virtual absence of agreement on the meaning of the term "arms race," not to speak of the lack of an operational definition of this widely used concept (see Brown, 1973; Rattinger, 1975). Similarly, we seem to be far from agreeing on what we expect this competition to be about: military hardware, manpower, armament expenditures, military potential, or even technological breakthroughs. Thus, today we are still as far away as Richardson was from such basic knowledge as a historical inventory of arms races, their participants, duration, and outcomes, which—at least to the present author—is just the starting point in the systematic empirical study of arms races.

Before outlining the scope and procedure of this article it is appropriate to state one important warning against exaggerated expectations. None of the fundamental issues that have been briefly touched on above will be resolved in this paper. This in fact will not even be attempted. Instead, I intend to focus on that variant of arms race models that deals with aggregate military budget data and is predominantly used in empirical studies because of the ease of access to that kind of data. By a redefinition of the variables of the model and the additional introduction of

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international tension as an exogenous variable, I will attempt to push the hypothesis of reactive military spending to the limits of its explanatory power in one specific historical instance.

This historical case is the armament dynamics exhibited in Europe by the countries of NATO and the Warsaw Pact since the early 1950s. The United States, even though a major participant in the postwar East-West arms race, will be excluded for two reasons. First and most important, there has been considerable and not readily controllable distortion of U.S. armament expenditures by two hot wars, i.e., Korea and Vietnam. Second, the available time-series data on international tension pertain only to postwar Europe. The omission of the United States is bound to stir objections, particularly among readers in the United States itself. It seems to me, however, that this restriction is a reasonable one as its detrimental effects are limited.

There is, of course, considerable U.S. pressure on the European NATO allies to share the common defense burden more evenly. As collective-good theories of alliance defense spending suggest, however, the very presence of the American deterrent is a strong incentive for the West European nations to withstand that pressure, so that the two influences might be expected to cancel out. Looking at the GNP shares of defense in East European countries, one might suspect that a similar argument holds for relations within the Warsaw Pact. It is therefore plausible to expect that only the explanation of Warsaw Pact spending is going to be affected by the omission of the United States.

Historical analysis suggests, moreover, that for the Warsaw Pact satellites the East-West conflict has predominantly been an intra-European confrontation, particularly so since the Federal Republic of Germany had joined NATO in 1955. Similar disentanglement of their opponents has been impossible for the European NATO nations, because America's adversary on the global scene at the same time maintains the largest fraction of the conventional power threatening Western Europe. It is therefore not unrealistic to conceive of European NATO as reacting to all of the military efforts of the Warsaw Pact and of the WTO satellites as responding to the defense preparations of European NATO. Our ability to account for Soviet military spending, of course, is going to suffer significantly from the exclusion of the United States.

In applying Richardson-type models to this European armaments race, however, one encounters a major methodological problem: the annual armament expenditures of both NATO and Warsaw Pact and of their individual member countries as well as their first differences—corresponding to the derivatives in the classical Richardson equations—tend to

increase monotonically over the years from 1950 to 1974, which form the data base for this study, even after controlling for inflationary effects. Straightforward application of one of Richardson's models or of a similar model would therefore result in highly inflated correlations between the increase in the armament expenditures of any state and the lagged armament expenditures of the respective opposing military alliance.

It is no longer innovative to the relevant literature to control statistically for this monotonous growth of armament expenditures and increases of armament expenditures by detrending them linearly, exponentially, or under even more sophisticated assumptions (Pryor, 1968). It seems preferable to look for a theoretical solution to this problem, since the presence of strong time trends in both dependent and independent variables seems to point to a third and neglected powerful explanatory variable that we might want to include explicitly into our models.

Such a solution appears to be readily available in applying to defense budgeting Lindblom's (1959) theory of incremental decision-making, which has received considerable confirmation in the context of bureaucratic budgeting. The following subsection will therefore introduce an incrementalist model that to a large extent accounts for the predominant growth pattern of defense spending in Europe. After that, the questions will be addressed, whether and which states of European NATO or of the Warsaw Pact deviate randomly from the behavior predicted by that model and whether and how their doing so is systematically related to the military spending of the enemy bloc and/or to the level of international tension in Europe and its fluctuations.

The models that will be presented thus are not arms race models in a classical sense, but they are inspired by Richardson's work as well as by other studies in the same tradition. The following paragraphs are theoretical in the sense that they derive a set of interrelated and testable hypotheses from rather generally held notions of the determinants of defense spending. A more axiomatic approach is consciously not taken since it seems useful to complement the abundance of analytical studies of arms races with some results on how their basic assumptions stand up in the light of empirical evidence. Since I have provided a discussion of static and dynamic equilibria in the context of arms races elsewhere (Rattinger, 1974), no similar anlyses will be performed here.

MODELS

BUREAUCRATIC MOMENTUM AND DEFENSE SPENDING

A number of contending explanations for the amount of resources that is allocated annually for defense in a specific state are being offered in the literature, apart from purely reactive arms race hypotheses. They might be grouped under the headings of theories of conspiracy (e.g., Barnet, 1969; Senghaas, 1972), of rational decision-making (e.g., Novick, 1965), and of bureaucratic budgeting. Because the empirical evidence is most impressive concerning the third group, and because it also lends itself best to the construction of a simple model, I will now explore the implications of the mechanisms of bureaucratic budgeting for defense spending.

In applying incrementalist models to the growth of armament expenditures, we assume that the behavior of defense bureaucracies in the competition for funds corresponds to the organizational routine behavior of other government agencies (Allison, 1974). Specifically, this implies that—regardless of the threat posed by the international environment—cuts in the defense budget from one year to the next during the process of appropriation in administration and legislatures have to be avoided by all means. Like any other bureaucratic apparatus, the military moreover perceives itself compelled to participate "adequately" in the growth of public spending, be it as a result of increases in the Gross National Product, in the government share of GNP, or of increases in both. The basic problem for any government agency in this process is to arrive at a request for funds that is likely to survive the interaction of competing claims with appropriation procedures without major modifications. Overinflated requests are bound to run into massive cuts; overly modest claims on the other hand tend to be interpreted as low demand that justifies further tightening of the allocated resources. Financial projections with medium-range growth rates thus generally have the highest chance of passing through the whole process without dramatic changes (Wildavsky, 1964).

These considerations suggest that the request of an agency for funds in one specific year will be a roughly constant percentage over last year's appropriation. This request can be expected to be cut again by a roughly constant percentage during the process of allocation, so that the budget administrated by a government bureaucracy in any given year is expected to amount to an approximately fixed percentage higher than the one in the previous year. This relationship is formally stated in model 1, where x_t denotes the *expected* defense budget of any state in t and X_{t-1} stands for its *actual* armament expenditures in t– 1.

$$x_t = k_1' X_{t-1} \qquad [1]$$

One might argue that model 1, which has received considerable empirical confirmation for a large number of civil government agencies in the United States (Davis et al., 1966), might not be readily applicable to defense budgeting and/or to socialist countries. Without anticipating the empirical findings, I should like to argue, however, that there are compelling reasons to expect this bureaucratic momentum to be higher in defense than in nondefense budgeting and higher in socialist than in Western countries. I see two reasons for the first expectation: first, a high proportion of defense expenditures are programmed long in advance and do not lend themselves to budgetary maneuvers on short notice, and second, the difficulties of planning specific weapons programs and the resulting financial needs from goal definitions as vague as "national security" or "deterrence." As to the centrally planned economies of the Warsaw Pact countries, it seems reasonable to suspect that if the time frames and procedures of their planning devices have any effect on the steady bureaucratic growth of defense expenditures at all, it will be a reinforcing one (Campbell, 1974).

According to Crecine (1969), major departures from the regular growth of armament expenditures predicted by model 1 have to be expected in the case of international crises or catastrophies. External stimuli of this kind render a redistribution of total revenue in favor of defense spending politically feasible. In extreme cases it will even be possible to expand overall resources for the military budget by increasing tax rates or national debts. This latter kind of reaction to events in the international environment is not likely to be reversed in the short run. Thus, the monotonous growth of armament expenditures is likely to be pushed up intermittently to higher levels of spending in very marked and discrete jumps.

This argument of Crecine's, though extremely clarifying when compared to previous thinking about defense spending, nevertheless suffers from its unnecessary restriction to an all-or-nothing perspective on sufficient conditions for departures from the trend. When—so we have to ask—does a departure from the incremental trend of spending qualify as important enough to demand close scrutiny of its causes, and how shall we go about it if such a deviation is not associated with one of those dramatic events in the international arena? Would it not be more reasonable to consider also the fine tuning of defense spending by conceiving of all deviations from the level of spending predicted by the bureaucratic model as worthy of further explanation? The following two subsections will

explore how action-reaction hypotheses and hypotheses on the effect of international tension on armament expenditures can be brought to bear on this explanatory problem.

ACTION-REACTION AND DEFENSE SPENDING

The first step in interpreting the familiar action-reaction hypothesis in terms of the problem outlined above is a redefinition of the dependent variable. Almost without exceptions, the arms race models to be encountered in the literature attempt to explain the increase in armaments (or better, armament expenditures) from one year to the next by means of some combination of independent variables. To avoid the problems that are associated with this approach and have been mentioned briefly in the introduction, we will first explore how the residuals from equation 1 can be meaningfully conceived of as the result of a—conscious or unconscious—process of reactive adjustment of defense spending to the military efforts of an opponent. It seems economical to start with a very parsimonious model in order not to inflate unnecessarily the number of variables. We can arrive at such a simple model by conceiving of any deviation from the level of military spending predicted from bureaucratic factors alone as a reaction to a similar departure from routine behavior on the side of opponent.

In our case of two arms race alliances, there is an additional requirement, namely, to specify the adversary whose fluctuating armament expenditures are expected to produce a reaction by a given state. It can be shown that if each state's annual military outlays in one alliance are largely governed by a model comparable to equation 1, then this also holds for the aggregate expenditures of the whole alliance. Given this fact, the most economical procedure is to represent the budgetary deviations from the trend of each state in the alliance as a reaction to a departure of the other alliance's aggregate spending from its bureaucratic trend at some previous point in time. Letting a_t denote the expected total military budgets of the hostile alliance in t and A_t its actual total budgets in t, we arrive at our basic reaction model 2, where e_2 is a random error term with mean zero and finite standard deviation.

$$X_t - x_t = k_2(A_{t-j} - a_{t-j}) + e_2 \qquad [2]$$

where

$$a_{t-j} = k_3' A_{t-j-1} \qquad [3]$$

Model 2 focuses on the one specific instance where all the considerations of "how much is enough" are crystallized, i.e., the budgetary

process. It seems highly realistic to assume that, in general, perceptions of the adversary as "overspending" or "underspending" play a decisive role in how to adjust one's own defense efforts. This reaction pattern should not be interpreted in any mechanistic sense. On the contrary, the input of the other side's departure from its expected behavior is likely either to strengthen or to weaken the position of those advocating either restraint or acceleration in their state's spending for military preparedness by conveying perceptions of the adversary as either being up to something unpleasant or having reconciled himself to the status quo. In that sense, this model seems to go beyond the black-box approach of most systemic arms race models. Creeine's model of defense budgeting is also superior in that respect; its major weakness is that it restricts the screening process relating adjustments in a nation's defense expenditures to the occurrence of fairly dramatic disturbances in its international environment. The present model goes further by partially regarding as the outcome of reactive fine tuning what the bureaucratic growth model treats as "noise."

Before proceeding to a second variant of the basic model, it seems advisable to expound one major implicit assumption of the present version of an arms race model. This assumption is that all states in Europe belonging either to NATO or to the Warsaw Pact are perfectly willing to abide by their pattern of incremental increases in armament expenditures, provided all the states in the hostile alliance—and thus this alliance itself—do the same. Model 2 views all positive deviations from what has to be expected from sheer bureaucratic momentum as essentially defensive moves in quest of the status quo. One alliance's remaining below the dynamic equilibrium level of spending is even answered by a step in the same direction on the other side, so that it is clearly impossible to model the armament expenditures of a state or alliance that is trying decidedly to outpace the opponent. Thus, the basic view taken of the East-West confrontation in Europe after the Second World War by model 2 corresponds to the familiar arms race paradox, where one side in countering a move of the adversary provokes him into countermeasures that demand further corrective action, and so on.

Let us now turn to the second variant of the arms race model. It is derived from the consideration that the impression on a nation's decision makers of a positive or negative departure from the expected amount of the hostile alliance's armament expenditures and thus its effect on the first state's military outlays, might not be independent of the current levels of spending on both sides. This leads to a second model that represents the proportionate distance of the actual armament expenditures of each state in the first alliance from the expected value in a given year as being

proportional to the proportionate deviation of the actual military spending of the second alliance from its predicted spending in some previous year:

$$(X_t - x_t) / x_t = k_4 (A_{t-i} - a_{t-i}) / a_{t-i} + e_4 \qquad [4]$$

INTERNATIONAL TENSION AND DEFENSE SPENDING

In this section, the dependent variable—residual spending on armaments—will be the same as above, but the effects of a different explanatory variable will be considered. This variable, international tension, needs no lengthy introduction to the subject, since the present treatment does not depart significantly from established, widely shared beliefs regarding its likely consequences. In spite of the rather meager quantitative research on international tension, there is general agreement within political science that a taut international situation of mutual mistrust, hostility, and high expectation of conflict is conducive to an emphasis on military precautions for security (e.g., Singer, 1958). The political debate—in Europe even more than in the United States—illustrates this judgment by stressing a process of detente as a precondition for restraint in force postures and military budgets.

Three models for the effects of tension on military over- or underspending will be set forth here. The first model simply views military overspending of a state as being dependent in a linear fashion on the level of tension in the international subsystem to which this state belongs. Thus, for every single state in the subsystem there exists a specific level of tension, T', for which this state's military budget will be determined solely by its own bureaucratic momentum and by random fluctuations. If tension falls below that level, we will expect less than normal spending to occur, and for values of tension above this level we will predict positive residual spending. Having T_t denote tension in t, this first tension-armaments model is formalized as follows:

$$X_t - x_t = k_5 (T_{t-i} - T') + e_5 \qquad [5]$$

Again, it is possible to argue that not so much the absolute magnitude of the difference between actual and expected military budgets will be affected by the level of international tension, but rather its proportional magnitude will be. This leads to:

$$(X_t - x_t) / x_t = k_6 (T_{t-i} - T') + e_6 \qquad [6]$$

In historical periods where fairly high levels of tension are predominant throughout an international subsystem for a protracted period of time—as has been the case in Europe after World War II—nations might become, however, more and more insensitive to the absolute level of tension and tend instead to view changes in this level as the crucial factor. Thus, a second tension-armaments model interprets the deflection of a state's actual defense budget from its expected value in a given year as depending on the rate of change of international tension in a previous point in time, where increases in tension produce positive, and decreases produce negative, residual spending, as is formalized in equation 7 and its proportionate variant equation 8.

$$X_t - x_t = k_7 (T_{t-i} - T_{t-i-1}) + e_7 \qquad [7]$$

$$(X_t - x_t) / x_t = k_8 (T_{t-i} - T_{t-i-1}) + e_8 \qquad [8]$$

This last argument leading up to models 7 and 8 can be generalized. If a historical span of time is characterized by comparatively high levels of tension that, however, exhibit a secular downward trend—and this description fits the European scene after World War II quite well—it does not seem too far fetched to suppose that besides the absolute level of tension and its increases or decreases, the rate of change of this change in tension levels itself is a factor that is taken into account in a state's decision on whether to regard the normal projection of its defense spending as adequate to its perceived security needs. So it is quite straightforward to represent distances of actual from expected defense expenditures in a given year in a third tension-armaments model—or proportionate distances in its second variant—as depending on the second differences of tension in a previous year, where positive second differences lead to overspending and negative second differences to underspending.

$$X_t - x_t = k_9 [(T_{t-i} - T_{t-i-1}) - (T_{t-i-1} - T_{t-i-2})] + e_9 \qquad [9]$$

$$(X_t - x_t) / x_t = k_{10} [(T_{t-i} - T_{t-i-1}) - (T_{t-i-1} - T_{t-i-2})] + e_{10} \qquad [10]$$

COMBINED MODELS

In favor of combining in one model the effects described separately in the action-reaction models and in the tension-armament models, it might be argued that, by simultaneously considering international tension *and*

fluctuations in the armament expenditures of an opponent, we approximate the inputs to actual decision processes on how many resources to allocate for defense in a given year much closer than by isolating both factors. The crucial issue becomes, then, how to construct composite models in order to gain maximum yield from the combination of the two explanatory variables. The obvious solution to this problem is the linear combination of the independent variables in a multiple regression model. Remembering that three tension-armament models have been introduced with two variants each—one for unweighted and one for proportionate residual spending—we obtain six combined models for every state in either NATO or the Warsaw Pact by adding a multiple of the opposing alliance's $(A_{t-i} - a_{t-i})$ to the right-hand sides of equations 5, 7, and 9, and a multiple of the opposing alliance's $(A_{t-i} - a_{t-i})/a_{t-i}$ to the right-hand sides of equations 6, 8, and 10. This will indeed be the procedure in the case of models 7 through 10.

In the case of equations 5 and 6, however, there are a number of objections to this approach, the most conspicuous one being theoretical in nature. The linear additive model adequately captures the directional dependence of a state's overspending on tension and the military expenditures of the opposing alliance. But by treating the effects of both explanatory variables as being independent from each other, the linear regression model leads to some theoretically unsatisfactory conclusions. It is entirely possible in this model that the effect of a considerable upward departure of an alliance from its predicted spending is cancelled out or even reversed by low tension levels. Similarly counterintuitive is the implication that with tension levels remaining roughly constant a state is going to react in its spending to a given amount of the other alliance's overspending regardless of whether international tension in its subsystem is fairly high or rather low.

For a remedy, we have to take the interaction between international tension levels and the hostile alliance's departures from its expected military expenditures into account. Thus, a first combined model can be written as equation 11 or as 12 in its variant for proportionate residual spending.

$$X_t - x_t = k_{11}\, T_{t-i}\, (A_{t-j} - a_{t-j}) + e_{11} \qquad [11]$$

$$(X_t - x_t) / x_t = k_{12}\, T_{t-i}\, (A_{t-j} - a_{t-j}) / a_{t-j} + e_{12} \qquad [12]$$

Whereas in the nonlinear models 11 and 12 we expect each state to spend the amount on defense predicted from the bureaucratic model if

tension and/or the hostile alliance's residual armament expenditures are zero, in the following models we want this only to happen if the first or second differences of tension are zero *and* the opposing alliance sticks to its expected volume of military outlays. Models 13 to 16 are therefore formalized as linear models:

$$X_t - x_t = k_{13}(A_{t-i} - a_{t-i}) + k_{14}(T_{t-j} - T_{t-j-1}) + e_{13} \qquad [13]$$

$$(X_t - x_t) / x_t = k_{15}(A_{t-i} - a_{t-i}) / a_{t-i} + k_{16}(T_{t-j} - T_{t-j-1}) + e_{14} \qquad [14]$$

$$X_t - x_t = k_{17}(A_{t-i} - a_{t-i}) + k_{18}[(T_{t-j} - T_{t-j-1}) - (T_{t-j-1} - T_{t-j-2})] + e_{15} \qquad [15]$$

$$(X_t - x_t) / x_t = k_{19}(A_{t-i} - a_{t-i}) / a_{t-i} + k_{20}[(T_{t-j} - T_{t-j-1}) - (T_{t-j-1} - T_{t-j-2})] + e_{16} \qquad [16]$$

Before proceeding to outline briefly the measurement procedures used in this study, it might seem useful to mention at least some expectations on the likely pattern of relative confirmation of all the models that have been presented so far. For the impression of any departure of an alliance from normal armament expenditures on the states in a rival alliance, the current level of spending is probably a crucial factor. Therefore we will expect model 4 to be superior to model 2, and all versions of the tension-armament models and the combined models that account for proportionate over- or underspending to be superior to their respective unweighted counterparts. To arrive at a similar judgment on the face validity of the treatment of the role of tension and its fluctuations in models 5 through 16 is less straightforward. From the preoccupation of the political debate and of public opinion in Europe with changes in tension, one might guess, however, that the decision process on the allocation of resources to defense is most likely to exhibit highest sensitivity to changes in tension levels, so that models 8 and 14 would have to be named as first choices.

MEASUREMENT

ARMAMENT EXPENDITURES

Armament expenditures data in constant U.S. dollars for the twelve European NATO countries (excluding Iceland) and for the seven members

of the Warsaw Pact for 1950 through 1974 were collected from the various editions of the SIPRI yearbooks. France was treated as a member of NATO for the whole period, which is probably not too unrealistic in that its decision makers perceive conflict with the Warsaw Pact as the single most likely contingency and that its military preparations almost certainly play quite some part in Warsaw Pact calculations. For Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, and Rumania data for some of the earlier years (all 1959 or earlier) are missing. Since the SIPRI yearbooks are not extremely explicit on how their data were arrived at, no attempt was made to fill these gaps in the data base.

At this point it should be stressed that using military expenditures to assess empirically the performance of the previously introduced models in no way implies a problem of indicator validity, as is so often the case with arms race studies. Since the whole theoretical framework has been cast in terms of defense spending, the only assumption about the data is one of an acceptable degree of reliability. This fact in itself might be interpreted as an advantage over quite a substantial proportion of the arms race literature, where theories are often formulated in terms of "armaments," "capabilities," "military power" and so forth, but empirical research almost invariably falls back on military expenditures as a solution to the problem of measurement.

INTERNATIONAL TENSION

In most studies dealing with international tension this variable is defined as the probability which the actors in an international subsystem assign to the occurrence of manifest conflict within their subsystem. Use in this article does not differ from this predominant notion. Since the tension data used here have received complete description in the literature, a very brief introduction into their modification for the present purpose must suffice. In a research project at the Swedish Institute of International Affairs (Goldmann, 1973, 1974), articulations of foreign policy elites in the European NATO countries and in the countries of the Warsaw Pact were rated according to their content of conflict expectation between the two blocs. The universe of articulations was taken from newspapers and other open sources, and no distinction was made whether a given statement had been intended for external or internal consumption. Rating was confined to four categories: no, low, or high conflict expectation, and articulations not pertaining to the relationship between the two alliances. All in all, data were collected for the years from 1946 to 1970. Whether their interpretation as East-West tension is entirely meaningful before the inauguration of NATO and the Warsaw Pact is irrelevant for this article, since its analysis starts only with 1950.

Whereas in the literary output from the project at the Swedish Institute tension is measured by coefficients of imbalance, in which high conflict expectation is offset by low expectation of conflict, an even simpler indicator for international tension is employed here. This is done by computing the annual proportion of all articulations that express high expectation of conflict between the two blocs to the overall number of articulations referring to the relationship between the two alliances. Thus, tension is measured on a scale that ranges from 0 for no tension to 100 for maximum tension. Its values do not pertain to either alliance alone, but only to the unordered couple of European NATO and the Warsaw Pact.

The main disadvantage of assessing international tension from observed verbal behavior alone and without any reference to the perceptions of the parties involved is obvious. Since elite articulations on foreign policy are highly instrumental in character, and are certainly perceived as being so by potential adversaries, one should be very careful about inferring actual perceptions of tension from tension levels derived from the Swedish Institute's data. Nevertheless, it seems reasonable to suppose that the amount of conflict expectation that is verbally referred to throughout the subsystem is not quite unrelated to what both sides believe the likelihood of actual conflict to be. Thus, even though one in the long run might want to explain armament expenditures and their fluctuations by perceptual variables, for the time being the introduction of international tension—as measured here—into the explanation of military over- or underspending in Europe can be expected to reduce unexplained variance by a significant proportion.

PRELIMINARY EMPIRICAL RESULTS

THE MOMENTUM OF DEFENSE SPENDING

As a first step in the data analysis the defense expenditures of all states and alliances were regressed on their armament expenditures in the previous year to obtain estimates of k'_1 and k'_3 for each state and the two blocs. Values of R^2 for these regressions are given in the second column of Table 1. As they have been derived from time series with different length, these values are not in all cases directly comparable from one country to another. They all are, however, highly significant.

Since the residuals from the regressions of X_t on X_{t-1} and of A_t on A_{t-1} are to be used as dependent and independent variables in the subsequent paragraphs, it is important to ascertain that the assumptions made in these regressions have not been grossly violated. Unfortunately

TABLE 1
Summary of Analysis for Best Fitting Models

	Trend	*Action-Reaction Models*		*Tension-Armament Models*		*Combined Models*	
Country	R^2	R^2	*Model/ lag*	R^2	*Model/ lag*	R^2	*Model/lag of defense spending/ lag of tension*
Belgium	.92[c]	.27[a]	(4)/2	–	–	.37[a]	(14)/1/2.5
Denmark	.90[c]	.44[c]	(4)/1	–	–	.53[c]	(12)/1/1
France	.67[c]	.52[c]	(4)/4	–	–	.58[b]	(14)/3/.5
West Germany	.88[c]	–	–	–	–	–	–
Greece	.96[c]	.41[b]	(4)/4	–	–	.46[b]	(12)/4/0
Italy	.96[c]	.16[a]	(4)/2	.22[a]	(6)/3	.24[a]	(12)/2/0
Luxembourg	.55[c]	.21[a]	(4)/3	–	–	.46[a]	(16)/1/1
Holland	.88[c]	–	–	–	–	–	–
Norway	.90[c]	.32[b]	(4)/1	.14[a]	(8)/2.5	.40[b]	(12)/1/1
Portugal	.94[c]	–	–	–	–	–	–
Turkey	.96[c]	–	–	–	–	–	–
Britain	.61[c]	.32[b]	(2)/4	–	–	.45[c]	(12)/1/0
Bulgaria	.92[c]	–	–	.24[a]	(8)/1.5	.53[a]	(14)/2/1.5
Czechoslovakia	.90[c]	.48[c]	(4)/3	.18[a]	(10)/2	.59[b]	(16)/2/2
East Germany	.92[c]	–	–	–	–	–	–
Hungary	.83[c]	–	–	–	–	–	–
Poland	.98[c]	.32[b]	(4)/1	.15[a]	(8)/2.5	.37[b]	(12)/1/2
Rumania	.96[c]	.32[a]	(4)/4	.35[a]	(10)/1	.72[a]	(16)/2/1
USSR	.94[c]	–	–	.22[a]	(8)/1.5	–	–
European NATO	.92[c]	.27[b]	(4)/1	.26[b]	(8)/2.5	.40[b]	(12)/4/2
WTO	.94[c]	.20[a]	(4)/3	.44[b]	(8)/2.5	.20[a]	(12)/3/2

a. $p \leq .05$.
b. $p \leq .01$.
c. $p \leq .001$.
Dashes (–) indicate that no model of specified type yields significant results for this country. All time lags are given in years.

the standard tests are inapplicable, but there seems to be no problem with the assumption of homoscedasticity. Correlating the absolute values of the residuals with time does not yield significant findings for any state or alliance.

Concerning the absence of autocorrelation, however, the situation is not that clear. Durbin-Watson ratios are not significant for any state or alliance, but—strictly speaking—the classical Durbin-Watson test is not applicable to regression equations that are autoregressive in variables (Kmenta, 1971). The autocorrelation coefficient, however, does not exceed .15 for any state or alliance. Even though residuals from ordinary least-squares (OLS) regression lead to underestimation of the true autocorrelation coefficient (Hibbs, 1974), it seems to be safe to proceed on the assumption that autocorrelation in residual defense spending is not much of a problem.

The real difficulty with using ordinary least-squares (OLS) regression, however, lies in the fact that the OLS estimates of the values of k_1' and k_3' exhibit all the desirable properties of OLS estimates only asymptotically, since they are derived from autoregressive regression equations (Kmenta, 1971). That the subsequent analyses are nevertheless performed on the OLS residuals can only be justified by the exploratory character of the present enterprise. Once we wanted to proceed to a complete estimation of models 2 and 4 through 16 we would definitely want to switch to generalized least-squares (GLS) regression. For the present purpose, however, the low degree of autocorrelation does not justify the computational efforts involved in GLS reestimation of the thousands of equations that result from introducing time lags from zero to ten years into models 2 and 4 through 16.

As a first empirical finding we can state that the regular annual growth of defense spending predicted by the model of bureaucratic budgeting is indeed exhibited in a remarkably strong fashion by the data for the individual countries of European NATO and the Warsaw Pact. Thus, the suspicion is strengthened that the factors which for most bureaucratic machineries produce almost incessant increases in the volume of resources administered by them are at work in the realm of military spending too. Comparisons between the two blocs should not be based on the analysis of their aggregate spending in the last two rows of Table 1, but rather on the findings for their individual nations. It should be mentioned here that the previous speculation about the reinforcing role of planning instruments in centrally planned economies is not quite born out by the data. That the values of R^2 are generally higher for the countries of the WTO is probably a statistical artifact due to the absence of data for some of these countries

in the 1950s. Another caveat is in order here: with the very low level of armament expenditures in Luxembourg, the findings for this country, too, should be viewed with caution since most of the adjustments in her amount of military spending are heavily distorted by rounding to millions of constant U.S. dollars in the SIPRI data.

In the case of NATO it is apparent that the states with the largest military budgets deviate strongest from the bureaucratic trend. Great Britain and France as well as the Federal Republic of Germany rank below most of their European allies in NATO as far as the strength of the momentum in their defense spending is concerned. Because of the leading role these nations play in Western Europe one might suspect that this is *due to a greater degree of reactivity in their military efforts* toward the armaments of the Warsaw Pact.

REACTION PATTERNS IN DEFENSE SPENDING

Before proceeding to summarize the findings on reactive over- or underspending on defense from Table 1, I must add a short methodological note. In Table 1 under the heading "reaction," values of R^2 measuring the extent to which residual defense spending of a given state can be explained by that of the hostile alliance are given. These values were not arrived at by correlating (proportionate) residual spending of each state with that of the hostile alliance, since this would have been equivalent to applying OLS regression to the structural forms of equations 2 and 4. Instead, the reduced forms of equations 2 and 4 were derived and estimated by OLS varying the lag of reaction from zero to ten years. The best fitting model for each country was then selected using the F-ratio as a criterion, since the number of cases decreases with increasing length of the time lag. It should be noted, incidentally, that multicollinearity did not pose an additional problem, because for all countries, for which a best fitting model could be identified at all, all coefficients of that model (except for the constant) were significant at the .05 level.

In a next step, departures from the bureaucratic trend could be *predicted for each country from the best fitting reduced form of the* action-reaction models 2 and 4. Together with the observed residuals from the trend model, these predictions allow the computation of the R^2s that are presented in Table 1. Because of the unequal number of cases their significance levels are again more appropriate for comparisons across countries than their absolute values. Analysis of residuals again had to be confined to computing autocorrelation coefficients, which generally turned out to be rather low (below .18). Coefficients are not presented here either for the reduced or for the structural forms of all models, since,

strictly speaking, OLS regression is not quite the appropriate technique to estimate the reduced forms of the action-reaction models, which are again autoregressive.

This implies that our results are preliminary in the sense that the R^2s and their significance levels in Table 1 enable us tentatively to decide whether or not a given state reacts to an opponent's military over- or underspending, to tension, or to both. They also give some information on how sensitive a given nation is to those factors when compared to another country. This information is, however, clearly inappropriate to compare the effects of reactivity on the defense spending of the states in Europe to those of bureaucratic momentum. Therefore, standardized regression coefficients (β) for the reduced forms of all best fitting models were computed; they are contained in Table 2. As their unweighted counterparts are neither efficient nor consistent estimates, they should be taken as indicating only orders of magnitude. Thus, if one wants to compare the sensitivity of different states to the fluctuations of the hostile alliance's military expenditures, the information from Table 1 is sufficient. If, however, some information on the differential impact of the opponent's spending and of own bureaucratic momentum on the behavior of a state is desired, Table 2 is to be consulted.

At this point it should be stressed that the way in which the standardized regression coefficients in Table 2 were arrived at makes the argument about the weighting of the role of reactivity against that of bureaucratic momentum much less plausible. In the derivation of the action-reaction models theoretical priority was given to the momentum component, but in the estimation of the reduced forms of these models both explanatory variables were introduced simultaneously and not in a stepwise fashion. This does not preclude the possibility that the trend-like phenomena themselves are the outcome of reaction processes, but the results in Table 2 present the best effort possible with the present approach to disentangle those effects.

The results presented in Tables 1 and 2 can be taken to indicate that action-reaction processes play a more than negligible role in the fluctuations of military expenditures in most European countries. Since there is no high-level coordination of overall NATO armament expenditures linking them to aggregate spending of the WTO and vice versa, comparisons between the two blocs should proceed from the findings for their individual nations and not from the analysis of their aggregate spending. The role of reactivity seems to be comparatively stronger for the states of NATO than for those of the Warsaw Pact, for which in fact we would expect higher values of R^2 on account of the lower degrees of freedom.

TABLE 2

Standardized Regression Coefficients (β) for Best Fitting Models

	Action-Reaction Models		*Tension-Armament Models*		*Combined Models*			
Country	*Trend*	*Residual defense spending of other alliance*	*Trend*	*Tension*	*Trend*	*Residual defense spending of other alliance*	*Tension*	*Residual defense spending of other alliance by Tension*
Belgium	.94	.17	–	–	.90	.14	.06	–
Denmark	.96	.09	–	–	.95	–	–	.10
France	.90	.21	–	–	.81	.19	.04	–
West Germany	–	–	–	–	–	–	–	–
Greece	.96	.07	–	–	.95	–	–	.09
Italy	.98	.02	.96	.08	.95	–	–	.09
Luxembourg	.65	.15	–	–	1.00	.56	.53	–
Holland	–	–	–	–	.83	–	–	.21
Norway	.94	.14	.96	.11	.90	–	–	.16
Portugal	–	–	–	–	–	–	–	–
Turkey	–	–	–	–	–	–	–	–
Britain	.36	.44	–	–	.84	–	–	.09
Bulgaria	–	–	.97	.20	.94	.13	.14	–
Czechoslovakia	.96	.18	.92	.16	.91	.26	.15	–
East Germany	–	–	–	–	–	–	–	–
Hungary	–	–	–	–	.94	–	–	.24
Poland	.99	.02	.99	.02	.98	–	–	.03
Rumania	.98	.01	.97	.10	.93	.02	.11	–
USSR	–	–	.97	.12	.94	–	–	.05
European NATO	.95	.10	.95	.10	.92	–	–	.14
WTO	.96	.03	.94	.14	.94	–	–	.11

The lower reactivity of the WTO nations is particularly evident from the figures in Table 2. It should be stressed, however, that the absence of a significant finding for the Soviet Union is probably due to the exclusion of the United States from the analysis.

For the remaining individual countries, however, some interesting propositions emerge. With one exception in the case of Great Britain, model 4 proves to be superior to model 2, which leads to the conclusion that proportionate over- or underspending tends to be a more salient and sensitive feature in armament dynamics than does absolute residual spending. Secondly, the time lag of the reaction to the spending pattern of the hostile alliance in no case exceeds 4 years. For all countries there is a sharp decline in the goodness of fit of models involving lags of more than 4 years. The average lag in all best fitting models yielding significant results is 2.6 years. This fairly high magnitude is probably due to the fact that military expenditures in a given year usually are the outcome of decisions taken some time in advance in which consideration is given to the enemy's armament expenditures of 1 or 2 years ago, since his more recent behavior cannot yet be realistically assessed.

A third noteworthy point is that France and Britain—countries for which bureaucratic momentum has been comparatively low—indeed exhibit the strongest degree of reactivity in their military spending, as is most clearly seen by comparing the effect of their own previous spending to that of residual spending of the Warsaw Pact in Table 2. The maverick role of France in the Western alliance has certainly been conducive to higher reactivity than is displayed by countries that rely more openly on superpower protection. The most important deviant case, however, is that of Great Britain, which is the only nation in Europe for which the level of defense spending is more determined by reaction processes than by bureaucratic momentum. It should not be overlooked, though, that only about 75% of the overall variance in British defense expenditures are accounted for by both explanatory variables. Since there are no clearly discernible systematic patterns in Britain's unexplained residual spending, we are led to conclude—from the point of view of our models—that Britain's armament expenditures in the postwar period have been more random than that of any other European nation. It is not within the limited scope of this paper to develop alternative models for the British case.

TENSION AND DETENTE IN EUROPE

The results on the role of international tension in Europe were derived in a way analogous to that described above in the context of action-

reaction models. There is, however, the additional problem of some multicollinearity between the lagged expenditures of most states—which exhibit a secular upward trend—and tension levels—which decrease over the years. We would therefore expect absolute tension levels to fare rather poorly as predictors when compared to first or second differences of tension. Again, autocorrelation of residuals seems to be negligible in the few instances where significant results can be reported.

The most striking finding on the tension-armament models 5 through 10 is the absence of any significant relationship between tension in Europe, changes in tension, or changes in the rate of change of tension on the one hand and the deviation of most European NATO countries from their expected levels of military outlays on the other. The only exceptions are Norway and Italy. For the Warsaw Pact, however, only Hungary and the German Democratic Republic do not react significantly to tension in Europe and its fluctuations. Together with the findings on action-reaction, this suggests that the nations in the Warsaw Pact are more sensitive to tension in Europe than to the armament expenditures of the European NATO allies, whereas the states in the latter alliance are primarily concerned with the military efforts of their potential adversaries and largely insensitive to tension. One possible explanation for this discrepancy between the two blocs will be offered below.

It should be mentioned, in addition, that whenever there is a significant reaction to tension levels and their fluctuations at all, it is again most marked in proportionate deviations from routine defense spending. Moreover, changes in the level of tension appear to be superior to absolute levels of tension (as expected!) or their second differences as predictors of residual defense spending on the part of those nations which exhibit some sensitivity to detente in Europe. In no case is the response to the progress or stagnation of detente delayed for more than three years, the mean lag being two years. That the lag in the response to tension is shorter than that of the reaction to the other side's spending does not come as a complete surprise, since the predominant international climate lends itself to more immediate—although imprecise—assessment.

COMBINED MODELS

All analyses for the combined models were performed in complete analogy to the previously described procedures. Multicollinearity of explanatory variables is of no importance here because absolute tension levels are imbedded in interactive terms in the nonlinear models 11 and 12. We therefore expect—and indeed observe—a revival of absolute tension levels as predictors of over- or underspending on defense. Autocorrelation coefficients for the OLS residuals from the reduced forms of all combined

models are generally very low, so that the values of R^2 for the combined models in Table 1 can again be supposed not to be too seriously inflated. A further complication is introduced into the interpretation of the results concerning the combined models by the fact that the number of independent variables and thus the degrees of freedom vary between models 11 and 12 on the one hand and models 13 through 16 on the other. Moreover, two independent variables have to be lagged so that the degrees of freedom can be considerably smaller for one country than for another. It is therefore important to look at significance levels and the values of R^2 as well as at maximum lags when comparing between models and between countries.

With only the exception of the Soviet Union, the combined models 11 through 16 yield significant findings for all states that in the fine tuning of their defense spending respond either to over- or underspending of the hostile alliance or to the progress of detente in Europe or to both. This finding is nontrivial only for those countries for which the nonlinear model 12 gives the best fit. As has to be expected, the values of R^2 are generally higher for the combined models than for the models isolating the explanatory variables, but significance levels tend to remain the same. For three nations, Belgium, France, and Czechoslovakia, the significance of the best fitting combined model is even below that of the simple action-reaction model due to reduced degrees of freedom.

The only exception to this pattern is Great Britain, for which the fit of the combined model 12 is more significant than that of model 2. A close look reveals that this increase in significance in spite of an only slightly higher R^2 is produced by the smaller lag of Britain's response to WTO armament expenditures in the combined model. This result underlines Britain's somewhat eccentric position in the overall picture of European defense spending. Britain is the only country for which the view expressed in the combined models, i.e., that action-reaction processes in Europe are to some extent modified and controlled by tension levels, receives some—although not very impressive—confirmation.

For all the other European nations, however, no additional explanatory benefit is derived from the combined models. To pursue their approach further is therefore at the present time not very reasonable. This does not imply that the introduction of additional exogenous variables into action-reaction models should not be attempted. We can state rather confidently, however, that international tension—as measured here—is not a very promising candidate for that role in the European context.

CONCLUSION

The purpose of this concluding section is to summarize and discuss briefly some of the findings on the relative importance of hostile armaments, detente, and bureaucratic expansion in the defense spending of European nations and to point to some areas of interest for future research. The empirical results can be summarized as follows:

(1) Except for Britain, bureaucratic momentum is the single most important determinant of defense spending in European NATO states and in the WTO nations.

(2) Superimposed on this momentum, reaction processes are discernible which are generally stronger in NATO nations. France and especially Britain react most heavily to the military spending of the Warsaw Pact.

(3) Tension in Europe is unrelated to NATO defense spending. There is some sensitivity to tension in Warsaw Pact defense budgets.

(4) Combining the effects of reactivity and of tension in joint models does not enhance our ability to account for armament expenditures in Europe.

I should like to supplement this simplified summary by some qualifications: the models that have been presented are not arms race models in a classical sense, but they embrace the assumption of reactivity basic to all arms race theorizing. This assumption is refined by taking into account the further assumptions that, for all we know, there is some kind of normal expansion of defense efforts and that reactivity—if it manifests itself at all—should manifest itself in deflections from what would be normal. This approach is obviously open to the objection that the regular growth of military efforts and even the mere existence of a defense establishment themselves might be reactions to the behavior of an adversary, so that it tended to belittle the effect of reaction processes and to exaggerate that of domestic and institutional factors. Naturally, a similar argument might be proposed on the relative importance of detente in Europe being underestimated by the present approach.

To my mind, however, the differential effects of tension and hostile armaments on NATO and Warsaw Pact are more important than their overall low influence on defense spending when compared to that of bureaucratic momentum. Whereas most European NATO allies exhibit more reactivity in their defense spending than the nations of the Warsaw Pact, they are almost without exception insensitive to tension in Europe. Contrasted with the significant sensitivity of most states of the Warsaw Pact to tension and with the frequency with which the importance of detente is stressed in West European politics and media as a prerequisite for arms control, expansion of trade, human improvements, and a number

of other beneficial developments in Europe, this finding is really amazing. One possible explanation might be that the extraordinary organizational complexity of high-level decision-making in West European democracies prevents perceptions of detente, which are widely held in the political arena, from entering the arena of decisions on resource allocation for defense which are left to the "experts." The political supremacy of the Communist party has possibly prevented a similar division of the two arenas in the countries of the Warsaw Pact.

Another observation leads us further into the field of suggestions for future research. All in all, there are six states for which not a single model yields significant results: Portugal, Holland, Turkey, Hungary, and both Germanies. Portugal's involvement in the European theater has been marginal throughout the whole period studied if compared with her colonial engagements, but how about the other five nations? It might well be worthwhile looking into what has caused these states to depart from their expected behavior, or why maybe they deviated only randomly from it.

In conclusion, some of the topics for future research along the lines of this study should be outlined:

(1) From a methodological point of view, reanalyzing the data by generalized least-squares regression and complete estimation of all models for all countries deserve highest priority. In that context, it might be worthwhile to look into the potential contribution of distributed lag and/or asymmetric response models. After complete estimation the models presented here could be used for postdictive and for short-range predictive purposes.

(2) The effects of armament expenditures of the United States on the countries of the Warsaw Pact, notably the Soviet Union, should be studied.

(3) One might want to see whether some countries of the Warsaw Pact—especially the German Democratic Republic, Poland, and Czechoslovakia—do mainly react to the defense efforts of the Federal Republic of Germany.

(4) The present economic crunch in Western Europe might influence what we would expect as normal defense spending, so that one should look out for indications of changes in the general trends of armament expenditures, maybe toward logistic growth curves.

(5) Tension leads—for some states—to overspending, but overspending might also increase tension. It would be interesting to perform research on this latter chain of causality with an eye to introduce it eventually into the models.

(6) Certainly the most ambitious project would be a large-scale collection of tension data in order to compare the power of the models over a number of historical instances.

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