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THE IMPACT OF STRATEGY AND MEASUREMENT ON MODELS OF FRENCH MILITARY EXPENDITURE

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There is now a considerable literature devoted to estimating models which explain military expenditure. In this paper, we present some estimates for France, that are used to examine two important general issues. The first issue is that quite different empirical results can be obtained depending on which measure of military expenditure is used in the analysis. Here a consistent dynamic system is used to provide a framework to analyse the differences between the relationships explaining four measures of military expenditure. The second issue is that we would expect the relationships to change with major changes in strategy. In the case of France, there are three obvious changes in strategic posture: withdrawal from the colonies after a series of expensive colonial wars; the decision to acquire an independent nuclear capability; and de Gaulle's withdrawal from NATO's integrated military command in 1966. We examine the impact of each on the different measures.

KEY WORDS: French military expenditure

INTRODUCTION

There is now a considerable literature devoted to estimating models which explain military expenditure. For a brief review of this literature see Smith (1989). In this paper, we present some estimates for France, that we use to illustrate two important issues that arise in studies of military expenditure. The first issue is that there are a number of different ways that military expenditure can be defined, and quite different results can be obtained depending on which measure is used. For France the national figure for military expenditure, which corresponds to the budget of the Ministry of Defence, is substantially lower than the figure on NATO definitions which is normally used in international analysis. Different estimates will be obtained depending on which measure is used. In addition, within the total budget, current expenditures on wages, salaries, etc. are likely to behave rather differently from capital expenditures for the procurement of equipment. In this paper, we use a consistent dynamic system, which provides a framework to analyse the relationship between the results obtained using different measures.

The second issue is that we would expect the relationship determining military expenditure to change with major changes in strategy. In the case of France, there are three obvious changes in strategic posture: withdrawal from the colonies after a series of expensive colonial wars; the decision to acquire an independent nuclear capability; and de Gaulle's withdrawl from NATO's integrated military command in 1966 and removal of NATO headquarters from France. Although for brevity we

shall refer to France's withdrawal from NATO, in fact France remained a member of the Alliance, albeit a more distant and independent one. After France's withdrawal from the integrated military command, NATO changed its strategy from massive retaliation to flexible response. Murdoch and Sandler (1984) suggest that this change also shifted the relationship between the military expenditures of the NATO allies, including France. We therefore wish to examine whether these shifts in strategy are reflected in shifts in the regression coefficients of models of military expenditure.

Section 1 describes the data and provides a brief review of the historical evolution of French military expenditures. Section 2 explains the general methodology that will be adopted. Section 3 examines the effect of withdrawing from NATO. Section 4 examines the effect of the nuclear programme, and Section 5 contains some conclusions.

1. DATA AND HISTORY

Any analysis of the evolution of military expenditures faces problems of definition. Whether particular activities should be treated as civil or military is not always obvious, and the data will vary depending on the source of the information, the degree of secrecy attached to particular activities, and the accounting conventions used. These problems are particularly severe in the case of France.

The main data series that we shall use are: Ministry of Defence (MOD) nuclear expenditures; MOD capital expenditures including nuclear; MOD current expenditures; the MOD budget (the sum of current and capital expenditures); and military expenditure on NATO definitions as published by SIPRI. These figures have all been put onto a consistent basis as part of the CEDSI data bank at the University of Grenoble. The NATO figures are substantially higher either than the military budget which is voted by the French Parliament (budget initial) or the amount actually spent in a year (defences definitives) which we use below.

It is well known that the dividing line between military and civilian expenditures can be difficult to draw. Although the budget represents the amount spent by the Ministry of Defence, there are military-related expenditures outside the Ministry of Defence in the Ministries of the Interior and of Industry and in the Department of the Prime Minister, notably the Secretary General for National Defence, as well as some nuclear expenditures in other Ministries. Conversely, certain civil activities, such as provision for natural disasters and certain infra-structure projects, fall within the budget of the Ministry of Defence. On balance, these offsetting effects are rather small and stable.

The major problems of measurement are associated with pensions, the Gendarmerie, and conscription. The principle difference between the SIPRI measure and the MOD budget is the treatment of pensions, which SIPRI includes but the budget does not. Pensions amount to about 20% of the budget. The theoretical status of military pensions is problematic, and if they are included it will induce differences between countries and over time which reflect the terms of the provision for retirement, rather than their military effort. The Gendarmerie accounts for about 10% of the military budget and although it is part of the Ministry of Defence it is primarily a para-military police force and is excluded from the NATO definition of military expenditure. Both the NATO and budget measures face the difficulty that conscription complicates the measurement of the real cost of the military efforts, though neither

adjust for it. Conscripts cost about half as much as professional soldiers, and also substitute for civilian personnel in the Ministry of Defence. An analysis of the impact of conscription can be found in Smith *et al.* (1987).

For the purpose of our analysis we shall work with each of the figures expressed as a share of GDP. This has the advantage that it corrects for inflation and income growth, is likely to reduce heteroskedasticity, and allows comparison between countries. Shares of military expenditure are often also taken as indications of commitment or intentions and play an important role in burden sharing debates.

Thus our measures are:

SN = MOD nuclear equipment expenditures;
SK = MOD capital expenditures including nuclear;
SC = MOD current expenditures;
SD = MOD budget, $SD = SC + SK$;
SO = off-budget military expenditures;
SS = The SIPRI–NATO total, $SS = SD + SO$;

all expressed as percentages of GDP.

The component SO represents the net effect of a number of expenditures whose military nature and strategic usefulness are controversial and whose measurement is a matter of interpretation.

Figure 1 plots the capital, SK, the budget, SD, and the SIPRI, SS, figures for expenditures over the period 1949–1987. The main features are very obvious: the volatility in the 1950s, followed by a strong downward trend, then relative stability from the mid 1960s. Thus the period 1950–1987 can be divided into two broad phases. Up to 1966 the strategic environment was dominant by colonial wars, membership of NATO, and initial development of the Force de Frappe. The period after 1966 was a more stable period, as France established a defence policy oriented to independence and autonomy. Over this period, France spent a lower proportion of GDP on defence than either the UK or the US, and while the broad downward trend is shared by the three countries, the French share tends to show less variation than the US and UK after 1966. Humm (1987) contains a detailed comparison of UK and French expenditures.

The detailed pattern was the outcome of a variety of factors. The war in Indo-China was important at the beginning of the 1950s, before the withdrawal after the defeat at Dien Bien Phu in 1953. The events of 1956—Hungary, Suez, and the real beginning of the war in Algeria—had a major impact. Subsequently, the war in Algeria absorbed resources of labour capital and energy to the extent that in 1958 a large part of the military expenditure was directed at North Africa. The acquisition of power by General de Gaulle in 1958 was followed by a progressive reduction in the defence effort and an improvement in the economic situation. This withdrawal also released resources which allowed France to acquire an independent nuclear capability without putting too much strain on the economy. Between 1964 and 1969, equipping the armed forces took priority, with capital expenditures accounting for half the military budget. In particular, nuclear expenditures moved from 9% of procurement spending to 52% in 1967. The French procurement process is described in Kolodziej (1987).

The withdrawal from NATO's integrated military command in 1966 and the changed relationship with the US, marked a break in the military and political strategy of France. In the earlier period French military expenditures were determined by factors over which France had relatively little control: membership of NATO,

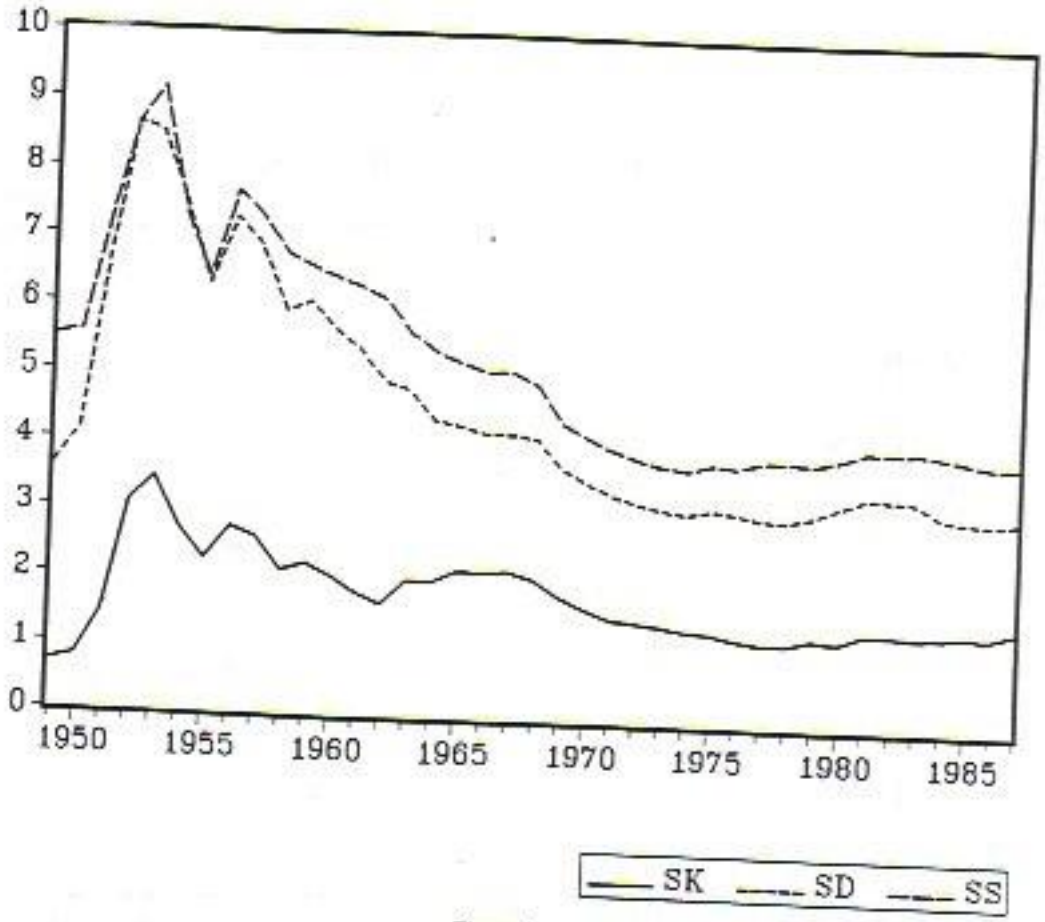

Figure 1.

and colonial wars in Indo-China and Algeria. In the later period, France emphasised independence and autonomy relative to allies and only conducted very limited external military interventions: those in Zaire and Chad were not very expensive. The period after 1966 is marked by great stability in military expenditures produced partly by bureaucratic forces of inertia within the military programme and partly by economic constraints.

The difference between the NATO and budget figures increases from the 1950s, because of the growing importance of pension payments. In the later part of the period capital expenditures tend to take a larger proportion of the budget, though there are marked cycles in the importance of procurement. In general, we would expect the switch between the two strategic regimes to be reflected in different trends in military expenditures, and changes in the relationship between French military expenditure and that of other countries, particularly the US. We would also expect the effect of the change in strategic environment to be different for the different categories of military expenditure (Figure 2).

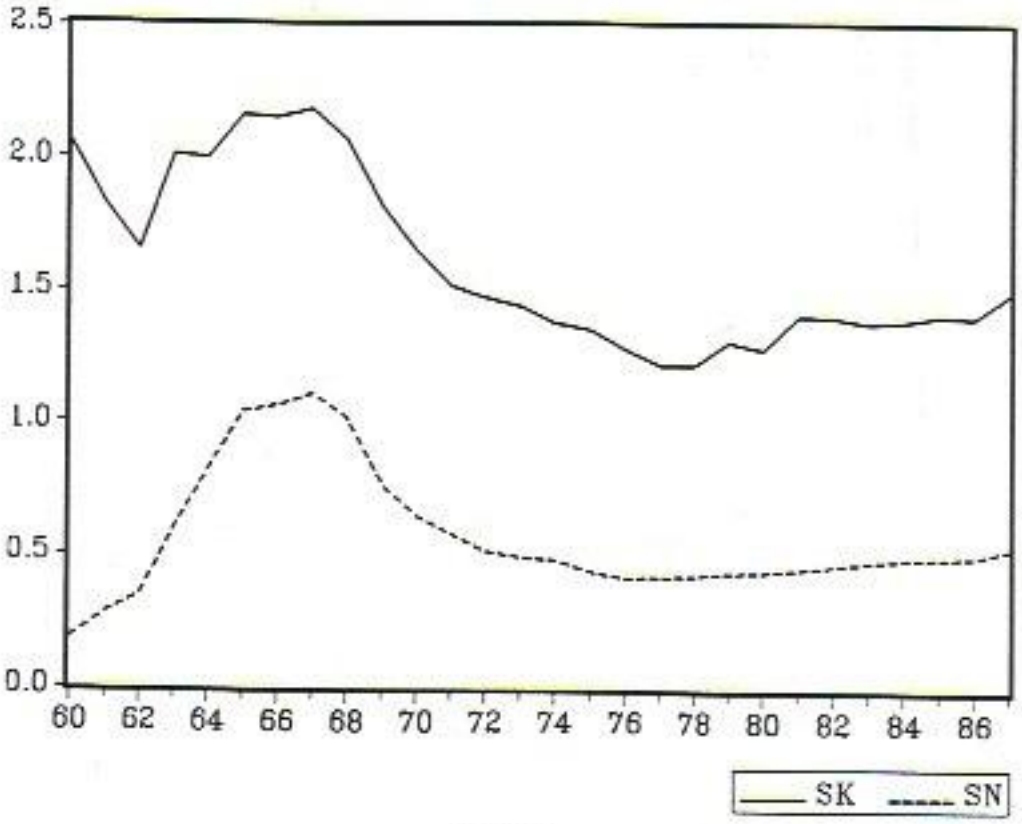

Figure 2.

2. METHODOLOGY

The general theoretical framework adopted in the literature concerned with modelling military expenditures suggests that the various measures of the share of French military expenditure in GDP will respond to other countries military expenditure. The response to the military expenditure of a potential adversary, such as the USSR, is likely to be positive. The response to "allies" such as the USA is more problematical. It may be negative, representing free-riding and dependence, or it may be positive, imitative, taking US spending as a signal. In addition to these spillovers from other countries military expenditures, economic and political factors may also influence the defence budgets.

In order to distinguish the differential effects of the various potential influences on the various components of the defence budget, we need to estimate a consistent system relating the equations for each of the measures. Suppose we denote the vector of exogenous variables, such as other countries military expenditures and economic influences, by X_t, then the system we estimate will have the form:

$$SK_t = X_t\beta_k + \varepsilon_{kt}$$
$$SC_t = X_t\beta_c + \varepsilon_{ct}$$
$$SD_t = X_t\beta_d + \varepsilon_{dt} \qquad \text{with} \quad \beta_d = \beta_k + \beta_c;$$

$$SO_t = X_t\beta_0 + \varepsilon_{0t}$$

$$SS_t = X_t\beta_s + \varepsilon_{st} \qquad \text{with} \quad \beta_s = \beta_d + \beta_0.$$

The dependent variables are the different measures of the share of military expenditure and ε_{it} are disturbances assumed to have the classical properties. Since $SD_t = SK_t + SC_t$, and $SS_t = SO_t + SD_t$ and the same explanatory variables appear in each equation, the adding up properties of ordinary least squares ensure that the coefficients in the equation explaining a total are merely the sum of the coefficients in the equations for its components. This allows us to identify where the differences between equations for different measures arise. For this system ordinary least squares is also the fully efficient estimator.

In addition to the effect of strictly exogenous variables, we would expect the dependent variables to be determined by their past values. The effect of the lagged dependent variable could arise from partial adjustment or error correction towards a desired share of GDP, or through bureaucratic incrementalism, where the Ministry bases its target share of GDP on the past share obtained. Within our system, the treatment of the lagged dependent variables raises complications. If we simply added the own lagged dependent variable to each equation, we would have different variables in each equation, and the adding up properties would no longer hold (i.e. $\beta_d \neq \beta_k + \beta_c$) unless the coefficient of the lagged dependent variable had the same value in each equation. Rather than constrain the coefficients to be the same, we can maintain adding up by including the other lagged dependent variables in each equation. This models the feedback between the various components of military expenditure and allows for different speeds of adjustment with respect to disequilibria in each component. Since $SD = SK + SC$, and $SS = SD + SO$, two of the five measures are linear combinations of the others, thus adding more than three components would induce exact multicollinearity.

3. THE RESULTS

The first model we shall examine is taken from Smith (1989). It was derived from a "general to specific" modelling approach on UK data, and then applied to French data, using the NATO measure of military expenditure. The model is of an error correction form. The share of military expenditure in France, adjusts to remove deviations between the share in the previous period and a target share which is equal to the Soviet share of military expenditure in output, SR_t, minus a constant. The construction of SR_t, which is only a very rough proxy for Western perceptions of Soviet spending, in described in Smith (1989). In the short run, France also adjusts to changes in the share of military expenditure in the US, ΔSA_t. Thus the equation estimated was:

$$\Delta SS_t = \beta\Delta SA_t - \gamma(SS_{t-1} - S^*_{t-1}),$$

with

$$S^*_t = SR_t - \alpha;$$

or

$$\Delta SS_t = \alpha\gamma + \beta\Delta SA_t - \gamma ZF_{t-1},$$

where $ZF = SS - SR$. γ is an adjustment coefficient: it measures the proportion of the difference between the actual and desired level that is removed in each year. The equation can also be written in levels as:

$$SS_t = \alpha\gamma + \beta\Delta SA_t + (1-\gamma)SS_{t-1} + \gamma SR_{t-1},$$

which can be interpreted as indicating that a small value of γ, slow adjustment, implies considerable inertia, a large effect of previous spending on current spending.

Although economic variables do not appear explicitly in this equation, the use of shares of GDP implies that the elasticities of military expenditures with respect to prices and income are equal to unity.

To adapt this model for our purposes, we need to allow for feedback between the different components of military expenditure; thus the lagged values of current and capital expenditure, SC_{t-1} and SK_{t-1} were also included. The ZF_{t-1} term allows for feedback from the NATO measure. As the model stands US expenditure has no long run effect on French expenditure, since this was not significant in the original equation for SS. But this may not be true for the other measures, and to allow for a long run effect, the lagged share of military expenditure in the US, SA_{t-1} was added. In addition, since the long-run effect of US spending should differ between the periods when France was and was not a member of NATO, this coefficient was allowed to shift after 1966. Thus the model used for each of the 5 components is:

$$\Delta S_t = \beta_0 + \beta_1\Delta SA_t + \beta_2 SA_{t-1} + \beta_3 D\cdot SA_{t-1} + \beta_4 ZF_{t-1} + \beta_5 SC_{t-1} + \beta_6 SK_{t-1}$$

where D is a dummy variable which equals 0 for 1950 to 1966, and 1 for 1967–1987. The use of both SA_{t-1} and $D\cdot SA_{t-1}$ is just an econometric device to allow the long run coefficient of US military expenditure to change.

The results are given in Table 1, which also includes some further test statistics, which will be discussed below. The most obvious feature of Table 1 is the differences between the equations for the various measures. Whereas for most of the measures there is a reasonable degree of explanation, between 60 and 80 per cent of the variance explained, in the case of SO, the difference between the defence budget and the NATO measure, there is virtually zero explanation. This series does not respond to strategic influences, which is not surprising, given that it is dominated by pensions.

Except for SO, all the series respond significantly to the change in the share of military expenditure in the US. A one per cent increase in the US share causes capital expenditures to increase as a share of GDP by 0.164%, current expenditures by 0.201%; and the total budget by the sum of these 0.365%. This captures the short-run, impact effect of US spending. In the long run military capital expenditures respond significantly to the level of the US share, whereas current expenditures respond to the Soviet share through the error-correction term ($ZF = SS - SR$). Thus while the total budget responds significantly to both US and Soviet expenditures, the channel by which they influence it is quite different.

The adjustment speeds, which are measured by the coefficients of the lagged dependent variables suggest that capital expenditures adjust very rapidly or show relatively little inertia and current expenditures, subject to more inertia, adjust very slowly. If the inertia arose from bureaucratic factors operating on the defence budget as a whole, these two variables would have had coefficients of equal size, but this is clearly rejected, indicating the importance of disaggregating the budget into its components. Since capital expenditures usually have to be planned well in advance it may seem surprising that they show rapid adjustment. But although they are

Table 1 Error correction model

1950–87	ΔSK	ΔSC	ΔSD	ΔSO	ΔSS
C (×100)	−0.53	−1.47	−2.00	−0.20	−2.20
	(0.79)	(2.20)	(2.33)	(0.23)	(2.19)
ΔSA	0.164	0.201	0.365	−0.059	0.307
	(4.09)	(4.99)	(7.05)	(1.10)	(5.06)
$ZF(-1)$	−0.049	−0.168	−0.217	−0.007	−0.224
	(0.79)	(2.71)	(2.73)	(0.09)	(2.41)
$SC(-1)$	−0.025	0.130	0.105	0.045	0.150
	(0.27)	(1.43)	(0.90)	(0.38)	(1.10)
$SK(-1)$	−0.683	−0.113	−0.796	0.377	−0.419
	(4.41)	(0.73)	(3.99)	(1.85)	(1.80)
$SA(-1)$	0.187	−0.034	0.153	−0.094	0.059
	(3.35)	(0.60)	(2.13)	(1.29)	(0.70)
$D.SA(-1)$	−0.012	0.010	−0.002	0.010	0.008
	(0.63)	(0.54)	(0.07)	(0.42)	(0.31)
R^2	0.632	0.676	0.812	0.050	0.661
$SER \times 100$	0.221	0.222	0.286	0.291	0.334
DW	1.72	2.43	2.50	2.64	2.14
Normality $\chi^2(2)$	0.17	5.06	11.44	67.45	35.14
Economic effects $F(3, 28)$	6.459	0.760	1.123	0.668	2.357
Structural stability					
1. $F(6, 26)$	2.159	0.485	0.550	0.300	0.894
2. $F(21, 11)$	0.299	0.092	0.094	0.054	0.129

The dependent variables are shares of military expenditure in GDP: SK = Capital, SC = Current, SD = Budget, $SD = SK + SC$. SO is off-budget spending and $SS = SD + SO$ is the NATO measure. Coefficients add correspondingly. SA is the US share of military expenditure in GDP; $ZF = SS - SR$, where SR is the Soviet share of military expenditure in output. SER is Standard Error of the Regression, and DW is the Durbin Watson statistic; absolute values of t statistics are given in parentheses.

planned ahead they are not constrained by the previous level and can be changed substantially from year to year as a project starts or finishes. Thus they show less inertia than current spending.

To test whether more general economic variables should be included in the equation, the significance of three additional variables was tested. These were the growth rate of GDP, GY_t, the share of government expenditure in GDP, SG_t, and the lagged share SG_{t-1}. At times of low growth, one might expect the share of defence expenditure to be constrained, while the share of government expenditure may proxy bureaucratic and political pressures or financing constraints. Of course there is a danger that the share of government expenditure may be endogenous, since militar expenditure is a component of it. The $F(3, 28)$ statistic given at the bottom of Table 1 tests for the significance of these extra variables. Only in the case of capital expenditures are they significant. In that case, growth has a significant negative effect: when the growth rate is high, the share of capital expenditures is lower. A possible explanation for this is that since capital expenditures are planned well in advance, when growth in GDP is faster than normal, the share of that pre-planned level in

Table 2 The effect of economic variables

1950–87	ΔSK	ΔSC	ΔSD	ΔSS
C ($\times 100$)	−0.89	−1.96	−2.85	−4.46
	(0.99)	(1.74)	(2.00)	(2.83)
ΔSA	0.203	0.182	0.385	0.320
	(5.89)	(4.23)	(7.07)	(5.31)
$ZF(-1)$	−0.089	−0.173	−0.262	−0.337
	(1.53)	(2.38)	(2.85)	(3.31)
$SC(-1)$	−0.047	0.109	0.062	0.052
	(0.58)	(1.08)	(0.49)	(0.37)
$SK(-1)$	−0.614	−0.180	−0.794	0.592
	(3.97)	(0.93)	(3.24)	(2.18)
$SA(-1)$	0.179	−0.025)	0.154	−0.085
	(3.83)	(0.43)	(2.07)	(1.03)
$D.SA(-1)$	−0.017	0.005	−0.012	−0.022
	(0.97)	(0.54)	(0.42)	(0.71)
GY	−0.025	0.012	−0.013	−0.026
	(2.75)	(1.03)	(0.92)	(1.63)
SG	0.035	0.003	0.038	0.063
	(1.82)	(0.12)	(1.24)	(1.84)
$SG(-1)$	−0.030	0.022	−0.007	0.026
	(1.51)	(0.913)	(0.23)	(0.75)
R^2	0.8176	0.6684	0.8144	0.7005
$SER \times 100$	0.1794	0.2249	0.2843	0.3145
DW	1.7131	2.5068	0.8144	0.3145

GY is the growth rate of GDP, SG the share of government expenditure in GDP.

the higher GDP will be lower than normal. The change in the share of government expenditures has a positive effect, but it is only on the margin of significance. The regression results are given in Table 2.

In both specifications and for all measures, the variable $D \cdot SA_{t-1}$, which allows for a change in the long-run impact of US expenditures, is not significantly different from zero. To test for a general change in the relationship when France left NATO, rather than merely a shift in the coefficient of US expenditure, the sample was split in 1966 and Chow's first (analysis of covariance) test which is distributed $F(6, 26)$ and second (predictive failure) test which is distributed $F(21, 11)$ were applied to the equation without the dummy. The two Chow tests are also shown in Table 1. They indicate that the regression coefficients are not significantly different between the two periods, and that the predictions for the second period from the regression estimated on the first period are within their expected confidence interval.

Thus the various tests for structural stability do not reject the hypothesis that the relationships determining French military expenditure were the same before and after the withdrawal from NATO. Unfortunately, in this particular case these tests are likely to have low power, that is they have a small probability of rejecting the hypothesis when it is false. This is because, as is obvious from Figure 1, the variance in the first period, a time of colonial wars, is large relative to the second period. In

these circumstances, the tests are likely to be inaccurate (see Pesaran *et al.* (1985)). The impact of the colonial wars is also indicated in large residuals in the early period, partly indicated by the test statistics for normality shown in the Table. For instance, the budget equation shows large negative residuals (the actual change was less than predicted by the model) in 1955, 1958 and 1962, and large positive residuals in 1956 and 1959.

Since we do not have quantitative measures of the cost of colonial wars, explicit modelling of them is difficult; but omitting a measure of them induces bias, since they are likely to be correlated with included variables. In these circumstances it is difficult to know if the conflicts resulted in higher military expenditures than would otherwise have occurred, or merely caused the transfer of military expenditures from European to colonial roles. In addition, much of the variation in the military expenditures which helps us to identify the effects of changes in variables is in the early part of the period. If the budget equation estimated in Table 1 is re-estimated over the period 1961–1987, then none of the coefficients are significant. Thus it is very difficult to separate the effect of other countries military expenditure from the effect of colonial wars, and this reduces our ability to test for the effect of the change in strategy in 1966. Without more precise measures of colonial conflict we need to remain agnostic.

4. THE EFFECT OF THE NUCLEAR PROGRAMME

There is another important strategic factor omitted from the estimates in the previous section: the decision to develop an independent nuclear capability. Data on nuclear expenditures are available from 1960, though work on research and development dates from much earlier. The data are plotted in Figure 2. We can use data for the period 1961–1987, after the main colonial conflicts were finished to investigate the effect of nuclear expenditures on the budget. SN is military expenditure on nuclear equipment expressed as a share of GDP, which is treated as exogenous. The equations then examine the effect of nuclear spending on capital, current and total military spending. These estimates can be used to examine the extent to which the nuclear programme displaced or substituted for conventional provision. Table 3 presents the results. The basic equation is the same as that in Table 1, except that $ZF(-1)$ and $D \cdot SA(-1)$ were excluded because they were insignificant in every equation.

Once nuclear expenditures are allowed for separately, the effect of US expenditures is substantially reduced, though they may influence the nuclear budget and thus have an indirect effect on SK and SC through SN. The short run impact is measured by the coefficients of ΔSN, the change in the nuclear budget expressed as a share of GDP. Nuclear expenditures are a component of capital expenditures, therefore a coefficient of zero in the ΔSK equation, would indicate that capital expenditures were no higher than they would have been otherwise and the whole of the nuclear programme is financed by reduced conventional conventional equipment purchases. In fact, the estimates suggest that the impact effect of raising the nuclear budget is to increase capital expenditures one for one, indicating that it does not seem to be immediately financed by reductions in other procurement. Rather there is a small though insignificant increase, since the coefficient is slightly greater than unity. The estimates suggest that the nuclear budget seems to be financed roughly equally by

Table 3 The effect of nuclear expenditures

1961–1987	ΔSK	ΔSC	ΔSD
Constant × 100	0.250 (4.6)	0.266 (3.1)	0.516 (4.8)
ΔSA	0.037 (1.37)	0.079 (1.85)	0.116 (2.19)
$SA(-1)$	0.052 (2.44)	−0.061 (1.80)	−0.009 (0.21)
$SC(-1)$	0.096 (1.55)	−0.219 (2.24)	−0.123 (1.01)
$SK(-1)$	−0.779 (6.16)	0.538 (2.69)	−0.241 (0.97)
ΔSN	1.152 (9.17)	−0.622 (3.13)	0.530 (2.15)
$SN(-1)$	0.721 (5.14)	−0.547 (2.46)	0.174 (0.63)
R^2	0.836	0.707	0.622
$SER \times 100$	0.505	0.079	0.098
DW	2.65	2.46	2.47

reductions in current expenditures (0.62) and by increases in the total defence budget (0.53) in the short run.

Once again, there are quite different adjustment patterns to lagged current and capital expenditure. To estimate the long run effect we have to take account of these adjustments. To see how this is done write the model, ignoring the effect of US military expenditure as:

$$\Delta SC_t = \alpha_c \Delta SN_t + \beta_c SN_{t-1} - \lambda_c SC_{t-1} + \psi_k SK_{t-1}, \tag{1}$$

and

$$\Delta SK_{t-1} = \alpha_k \Delta S_t + \beta_k SN_{t-1} + \psi_c SC_{t-1} - \lambda_k SK_{t-1}, \tag{2}$$

where the λ are the "own" adjustment coefficients and the ψ are the cross adjustment effects. In long run equilibrium, when $\Delta SC = \Delta SK = 0$, the solution is:

$$SC = SN(\lambda_k \beta_c + \psi_c \beta_k)/(\lambda_k \lambda_c - \psi_k \psi_c);$$

and

$$SK = SN(\lambda_c \beta_k + \psi_k \beta_c)/(\lambda_k \lambda_c - \psi_k \psi_c);$$

subject to a stability condition, that the denominator is positive, as it is in this case. Notice, that if ψ_k was equal to zero, there was no feedback from capital spending to current spending, then the long run solution for current spending would merely be β_c/λ_c, the usual formula; similarly for capital spending if ψ_c was zero. The estimates suggest that the main cross-feedback is from capital to current; higher equipment expenditure generates a subsequent increase in current expenditure as one might expect.

The long run effects are slightly smaller than the short run effects, +0.89 on capital and −0.32 on current. Thus in the long run an increase in the nuclear budget as a share of GDP by 1% is financed by a reduction of 0.11% in the share of GDP devoted to conventional equipment, a reduction of 0.32% in the share of GDP devoted to current spending, and an increase of the total defence budget by 0.57% of GDP. Historically, this seems a plausible decomposition.

5. CONCLUSION

This paper has used a dynamic systems framework to examine the sensitivity of models of French military expenditure to the use of alternative measures of military expenditure, and to the effects of strategic change. Our general methodological conclusion is the rather unsurprising one that the inferences one might make about the factors determining military expenditure can be sensitive to the definition of military expenditure used and the treatment of strategic change.

The effect of measurement is substantial, and we would give quite different interpretations of the factors determining the evolution of French military expenditure depending on the choice of a particular measure of the dependent variable. This indicates the importance of looking at the effects on different components separately, something that is not often done in the literature.

This approach revealed a number of interesting results. In particular the off-budget component, the difference between the Defence Ministry budget and the NATO measure, did not seem to respond to any of the strategic influences. This confirms what we might have expected, that the Ministry budget is the relevant decision variable. In addition, adjustment speeds differed significantly between capital and current spending, indicating that bureaucratic inertia cannot be modelled simply by including the lagged defence budget.

On the strategic influences, the conclusions were less clear cut. Since for much of the earlier period, when France was a member of NATO, the defence budget was responding to Colonial Wars, it proved difficult to separate the effects of withdrawing from NATO from withdrawing from the colonies. Although formal tests of structural stability do not show a significant break in 1966, this is probably because of their low power, and the coefficient estimates are very sensitive to the sample period used.

The investigation of the impact of the development of nuclear forces, using data for the post-colonial period was somewhat more satisfactory. The results suggest that the nuclear buildup was financed primarily by higher defence budgets and lower current spending. The estimates again indicated the importance of the dynamic interactions between components.

These results can only be taken as exploratory, and a major avenue for further research is to try and quantify the impact of colonial conflicts on the French defence budget.

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