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Conventional versus strategic expenditures in NATO: a public goods approach

Laurna Jane Hansen
Iowa State University

Conventional versus strategic expenditures

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Laurna Jane Hansen

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CHAPTER I. INTRODUCTION

During the first half of this decade, the United States defense budget has doubled in current dollar figures or increased by 52% in constant 1985 dollar values (Collins, 1985). Currently the U.S. Department of Defense budget ranks second based on size and accounts for over 25% of the discretionary Federal budget. This is equivalent to approximately 7% of Gross Domestic Product (GDP), or nearly $350 billion.

Membership in an alliance, such as NATO, may ease the defense budget burden since other members also contribute to the alliance-wide benefits. Among the European NATO allies, an average member contributes 3.8% of GDP to military expenditures. However, alliance provision of defense benefits is not efficient; Iceland has no defense budget while Turkey reports over 7% of GDP for defense. For this reason, it is of interest to study the alliance defense expenditures and the factors which influence the level an ally chooses to spend.

The theory and empirical analysis in defense economics is not new. In 1966, Mancur Olson and Richard Zeckhauser introduced the public goods approach for studying military alliances. Statistical analysis supports Olson and Zeckhauser's hypothesis that the large, wealthy allies carry a larger portion of the defense burden, allowing the small allies to enjoy a free ride.

A series of interesting papers examine the Israeli-U.S. alliance (McGuire, 1982), modern day alliances (Murdoch and Sandler, 1982, 1984, 1986), international defense comparisons (Dudley and Montmarquette, 1981) and trade in alliances (Jones, 1988). Introduction of the joint products theory allows defense expenditures to produce public, private and impure public outputs based upon the mix of conventional and strategic weapons (Sandler and Cauley, 1975; Sandler, 1977; Murdoch and Sandler, 1982). Along with the more advanced theory are more sophisticated statistical testing procedures.

Although there have been attempts to test the joint products hypothesis for the NATO alliance, these exercises relied on imperfect proxies to differentiate between strategic and nonstrategic military activity. My thesis will carefully develop a strategic time series to use in testing the joint products theory. Using data for each of the nuclear allies and seven of the nonnuclear allies, I will regress each ally's military expenditure against conventional spillins (all other alliance members' conventional expenditures), strategic spillins, and Gross Domestic Product.

By clarifying the responsiveness of alliance members' defense expenditures, economists have the tools to analyze the impact of changes in policy, defense technology, or the level of an ally's defense expenditure.

Literature Review

In their seminal article, "An Economic Theory of Alliances," Olson and Zeckhauser (1966) use public goods theory to analyze alliance behavior. Finding that the larger countries within NATO bear a greater portion of the defense burden, Olson and Zeckhauser suggest that such behavior is a result of the inequality between an ally's marginal cost share of defense and the marginal benefits of the alliance defense. Another observation is that larger countries place a higher value on defense, since in the event of an adversary attack, the larger countries have more to lose. Empirical evidence supports this with a significant positive correlation between an ally's national income and that ally's percentage of national income for defense.

Jacques van Ypersele de Strihou (1967) determines an ally's burden share as the difference between defense expenditures and benefits. Defense expenditures include both military costs and foreign aid programs since both provide external security. Strictly national benefits such as internal security, research and development, economic benefits, and political benefits are the private benefits of defense, whereas external security is the public defense benefit. These establish the joint products of a country's defense budget. National benefits are deducted from a country's defense expenditure to obtain the net contribution to the public good. This difference is the measure of the "burden" for a country in the provision of the international common good. Although Van Ypersele de Strihou finds that the larger countries do support a larger burden, when including conscripts and foreign aid in costs, he concludes that the shortcomings of the small countries are not great in dollar terms.

Contributions to the literature by Sandler (1977), Sandler and Loehr (1978), and Sandler, Cauley and Forbes (1980) provide a taxonomy of defense goods. By distinguishing among deterrent weapons, protective weapons, and mixed weapons these authors develop a joint products model.

The joint products model allows for public, private, and impure public output from defense expenditures. To extend Olson and Zeckhausers' disproportionate burden sharing results, application of impure public goods theory and the joint products model reveals that the greater the proportion of deterrent defense an ally provides, the greater will be the disproportionate burden sharing. Alliance members in this case do not equate the marginal benefits of alliance defense to their marginal cost (contribution). This is the cause of free riding among the NATO allies.

Empirical studies by Sandler and Forbes (1980) and Murdoch and Sandler (1982, 1984) measure the responsiveness of an ally's defense expenditures to the level of defense provided by all other allies. The statistical tests of the data support the notion of free riding behavior. As other alliance members increase total provision of defense, an individual member has an incentive to reduce military expenditures. This is particularly prevalent among the European alliance members and Canada.

Murdoch and Sandler (1984) track the effect of the NATO strategy shift from Mutual Assured Destruction (MAD) to the doctrine of Flexible Response. Once NATO adopts the flexible response strategy (which calls for a conventional and tactical nuclear weapon exchange rather than an all-out nuclear confrontation), European countries no longer rely as strongly on the deterrent defense within NATO. Rather, their own conventional forces are necessary to complement the strategic forces. To capture the response to this strategy shift, Murdoch and Sandler (1984) include a dummy variable in the joint products military expenditure model.

The empirical results support the hypothesis that the doctrine of Flexible Response induces complementarity between nuclear and nonnuclear forces and reduces the free riding behavior. The same statistical test suggests that the United States begins to substitute other NATO members' military expenditures for their own as a result of the strategy shift.

A similar joint products military expenditure model for the Australian, New Zealand, U.S. alliance (ANZUS) enables Murdoch and Sandler (1985) to analyze the level of free riding and other factors which influence military expenditures for these countries. This model yields interesting results not found in the NATO alliance, primarily that it is feasible for members in the alliance to be excluded from the deterrent umbrella, therefore free riding behavior is not as extensive.

Sweden, Switzerland, and Finland, are neutral countries, yet due to geographical proximity may receive defense benefits from other surrounding countries or the NATO alliance. Murdoch and Sandler (1986) modify the joint products model for military expenditure to take into account nonalliance spillin benefits. The authors discuss the extent of free riding or neutrality for each Scandinavian country by analyzing the coefficients of the spillin terms. Murdoch and Sandler find that Switzerland and Finland do not free ride on NATO defense expenditures. After the doctrine of Flexible Response, Sweden relies on NATO's and other countries' conventional forces to a small extent. Denmark and Norway have similar responses to the NATO spillins. Other interesting results from their study reveal that Finland and Denmark respond in a similar manner to an increase in their own real GDP. Likewise, Norway and Sweden share a similar type of response to their own GDP increase in determining the level of defense expenditures.

Prados, Wit, and Zagurek (1986) discuss plans for upgrading the British and French nuclear forces. The nuclear force increases proposed for the next decade will change the dynamics of strategic arms negotiations and have implications within the NATO alliance. According to these authors, by 1990 France will have the capability of destroying two-thirds of the Soviet production base and killing 81 million Soviet citizens. The French are aiming their possible attack at the adversary's administrative, economic, and social structure. The British, on the other hand, are targeting Soviet urban and industrial centers. The British strategic capability estimates for the 1990s project 24-68 million fatalities and up to half the production capabilities of the Soviet Union.

This level of strategic power will not be ignored by the Soviet Union. Even prior to the intensive strategic build-up, there has been a Soviet recommendation to tie U.S. strategic negotiations to limit the other nuclear NATO members' forces. In the future, these countries may choose to negotiate separately from the United States. The shift of strategic dominance away from the United States within NATO may have other implications as well.

Sandler (1988) adds to the literature the possible impact that a counterdeterrent force such as SDI might have on burden sharing within the NATO alliance. Depending on the technology (whether missiles are destroyed during the boost phase or during the reentry phase) the extent of free riding will vary. If the SDI is a pure public good it will eliminate the missile prior to the target destination being known. This will induce free riding behavior on the SDI program. If the technology is capable of eliminating the missile once the target is determined, then the defense technology is private. Being able to exclude alliance members from the defense will induce each ally to contribute proportionately for the benefits. Sandler's article also discusses the implications of the U.S.-Soviet nuclear disarmament proposal for European-based missiles. If an agreement is reached, the European countries will have less free riding ability. Sandler suggests this will create a greater need for those countries to increase their own conventional forces, thereby redistributing the NATO defense burden more equitably. Sandler concludes that the burden sharing within the NATO alliance will depend upon advancements in technology, the strategic capabilities of other alliance members and the outcome of U.S.-Soviet strategic negotiations.

Sandler (1987) uses a joint products military expenditure model to analyze an alliance policy for a fixed rate of military expenditure increase. Cross sectional and time series data provide empirical results showing that an ally bases their military expenditure on a variety of factors. Both external spillin benefits from the alliance and an alliance policy change influence a country's defense expenditures. Economic factors also play an important role in resource allocation to defense. Trends such as free riding, complementarity between conventional and strategic forces, and substitution possibilities for the nuclear allies are also supported by Sandler's empirical results.

Sandler's application of the joint products model to alliance defense provides a way to predict an ally's military contribution capabilities and allows for comment on alliance policy. Sandler concludes that a fixed percentage increase in real military expenditures is not a feasible plan since there are many other factors to consider in determining defense expenditures. Sandler also uses different GDP growth scenarios and varying spillin levels to calculate the possible defense expenditure changes for France, Britain, and the Federal Republic of Germany.

Reference Sources

The following reference books provide useful information for analyzing U.S. defense expenditures. I obtained detailed data and/or background information necessary for calculating the U.S. strategic time series from these sources.

Budget of the United States: Appendix provides line item appropriations, budget authority, or obligations for the various agencies, departments and branches of the government.

Budget of the United States: Historical Tables has useful tables showing government expenditures over extended periods of time. It provides a quick review of military expenditure percentages and shows trends in military size.

Department of Defense Annual Report provides the Secretary of Defense's annual message to Congress. This report includes detailed information for all branches of the military.

Jane's Yearbooks provides a complete listing of weaponry for each country. This is useful in determining whether a weapon belongs in the strategic or conventional calculation.

Scope of Thesis

To both complement and extend the previous studies in alliance defense, this thesis will focus on the responsiveness of NATO members to conventional spillins and strategic spillins. The data are 1970-1985 military expenditures for Belgium, Canada, Denmark, France, the Federal Republic of Germany, Italy, Netherlands, Norway, the United Kingdom and the United States. Throughout this period, NATO was operating under the doctrine of Flexible Response, so, unlike previous work by Murdoch and Sandler (1984), it is not necessary to include a strategy shift variable in the models. The Reagan administration's renewed defense emphasis is captured by using a dummy variable after 1981.

A priori the best proxy for strategic spillins is unknown. For this reason, I will estimate the joint products defense model using three slightly different methods for calculating the strategic spillin proxy. One proxy will be the sum of British, French, and U.S. strategic procurement since this is the most visile form of strategic expenditures. The United States has been the dominant strategic member in NATO; therefore allies may respond only to strategic spillins from the U.S. A proxy for the U.S. will be calculated first as the total strategic budget. Again, since procurement is the most visable form of strategic expenditure, I will also calculate a proxy for U.S. strategic procurement.

In addition, for the three nuclear members (France, the United Kingdom, and the United States) I measure the responsiveness of conventional expenditures to spillins and the responsiveness of strategic expenditures to spillins. From these results, I observe whether the nuclear alliance members have different responses for conventional and strategic expenditures.

The remainder of the thesis is divided into four chapters. Chapter II provides background terminology and definitions. The joint products theory is developed for a representative nonnuclear ally as well as for a representative nuclear ally. The notions of substitutes and complements among defense expenditures are also discussed. Chapter III examines the procedure to calculate the strategic data sets for the United States, the United Kingdom and France, as well as the statistical models and definitions of the variables. Chapter IV presents the empirical results. A short summary of major conclusions from the thesis is found in Chapter V.

CHAPTER II. THEORETICAL MODELS

Nonnuclear Allies

The NATO alliance now consists of sixteen allies, three of which possess nuclear strategic weapons in their arsenals. The nuclear allies include the United States, Britain, and France, while the nonnuclear allies include Iceland, Luxembourg, Belgium, the Netherlands, Canada, Denmark, Norway, Italy, Greece, Turkey, Portugal, West Germany, and Spain. To capture the differences between the behavior of the nuclear and nonnuclear allies, it is necessary to distinguish the utility-maximizing behavior for the representative nuclear and nonnuclear ally in an n-country alliance like that of NATO. Following the convention of previous work (Murdoch and Sandler, 1982, 1984, 1986), I employ a joint product model of alliance behavior in which an ally's arsenal is characterized as providing multiple outputs of varying degrees of publicness (Sandler and Cauley, 1975; Murdoch and Sandler, 1982, 1984, 1986; Sandler, 1977; Sandler and Forbes, 1980).

The arsenal of a nonnuclear ally yields at least two kinds of benefits: damage-limiting protection in the event of a conventional attack and private defense benefits to the ally. These private defense benefits include, among others, protection of coastal waters (if the country is not landlocked), relief in times of national disaster, and control of domestic terrorists. Such private defense benefits are private between allies, but yield nonrival and nonexcludable or public benefits within the nation.[1] Although multiple private benefits are typically derived from an alliance's arsenal, for simplicity, it is assumed that only one private benefit exists. No generality is lost with this assumption, since the model's variables can be interpreted easily as vectors of benefits. In addition to the private benefit, a conventional-arms arsenal yields damage-limiting protection, used to deter an enemy and to impede an enemy's attack during war (Sandler, 1977; Sandler and Forbes, 1980). Most damaging-limiting protection benefits are partially rival owing to a thinning of forces as the fixed-sized arsenal is spread along a longer perimeter.[2] Moreover, a portion of these protective benefits is excludable, since the providing country can deploy its forces elsewhere. There are, however, deterrent aspects of a conventional arsenal that surely yield some pure public benefits to the allies.

Consider a representative, but not necessarily identical, nonnuclear ally that must allocate its scarce resources between a military activity, q, and a private consumption activity, y. A unit of the private nondefense activity yields a unit of the private good, also denoted by y, while a unit of the conventional military activity yields both a private

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[1]A pure public good is totally nonrival in consumption, since its consumption by one individual (nation) does not detract in the slightest from the consumption opportunities available to other persons (nations). Moreover, the benefits of a pure public good are nonexcludable; once it is provided, the good is available to all. In contrast, a private good (e.g., a drink of water) is totally rival and its benefits are excludable. Impure public goods (benefits) exhibit varying degrees of rivalry.

[2]In a more complicated model, thinning effects could be handled by including the number of allies as a choice variable as in Murdoch and Sandler (1982).

and an impure public defense output. Let x stand for the private defense output and z for the impure defense output of damage-limiting protection. The joint product relationships are

$$x = f(q) \qquad [2.1]$$

and

$$z = g(q), \qquad [2.2]$$

where $\delta x/\delta q = f' > 0$ and $\delta z/\delta q = g' > 0$, and where both f(q) and g(q) are strictly concave, twice-continuously differentiable functions. In equations 2.1 and 2.2, f' and g' measure the respective marginal productivities of the military activity in providing private outputs and damage-limitation benefits.

In an alliance, an ally may obtain benefits in terms of conventional-war deterrence and damage limitation from other allies' conventional expenditure activity. Along the central front in the Rhine Valley, for example, arms and soldiers from various NATO allies are deployed to deter Warsaw Pact aggression. The amount of conventional-based benefits, $\tilde{Z}$, that are provided by the other allies is a function of the aggregate conventional military activity, $\tilde{Q}$, in the other allies, including both the nuclear and nonnuclear allies -- i.e.,

$$\tilde{Z} = h(\tilde{Q}), \qquad [2.3]$$

where $h' > 0$ and $h'' < 0$, and $\tilde{Q}$ is all other allies' conventional military activities. The total level of conventional-based benefits, Z, can be simply represented as

$$Z = z + \tilde{Z}. \qquad [2.4]$$

Clearly, a weighting scheme could be applied to aggregating conventional benefits across allies; but such a scheme, while complicating the presentation, would not alter the reduced-form equations for the demand for military expenditures, which I seek to derive and estimate. Some impurity aspects can be captured by the $f(\cdot)$ and $h(\cdot)$ functions.

Each ally, nonnuclear or otherwise, also derives a purely public benefit from the deterrence yielded by strategic activities (e.g., expenditure on Trident Submarines) of the so-called nuclear allies. The aggregate strategic deterrence for the alliance is notated as S, which is the sum of the strategic deterrent activities in the nuclear allies. As a pure public benefit, S enters each ally's utility function.

This provides the arguments for the stylized utility-optimizing problem[3] for a representative nonnuclear ally. The preferences of a representative ally are depicted by a well-behaved, strictly concave, nonsatiable twice-continuously differentiable utility function:

$$U = U(y,\ x,\ Z,\ S) \qquad [2.5]$$

Using equations 2.1 to 2.4 to substitute for x and Z, the utility function can be expressed in terms of activity space:

$$U = U(y,\ q,\ \tilde{Q},\ S). \qquad [2.6]$$

By formulating the model in activity space, it facilitates the empirical analysis since military activity can be proxied by military expenditures. To derive a nonnuclear ally's demand equation for military activities,

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[3]For purposes here, the utility function belongs to a decision-making oligarchy in the respective country. The problem can be respecified to apply to other agents. See the discussion concerning decision makers in Oppenheimer (1979), McGuire and Groth (1985), and Sandler, Cauley, and Forbes (1980).

the utility function in equation 2.6 is maximized subject to the constancy of conventional and strategic spillovers -- i.e., $\tilde{Q}$ and S constant -- and to the budget constraint:

$$I = y + p_c q, \qquad [2.7]$$

where I is the nation's income, p_c is the per-unit cost of conventional military activity, and unity is the per-unit cost of the private activity. The constancy of $\tilde{Q}$ implies Nash-Cournot behavior, whereby an ally considers all possible conventional activity levels of the other allies when choosing its own level of conventional expenditure. In particular, the ally picks its maximizing level of military activity based upon the best choice for $\tilde{Q}$ of the other allies (McGuire and Groth, 1985; Sandler and Murdoch, 1988).

The demand for military expenditures is found in two steps. First, I derive the first-order conditions associated with optimizing utility subject to the relevant constraints. This is accomplished by differentiating with respect to y, q, and the Lagrangian multiplier, associated with the budget constraint. The first-order conditions yield three equations in which our choice variables -- y and q -- are implicitly defined in terms of the parameters -- I, p_c, $\tilde{Q}$, and S. Second, I invoke the implicit function theorem to express choice variables as explicit functions. In particular, a nonnuclear ally's demand for military activity is

$$q = q(p_c, I, \tilde{Q}, S) \qquad [2.8]$$

In Chapter IV, equation 2.8 is estimated for a sample of nonnuclear NATO allies. The following partial derivatives of this equation prove important: $\delta q/\delta I$, $\delta q/\delta\tilde{Q}$, and $\delta q/\delta S$. The first measures the effect of an income (i.e., Gross Domestic Product) change on a nonnuclear ally's demand for military activity, the second denotes the effect of other allies' conventional expenditures (or spillins) on a nonnuclear ally's military demand, and the third depicts the effect of strategic expenditures or spillins on a nonnuclear ally's military demand. Income normality is implied by a positive $\delta q/\delta I$ and is expected to hold for all allies. The sign of $\delta q/\delta\tilde{Q}$ depends on the consumption relationship of the jointly produced defense outputs and on income effects (see Murdoch and Sandler (1984) for details). If the two defense activities are substitutes (i.e., they fulfill similar purposes), then there is a tendency for $\delta q/\delta\tilde{Q}$ to be negative. The tendency is stronger, the smaller is the associated income effect, which for normal goods is in the opposite direction to the substitution effect. In the case of complements (i.e., a case where two defense outputs enhance one another's marginal benefits), the tendency is for $\delta q/\delta\tilde{Q}$ to be positive, but near zero. For nonnuclear allies, the degree of substitutability between the allies' conventional forces is, indeed, very limited owing to thinning -- a tank on the border of France is not going to substitute greatly for a tank on the northern border of Norway. With the doctrine of flexible response, each ally must maintain strong conventional forces if the ally wants to keep its soil from becoming the initial battlefield for a conventional exchange (Murdoch and Sandler (1984, pp. 90-91). Thus, increases in the other allies' conventional expenditures are not expected to elicit a substitution reaction; for normal goods, the sign of $\delta q/\delta\tilde{Q}$ is expected to be positive. In fact, an increase in the other allies' conventional expenditures should induce the nonnuclear ally to spend more on conventional armaments so that it does not appear weak to the opposition. This predicted reaction is in opposition to free riding, whereby an ally relies on another for its defense.

The sign of $\delta q/\delta S$ also depends on the consumption relationship of conventional and strategic expenditures. A complementary relationship is consistent with a positive sign, while a substitution relationship is consistent with a smaller positive value or negative value, depending upon the income effect.

Before I turn to the nuclear allies, there is an interpretation of the first-order conditions that is worth presenting. Maximizing the utility function subject to equations 2.1-2.4 and 2.7 yields the following requirement from the nonnuclear ally's viewpoint:

$$f'MRS_{xy} + g'MRS_{zy} = p_c, \qquad [2.9]$$

where MRS_{xy} is the marginal rate of substitution of good x for good y, and MRS_{zy} is the marginal rate of substitution of good z for good y. The left-hand side of equation 2.9 is the marginal benefit derived by the ally from a unit of conventional expenditure. Since each unit of q yields units of private and damage-limiting benefits, the marginal value of each must be accounted for and weighted by the respective marginal productivities. The right-hand side of equation 2.9 is the marginal cost of a unit of q.

Nuclear Allies

Unlike the nonnuclear allies, the nuclear ally must allocate defense expenditures to both conventional and strategic armaments. As before, conventional defense activity, q, yields joint products: a private defense output, x, and an impure public output, z, of damage-limiting protection. Thus, the nuclear allies also abide by equations 2.1 and 2.2. Moreover, the spillin of conventional defense from the other allies satisfies equation 2.3, where $\tilde{Z} = h(\tilde{Q})$. Total damage-limitation benefits is the sum of z and $\tilde{Z}$. In keeping with the literature (see, e.g., Olson and Zeckhauser, 1966), deterrence benefits, derived from strategic weapons expenditure, are treated as a pure public good.

Strategic activities, unlike conventional activities, are assumed only to give off a single output of deterrence, obtained from the threat of retaliation. Let s denote the representative nuclear ally's provision of the strategic activity, and let $\tilde{S}$ depict the provision of the strategic activity by the other nuclear allies. Without sacrificing generality, it can be assumed that each unit of strategic activity yields a unit of deterrence, which we also denote by s. Thus, total strategic benefits, S, are

$$S = s + \tilde{S}. \qquad [2.10]$$

The nuclear ally's well-behaved utility function is

$$U = U(y, x, Z, s + \tilde{S}), \qquad [2.11]$$

which can be expressed, once again, in terms of activity space:

$$U = U(y, q, \tilde{Q}, s + \tilde{S}). \qquad [2.12]$$

To derive a nuclear ally's demand equations for conventional and strategic defense activities, the utility function in equation 2.12 is maximized subject to the constancy of conventional and strategic spillovers -- i.e., $\tilde{Q}$ and $\tilde{S}$ constant -- and to the budget constraint:

$$I = y + p_c q + p_s s, \qquad [2.13]$$

where p_s is per-unit cost of strategic activities. The nuclear ally's problem differs from that of the nonnuclear ally owing to the additional choice variable of strategic expenditure. When utility is maximized subject to the relevant constraints, four first-order conditions are derived that implicitly define the ally's demands for y, q, and s in terms of the parameters. These latter two demand equations are

$$q = q(p_c, p_s, I, \tilde{Q}, \tilde{S}) \qquad [2.14]$$

$$s = s(p_c, p_s, I, \tilde{Q}, \tilde{S}). \qquad [2.15]$$

Total military activity demand, ME, would then equal

$$ME = p_c q(\cdot) + p_s s(\cdot), \qquad [2.16]$$

where the arguments have been suppressed. In Chapter IV, equations 2.14 and 2.15 can be estimated individually or else can be estimated as equation 2.16; the overall results will be unchanged when the former two equations are linear. Even so, estimating the individual demands for strategic and conventional expenditures can provide additional insights. The following partial derivatives of ME prove of interest in Chapter IV: $\delta ME/\delta I$, $\delta ME/\delta\tilde{Q}$, and $\delta ME/\delta\tilde{S}$. The first measures the influence of income changes on the nuclear ally's total military expenditures and is expected to be positive, while the second denotes the influence of changes in conventional spillins on the ally's military expenditures and, by the previous discussion, is predicted to be positive. The third partial, $\delta ME/\delta\tilde{S}$, indicates the effect of changes in strategic spillins on military expenditures. There is a greater possibility for substitution, especially between the strategic arsenals of the nuclear allies (i.e., $\delta s/\delta\tilde{S} < 0$ in equation 2.15), when strategic spillins are considered owing to the pure publicness of these spillins. A British-deployed Trident II missile possesses the same threat of retaliation as that of a U.S.-deployed missile. Each of the three nuclear allies deploys its nuclear arsenal to be within striking distance of the Warsaw Pact. Unlike conventional forces, thinning does not characterize these strategic weapons.

The first-order conditions associated with the nuclear ally's utility-maximizing problem also provide the requirement for deciding the division between strategic and conventional expenditures:

$$\frac{MRS_{sy}}{P_s} = \frac{f'MRS_{xy} + g'MRS_{zy}}{P_c} \qquad [2.17]$$

where MRS_{sy} is the marginal rate of substitution between strategic output and the private numeraire good. The right-hand side of equation 2.17 is the marginal benefit per dollar derived from strategic activities, while the left-hand side is the marginal benefit per dollar derived from conventional activities. The terms on the right account for the jointly produced outputs.

CHAPTER III. PROCEDURES

Strategic Data Sets

U.S. military expenditure data are easily accessible, but the strategic component of these data are not consistent or complete. For this reason, it is necessary to develop an accurate strategic data set. The Budget of the United States Government: Appendix appears to be the most reliable source for detailed information. Since free or easy riding depends on the anticipated contributions of the other allies, I will make use of the line item appropriations for defense. The true strategic calculation includes both the strategic force line items and additional "buried appropriations" such as training, central supply and maintenance, support equipment, administration, etc. Descriptions of the budget line items provide additional information to determine whether to include the line item with strategic or conventional appropriations.

Each branch of the military (army, navy, air force, and marine corps) has three categories necessary for calculating strategic appropriations. These categories are personnel, operation and maintenance (O&M), and procurement. Also included in the strategic calculation are the relevant line items from the military research, development, test and evaluation (RDT&E) category, the Department of Energy, and the National Aeronautics and Space Administration (NASA).

The army, navy, air force, and marine corps use identical line items from the personnel category; therefore, the same procedure applies to each branch. The personnel subtotal consists of the following line items:

1) strategic forces, 2) research and development, 3) central supply and maintenance, 4) training, and 5) administration. A strategic percentage is found by dividing expenditures on strategic forces by expenditures on total forces (i.e., general purpose forces plus strategic forces). This percentage is applied to line items 2, 3, 4 and 5. The sum of these four figures added to line item 1 provides the branch personnel subtotals. By summing the four military branches' personnel subtotal, I obtain the strategic personnel expenditure. The 1970-1981 data for strategic personnel are in Table 1.

In 1982, the line item descriptions for the personnel category change and it is no longer possible to separate out strategic personnel from total personnel. Since strategic personnel data are available for 1970-1981, it is possible to make fairly reliable point forecasts for 1982-1985. A detailed explanation of the second-order autoregression forecast procedure is in Appendix B. The forecast model appears to be correctly specified and the point estimates are intuitively appealing. Forecast personnel data for 1982-1985 are in Table 1.

The operations and maintenance (O&M) category also has identical line items for each branch. Each branch's O&M subtotal consists of the following line items: 1) strategic forces, 2) central supply and maintenance, 3) training, and 4) administration. Again, a strategic percentage is found by dividing expenditures for strategic forces by the expenditures for total forces. This percentage is applied to line items 2, 3, and 4. The sum of these three figures plus line item 1 yields each branch's O&M subtotal. By summing the army, navy, air force, and

Table 1: 1970-1985 U.S. Strategic Appropriations by Category
(All figures in thousands of current dollars)

Year	Personnel	O & M	Procurement
1970	2,684,879.568	3,493,280.115	2,649,852.724
1971	2,621,137.861	3,422,407.498	2,423,901.902
1972	2,875,194.290	3,716,495.700	2,820,947.224
1973	3,151,289.035	4,155,472.793	2,802,454.368
1974	3,420,729.748	4,266,133.621	2,485,432.467
1975	3,364,852.173	4,669,216.474	3,012,722.440
1976	3,347,290.164	4,965,323.663	2,313,583.045
1977	3,174,075.573	5,232,725.262	3,496,368.684
1978	3,191,058.773	5,223,661.123	4,123,441.256
1979	3,262,837.954	5,757,770.395	1,620,730.209
1980	3,422,549.351	6,763,552.216	2,520,146.776
1981	4,006,807.338	8,090,231.245	2,853,229.437[a]
1982	4,316,982.501[b]	8,830,188.225	2,144,011.791[a]
1983	5,373,445.349[b]	9,377,437.945	6,733,419.387[a]
1984	5,972,843.995[b]	9,851,723.378	12,722,852.728[a]
1985	8,651,140.824[b]	10,783,350.480	13,385,905.516[a]

[a] Includes B-1B bomber appropriations.

[b] Forecast value from AR(2) procedure.

RDT&E	Energy	NASA
1,955,395.198	1,456,925.085	0.000
1,595,398.386	1,450,596.537	0.000
1,488,808.989	1,457,527.609	102,975.000
1,579,495.154	1,408,774.355	82,260.000
1,814,500.633	1,531,539.291	0.000
1,775,825.456	1,709,370.000	0.000
1,931,144.487	1,695,999.158	0.000
2,945,717.761	2,086,727.246	0.000
3,162,735.942	2,173,909.500	0.000
2,652,807.987	2,331,630.348	0.000
2,974,238.054	2,779,772.000	0.000
4,601,190.131 [a]	3,545,941.000	0.000
5,760,355.140 [a]	4,428,251.000	0.000
7,986,571.790 [a]	5,599,902.000	0.000
10,464,440.864 [a]	6,580,093.000	0.000
11,571,123.940 [a]	7,448,567.000	0.000

marine corps O&M subtotal plus a line item for defense nuclear agency (from the defense agency branch), I obtain strategic O&M. These data are reported in Table 1.

The army and air force have identical line items for the procurement category. These line items are: 1) ballistic missiles, 2) modification of missiles, 3) spares and repair of missiles, and 4) support equipment. Dividing line item 1 by total expenditure for missile procurement, I find a strategic percentage to apply to line items 2, 3, and 4. The sum of these three figures plus line item 1 provides the army or air force procurement subtotal. From 1982-1985, the air force has an additional line item for the B-1B bomber plane program. These B-1B bomber figures were obtained from the February 28, 1984 Senate Budget committee hearing report[1].

The navy has two strategic procurement line items which are: 1) ballistic missiles and 2) fleet ballistic ships. A strategic percentage is found by dividing the navy's strategic procurement expenditures by the expenditures for total navy missile and ship procurement. This percentage is applied to the following five support line items: 3) ship support equipment, 4) communications and electronic equipment, 5) ordnance support equipment, 6) supply support equipment, and 7) personnel and command support equipment. For some years there are also line items for modification, repairs, and support of missiles.

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[1]In 1982, the air force spent $1.61 billion for B-1B bomber program procurement, $4.04 billion in 1983, $6.12 billion in 1984, and $7.17 billion in 1985.

In these cases, the percentage of strategic missiles (strategic missiles divided by total missile procurement for the navy) is applied to the missile support line items. Summing the above line items yields the navy procurement subtotal.

The marine corps has a single strategic expenditure line item, which is guided missiles and equipment. This provides the marine corps procurement subtotal.

By summing the army, air force, navy, and marine corps procurement subtotals, I obtain strategic procurement. Table 1 provides these data.

The military's research, development, test, and evaluation (RDT&E) category has three strategic line items from 1970-1981 and four strategic line items from 1981-1985. There were line item description changes in 1977. Prior to 1977, the RDT&E line items consisted of: 1) missiles and related equipment, 2) military astronautics, and 3) program management and support. Fifty percent of the first line item and all of the second line item are attributed to the strategic subtotal[2]. A strategic percentage is found by summing the value from the strategic line items and dividing by total RDT&E. This percentage is applied to the third line item. The sum of these three line items yields the strategic RDT&E for each year between 1970-1977.

For the years 1977-1985 the line items are: 1) strategic programs, 2) advanced technological development, and 3) program management and support. During these years, fifty percent of the second line item and

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[2]These assumptions are based on the line item descriptions and apply to the 1970-1977 calculations.

all of the first line item[1] plus a strategic percentage times the third line item is included in the strategic RDT&E. From 1981-1985 the fourth line item is for the B-1B bomber program. These figures are found in the February 28, 1984 Senate Budget Committee hearing report[2]. The sum of these four line items provides the strategic RDT&E figures for 1981-1985. Data for strategic RDT&E are in Table 1.

The Department of Energy has five line items which include 1) nuclear weapons, 2) intelligence, and arms control, 3) nuclear security and safety, 4) naval reactor development and 5) special materials production. Where applicable, capital investment for the above line items is also included in the strategic calculation. The sum of the above line items provides the Department of Energy strategic component. Table 1 contains these data.

The National Aeronautics and Space Administration (NASA) has a single line item, space and nuclear research, for 1972 and 1973. This is the strategic subtotal for NASA. It is somewhat suspicious that no other strategic research is openly reported by NASA. The data for NASA are reported in Table 1.

By summing the strategic category figures for personnel, O&M, procurement, RDT&E, Department of Energy, and NASA, I derive the total strategic expenditure for a year. The conventional expenditure is the

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[1]These assumptions are based on the line item descriptions and apply to 1977-1985 calculations.

[2]In 1981, $0.22 billion was spent on RDT&E for the B-1B bomber program, $0.47 billion in 1982, $0.75 billion in 1983, $0.74 billion in 1984 and $0.51 billion in 1985.

difference between total military expenditure as published in SIPRI (1983, 1987) and the strategic calculation. Both the strategic and conventional figures for the U.S. can be found in Table 2. The annual line item calculations for strategic appropriations are presented in Appendix D.

All U.S. data are converted from current dollar figures to constant 1980 dollars by employing the 1980 price deflator as reported in the International Monetary Fund Yearbook (IMF, 1980).

The strategic data for the United Kingdom are the efforts of Dr. Keith Hartley from the University of York. Dr. Hartley's efforts are funded by a NATO fellowship.[3] At this time there are insufficient data to calculate a strategic time series for the United Kingdom which is consistant with the detailed U.S. strategic calculation. For this reason, U.K. strategic procurement will serve as a proxy. Conventional military expenditure is the difference between total military expenditure and strategic procurement. GDP figures are obtained from the IMF (1983, 1987). These figures are converted from current pound figures to constant figures by dividing with the 1980 price deflator (IMF, 1980). All data are transformed to U.S. dollars by employing the average annual exchange rates. This produces constant 1980 U.S. dollar figures for the British

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[3]Sources for these data consist of: Statement on Defence Estimates, HMSO, London (annual). House of Commons Defence Committee Reports, HPC 399 (1986); HPC 479 (1985); HPC 37-II (1985), HMSO, London. National Audit Office, Control and Management of the Trident Programme, HMSO, London, HCP 27 (July 1987). Public Accounts Committee, Ninth Report, Chevaline Improvement to Polaris Missile System, HMSO, London, HCP 269 (March 1982).

Table 2: 1970-1985 U.S. Strategic and Conventional Appropriations[a]

(All figures in thousands of current dollars)

Year	Strategic	%	Conventional	%
1970	12,240,332.690	15.728	65,586,667.310	84.272
1971	11,513,442.184	15.387	63,312,557.816	84.613
1972	12,461,948.812	15.670	67,066,051.188	84.330
1973	13,179,745.705	16.735	65,575,254.295	83.265
1974	13,482,579.253	15.695	72,423,420.747	84.305
1975	14,531,986.543	15.978	76,416,013.457	84.022
1976	14,253,340.517	15.661	76,759,659.483	84.339
1977	16,935,614.526	16.780	83,989,385.474	83.220
1978	17,874,806.594	16.362	91,372,193.406	83.638
1979	15,625,776.893	12.779	106,653,223.107	87.221
1980	18,460,258.397	12.821	125,520,746.603	87.179
1981	23,097,399.151	13.596	146,790,600.849	86.404
1982	25,479,788.657	12.974	170,910,211.343	87.026
1983	35,070,776.471	16.147	182,127,223.529	83.853
1984	45,591,953.965	19.233	191,460,046.035	80.767
1985	51,840,087.760	19.442	214,801,912.240	80.558

[a]U.S. Annual military figures from World Armaments and Disarmament: SIPRI Yearbooks (1974, 1980, 1986).

military strategic and conventional expenditures.

The French strategic data are provided by Dr. Humm from his Ph.D. dissertation. Once again, due to limitations of available defense data, only a procurement time series is calculated. In a fashion similar to the British data, conventional military expenditures are found as the difference of total military expenditures and strategic procurement. GDP figures are from the IMF (1983, 1987). French data are also converted to constant 1980 U.S. dollars.

The data for the nonnuclear allies military expenditure are from World Armaments and Disarmament: SIPRI Yearbooks (1974, 1980, 1986) and the GDP estimates are from IMF (1983, 1987). The implicit price deflator for 1980 is employed to convert current expenditure figures to constant figures. The average annual exchange rates from IMF (1983,1987) are applied to transform the local currencies to U.S. dollars. This allows all calculations to be performed on constant 1980 dollar figures.

Statistical Models and Tests

My thesis uses three statistical models to analyze NATO allies' military expenditure responsiveness. Additionally, each of these models is modified to capture changes brought about by the effects of the Reagan administration.

This notation is similar to previous models (Murdoch and Sandler, 1982, 1984, 1986), but now distinguishes between conventional and strategic spillins. The joint products military expenditure model is notated as

$$ME_{it} = \alpha_i + \beta_{1i} GDP_{it} + \beta_{2i} CSP_{i,t-1} + \beta_{2i} NUC_{i,t-1} + e_{it} \qquad [3.1]$$

for ally i in year t. Data are included from ten NATO allies (i=1,...,10) and for the years 1970-1985 (t=1,...,16). This corresponds to the military expenditure equation 2.8 for nonnuclear allies and equation 2.16 for nuclear allies.

An ally's military expenditures are represented by ME. For nuclear allies, this figure is the sum of conventional and strategic expenditures. GDP is a country's Gross Domestic Product. Conventional spillins, CSP, consists of total alliance conventional expenditures less the respective ally's conventional contribution. Thus, CSP is the net conventional benefits an ally may receive from association with the alliance. For the nonnuclear ally, nuclear spillins, NUC, represents the sum of British, French, and U.S. strategic procurement expenditures. The nuclear allies receive a net strategic spillin which is simply total strategic expenditures (British, French, and U.S.) less their own strategic expenditure.

Allies, unable to possess perfect foresight, base their military expenditure decision on the best available information (actual spillins from last year). Both CSP and NUC are lagged by one year, t-1, to take this into account. This will be the same for all statistical models in the thesis.

To capture any affects brought about by the increased U.S. defense expenditures (especially research and development and strategic expenditures) under the Reagan administration, a dummy variable is included in the military model. The dummy, REAGAN, equals zero prior to 1982 and one from 1982-1985. This equation is specified as

$$ME_{it}=\alpha_{i}+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}NUC_{i,t-1}+\beta_{4i}REAGAN_{it}+e_{it} \quad [3.2]$$

for country i in year t.

Another possible way to capture the Reagan impact is to multiply each spillin term by a dummy. A model which incorporates this sort of specification allows the Reagan administration affect to influence directly the magnitude (and sign) of an ally's response to CSP and NUC. Equation 3.3 represents the joint product military expenditure model with a dummy times the spillin terms for country i in year t.

$$\begin{aligned} ME_{it} = {} & \alpha_{i} + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}D\cdot CSP_{i,t-1} \quad [3.3] \\ & + \beta_{4i}NUC_{i,t-1} + \beta_{5i}D\cdot NUC_{i,t-1} + e_{it} \end{aligned}$$

Once again, the value of the dummy, D, is zero prior to 1982 and one from 1982-1985.

The second statistical model gives additional insight into the behavior of the nuclear alliance members. In this model the military expenditures are disaggregated into the conventional portion, CONV, and strategic portion, PRO, for the left-hand side of the equation. This allows the CSP and NUC spillins to have different influences on the two types of military expenditures. Equation 3.4 is the disaggregate military expenditure model and corresponds to equations 2.14 and 2.15.

$$CONV_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{2i}NUC_{i,t-1} + e_{it} \quad [3.4]$$

$$PRO_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}NUC_{i,t-1} + e_{it}$$

The data are for three nuclear allies (i=1,2,3) for the years 1970-1985 (t=1,...,16). To obtain the net alliance strategic expenditure, NUC, I subtract ally i's strategic expenditure from total alliance strategic expenditures. CSP is found in a similar manner, as the net alliance conventional expenditure.

The latter statistical model is also modified to capture any impacts after 1981 from the Reagan administration. Equation 3.5 represents the model with a dummy variable and equation 3.6 incorporates a dummy times the spillin terms.

$$CONV_{it}=\alpha_i+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}NUC_{i,t-1}+\beta_{4i}REAGAN_{it}+e_{it} \quad [3.5]$$

$$PRO_{it}=\alpha_i+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}NUC_{i,t-1}+\beta_{4i}REAGAN_{it}+e_{it}$$

$$CONV_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}D\cdot CSP_{i,t-1} + \beta_{4i}NUC_{i,t-1} + \beta_{5i}D\cdot NUC_{i,t-1} + e_{it} \quad [3.6]$$

$$PRO_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}D\cdot CSP_{i,t-1} + \beta_{4i}NUC_{i,t-1} + \beta_{5i}D\cdot NUC_{i,t-1} + e_{it}$$

The final statistical model focuses on only U.S. strategic appropriations as nuclear spillins. Since the United States is the dominant strategic ally, and Britain and France have only recently become credible in strategic capabilities, it is reasonable to assume that the alliance members may respond in a different way to U.S. strategic spillins.

The joint product military expenditure model using only U.S. strategic appropriations as spillins is specified as

$$ME_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}USSTRAT_{i,t-1} + e_{it} \quad [3.7]$$

To capture the effects of the Reagan administration, I incorporate a dummy variable in the same manner as the previous models. The dummy can either be a separate variable denoted in equation 3.8, or multiplied by the spillin terms as in equation 3.9.

$$ME_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}USSTRAT_{i,t-1} + \beta_{it}REAGAN_{it} + e_{it} \quad [3.8]$$

$$ME_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}D\cdot CSP_{i,t-1} + \beta_{4i}USSTRAT_{i,t-1} + \beta_{5i}D\cdot USSTRAT_{i,t-1} + e_{it} \quad [3.9]$$

Each of the equations in Chapter III is estimated using ordinary least squares (OLS) on each ally's data set[4]. By analyzing the t-statistic,

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[4]Agresti and Agresti, 1979, pp. 290-291, 327-338. Judge et al., 1982, pp. 479-480.

it is possible to comment on the level of significance of a particular parameter estimate. The R-square statistic, or the coefficient of determination, shows the degree to which the independent variables in the model explain the variation in the dependent variable. The Durbin-Watson statistic (DW) indicates whether or not first-order autocorrelation exists. If the DW statistic is less than the lower bound critical DW value, then autocorrelation exists; if however, the DW statistic is considerably greater than the upper bound critical DW value, then negative autocorrelation exists.

The United States equation, under some model specifications, does indicate the presence or first-order autocorrelation; conversely, the Netherlands equation, under all model specifications, indicates the presence of negative first-order autocorrelation. The Cochrane-Orcutt test is used to correct for first-order autocorrelation. This method uses the least squares residuals to estimate rho in an iterative procedure. The corrected results for the U.S. and Netherlands equations reveal no more signs of autocorrelation.

Estimation and discussion of these nine equations are presented in the next chapter.

CHAPTER IV. RESULTS AND DISCUSSION

Estimating equation 3.1, the demand for military expenditures, by ordinary least squares (OLS) produces the results in Table 3. The high R-square statistic for each country's equation, when viewed in conjunction with the Durbin-Watson test and the number of statistically significant parameter estimates, suggests that the independent variables do a good job of explaining the variation in military expenditure. The Durbin-Watson (DW) critical bounds are listed in a footnote below the table. Using OLS, the Netherlands equation has first-order autocorrelation. Table 3 reports the AR(1) corrected results for the Netherlands.

As expected, all coefficients for GDP are positive and significant at the 0.05 level (with the exception of the U.S.). This indicates that military expenditures are an economic decision based on the country's GDP and that military expenditures are normal goods. The GDP coefficient estimates range from 0.01 (Canada) to 0.05 (Belgium). Similar responses are found among Denmark, the Netherlands, Norway, the United Kingdom, and West Germany--each with a GDP coefficient estimate of approximately 0.02.

Overall, the coefficient estimates support the impure public goods theory for alliance defense. Positive coefficient estimates for conventional spillins (CSP) mean that an ally increases military expenditures as other alliance members increase conventional spending. Notice that all statistically significant CSP estimates are positive. A negative NUC parameter estimate (or a positive value less than CSP) signifies

Table 3. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: Strategic procurement spillins and conventional spillins (t statistics in parentheses)

$$ME_{it}=\alpha_i+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}NUC_{i,t-1}+e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	0.004 (0.17)	0.040** (19.13)	0.029** (3.84)	0.010** (4.54)
CSP	0.244 (0.31)	0.030** (4.24)	0.063** (4.94)	0.014** (4.44)
NUC	46.335 (7.77)	-0.209** (-3.59)	0.011 (0.10)	0.052* (1.97)
Constant	-25.458 (-1.26)	-5.738** (-5.89)	-2.921 (-1.07)	-1.297** (-2.95)
DW[b]	1.081	1.493	2.243	2.082
R-square	0.94	0.99	0.93	0.95
Rho				

[a] Autocorrelation corrected using AR(1).

[b] Durbin-Watson test significant points at .05 level: $d_L = 0.814$, $d_U = 1.750$.

**Statistically significant two tail t-test at .05 level: t=2.201; for Netherlands equation t=2.228.

*Statistically significant two tail t-test at .10 level: t=1.796; for Netherlands equation t=1.812.

Belgium	Nether-lands [a]	Denmark	Norway	West Germany	Italy
0.050**	0.024**	0.021**	0.024**	0.023**	0.013**
(9.97)	(16.91)	(3.87)	(6.95)	(6.17)	(5.16)
-0.0004	0.003	0.002*	-0.0001	0.007	-0.002
(-0.15)	(2.82)	(1.84)	(-0.10)	(0.55)	(-0.23)
-0.023	-0.014	-0.026**	0.010	-0.111	0.089
(-1.12)	(-1.27)	(-2.87)	(1.01)	(-1.13)	(1.52)
-1.791**	0.768**	-0.151	0.297	7.458**	4.297*
(-4.70)	(4.58)	(-0.77)	(1.72)	(3.93)	(4.68)
1.766	2.704	1.746	2.428	0.939	1.912
0.95	0.96	0.88	0.94	0.90	0.85
	-0.746**				
	(-3.58)				

free riding behavior.

Looking at the French equation, for example, the parameter estimates may be interpreted as follows. A billion dollar increase in French GDP will generate a 40 million dollar increase in military expenditures. A $30 million increase in French military expenditures will result from a one billion dollar increase in CSP, and a one billion dollar increase in NUC will cause the French to reduce military expenditures by 21 million dollars. These results suggest complementary characteristics between CSP and military expenditures and free riding behavior on NUC (i.e., substitute characteristics between NUC and military expenditures).

The Norway and Italy equations reveal unpredicted responses to CSP and NUC. Note, however, that these parameter estimates are not statistically significant. Both countries are flanking nations to WARSAW Pact countries; therefore NATO assigns additional conventional forces for protection. This may partially explain the unanticipated response to spillins. Canada has a statistically significant positive coefficient for CSP, as theory suggests, but has a larger positive NUC coefficient. As in previous empirical studies, the U.S. equation is not similar to the other NATO allies. The only statistically significant estimate is for NUC, and this is a very large coefficient. The United States, being the only strategic member capable of mutual assured destruction, may respond differently than other allies to spillins from the alliance. Currently the U.S. is in the midst of a large multi-year strategic procurement program (the B-1B bomber planes) and the British and French are both upgrading their outdated nuclear forces. This will influence the NUC coefficient to be either positive or a relatively small negative value.

Including a dummy variable to monitor the impact of the Reagan administration does not improve the explanatory capabilities of the equations. The results for the model incorporating a dummy used as a separate independent variable are in Table 6 of Appendix E, while Table 7 contains the coefficient estimates for a dummy times the spillin terms. To interpret the results in Table 7, the spillin coefficient after 1981 is the sum of CSP and D·CSP or NUC and D·NUC.

For the first time, it is possible to distinguish the response of conventional and strategic procurement expenditures to both nuclear and conventional spillins. The empirical results in Table 4 support the notion of free riding on deterrence and increasing military expenditures in response to conventional spillins. Again, the statistical tests indicate a good model. The U.S. equation has been corrected for autocorrelation.

France and Britain base conventional defense expenditures on the Gross Domestic Product (estimates are positive and significant at the 0.05 level). For all three nuclear allies, conventional spillins generate an increase in both conventional and strategic procurement expenditures (note that all CSP coefficients are significant at the 0.05 level exceptfor U.S. conventional expenditures). This reinforces the notion of complements between nuclear allies' military expenditures and alliance conventional spillins. France and the United Kingdom treat nuclear spillins as substitutes for provision of strategic forces. The French

Table 4. OLS coefficient estimates for nuclear countries' demand of disaggregate military expenditures using 1980 exchange rates: Strategic procurement spillins and conventional spillins (t statistics in parentheses)

$$PRO_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}NUC_{i,t-1} + e_{it}$$
$$CONV_{it} = \alpha_i + \beta_{1i}GDP_{it} + \beta_{2i}CSP_{i,t-1} + \beta_{3i}NUC_{i,t-1} + e_{it}$$

Nation / Variable	United States PRO[a]	United States CONV	France PRO	France CONV	United Kingdom PRO	United Kingdom CONV
GDP	0.013*	-0.001	0.002*	0.038**	0.001**	0.028**
	(1.92)	(-0.06)	(2.08)	(22.02)	(2.11)	(3.68)
CSP	0.840*	0.441	0.010**	0.020**	0.007**	0.057**
	(2.18)	(0.67)	(3.84)	(3.42)	(7.66)	(4.41)
NUC	3.480	42.539**	-0.019	-0.190**	-0.003	0.014
	(0.72)	(8.48)	(-0.88)	(-3.92)	(-0.43)	(0.13)
Constant	-166.767	-24.484	-0.348	-5.389**	-1.498**	-1.423
	(1.75)	(-1.44)	(-0.99)	(-6.63)	(-8.16)	(-0.52)
DW[b]	1.997	1.599	1.018	2.007	2.262	2.221
R-square	0.78	0.95	0.87	0.99	0.95	0.92
Rho	0.944**					
	(14.44)					

[a] Autocorrelation corrected using AR(1).

[b] Durbin-Watson test significant point at .05 level: $d_L = 0.814$ $d_U = 1.750$.

**Statistically significant two tail t-test at .05 level: t=2.201: for U.S. equation t=2.228.

*Statistically significant two tail t-test at .10 level: t=1.796; for U.S equation t=1.812.

conventional expenditures decrease as NUC increases, whereas the British treat NUC spillins as complements to conventional expenditures. The U.S. response to nuclear spillins is to increase both conventional expenditures (significant at the 0.05 level) and strategic procurement. Because French and British independent strategic capabilities are not yet credible, the U.S. does not free ride on strategic spillins. In fact, a positive NUC coefficient for U.S. strategic procurement signifies that the U.S. increases strategic procurement in response to an increase in NUC, perhaps to maintain its dominant strategic status.

Using the United States strategic calculations as a proxy for the alliance nuclear spillin term, equation 3.7, I obtain the coefficient estimates in Table 5. Both the U.S. and Netherlands equations are corrected for autocorrelation. The results are similar to the estimates in Table 3.

Each country (excluding the United States) has a positive and significant (at the 0.05 level) coefficient estimate for GDP. For a one billion dollar increase in GDP, there is a 1 million dollar increase in Canadian and Italian military expenditures; approximately 2 million dollar increase in defense for Denmark, the Netherlands, and West Germany; Norway and the U.K. each allot an additional 3 million dollars towards defense expenditures; the French military budget increases by 4 million dollars; and Belgium spends an additional 5 million on defense. All statistically significant (at the .05 level) coefficient estimates for CSP are positive. Complementarity is present between a country's military expenditure and alliance conventional spillins. There is a large

Table 5. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: U.S. strategic spillins (t statistics in parentheses)

$$ME_{it} = \alpha_i + \beta_{1i} GDP_{it} + \beta_{2i} CSP_{i,t-1} + \beta_{3i} USSTRAT_{i,t-1} + e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	0.006 (0.25)	0.039** (18.61)	0.029** (3.82)	0.011** (4.82)
CSP	3.693** (3.46)	0.044** (4.78)	0.063** (4.12)	0.012** (3.20)
USSTRAT		-0.109** (-3.56)	0.047 (0.83)	0.039** (2.90)
Constant	-252.145* (-2.16)	-6.002** (-6.33)	-2.992 (-1.09)	-1.244** (-2.92)
DW[b]	1.940	1.619	2.276	2.093
R-square	0.94	0.99	0.93	0.95
Rho	0.743** (6.32)			

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.814$ $d_U = 1.750$.

**Statistically significant two tail t-test at .05 level: t=2.201; for U.S. equation t=2.179; for Netherlands equation t=2.228.

*Statistically significant one tail t-test at .05 level: t=1.796; for U.S. equation t=1.782; for Netherlands equation t=1.812.

Belgium	Nether-lands [a]	Denmark	Norway	West Germany	Italy
0.048**	0.024**	0.019**	0.025**	0.023	0.013*
(9.85)	(16.47)	(3.69)	(6.86)	(5.85)	(5.50)
0.001	0.003**	0.003**	-0.0006	0.008	-0.006
(0.50)	(2.62)	(2.45)	(-0.37)	(0.54)	(-0.80)
-0.017	-0.006	-0.014**	0.006	-0.046	0.057*
(-1.70)	(-1.04)	(-3.04)	(1.14)	(-0.86)	(1.95)
-1.784**	0.755**	-0.156	0.319*	7.433**	4.433*
(-4.94)	(4.54)	(-0.83)	(1.80)	(3.82)	(4.99)
1.807	2.715	1.841	2.501	0.869	2.016
0.96	0.96	0.89	0.94	0.90	0.86
	-0.747**				
	(-3.55)				

variation in CSP parameter estimates; 3.69 for the United States and 0.003 for the Netherlands and Denmark. Not all statistically significant USSTRAT estimates support the notion of free riding. The estimates for France and Denmark are both negative, as theory suggests, indicating a decrease in military expenditures as USSTRAT spillins increase. The Canadian and Italian equations are counter intuitive, both revealing a positive military expenditure response to a USSTRAT increase. These two equations also were abberations under equation 3.1, but the results were not statistically significant at the 0.05 level. For this reason, I favor equation 3.1 NUC proxy (the sum of British, French and U.S. strategic procurement) over the USSTRAT proxy equation.

Adding a separate dummy variable to monitor the impact from the Reagan administration after 1981 does not lend additional support to the joint products theory. These coefficient estimates are in Table 8 of Appendix E. Multiplying a dummy variable by each of the spillin terms does cause the Italian equation to support the joint products theory. The sum of CSP and D-CSP (significant at the 0.05 level) yields a positive value and the sum of USSTRAT (significant at the 0.05 level) and D-USSTRAT produces a negative coefficient. The Norway equation also improves, although the results are not significant at the 0.05 level. Table 9 contains the results for equation 3.9, the demand for military expenditures using USSTRAT as spillin proxy and including a dummy variable times the spillin terms.

Since procurement is the most visible part of strategic expenditures, I also use U.S. strategic procurement as a proxy for the alliance strategic spillins. In Appendix E, the results for the demand for military expenditures using USPRO as spillin are in Table 10, while Table 11 includes the separate dummy variable, and Table 12 includes a dummy times the spillin terms. In general, the significant coefficient estimates support the complementary response to CSP and a free riding response (except for Canada) to U.S. strategic procurement. There are minimal differences in parameter estimate values, which suggests that the USSTRAT and USPRO proxies generate the same influence on other allies' military expenditure behavior.

CHAPTER V. CONCLUSION

The main objective of my thesis has been to construct a strategic expenditure time series for the NATO alliance and to test the joint products theory against a good proxy for strategic and conventional spillins. Not knowing a priori the best proxy for the strategic time series, I use three different procedures to calculate the strategic expenditure proxy. First, the strategic spillin for equations 3.1-3.3 is the sum of British, French and U.S. strategic procurement. Procurement figures are used because detailed information is not accessible for French and British military expenditures. Moreover, these proxies are reliable since strategic procurement is the most visible to other allies. The second strategic proxy for equations 3.7-3.9 is total U.S. strategic expenditures. A similar set of equations is tested using the third proxy, U.S. strategic procurement expenditures.

The empirical results, using all methods of calculating the strategic spillin proxy, support the joint products theory for alliance defense. Almost all statistically significant estimates reveal the correct coefficient sign to support the theory. A positive value for $\delta ME/\delta I$ shows that military expenditures are economic decisions based on the Gross Domestic Product of the respective ally. Moreover, military expenditures are normal goods. The conventional spillins from an alliance induce an increase in an ally's military expenditures (i.e., $\delta ME/\delta\tilde{Q}>0$). Conventional military expenditures have both private and impure public characteristics which reflect complementary behavior between conventional spillins and conventional military expenditures. Free riding behavior is noticed for strategic spillins (i.e., $\delta ME/\delta\tilde{S}<0$) owing to the pure public nature of these expenditures.

Additional insight is also given to the three nuclear allies' military expenditures by disaggregating strategic and conventional expenditure responses. Each of these countries is in the midst of a sizeable strategic modification or build-up program, so the anticipated free riding between strategic spillins and strategic expenditures is reduced.

The results in my thesis differ in some respects from previous empirical tests by Murdoch and Sandler (1984). In particular, by disaggregating spillins, the French and British military responses are different from each other. Murdoch and Sandler (1984) could not reject the hypothesis that the medium-sized nuclear powers have identical military expenditure responses to income (GDP) and total spillins. Similarly, Murdoch and Sandler (1984) do not reject the hypothesis that Belgium and the Netherlands respond similarly to GDP and spillins, whereas my disaggregate spillins reveal that these countries behave differently. This implies that disaggregation of the joint products does matter. A separate equation with disaggregate spillins should be used for each ally to capture precise military expenditure responses.

The results are also sensitive to the time period of the data. This suggests that over time strategic capabilities and diplomatic considerations influence the defense doctrine, which in turn has an impact on military expenditure responses within an alliance. Additionally, technological advancements in defense influence allies' military expenditures.

Developing a method to distinguish these military responses is extremely important in light of the level of military expenditures within NATO. Using these strategic time series proxies and the empirical results from the joint products model, it is possible to analyze any changes in an ally's GDP, conventional spillins or strategic spillins. Extension of these results can help in the analysis of NATO policy changes, improvements in defense technology or changes in an ally's defense contribution. Construction of the strategic time series will also enable further statistical tests to analyze the NATO alliance or the military expenditures of individual allies within NATO.

Future studies may obtain more precise military expenditure responses to conventional and strategic spillins by constructing a comparable time series for British, French and U.S. total strategic expenditures. This will require accessing detailed military expenditure records for both Britain and France and developing a consistent procedure for calculating the total strategic proxy. At this point, the general behavior patterns have been captured using French, British and U.S. strategic procurement as the proxy. Another area for expansion is to construct a time series distinguishing NATO military expenditures for European defense (versus all other alliance military expenditures). Such a European defense disaggregation could provide further insights of alleged European free riding behavior. In addition, continued refinement of alliance spillins may reveal that the equations for Canada, Italy, Norway and the U.S. fully support the joint products theory of defense.

In an effort to distinguish the private and public benefits of defense, my thesis has studied the response of alliance members' military expenditures to disaggregated defense spillins. The procedure used here is not limited to economic analysis of defense. Rather, any activity which produces both private and public goods should be analyzed by disaggregating the effects from the joint products. Refining the technique to analyze joint product activities leaves room for improved economic analysis in areas including education, charities, police forces, and environmental economics.

APPENDIX A:

THEORY DERIVATIONS

The representative nuclear ally's problem can be written as

$$\text{maximize } U(y,\ x,\ Z,\ s + \tilde{S})$$

$$\text{subject to } \quad x = f(q)$$

$$z = g(q),\ \tilde{Z} = h(\tilde{Q})$$

$$Z = z + \tilde{Z}$$

$$I = y + p_c q + p_s s.$$

By substitution, this problem can be reformulated as

$$\underset{\{y,\ q,\ s\}}{\text{maximize}}\ U(y,\ f(q) + h(\tilde{Q}),\ s + \tilde{S})$$

$$\text{subject to } I = y + p_c q + p_s s.$$

Assuming that $\tilde{Q}$ and $\tilde{S}$ are fixed, we have the following first-order conditions:

$$y:\quad U_y - \lambda = 0 \qquad [A.1]$$

$$q:\quad f'U_x + g'U_z - \lambda p_c = 0 \qquad [A.2]$$

$$s:\quad U_s - \ p_s = 0 \qquad [A.3]$$

$$\lambda:\quad y + p_c q + p_s s = I, \qquad [A.4]$$

where λ is the associated Lagrangian multiplier and the subscripts on the U terms denote partial derivatives -- e.g., $U_y = \delta U/\delta y$. Equations A.1 and A.2 can be reorganized to give

$$f'MRS_{xy} + g'MRS_{zy} = p_c, \qquad [A.5]$$

and equations 1A and 3A can be altered to yield

$$MRS_{sy} = p_s. \qquad [A.6]$$

Finally, equations A.5 and A.6 can be rearranged to give equation 2.17 of the text. The nonnuclear ally problem is treated in a similar fashion. The demand equations follow, via the implicit function theorem, from equations A.1 to A.4.

APPENDIX B:

FIRST-ORDER AUTOREGRESSION FORECAST FOR 1982-1985 STRATEGIC PERSONNEL

Caution must be taken in making a forecast based on a small data set. For this reason, I have carefully selected a forecast procedure and analyzed the diagnostic tests for model adequacy.

To eliminate the problems inherent in current dollar figures (i.e., inflation) for military appropriations, I evaluate the strategic personnel subtotals for 1970-1981 as the percentage of total personnel which is strategic. Each year's percentage represents a data point (twelve total). The mean is 12.34 and the standard deviation is 0.9569. The autocorrelation of these data points produces an oscillating pattern with overall geometric decay and decay among the oscillations. This is the same general pattern which is observed in a second-order autoregression process.

The autocorrelation check for white noise analyzes the data to determine whether the autocorrelation among the points is due to white noise. Prior to any model specification, the probability that the data are caused by white noise is 0.00. In other words, some pattern exists among the raw data. Therefore, it is necessary to fit a model.

One possible model for forecasting is the second-order autoregression, notated hereafter as AR(2). The AR(2) allows the value of the previous two periods to influence the value for the current period. In equation form the basic AR(2) is represented as

$$z_t = \Phi_1 z_{t-1} + \Phi_2 z_{t-2} + e_t \qquad [B.1]$$

PROC ARIMA, the computer package, runs AR(2) on the data, then provides diagnostic information to judge if the model is adequately specified. The parameter estimates for the mean, Φ_1, and Φ_2 are all significant based on the t-statistics.

The autocorrelation check on the fitted model (which incorporates the portmanteau asymptotic chi square test) determines the probability that the residuals are merely white noise. If the model specification is good, then all explainable elements of correlation will be fitted within the model and the residuals will be white noise. The result of the autocorrelation check of residuals reveals an extremely high probability, 0.799. This suggests that the residuals are white noise and that the model is correctly specified.

The autocorrelation of residuals reveals no discernible pattern. Likewise, the partial autocorrelation of residuals produces no pattern to the AR(2) fitted model residuals. Again this supports a belief that the model is correctly chosen.

Since the model appears to be adequate from these various tests, four point estimates are predicted using AR(2). The point estimates are intuitively appealing and seem to follow the general trend of strategic defense appropriations.

To convert these forecast percentages of strategic personnel to dollar values, simply multiply the point estimate times the personnel budget for the appropriate year.

APPENDIX C:

PERCENTAGE OF STRATEGIC APPROPRIATIONS BY CATEGORY

Year	Personnel	O & M	Procurement	RDT&E	Total
1970	11.937	16.859	13.048	26.286	15.728
1971	11.929	17.610	13.477	22.441	15.387
1972	12.633	18.722	15.073	19.181	15.670
1973	13.557	20.093	15.106	19.696	16.735
1974	14.037	19.145	13.318	21.775	15.695
1975	13.462	19.458	17.343	20.612	15.978
1976	13.095	18.862	10.788	20.268	15.661
1977	12.109	17.750	12.185	27.801	16.780
1978	11.708	16.401	13.690	27.713	16.362
1979	11.443	16.784	5.349	21.653	12.779
1980	11.149	17.202	7.030	22.004	12.821
1981	11.034	16.056	6.346	28.273[2]	13.596
1982	11.324[1]	15.627	5.420[2]	28.159[2]	12.974
1983	11.812[1]	15.259	7.989[2]	42.398[2]	16.147
1984	12.297[1]	15.110	13.829[2]	37.903[2]	19.233
1985	12.639[1]	14.980	12.915[2]	36.203[2]	19.442

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[1] Forecast value using AR(2).

[2] Includes B-1B bomber program appropriations.

APPENDIX D:

ANNUAL U.S. STRATEGIC CALCULATIONS
(All figures in thousands of dollars)
1970

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	91,234.000	
2. 2.110%x Research & development	1,386.460	
3. 2.110%x Central supply & maint	1,786.284	
4. 2.110%x Training	71,242.800	
5. 2.110%x Administration	2,441.249	
Army Subtotal		168,090.793
Navy		
1. Strategic forces	139,648.000	
2. 5.280%x Research & development	3,448.262	
3. 5.280%x Central supply & maint	5,703.139	
4. 5.280%x Training	76,810.747	
5. 5.280%x Administration	4,648.512	
Navy Subtotal		230,258.660
Air Force		
1. Strategic forces	1,415,993.000	
2. 44.317%x Research & development	84,619.766	
3. 44.317%x Central supply & maint	49,327.037	
4. 44.317%x Training	654,991.079	
5. 44.317%x Administration	80,329.881	
Air Force Subtotal		2,285,260.763
Marine Corps		
1. Strategic forces	709.000	
2. 0.080%x Research & development	0.382	
3. 0.080%x Central supply & maint	14.459	
4. 0.080%x Training	513.070	
5. 0.080%x Administration	32.441	
Marine Corps Subtotal		1,269.352
STRATEGIC PERSONNEL		2,684,879.568

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	77,805.000	
2. 3.212%x Central supply & maint	76,945.098	
3. 3.212%x Training	38,749.825	
4. 3.212%x Administration	10,270.627	
Army Subtotal		203,770.550
Navy		
1. Strategic forces	212,769.000	
2. 10.625%x Central supply & maint	222,166.944	
3. 10.625%x Training	50,531.544	
4. 10.625%x Administration	19,879.163	
Navy Subtotal		505,346.651
Air Force		
1. Strategic forces	1,138,211.000	
2. 49.494%x Central supply & maint	1,230,941.022	
3. 49.494%x Training	327,421.123	
4. 49.494%x Administration	87,577.158	
Air Force Subtotal		2,784,150.303
Marine Corps		
1. Strategic forces	6.000	
2. 0.003%x Central supply & maint	4.550	
3. 0.003%x Training	1.249	
4. 0.003%x Administration	0.812	
Marine Corps Subtotal		12.611

STRATEGIC OPERATION AND MAINTENANCE 3,493,280.115

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	529,800.000	
2. Fleet ballistic missile ships	354,700.000	
3. 16.153%x Ship support equipment	83,139.491	
4. 16.153%x Commun & electronic equip	45,293.012	
5. 16.153%x Ordnance support equip	79,763.514	
6. 16.153%x Supply support equipment	2,083.737	
7. 16.153%x Command support equip	4,619.758	
8. 70.172%x Modification of missiles	14,104.572	
9. 70.172%x Spares and repairs	24,279.512	
10.70.172%x Support equipment	7,578.576	
Navy Subtotal		1,145,362.172
Air Force		
1. Ballistic missiles	457,400.000	
2. 86.744%x Modification of missiles	147,117.824	
3. 86.744%x Spares and repair	60,200.336	
4. 86.744%x Other support	689,354.568	
Air Force Subtotal		1,501,190.552
Marine Corps		
1. Guided missiles & equipment	3,300.000	
Marine Corps Subtotal		3,300.000
STRATEGIC PROCUREMENT		2,649,852.724

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	1,142,200.500	
2. Military astronautics	673,770.000	
3. 26.554%x Program mgmt & support	139,424.698	
STRATEGIC RDT&E		1,955,395.198

DEPARTMENT OF ENERGY

1. Naval reactor development	207,285.000	
2. Weapons	808,150.000	
3. Special materials production	179,951.000	
CAPITAL INVESTMENT:		
4. Naval reactor dev	78,073.158	
5. Weapons	159,698.000	
6. Special materials production	23,767.927	
STRATEGIC DEPARTMENT OF ENERGY		1,456,925.085

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	2,684,879.568	
O & M	3,493,280.115	
PROCUREMENT	2,649,852.724	
RDT&E	1,955,395.198	
ENERGY	1,456,925.085	
NASA	0.000	
1970 STRATEGIC		12,240,332.690

1971

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	75,359.000	
2. 1.840%x Research & development	1,509.223	
3. 1.840%x Central supply & maint	2,149.249	
4. 1.840%x Training	55,786.003	
5. 1.840%x Administration	2,542.917	
Army Subtotal		137,346.392
Navy		
1. Strategic forces	128,734.000	
2. 5.200%x Research & development	3,425.292	
3. 5.200%x Central supply & maint	5,496.400	
4. 5.200%x Training	74,466.860	
5. 5.200%x Administration	4,814.420	
Navy Subtotal		216,936.972
Air Force		
1. Strategic forces	1,380,677.000	
2. 44.226%x Research & development	85,939.521	
3. 44.226%x Central supply & maint	37,501.437	
4. 44.226%x Training	674,515.493	
5. 44.226%x Administration	86,906.301	
Air Force Subtotal		2,265,539.752
Marine Corps		
1. Strategic forces	753.000	
2. 0.093%x Research & development	0.515	
3. 0.093%x Central supply & maint	17.837	
4. 0.093%x Training	502.308	
5. 0.093%x Administration	41.085	
Marine Corps Subtotal		1,314.745

STRATEGIC PERSONNEL 2,621,137.861

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

<u>Army</u>		
1. Strategic forces	96,100.000	
2. 4.760%x Central supply & maint	100,264.116	
3. 4.760%x Training	59,235.154	
4. 4.760%x Administration	15,647.881	
Army Subtotal		271,247.151
<u>Navy</u>		
1. Strategic forces	247,686.000	
2. 13.794%x Central supply & maint	260,247.260	
3. 13.794%x Training	69,363.405	
4. 13.794%x Administration	27,242.322	
Navy Subtotal		604,538.987
<u>Air Force</u>		
1. Strategic forces	1,008,183.000	
2. 48.812%x Central supply & maint	1,116,854.681	
3. 48.812%x Training	331,022.483	
4. 48.812%x Administration	90,541.379	
Air Force Subtotal		2,546,601.543
<u>Marine Corps</u>		
1. Strategic forces	10.000	
2. 0.005%x Central supply & maint	6.418	
3. 0.005%x Training	2.062	
4. 0.005%x Administration	1.337	
Marine Corps Subtotal		19.817
STRATEGIC OPERATION AND MAINTENANCE		3,422,407.498

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	549,300.000	
2. Fleet ballistic missile ships	382,000.000	
3. 16.591%x Ship support equipment	85,277.740	
4. 16.591%x Commun & electronic equip	48,150.068	
5. 16.591%x Ordnance support equip	71,527.949	
6. 16.591%x Supply support equipment	1,095.006	
7. 16.591%x Command support equip	8,642.750	
8. 65.487%x Modification of missiles	19,089.461	
9. 65.487%x Spares and repairs	14,276.166	
10. 65.487%x Support Equipment	7,993.998	
Navy Subtotal		1,187,353.138
Air Force		
1. Ballistic missiles	587,200.000	
2. 82.646%x Modification of missiles	99,257.846	
3. 82.646%x Spares and repair	39,422.142	
4. 82.646%x Other support	508,768.776	
Air Force Subtotal		1,234,648.764
Marine Corps		
1. Guided missiles & equipment	1,900.000	
Marine Corps Subtotal		1,900.000
STRATEGIC PROCUREMENT		2,423,901.902

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	1,005,450.000	
2. Military astronautics	467,194.000	
3. 22.600%x Program mgmt & support	122,754.386	
STRATEGIC RDT&E		1,595,398.386

DEPARTMENT OF ENERGY

1. Naval reactor development	168,775.000	
2. Weapons	829,260.000	
3. Special materials production	172,121.000	
4. Nuclear security & safeguards	6,276.000	
CAPITAL INVESTMENT:		
5. Naval reactor dev	57,316.589	
6. Weapons	180,498.000	
7. Special materials production	36,349.948	
STRATEGIC DEPARTMENT OF ENERGY		1,450,596.537

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	2,621,137.861
O & M	3,422,407.498
PROCUREMENT	2,423,901.902
RDT&E	1,595,398.386
ENERGY	1,450,596.537
NASA	0.000
1971 STRATEGIC	11,513,442.184

1972

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	62,093.000	
2. 1.608%x Research & development	1,264.869	
3. 1.608%x Central supply & maint	1,943.364	
4. 1.608%x Training	48,289.253	
5. 1.608%x Administration	2,039.346	
Army Subtotal		115,629.832
Navy		
1. Strategic forces	147,391.000	
2. 5.486%x Research & development	3,756.648	
3. 5.486%x Central supply & maint	6,408.635	
4. 5.486%x Training	86,010.495	
5. 5.486%x Administration	4,907.940	
Navy Subtotal		248,474.718
Air Force		
1. Strategic forces	1,473,791.000	
2. 45.004%x Research & development	90,337.429	
3. 45.004%x Central supply & maint	44,953.145	
4. 45.004%x Training	803,436.160	
5. 45.004%x Administration	97,089.379	
Air Force Subtotal		2,509,607.113
Marine Corps		
1. Strategic forces	889.000	
2. 0.108%x Research & development	0.606	
3. 0.108%x Central supply & maint	19.472	
4. 0.108%x Training	517.695	
5. 0.108%x Administration	55.854	
Marine Corps Subtotal		1,482.627

STRATEGIC PERSONNEL 2,875,194.290

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	111,803.000	
2. 5.636%x Central supply & maint	117,735.476	
3. 5.636%x Training	76,030.993	
4. 5.636%x Administration	21,160.926	
Army Subtotal		326,730.395
Navy		
1. Strategic forces	276,380.000	
2. 14.344%x Central supply & maint	271,759.416	
3. 14.344%x Training	89,997.842	
4. 14.344%x Administration	24,982.945	
Navy Subtotal		663,120.203
Air Force		
1. Strategic forces	1,038,734.000	
2. 51.701%x Central supply & maint	1,188,244.600	
3. 51.701%x Training	399,912.922	
4. 51.701%x Administration	99,742.603	
Air Force Subtotal		2,726,634.125
Marine Corps		
1. Strategic forces	6.000	
2. 0.003%x Central supply & maint	2.664	
3. 0.003%x Training	1.550	
4. 0.003%x Administration	0.763	
Marine Corps Subtotal		10.977
STRATEGIC OPERATION AND MAINTENANCE		3,716,495.700

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

<u>Army</u>

1. Other missiles	612,500.000	
2. 67.747%x Modification of missiles	26,827.812	
3. 67.747%x Spares and repair	31,841.090	
4. 67.747%x Support equipment	28,860.222	
Army Subtotal		700,029.124

<u>Navy</u>

1. Ballistic missiles	363,169.000	
2. Fleet ballistic missile ships	391,528.000	
3. 11.345%x Ship support equipment	57,532.424	
4. 11.345%x Commun & electronic equip	39,957.090	
5. 11.345%x Ordnance support equip	50,086.133	
6. 11.345%x Supply support equipment	748.657	
7. 11.345%x Command support equip	3,596.932	
8. 57.434%x Modification of missiles	11,759.612	
9. 57.434%x Spares and repairs	17,911.367	
10. 57.434%x Support Equipment	6,981.529	
Navy Subtotal		943,270.744

<u>Air Force</u>

1. Ballistic missiles	741,100.000	
2. 69.876%x Modification of missiles	37,593.288	
3. 69.876%x Spares and repair	30,465.936	
4. 69.876%x Other support	367,338.132	
Air Force Subtotal		1,176,547.356

<u>Marine Corps</u>

1. Guided missiles & equipment	1,100.000	
Marine Corps Subtotal		1,100.000

STRATEGIC PROCUREMENT 2,820,947.224

<u>RDT&E</u>

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	972,850.000	
2. Military astronautics	404,723.000	
3. 19.305%x Program mgmt & support	111,235.989	
STRATEGIC RDT&E		1,488,808.989

DEPARTMENT OF ENERGY

1. Naval reactor development	158,239.000
2. Weapons	842,846.000
3. Special materials production	142,840.000
4. Nuclear security & safeguards	4,909.000
5. Waste management	4,742.000

CAPITAL INVESTMENT:

5. Naval reactor dev	87,660.000	
6. Weapons	172,257.000	
7. Special materials production	44,034.609	
STRATEGIC DEPARTMENT OF ENERGY		1,457,527.609

NASA

1. Space and nuclear research tech	102,975.000	
STRATEGIC NASA		102,975.000

PERSONNEL	2,875,194.290	
O & M	3,716,495.700	
PROCUREMENT	2,820,947.224	
RDT&E	1,488,808.989	
ENERGY	1,457,527.609	
NASA	102,975.000	
1972 STRATEGIC		12,461,948.812

1973

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	58,825.000	
2. 1.563%x Research & development	1,254.589	
3. 1.563%x Central supply & maint	1,912.112	
4. 1.563%x Training	42,620.775	
5. 1.563%x Administration	2,308.614	
Army Subtotal		106,921.090
Navy		
1. Strategic forces	162,990.000	
2. 5.547%x Research & development	4,018.247	
3. 5.547%x Central supply & maint	6,562.046	
4. 5.547%x Training	94,158.772	
5. 5.547%x Administration	4,712.010	
Navy Subtotal		272,441.075
Air Force		
1. Strategic forces	1,582,014.000	
2. 46.576%x Research & development	100,609.919	
3. 46.576%x Central supply & maint	56,112.562	
4. 46.576%x Training	926,683.425	
5. 46.576%x Administration	106,506.964	
Air Force Subtotal		2,771,926.870
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.0.00x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,151,289.035

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	109,742.000	
2. 6.012%x Central supply & maint	128,957.160	
3. 6.012%x Training	89,840.623	
4. 6.012%x Administration	22,976.662	
5. Supplement request	637.272	
Army Subtotal		352,153.717
Navy		
1. Strategic forces	321,676.000	
2. 15.150%x Central supply & maint	311,017.532	
3. 15.150%x Training	110,447.742	
4. 15.150%x Administration	26,077.695	
5. Supplement request	893.850	
Navy Subtotal		770,112.819
Air Force		
1. Strategic forces	1,140,281.000	
2. 54.572%x Central supply & maint	1,299,193.421	
3. 54.572%x Training	454,560.748	
4. 54.572%x Administration	110,083.184	
5. Supplement request	18,117.904	
Air Force Subtotal		3,022,236.257
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Nuclear defense agency	10,970.000	
Defense Agencies Subtotal		10,970.000
STRATEGIC OPERATION AND MAINTENANCE		4,155,472.793

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

<u>Army</u>		
1. Other missiles	285,400.000	
2. 46.642%x Modification of missiles	12,919.834	
3. 46.642%x Spares and repair	18,796.726	
4. 46.642%x Support equipment	9,141.832	
Army Subtotal		326,258.392
<u>Navy</u>		
1. Ballistic missiles	312,400.000	
2. Fleet ballistic missile ships	718,700.000	
3. 15.491%x Ship support equipment	87,666.529	
4. 15.491%x Commun & electronic equip	66,373.651	
5. 15.491%x Ordnance support equip	96,980.226	
6. 15.491%x Supply support equipment	1,425.724	
7. 15.491%x Command support equip	6,938.007	
8. 50.088%x Modification of missiles	6,811.968	
9. 50.088%x Spares and repairs	6,912.144	
10. 50.088%x Support Equipment	22,339.248	
Navy Subtotal		1,326,547.497
<u>Air Force</u>		
1. Ballistic missiles	663,600.000	
2. 66.861%x Modification of missiles	24,671.709	
3. 66.861%x Spares and repair	28,014.759	
4. 66.861%x Other support	411,262.011	
Air Force Subtotal		1,127,548.479
<u>Marine Corps</u>		
1. Guided missiles & equipment	22,100.000	
Marine Corps Subtotal		22,100.000
STRATEGIC PROCUREMENT		2,802,454.368

<u>RDT&E</u>

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	1,047,641.500	
2. Military astronautics	407,889.000	
3. 19.696%x Program mgmt & support	123,964.654	
STRATEGIC RDT&E		1,579,495.154

DEPARTMENT OF ENERGY

1. Naval reactor development	149,800.000
2. Weapons	867,729.000
3. Special materials production	143,947.000
4. Nuclear security & safeguards	1,565.000
5. Nuclear waste management	7,400.000
6. 52.630%x Program support	88,929.964
CAPITAL INVESTMENT:	
7. Naval reactor dev	16,825.000
8. Weapons	129,877.000
9. Program support	2,701.391

STRATEGIC DEPARTMENT OF ENERGY 1,408,774.355

NASA

1. Space and nuclear research tech 82,260.000

STRATEGIC NASA 82,260.000

PERSONNEL	3,151,289.035	
O & M	4,155,472.793	
PROCUREMENT	2,802,454.368	
RDT&E	1,579,495.154	
ENERGY	1,408,774.355	
NASA	82,260.000	
1973 STRATEGIC		13,179,745.705

1974

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	60,393.000	
2. 1.415%x Research & development	1,256.845	
3. 1.415%x Central supply & maint	1,671.907	
4. 1.415%x Training	36,384.475	
5. 1.415%x Administration	2,033.567	
6. Supplement request	473.426	
Army Subtotal		102,213.220
Navy		
1. Strategic forces	178,309.000	
2. 5.865%x Research & development	4,201.686	
3. 5.865%x Central supply & maint	7,282.629	
4. 5.865%x Training	112,391.523	
5. 5.865%x Administration	5,537.205	
6. Supplement request	1,448.316	
Navy Subtotal		309,170.359
Air Force		
1. Strategic forces	1,628,382.000	
2. 48.588%x Research & development	105,639.058	
3. 48.588%x Central supply & maint	61,956.988	
4. 48.588%x Training	1,084,757.225	
5. 48.588%x Administration	108,103.441	
6. Supplement request	20,507.457	
Air Force Subtotal		3,009,346.169
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.0.00x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,420,729.748

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	101,464.000	
2. 5.621%x Central supply & maint	106,694.787	
3. 5.621%x Training	99,332.007	
4. 5.621%x Administration	19,623.417	
5. Supplement request	9,014.459	
Army Subtotal		336,158.670
Navy		
1. Strategic forces	340,898.000	
2. 12.433%x Central supply & maint	263,228.741	
3. 12.433%x Training	102,456.126	
4. 12.433%x Administration	32,197.118	
5. Supplement request	20,991.113	
Navy Subtotal		759,771.098
Air Force		
1. Strategic forces	1,126,924.000	
2. 52.619%x Central supply & maint	1,252,674.224	
3. 52.619%x Training	506,389.470	
4. 52.619%x Administration	119,711.908	
5. Supplement request	145,207.251	
Air Force Subtotal		3,150,906.853
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Nuclear defense agency	19,297.000	
Defense Agencies Subtotal		19,297.000
STRATEGIC OPERATION AND MAINTENANCE		4,266.133.621

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	159,300.000	
2. 31.464%x Modification of missiles	3,744.216	
3. 31.464%x Spares and repair	5,757.912	
4. 31.464%x Support equipment	6,481.584	
Army Subtotal		175,283.712
Navy		
1. Ballistic missiles	253,400.000	
2. Fleet ballistic missile ships	779,500.000	
3. 13.974%x Ship support equipment	43,799.267	
4. 13.974%x Commun & electronic equip	54,344.886	
5. 13.974%x Ordnance support equip	33,188.250	
6. 13.974%x Supply support equipment	1,704.828	
7. 13.974%x Command support equip	7,308.402	
8. Supplement request	14,253.480	
9. Supplement missile ships	24,800.000	
Navy Subtotal		1,212,299.113
Air Force		
1. Ballistic missiles	621,900.000	
2. 73.277%x Modification of missiles	31,509.110	
3. 73.277%x Spares and repair	26,672.828	
4. 73.277%x Other support	362,867.704	
Air Force Subtotal		1,042,949.642
Marine Corps		
1. Guided missiles & equipment	32,600.000	
2. Supplement request	22,300.000	
Marine Corps Subtotal		54,900.000
STRATEGIC PROCUREMENT		2,485,432.467

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	1,062,381.000	
2. Military astronautics	593,926.000	
3. 21.775%x Program mgmt & support	158,193.633	
STRATEGIC RDT&E		1,814,500.633

DEPARTMENT OF ENERGY

1. Naval reactor development	154,200.000
2. Weapons	835,580.000
3. Special materials production	161,845.000
4. 48.425%x Program support	80,467.823
CAPITAL INVESTMENT:	
5. Naval reactor dev	64,097.000
6. Weapons	152,682.000
7. Special materials production	71,386.561
8. Nuclear materials security	7,875.000
9. Program support	3,405.907

STRATEGIC DEPARTMENT OF ENERGY 1,531,539.291

NASA

1. Space and nuclear research tech	0.000

STRATEGIC NASA 0.000

PERSONNEL	3,420,729.748	
O & M	4,230,377.114	
PROCUREMENT	2,485,432.467	
RDT&E	1,814,500.633	
ENERGY	1,531,539.291	
NASA	0.000	
1974 STRATEGIC		13,482,579.253

1975

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	25,087.000	
2. 0.565%x Research & development	504.528	
3. 0.565%x Central supply & maint	560.531	
4. 0.565%x Training	15,871.630	
5. 0.565%x Administration	663.807	
6. Supplement request	104.171	
Army Subtotal		42,791.667
Navy		
1. Strategic forces	188,650.000	
2. 6.070%x Research & development	4,367.911	
3. 6.070%x Central supply & maint	7,234.347	
4. 6.070%x Training	121,221.421	
5. 6.070%x Administration	5,841.161	
Navy Subtotal		327,314.840
Air Force		
1. Strategic forces	1,639,626.000	
2. 48.320%x Research & development	112,932.054	
3. 48.320%x Central supply & maint	61,526.822	
4. 48.320%x Training	1,070,546.995	
5. 48.320%x Administration	105,702.416	
6. Supplement request	4,411.379	
Air Force Subtotal		2,994,745.666
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
STRATEGIC PERSONNEL		3,364,852.173

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

<u>Army</u>		
1. Strategic forces	89,386.000	
2. 4.333%x Central supply & maint	81,979.840	
3. 4.333%x Training	70,750.047	
4. 4.333%x Administration	20,549.296	
Army Subtotal		262,665.183
<u>Navy</u>		
1. Strategic forces	490,230.000	
2. 13.375%x Central supply & maint	305,928.248	
3. 13.375%x Training	100,832.386	
4. 13.375%x Administration	30,897.855	
Navy Subtotal		927,888.489
<u>Air Force</u>		
1. Strategic forces	1,517,116.000	
2. 53 428%x Central supply & maint	1,353,945.662	
3. 53.428%x Training	448,100.636	
4. 53.428%x Administration	137,466.504	
Air Force Subtotal		3,456,628.802
<u>Marine Corps</u>		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
<u>Defense Agencies</u>		
1. Defense nuclear agency	22,034.000	
Defense Agencies Subtotal		22,034.000
STRATEGIC OPERATION AND MAINTENANCE		4,669,216.474

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army

1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000

Navy

1. Ballistic missiles	78,300.000	
2. Fleet ballistic missile ships	1,330,700.000	
3. 21.060%x Ship support equipment	75,858.120	
4. 21.060%x Commun & electronic equip	110,375.460	
5. 21.060%x Ordnance support equip	60,421.140	
6. 21.060%x Supply support equipment	2,232.360	
7. 21.060%x Command support equip	16,174.080	
Navy Subtotal		1,674,061.160

Air Force

1. Ballistic missiles	597,300.000	
2. 81.744%x Modification of missiles	33,433.296	
3. 81.744%x Spares and repair	35,395.152	
4. 81.744%x Other support	594,932.832	
Air Force Subtotal		1,261,061.280

Marine Corps

1. Guided missiles & equipment	77,600.000	
Marine Corps Subtotal		77,600.000

STRATEGIC PROCUREMENT		3,012,722.440

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	1,053,767.000	
2. Military astronautics	523,757.000	
3. 20.612%x Program mgmt & support	198,301.456	
STRATEGIC RDT&E		1,775,825.456

DEPARTMENT OF ENERGY

1. Naval reactor development	167,000.000	
2. Weapons	819,997.000	
3. Special materials production	188,827.000	
4. Nuclear security & safeguards	5,863.000	
5. Laser fusion	41,400.000	
CAPITAL INVESTMENT:		
5. Naval reactor dev	19,201.000	
6. Weapons	179,826.000	
7. Special materials production	262,367.000	
8. Nuclear materials security	4,175.000	
9. Laser fusion	20,714.000	
STRATEGIC DEPARTMENT OF ENERGY		1,709,370.000

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	3,364,852.173	
O & M	4,669,216.474	
PROCUREMENT	3,012,722.440	
RDT&E	1,775,825.456	
ENERGY	1,709,370.000	
NASA	0.000	
1975 STRATEGIC		14,531,986.543

1976

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	10,302.000	
2. 0.213%x Research & development	191.078	
3. 0.213%x Central supply & maint	211.011	
4. 0.213%x Training	6,010.743	
5. 0.213%x Administration	238.564	
Army Subtotal		16,953.396
Navy		
1. Strategic forces	196,954.000	
2. 6.261%x Research & development	4,757.671	
3. 6.261%x Central supply & maint	7,432.183	
4. 6.261%x Training	126,481.967	
5. 6.261%x Administration	5,824.921	
Navy Subtotal		341,450.742
Air Force		
1. Strategic forces	1,577,787.000	
2. 48.556%x Research & development	117,879.401	
3. 48.556%x Central supply & maint	57,741.339	
4. 48.556%x Training	1,125,676.661	
5. 48.556%x Administration	109,801.625	
Air Force Subtotal		2,988,886.026
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,347,290.164

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	85,656.000	
2. 3.489%x Central supply & maint	74,647.713	
3. 3.489%x Training	59,267.678	
4. 3.489%x Administration	16,967.042	
Army Subtotal		236,538.433
Navy		
1. Strategic forces	601,842.000	
2. 14.003%x Central supply & maint	356,999.344	
3. 14.003%x Training	111,021.665	
4. 14.003%x Administration	35,086.897	
Navy Subtotal		1,104,949.906
Air Force		
1. Strategic forces	1,543,179.000	
2. 54.137%x Central supply & maint	1,430,999.531	
3. 54.137%x Training	476,628.103	
4. 54.137%x Administration	150,354.690	
Air Force Subtotal		3,601,161.324
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	22,674.000	
Defense Agencies Subtotal		22,674.000

STRATEGIC OPERATION AND MAINTENANCE 4,965,323.663

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	270,000.000	
2. Fleet ballistic missile ships	647,500.000	
3. 11.371%x Ship support equipment	44,773.313	
4. 11.371%x Commun & electronic equip	63,552.519	
5. 11.371%x Ordnance support equip	44,073.996	
6. 11.371%x Supply support equipment	2,046.780	
7. 11.371%x Command support equip	8,334.943	
Navy Subtotal		1,080,281.551
Air Force		
1. Ballistic missiles	677,100.000	
2. 68.818%x Modification of missiles	31,381.008	
3. 68.818%x Spares and repair	43,424.158	
4. 68.818%x Other support	426,396.328	
Air Force Subtotal		1,178,301.494
Marine Corps		
1. Guided missiles & equipment	55,000.000	
Marine Corps Subtotal		55,000.000
STRATEGIC PROCUREMENT		2,313,583.045

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. 50%x Missiles & related equip	1,139,685.500	
2. Military astronautics	583,592.000	
3. 20.268%x Program mgmt & support	207,866.987	
STRATEGIC RDT&E		1,931,144.487

DEPARTMENT OF ENERGY

1. Naval reactor development	186,200.000	
2. Weapons	849,630.000	
3. Special materials production	267,692.000	
4. Nuclear security & safeguards	11,975.000	
5. 35.944%x Program support	85,080.167	
CAPITAL INVESTMENT:		
6. Naval reactor dev	14,700.000	
7. Weapons	164,376.000	
8. Special materials production	104,279.000	
9. Nuclear materials security	6,020.000	
10. Program support	6,046.991	
STRATEGIC DEPARTMENT OF ENERGY		1,695,999.158

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	3,347,290.164	
O & M	4,965,323.663	
PROCUREMENT	2,313,583.045	
RDT&E	1,931,144.487	
ENERGY	1,695,999.158	
NASA	0.000	
1976 STRATEGIC		14,253,340.517

1977

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	2,825.000	
2. 0.054%x Research & development	46.370	
3. 0.054%x Central supply & maint	55.546	
4. 0.054%x Training	1,568.926	
5. 0.054%x Administration	60.018	
Army Subtotal		4,555.860
Navy		
1. Strategic forces	216,977.000	
2. 6.526%x Research & development	4,892.673	
3. 6.526%x Central supply & maint	7,971.509	
4. 6.526%x Training	134,117.784	
5. 6.526%x Administration	7,696.242	
Navy Subtotal		371,655.208
Air Force		
1. Strategic forces	1,500,088.000	
2. 46.989%x Research & development	117,566.948	
3. 46.989%x Central supply & maint	59,437.796	
4. 46.989%x Training	1,026,907.474	
5. 46.989%x Administration	93,864.287	
Air Force Subtotal		2,797,864.505
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,174,075.573

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	26,321.000	
2. 0.997%x Central supply & maint	24,661.623	
3. 0.997%x Training	19,258.311	
4. 0.997%x Administration	5,110.732	
Army Subtotal		75,351.666
Navy		
1. Strategic forces	853,223.000	
2. 16.263%x Central supply & maint	459,821.526	
3. 16.263%x Training	141,071.279	
4. 16.263%x Administration	44,028.820	
Navy Subtotal		1,498,144.625
Air Force		
1. Strategic forces	1,569,355.000	
2. 51.231%x Central supply & maint	1,483,135.401	
3. 51.231%x Training	466,271.262	
4. 51.231%x Administration	115,584.308	
Air Force Subtotal		3,634,345.971
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	24,883.000	
Defense Agency Subtotal		24,883.000
STRATEGIC OPERATION AND MAINTENANCE		5,232,725.262

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	1,075,300.000	
2. Fleet ballistic missile ships	794,400.000	
3. 16.799%x Ship support equipment	85,117.845	
4. 16.799%x Commun & electronic equip	105,918.871	
5. 16.799%x Ordnance support equip	73,429.269	
6. 16.799%x Supply support equipment	10,535.493	
7. 16.799%x Command support equip	15,248.116	
Navy Subtotal		2,159,949.594
Air Force		
1. Ballistic missiles	654,800.000	
2. 68.386%x Modification of missiles	36,107.808	
3. 68.386%x Spares and repair	58,196.486	
4. 68.386%x Other support	525,614.796	
Air Force Subtotal		1,274,719.090
Marine Corps		
1. Guided missiles & equipment	61,700.000	
Marine Corps Subtotal		61,700.000
STRATEGIC PROCUREMENT		3,496,368.684

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	2,235,487.000	
2. 50%x Advance techn development	317,977.000	
3. 27.801%x Program mgmt & support	392,253.761	
STRATEGIC RDT&E		2,945,717.761

DEPARTMENT OF ENERGY

1. Naval reactor development	202,600.000	
2. Weapons	966,305.000	
3. Special materials production	336,636.000	
4. Nuclear safeguards & security	23,640.000	
5. 38.557%x Program support	120,649.865	
CAPITAL INVESTMENT:		
7. Naval reactor dev	24,422.000	
8. Weapons	205,827.000	
9. Special materials production	195,758.000	
10. Nuclear materials security	4,376.000	
11. Program support	6,513.381	
STRATEGIC DEPARTMENT OF ENERGY		2,086,727.246

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	3,174,075.573	
O & M	5,232,725.262	
PROCUREMENT	3,496,368.684	
RDT&E	2,945,717.761	
ENERGY	2,086,727.246	
NASA	0.000	
1977 STRATEGIC		16,935,614.526

1978

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	162.000	
2. 0.003%x Research & development	2.744	
3. 0.003%x Central supply & maint	3.147	
4. 0.003%x Training	82.310	
5. 0.003%x Administration	3.650	
Army Subtotal		253.851
Navy		
1. Strategic forces	231,480.000	
2. 6.773%x Research & development	5,331.096	
3. 6.773%x Central supply & maint	9,191.774	
4. 6.773%x Training	150,283.117	
5. 6.773%x Administration	8,309.116	
Navy Subtotal		404,595.103
Air Force		
1. Strategic forces	1,564,319.000	
2. 45.556%x Research & development	118,069.307	
3. 45.556%x Central supply & maint	62,529.710	
4. 45.556%x Training	961,808.339	
5. 45.556%x Administration	79,483.375	
Air Force Subtotal		2,786,209.731
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,191,058.773

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	822,597.000	
2. 14.038%x Central supply & maint	477,431.819	
3. 14.038%x Training	128,765.380	
4. 14.038%x Administration	45,524.532	
Navy Subtotal		1,474,318.731
Air Force		
1. Strategic forces	1,615,367.000	
2. 49.986%x Central supply & maint	1,514,295.878	
3. 49.986%x Training	483,741.015	
4. 49.986%x Administration	112,471.499	
Air Force Subtotal		3,725,875.392
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	23,467.000	
Defense Agency Subtotal		23.467.000
STRATEGIC OPERATION AND MAINTENANCE		5,223,661.123

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	1,199,750.000	
2. Fleet ballistic missile ships	1,703,200.000	
3. 25.208%x Ship support equipment	90,018.524	
4. 25.208%x Commun & electronic equip	194,473.922	
5. 25.208%x Ordnance support equip	95,734.186	
6. 25.208%x Supply support equipment	17,750.213	
7. 25.208%x Command support equip	30,725.779	
Navy Subtotal		3,331,652.624
Air Force		
1. Ballistic missiles	263,100.000	
2. 39.912%x Modification of missiles	28,137.960	
3. 39.912%x Spares and repair	23,029.224	
4. 39.912%x Other support	380,321.448	
Air Force Subtotal		694,588.632
Marine Corps		
1. Guided missiles & equipment	97,200.000	
Marine Corps Subtotal		97,200.000
STRATEGIC PROCUREMENT		4,123,441.256

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	2,536,426.000	
2. 50%x Advance techn development	243,413.000	
3. 27.713%x Program mgmt & support	382,896.942	
STRATEGIC RDT&E		3,162,735.942

DEPARTMENT OF ENERGY

1. Naval reactor development	223,692.000	
2. Weapons	1,079,575.000	
3. Intelligence & arms control	11,662.500	
4. Special materials production	400,744.000	
5. Nuclear safeguards & security	33,578.000	
CAPITAL INVESTMENT:		
6. Naval reactor dev	28,075.000	
7. Weapons	191,314.000	
8. Special materials production	202,146.000	
9. Nuclear material security	3,123.000	
STRATEGIC DEPARTMENT OF ENERGY		2,173,909.500

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	3,191,058.773	
O & M	5,223,661.123	
PROCUREMENT	4,123,441.256	
RDT&E	3,162,735.942	
ENERGY	2,173,909.500	
NASA	0.000	
1978 STRATEGIC		17,874,806.594

1979

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	246,250.000	
2. 6.720%x Research & development	5,335.411	
3. 6.720%x Central supply & maint	9,890.630	
4. 6.720%x Training	151,726.915	
5. 6.720%x Administration	8,430.576	
Navy Subtotal		421,633.532
Air Force		
1. Strategic forces	1,614,149.000	
2. 44.668%x Research & development	122,628.731	
3. 44.668%x Central supply & maint	66,802.781	
4. 44.668%x Training	955,751.816	
5. 44.668%x Administration	82,872.094	
Air Force Subtotal		2,841,204.422
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,262,837.954

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	970,803.000	
2. 15.382%x Central supply & maint	560,303.040	
3. 15.382%x Training	152,000.617	
4. 15.382%x Administration	50,109.634	
Navy Subtotal		1,733,216.291
Air Force		
1. Strategic forces	1,680,988.000	
2. 49.831%x Central supply & maint	1,683,755.107	
3. 49.831%x Training	508,924.003	
4. 49.831%x Administration	124,136.994	
Air Force Subtotal		3,997,804.104
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	26,750.000	
Defense Agency Subtotal		26,750.000
STRATEGIC OPERATION AND MAINTENANCE		5,757,770.395

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	945,100.000	
2. Fleet ballistic missile ships	198,000.000	
3. 11.347%x Ship support equipment	60,308.511	
4. 11.347%x Commun & electronic equip	107,204.641	
5. 11.347%x Ordnance support equip	55,945.476	
6. 11.347%x Supply support equipment	6,095.495	
7. 11.347%x Command support equip	15,852.440	
Navy Subtotal		1,388,506.563
Air Force		
1. Ballistic missiles	66,100.000	
2. 13.837%x Modification of missiles	4,676.906	
3. 13.837%x Spares and repair	8,482.081	
4. 13.837%x Other support	130,164.659	
Air Force Subtotal		209,423.646
Marine Corps		
1. Guided missiles & equipment	22,800.000	
Marine Corps Subtotal		22,800.000
STRATEGIC PROCUREMENT		1,620,730.209

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	1,992,396.000	
2. 50%x Advance techn development	255,877.000	
3. 21.653%x Program mgmt & support	404,534.987	
STRATEGIC RDT&E		2,652,807.987

DEPARTMENT OF ENERGY

1. Naval reactor development	240,100.000	
2. Weapons	1,169,850.000	
3. Defense nuclear waste	150,940.000	
4. Special materials production	312,400.000	
5. Nuclear safeguards & security	35,089.000	
6. 93.652%x Program support	1,101.348	
CAPITAL INVESTMENT:		
7. Naval reactor dev	21,000.000	
8. Weapons	187,650.000	
9. Special materials production	85,085.000	
10. Defense nuclear waste	125,415.000	
11. Nuclear material security	3,000.000	
STRATEGIC DEPARTMENT OF ENERGY		2,331,630.348

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	3,262,837.954	
O & M	5,757,770.395	
PROCUREMENT	1,620,730.209	
RDT&E	2,652,807.987	
ENERGY	2,331,630.348	
NASA	0.000	
1979 STRATEGIC		15,625,776.893

1980

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Stràtegic forces	261,289.000	
2. 6.638%x Research & development	5,763.045	
3. 6.638%x Central supply & maint	10,721.100	
4. 6.638%x Training	164,286.185	
5. 6.638%x Administration	8,172.108	
Navy Subtotal		450,231.438
Air Force		
1. Strategic forces	1,656,179.000	
2. 43.880%x Research & development	124,969.362	
3. 43.880%x Central supply & maint	70,297.076	
4. 43.880%x Training	1,035,146.752	
5. 43.880%x Administration	85,725.723	
Air Force Subtotal		2,972,317.913
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 3,422,549.351

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	1,274,239.000	
2. 17.375%x Central supply & maint	727,509.841	
3. 17.375%x Training	197,734.276	
4. 17.375%x Administration	61,975.930	
Navy Subtotal		2,261,459.047
Air Force		
1. Strategic forces	1,891,043.000	
2. 48.823%x Central supply & maint	1,856,181.131	
3. 48.823%x Training	573,633.633	
4. 48.823%x Administration	152,508.405	
Air Force Subtotal		4,473,366.169
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	28,727.000	
Defense Agency Subtotal		28,727.000
STRATEGIC OPERATION AND MAINTENANCE		6,763,552.216

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

<u>Army</u>		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
<u>Navy</u>		
1. Ballistic missiles	804,900.000	
2. Fleet ballistic missile ships	1,049,650.000	
3. 14.186%x Ship support equipment	86,925.141	
4. 14.186%x Commun & electronic equip	145,286.345	
5. 14.186%x Ordnance support equip	61,854.223	
6. 14.186%x Supply support equipment	6,351.923	
7. 14.186%x Command support equip	16,076.426	
Navy Subtotal		2,171,044.068
<u>Air Force</u>		
1. Ballistic missiles	108,500.000	
2. 15.053%x Modification of missiles	10,958.584	
3. 15.053%x Spares and repair	14,285.297	
4. 15.053%x Other support	194,858.827	
Air Force Subtotal		328,602.708
<u>Marine Corps</u>		
1. Guided missiles & equipment	20,500.000	
Marine Corps Subtotal		20,500.000
STRATEGIC PROCUREMENT		2,520,146.776

<u>RDT&E</u>

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	2,199,734.000	
2. 50%x Advance techn development	319,216.500	
3. 21.930%x Program mgmt & support	455,287.554	
STRATEGIC RDT&E		2,974,238.054

DEPARTMENT OF ENERGY

1. Naval reactor development	249,567.000	
2. Weapons	1,351,800.000	
3. Defense nuclear waste	195,548.000	
4. Special materials production	339,353.000	
5. Nuclear safeguards & security	39,612.000	
6. Verification & control techn	35,600.000	
CAPITAL INVESTMENT:		
7. Naval reactor dev	22,000.000	
8. Weapons	278,475.000	
9. Special materials production	138,300.000	
10. Defense nuclear waste	125,057.000	
11. Nuclear material security	3,400.000	
12. Verification & control tech	1,060.000	
STRATEGIC DEPARTMENT OF ENERGY		2,779,772.000

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	3,422,549.351	
O & M	6,763,552.216	
PROCUREMENT	2,520,146.776	
RDT&E	2,974,238.054	
ENERGY	2,779,772.000	
NASA	0.000	
1980 STRATEGIC		18,460,258.397

1981

PERSONNEL

(Strategic percentage is found by dividing expenditures for strategic personnel forces by total expenditures for personnel forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	293,544.000	
2. 6.316%x Research & development	6,380.234	
3. 6.316%x Central supply & maint	11,928.713	
4. 6.316%x Training	186,682.075	
5. 6.316%x Administration	9,035.164	
Navy Subtotal		507,570.186
Air Force		
1. Strategic forces	1,933,907.000	
2. 43.946%x Research & development	147,427.404	
3. 43.946%x Central supply & maint	86,721.718	
4. 43.946%x Training	1,231,450.857	
5. 43.946%x Administration	99,730.173	
Air Force Subtotal		3,499,237.152
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Research & development	0.000	
3. 0.000%x Central supply & maint	0.000	
4. 0.000%x Training	0.000	
5. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000

STRATEGIC PERSONNEL 4,006,807.338

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	1,505,790.000	
2. 15.626%x Central supply & maint	799,568.357	
3. 15.626%x Training	222,682.376	
4. 15.626%x Administration	63,305.770	
Navy Subtotal		2,591,346.503
Air Force		
1. Strategic forces	2,530,979.000	
2. 46.124%x Central supply & maint	2,102,598.517	
3. 46.124%x Training	674,828.713	
4. 46.124%x Administration	161,594.512	
Air Force Subtotal		5,470,000.742
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	28,884.000	
Defense Agency Subtotal		28,884.000
STRATEGIC OPERATION AND MAINTENANCE		8,090,231.245

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

<u>Army</u>

1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000

<u>Navy</u>

1. Ballistic missiles	884,203.000	
2. Fleet ballistic missile ships	1,135,000.000	
3. 12.363%x Ship support equipment	85,100.958	
4. 12.363%x Commun & electronic equip	129,990.145	
5. 12.363%x Ordnance support equip	75,456.211	
6. 12.363%x Supply support equipment	8,604.524	
7. 12.363%x Command support equip	22,077.598	
Navy Subtotal		2,340,432.436

<u>Air Force</u>

1. Ballistic missiles	141,990.000	
2. 13.409%x Modification of missiles	14,019.378	
3. 13.409%x Spares and repair	19,589.342	
4. 13.409%x Other support	245,570.281	
Air Force Subtotal		421,241.001

<u>Marine Corps</u>

1. Guided missiles & equipment	91,556.000	
Marine Corps Subtotal		91,556.000

STRATEGIC PROCUREMENT 2,853,229.437

<u>RDT&E</u>

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	3,470,208.000	
2. 50%x Advance techn development	301,490.000	
3. 27.290%x Program mgmt & support	609,492.131	
4. B-1B Bomber research	220,000.000	

STRATEGIC RDT&E 4,601,190.131

DEPARTMENT OF ENERGY

1. Naval reactor development	259,600.000	
2. Weapons	1,873,318.000	
3. Defense nuclear waste	234,142.000	
4. Special materials production	451,101.000	
5. Nuclear safeguards & security	40,150.000	
CAPITAL INVESTMENT:		
6. Naval reactor dev	52,700.000	
7. Weapons	341,645.000	
8. Special materials production	211,996.000	
9. Defense nuclear waste	77,886.000	
STRATEGIC DEPARTMENT OF ENERGY		3,545,941.000

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	4,006,807.338	
O & M	8,090,231.245	
PROCUREMENT	3,073,229.437	
RDT&E	4,381,190.131	
ENERGY	3,545,941.000	
NASA	0.000	
1981 STRATEGIC		23,097,399.151

1982

(Strategic personnel expenditure is a forecast figure due to change in annual budget line items. For details of forecast procedure see Appendix B.)

STRATEGIC PERSONNEL		4,316,982.501

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	1,435,282.000	
2. 12.785%x Central supply & maint	675,095.688	
3. 12.785%x Training	212,205.302	
4. 12.785%x Administration	55,007.718	
Navy Subtotal		2,377,590.708
Air Force		
1. Strategic forces	3,153,726.000	
2. 46.873%x Central supply & maint	2,282,743.224	
3. 46.873%x Training	822,642.243	
4. 46.873%x Administration	159,955.050	
Air Force Subtotal		6,419,066.517
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	33,531.000	
Defense Agency Subtotal		33,531.000
STRATEGIC OPERATION AND MAINTENANCE		8,830,188.225

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	955,000.000	
2. Fleet ballistic missile ships	353,700.000	
3. 6.234%x Ship support equipment	43,143.394	
4. 6.234%x Commun & electronic equip	73,196.262	
5. 6.234%x Ordnance support equip	51,751.364	
6. 6.234%x Supply support equipment	4,732.915	
7. 6.234%x Command support equip	13,140.025	
Navy Subtotal		1,494,663.960
Air Force		
1. Ballistic missiles	110,762.000	
2. 6.002%x Modification of missiles	4,840.733	
3. 6.002%x Spares and repair	12,590.275	
4. 6.002%x Other support	146,337.823	
5. B-1B Bomber planes	1,610,000.000	
Air Force Subtotal		1,884,530.831
Marine Corps		
1. Guided missiles & equipment	213,817.000	
Marine Corps Subtotal		213,817.000
STRATEGIC PROCUREMENT		3,593,011.791

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	4,586,427.000	
2. 50%x Advance Techn Development	367,724.000	
3. 28.586%x Program mgmt & support	759,204.140	
4. B-1B Bomber research	470,000.000	
STRATEGIC RDT&E		5,760,355.140

DEPARTMENT OF ENERGY

1. Naval reactor development	335,500.000	
2. Weapons	2,779,056.000	
3. Defense waste management	383,151.000	
4. Special materials production	887,768.000	
5. Nuclear security & safeguards	42,776.000	
STRATEGIC DEPARTMENT OF ENERGY		4,428,251.000

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	4,316,982.501	
O & M	8,830,188.225	
PROCUREMENT	2,144,011.791	
RDT&E	5,760,355.140	
ENERGY	4,428,251.000	
NASA	0.000	
1982 STRATEGIC		25,479,788.657

1983

(Strategic personnel expenditure is a forecast figure due to change in annual budget line items. For details of forecast procedure see Appendix B.)

STRATEGIC PERSONNEL	5,373,445.349

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	1,720,732.000	
2. 14.069%x Central supply & maint	792,194.016	
3. 14.069%x Training	258,968.505	
4. 14.069%x Administration	66,009.356	
Navy Subtotal		2,837,903.877
Air Force		
1. Strategic forces	3,044,998.000	
2. 44.917%x Central supply & maint	2,413,364.358	
3. 44.917%x Training	861,539.523	
4. 44.917%x Administration	178,376.187	
Air Force Subtotal		6,498,278.068
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	41,256.000	
Defense Agency Subtotal		41,256.000
STRATEGIC OPERATION AND MAINTENANCE		9,377,437.945

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	696,500.000	
2. Fleet ballistic missile ships	1,534,800.000	
3. 7.450%x Ship support equipment	39,492.227	
4. 7.450%x Commun & electronic equip	105,029.281	
5. 7.450%x Ordnance support equip	51,742.783	
6. 7.450%x Supply support equipment	6,051.188	
7. 7.450%x Command support equip	16,943.908	
Navy Subtotal		2,450,559.387
Air Force		
1. Ballistic missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Other support	0.000	
5. B-1B Bomber planes	4,040,000.000	
Air Force Subtotal		4,040,000.000
Marine Corps		
1. Guided missiles & equipment	242,860.000	
Marine Corps Subtotal		242,860.000
STRATEGIC PROCUREMENT		6,733,419.387

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	5,900,741.000	
2. 50%x Advance Techn Development	410,212.500	
3. 31.733%x Program mgmt & support	925,618.290	
4. B-1B Bomber research	750,000.000	
STRATEGIC RDT&E		7,986,571.790

DEPARTMENT OF ENERGY

1. Naval reactor development	418,877.000	
2. Weapons	3,351,536.000	
3. Defense waste management	473,058.000	
4. Special materials production	1,308,820.000	
5. Nuclear security & safeguards	47,611.000	
STRATEGIC DEPARTMENT OF ENERGY		5,599,902.000

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	5,373,445.349	
O & M	9,377,437.945	
PROCUREMENT	6,733,419.387	
RDT&E	7,986,571.790	
ENERGY	5,599,902.000	
NASA	0.000	
1983 STRATEGIC		35,070,776.471

1984

(Strategic personnel expenditure is a forecast figure due to change in annual budget line items. For details of forecast procedure see Appendix B.)

STRATEGIC PERSONNEL	5,972,843.995

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	1,946,104.000	
2. 15.902%x Central supply & maint	946,477.499	
3. 15.902%x Training	316,284.419	
4. 15.902%x Administration	98,856.850	
Navy Subtotal		3,307,722.768
Air Force		
1. Strategic forces	3,038,056.000	
2. 44.098%x Central supply & maint	2,368,911.927	
3. 44.098%x Training	862,051.517	
4. 44.098%x Administration	229,888.166	
Air Force Subtotal		6,498,907.610
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	45,093.000	
Defense Agency Subtotal		45,093.000
STRATEGIC OPERATION AND MAINTENANCE		9,851,723.378

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

<u>Army</u>		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
<u>Navy</u>		
1. Ballistic missiles	578,400.000	
2. Fleet ballistic missile ships	1,672,700.000	
3. 8.873%x Ship support equipment	59,141.917	
4. 8.873%x Commun & electronic equip	134,285.934	
5. 8.873%x Ordnance support equip	79,963.831	
6. 8.873%x Supply support equipment	9,437.766	
7. 8.873%x Command support equip	24,837.923	
Navy Subtotal		2,558,767.371
<u>Air Force</u>		
1. Ballistic missiles	2,110,188.000	
2. 49.581%x Modification of missiles	68,099.504	
3. 49.581%x Spares and repair	164,667.921	
4. 49.581%x Other support	1,530,214.932	
5. B-1B Bomber planes	6,120,000.000	
Air Force Subtotal		9,993,170.357
<u>Marine Corps</u>		
1. Guided missiles & equipment	170,915.000	
Marine Corps Subtotal		170,915.000
STRATEGIC PROCUREMENT		12,722,852.728

<u>RDT&E</u>

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	7,842,682.000	
2. 50%x Advance Techn Development	693,097.500	
3. 36.193%x Program mgmt & support	1,188,661.364	
4. B-1B Bomber research	740,000.000	
STRATEGIC RDT&E		10,464,440.864

DEPARTMENT OF ENERGY

1. Naval reactor development	493,398.000	
2. Weapons	3,764,237.000	
3. Defense waste management	723,411.000	
4. Special materials production	1,545,929.000	
5. Nuclear security & safeguards	53,118.000	
STRATEGIC DEPARTMENT OF ENERGY		6,580,093.000

NASA

1. Space and nuclear research tech	0.000	
STRATEGIC NASA		0.000

PERSONNEL	5,972,843.995	
O & M	9,851,723.378	
PROCUREMENT	12,722,852.728	
RDT&E	10,464,440.864	
ENERGY	6,580,093.000	
NASA	0.000	
1984 STRATEGIC		45,591,953.965

1985

(Strategic personnel expenditure is a forecast figure due to change in annual budget line items. For details of forecast procedure see Appendix B.)

STRATEGIC PERSONNEL	8,651,140.824

OPERATIONS AND MAINTENANCE

(Strategic percentage is found by dividing expenditures for strategic forces by expenditures for total forces.)

Army		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Army Subtotal		0.000
Navy		
1. Strategic forces	2,257,266.000	
2. 15.895%x Central supply & maint	1,003,237.244	
3. 15.895%x Training	373,798.900	
4. 15.895%x Administration	111,611.670	
Navy Subtotal		3,745,913.814
Air Force		
1. Strategic forces	3,195,898.000	
2. 44.203%x Central supply & maint	2,636,706.740	
3. 44.203%x Training	907,086.669	
4. 44.203%x Administration	250,179.255	
Air Force Subtotal		6,989,870.664
Marine Corps		
1. Strategic forces	0.000	
2. 0.000%x Central supply & maint	0.000	
3. 0.000%x Training	0.000	
4. 0.000%x Administration	0.000	
Marine Corps Subtotal		0.000
Defense Agencies		
1. Defense nuclear agency	47,566.000	
Defense Agency Subtotal		47,566.000
STRATEGIC OPERATION AND MAINTENANCE		10,783,350.480

PROCUREMENT

(Strategic percentage applied to support or maintenance procurement line items is found by dividing expenditures for strategic procurement by expenditures for total procurement.)

Army		
1. Other missiles	0.000	
2. 0.000%x Modification of missiles	0.000	
3. 0.000%x Spares and repair	0.000	
4. 0.000%x Support equipment	0.000	
Army Subtotal		0.000
Navy		
1. Ballistic missiles	385,775.000	
2. Fleet ballistic missile ships	1,724,674.000	
3. 7.887%x Ship support equipment	60,519.317	
4. 7.887%x Commun & electronic equip	142,978.139	
5. 7.887%x Ordnance support equip	89,867.554	
6. 7.887%x Supply support equipment	10,864.816	
7. 7.887%x Command support equip	42,389.943	
Navy Subtotal		2,457,068.769
Air Force		
1. Ballistic missiles	1,449,752.000	
2. 38.934%x Modification of missiles	75,278.889	
3. 38.934%x Spares and repair	187,277.212	
4. 38.934%x Other support	1,266,631.646	
5. B-1B Bomber planes	7,710,000.000	
Air Force Subtotal		10,688,939.747
Marine Corps		
1. Guided missiles & equipment	239,897.000	
Marine Corps Subtotal		239,897.000
STRATEGIC PROCUREMENT		13,385,905.516

RDT&E

(Strategic percentage is found by dividing expenditures for strategic RDT&E by expenditures for total RDT&E.)

1. Strategic programs	8,358,953.000	
2. 50%x Advance Techn Development	1,382,904.000	
3. 35.168%x Program mgmt & support	1,319,226.940	
4. B-1B Bomber research	510,000.000	
STRATEGIC RDT&E		11,571,123.940

DEPARTMENT OF ENERGY

1. Naval reactor development	500,421.000
2. Weapons	4,228,394.000
3. Defense waste management	844,528.000
4. Special materials production	1,811,536.000
5. Nuclear security & safeguards	63,688.000

STRATEGIC DEPARTMENT OF ENERGY 7,448,567.000

NASA

1. Space and nuclear research tech	0.000

STRATEGIC NASA 0.000

PERSONNEL	8,651,140.824	
O & M	10,783,350.480	
PROCUREMENT	13,385,905.516	
RDT&E	11,571,123.940	
ENERGY	7,448,567.000	
NASA	0.000	
1985 STRATEGIC		51,840,087.760

APPENDIX E:

TABLES OF COEFFICIENT ESTIMATE RESULTS

Table 6. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: Strategic procurement spillins, conventional spillins and dummy variable after 1981 (t statistics in parentheses)

$$ME_{it}=\alpha_i+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}NUC_{i,t-1}+\beta_{4i}REAGAN_{it}+e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	0.016	0.040**	0.029**	0.011**
	(0.70)	(19.38)	(3.75)	(5.78)
CSP	-0.271	0.042**	0.049*	0.003
	(-0.35)	(3.30)	(1.85)	(0.59)
NUC	35.411**	-0.219**	0.021	0.063**
	(4.14)	(-3.77)	(0.19)	(2.74)
REAGAN	15.505	-0.666	0.774	0.568**
	(1.67)	(-1.12)	(0.61)	(2.31)
Constant	23.057	-8.146**	-0.370	0.669
	(0.67)	(-3.46)	(-0.07)	(0.72)
DW[b]	1.251	1.544	2.223	1.894
R-square	0.95	0.99	0.93	0.97
Rho				

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.685$ $d_U = 1.977$.

**Statistically significant two tail t-test at .05 level: t=2.228; for Netherlands equation t=2.262.

*Statistically significant two tail t-test at .10 level: t=1.812; for Netherlands equation t=1.833.

Belgium	Nether-lands[a]	Denmark	Norway	West Germany	Italy
0.049**	0.024**	0.020**	0.025**	0.024**	0.013*
(10.02)	(14.43)	(3.73)	(6.91)	(6.07)	(6.49)
0.004	0.003	0.004	-0.002	-0.007	-0.024*
(0.98)	(0.92)	(1.64)	(-0.80)	(-0.30)	(-2.24)
-0.027	-0.014	-0.027**	0.012	-0.096	0.110*
(-1.35)	(-1.16)	(-2.88)	(1.16)	(-0.93)	(2.24)
-0.253	-0.0005	-0.074	0.096	0.739	1.245*
(-1.26)	(-0.003)	(-0.72)	(0.90)	(0.71)	(2.47)
-2.655**	0.766	-0.405	0.650	9.804**	8.599*
(-3.40)	(1.61)	(-1.00)	(1.52)	(2.55)	(4.52)
1.744	2.704	1.914	2.675	1.081	2.374
0.96	0.96	0.89	0.94	0.91	0.90
	-0.746**				
	(-3.39)				

Table 7. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: Strategic procurement spillins, conventional spillins and dummy variable times spillins after 1981 (t statistics in parentheses)

$$ME_{it} = \alpha_i + \beta_{1i} GDP_{it} + \beta_{2i} CSP_{i,t-1} + \beta_{3i} D\cdot CSP_{i,t-1} + \beta_{4i} NUC_{i,t-1} + \beta_{4i} D\cdot NUC_{i,t-1} + e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	-0.014	0.041**	0.021**	0.010**
	(-0.91)	(18.76)	(2.83)	(3.17)
CSP	0.651	0.052**	0.028	0.014**
	(1.27)	(4.67)	(1.59)	(2.49)
D·CSP	10.513**	-0.003	-0.003	-0.0006
	(3.48)	(-1.13)	(-0.45)	(-0.26)
NUC	37.830**	-0.063	-0.436*	0.035
	(7.63)	(-0.46)	(-1.91)	(0.43)
D·NUC	-303.415**	-0.147	0.520*	0.023
	(-3.44)	(-0.91)	(1.84)	(0.23)
Constant	4.119	-11.272**	11.267*	-1.130
	(0.23)	(-4.04)	(1.94)	(-0.73)
DW [b]	1.923	1.630	2.489	1.969
R-square	0.989	0.99	0.96	0.95
Rho				

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.562$ $d_U = 2.220$.

**Statistically significant two tail t-test at .05 level: t=2.262; for Netherlands equation t=2.306.

*Statistically significant two tail t-test at .10 level: t=1.833; for Netherlands equation t=1.860.

Belgium	Nether- lands [a]	Denmark	Norway	West Germany	Italy
0.048** (7.98)	0.024** (12.08)	0.020** (3.32)	0.026** (5.37)	0.021** (4.30)	0.016** (6.10)
0.004 (1.21)	0.003 (1.50)	0.005** (2.65)	-0.0006 (-0.26)	0.004 (0.19)	-0.011 (-1.16)
-0.001 (-0.81)	-0.0002 (-0.20)	-0.0007 (-1.09)	0.0004 (0.49)	-0.005 (-0.56)	0.010** (2.46)
-0.017 (-0.30)	-0.125 (-0.32)	-0.025 (-1.07)	0.020 (0.68)	-0.290 (-1.03)	0.324** (2.30)
0.003 (0.04)	0.002 (0.04)	0.006 (0.20)	-0.015 (-0.41)	0.230 (0.68)	-0.324* (-1.97)
-2.740** (-2.53)	0.645 (0.88)	-0.601 (-1.14)	0.260 (0.49)	10.640* (1.87)	3.231* (1.31)
2.080	2.677	2.016	2.498	1.144	2.615
0.96	0.96	0.92	0.94	0.91	0.91
	-0.754** (-3.21)				

Table 8. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: U.S. strategic spillins and dummy after 1981 (t statistics in parentheses)

$$ME_{it} = \alpha_i + \beta_{1i} GDP_{it} + \beta_{2i} CSP_{i,t-1} + \beta_{3i} USSTRAT_{i,t-1} + \beta_{4i} REAGAN_{it} + e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	0.023	0.039**	0.030**	0.012**
	(0.64)	(18.12)	(3.75)	(5.92)
CSP	-0.237	0.051**	0.048	0.002
	(-0.19)	(3.60)	(1.75)	(0.39)
USSTRAT		-0.107**	0.041	0.037**
		(-3.40)	(0.69)	(3.18)
REAGAN	43.816**	-0.383	0.844	0.504*
	(4.37)	(-0.66)	(0.69)	(2.17)
Constant	102.391**	-7.389**	-0.171	0.502
	(2.24)	(-3.20)	(-0.03)	(0.57)
DW[b]	1.244	1.630	2.247	1.780
R-square	0.87	0.99	0.93	0.97
Rho				

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.685$ $d_U = 1.977$; for U.S. equation $d_L = 0.814$ $d_U = 1.750$.

**Statistically significant two tail t-test at .05 level: t=2.228; for U.S. equation t=2.201; for Netherlands equation t=2.262.

*Statistically significant two tail t-test at .10 level: t=1.812; for U.S. equation t=1.796; for Netherlands equation t=1.833.

Belgium	Nether-lands[a]	Denmark	Norway	West Germany	Italy
0.048**	0.024**	0.019**	0.025**	0.024**	0.013**
(9.97)	(14.68)	(3.53)	(6.76)	(5.84)	(6.57)
0.005	0.002	0.004*	-0.002	-0.008	-0.025**
(1.26)	(0.88)	(1.83)	(-0.83)	(-0.33)	(-2.34)
-0.016	-0.006	-0.014**	0.005	-0.049	0.051*
(-1.62)	(-1.01)	(-2.84)	(1.05)	(-0.90)	(2.04)
-0.225	0.032	-0.036	0.080	0.882	1.080**
(-1.21)	(0.24)	(-0.37)	(0.77)	(0.87)	(2.24)
-2.561**	0.860*	-0.281	0.611	10.249**	8.155**
(-3.50)	(1.86)	(-0.73)	(1.46)	(2.70)	(4.47)
1.772	2.732	1.906	2.692	1.068	2.408
0.94	0.96	0.89	0.94	0.90	0.91
	-0.745**				
	(-3.37)				

Table 9. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: U.S. strategic spillins and dummy variable times spillins after 1981 (t statistics in parentheses)

$$ME_{it} = \alpha_i + \beta_{1i} GDP_{it} + \beta_{2i} CSP_{i,t-1} + \beta_{3i} D\cdot CSP_{i,t-1} + \beta_{4i} USSTRAT_{i,t-1} + \beta_{5i} D\cdot USSTRAT_{i,t-1} + e_{it}$$

Variable / Nation	United States	France	United Kingdom	Canada
GDP	-0.022 (-0.57)	0.040** (17.24)	0.020** (2.60)	0.011** (3.65)
CSP	1.478 (1.20)	0.056** (4.97)	0.037* (2.16)	0.013** (2.35)
D·CSP	0.329** (3.44)	0.006 (0.67)	-0.016 (-1.10)	0.002 (0.35)
USSTRAT		-0.002 (-0.02)	-0.222 (1.67)	0.061 (1.35)
D·USSTRAT		-0.107 (-1.19)	0.283 (1.75)	-0.024 (-0.45)
Constant	48.783 (1.10)	-11.455** (-4.01)	12.016* (1.89)	-2.140 (-1.31)
DW[b]	1.094	1.606	2.560	2.166
R-square	0.82	0.99	0.96	0.95
Rho				

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.685$ $d_U = 1.977$, for U.S. equation $d_L = 0.946$ $d_U = 1.543$.

**Statistically significant two tail t-test at .05 level: t=2.228: for U.S. equation t=2.179; for Netherlands equation t=2.306.

*Statistically significant two tail t-test at .10 level: t=1.812: for U.S. equation t=1.782; for Netherlands equation t=1.860.

Belgium	Nether-lands[a]	Denmark	Norway	West Germany	Italy
0.046**	0.024**	0.020**	0.027**	0.023**	0.016**
(7.58)	(12.28)	(3.02)	(5.31)	(3.95)	(6.52)
0.005	0.003	0.005**	-0.001	0.006	-0.015
(1.45)	(1.64)	(2.82)	(-0.53)	(0.27)	(-1.72)
-0.002	0.0003	-0.0005	0.001	-0.002	0.018**
(-0.83)	(0.16)	(-0.33)	(0.79)	(-0.85)	(2.42)
-0.022	0.0001	-0.009	0.017	-0.072	0.180**
(-0.75)	(0.004)	(-0.68)	(1.02)	(-0.41)	(2.50)
-0.015	-0.006	-0.001	-0.016	0.028	-0.181*
(0.45)	(-0.23)	(-0.06)	(-0.77)	(0.13)	(-2.14)
-2.250*	0.508	-0.611	0.074	8.723	2.365
(-1.99)	(0.61)	(-1.02)	(0.13)	(1.26)	(0.94)
1.991	2.713	1.922	2.687	0.902	2.687
0.97	0.96	0.91	0.95	0.90	0.92
	-0.757**				
	(-3.22)				

Table 10. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: U.S. strategic procurement as spillin (t statistics in parentheses)

$$ME_{it}=\alpha_{i}+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}USPRO_{i,t-1}+e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	0.006	0.040**	0.029**	0.010**
	(0.25)	(18.85)	(3.87)	(4.52)
CSP	3.69**	0.029**	0.062**	0.015**
	(3.28)	(4.13)	(5.11)	(5.19)
USPRO		-0.207**	0.019	0.050*
		(-3.55)	(0.18)	(1.94)
Constant	-252.145*	-5.476**	-2.971	-1.331**
	(-2.05)	(-5.61)	(-1.08)	(-3.02)
DW[b]	1.940	1.494	2.249	2.082
R-square	0.94	0.99	0.93	0.95
Rho	0.743**			
	(7.30)			

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.814$ $d_U = 1.750$.

**Statistically significant two tail t-test at .05 level: t=2.201; for Netherlands equation t=2.228.

*Statistically significant two tail t-test at .10 level: t=1.796; for Netherlands equation t=1.812.

Belgium	Nether-lands[a]	Denmark	Norway	West Germany	Italy
0.050**	0.024**	0.021**	0.024**	0.024**	0.012**
(10.22)	(17.97)	(4.07)	(6.99)	(6.21)	(5.20)
-0.0007	0.002**	0.002	0.00007	0.004	0.0002
(-0.35)	(2.94)	(1.54)	(0.05)	(0.34)	(0.03)
-0.023	-0.014	-0.026**	0.010	-0.097	0.087
(-1.20)	(-1.35)	(-2.99)	(1.02)	(-1.00)	(1.54)
-1.774**	0.784**	-0.136	0.286	7.494**	4.220**
(-4.67)	(4.68)	(-0.71)	(1.68)	(3.89)	(4.63)
1.801	2.713	1.772	2.429	0.916	1.941
0.95	0.96	0.89	0.94	0.90	0.85
	-0.750**				
	(-3.63)				

Table 11. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: U.S. strategic procurement spillins and dummy variable after 1981 (t statistics in parentheses)

$$ME_{it}=\alpha_i+\beta_{1i}GDP_{it}+\beta_{2i}CSP_{i,t-1}+\beta_{3i}USPRO_{i,t-1}+\beta_{4i}REAGAN_{it}+e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	0.023	0.040**	0.029**	0.011**
	(0.64)	(19.20)	(3.79)	(5.64)
CSP	-0.237	0.041**	0.048*	0.005
	(-0.19)	(3.26)	(1.89)	(0.92)
USPRO		-0.219**	0.027	0.059**
		(-3.76)	(0.25)	(2.61)
REAGAN	43.816**	-0.703	0.802	0.553*
	(4.37)	(-1.17)	(0.63)	(2.21)
Constant	102.391**	-7.992**	-0.303	0.564
	(2.24)	(-3.40)	(-0.06)	(0.60)
DW[b]	1.244	1.549	2.231	1.856
R-square	0.87	0.99	0.93	0.97
Rho				

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.685$ $d_U = 1.977$, for U.S. equation $d_L = 0.814$ $d_U = 1.750$.

**Statistically significant two tail t-test at .05 level: t=2.228; for U.S. equation t=2.201; for Netherlands equation t=2.262.

*Statistically significant two tail t-test at .10 level: t=1.812; for U.S. equation t=1.796; for Netherlands equation t=1.833.

Belgium	Nether-lands[a]	Denmark	Norway	West Germany	Italy
0.049**	0.024**	0.021**	0.025**	0.024**	0.013**
(10.34)	(15.98)	(3.94)	(6.95)	(6.13)	(6.48)
0.004	0.002	0.003	-0.002	-0.101	-0.021*
(0.92)	(0.92)	(1.47)	(-0.71)	(-0.47)	(-2.09)
-0.027	-0.014	-0.027**	0.011	-0.082	0.105
(-1.43)	(-1.24)	(-3.00)	(1.15)	(-0.81)	(2.22)
-0.255	-0.0001	-0.741	0.094	0.789	1.228**
(-1.28)	(-0.001)	(-0.74)	(0.89)	(0.75)	(2.44)
-2.639**	0.784	-0.390	0.628	9.986**	8.427**
(-3.43)	(1.67)	(-0.99)	(1.49)	(2.59)	(4.47)
1.784	2.713	1.933	2.660	1.081	2.375
0.96	0.96	0.89	0.95	0.90	0.90
	-0.750**				
	(-3.44)				

Table 12. OLS coefficient estimates for the demand of military expenditures using 1980 exchange rates: U.S. strategic procurement spillins and dummy variable times spillins after 1981 (t statistics in parentheses)

$$ME_{it} = \alpha_i + \beta_{1i} GDP_{it} + \beta_{2i} CSP_{i,t-1} + \beta_{3i} D \cdot CSP_{i,t-1} + \beta_{4i} USPRO_{i,t-1} + \beta_{5i} D \cdot USPRO_{i,t-1} + e_{it}$$

Nation / Variable	United States	France	United Kingdom	Canada
GDP	-0.022 (-0.57)	0.041** (18.31)	0.022** (3.07)	0.009** (3.24)
CSP	1.478 (1.20)	0.051** (4.53)	0.019 (1.01)	0.014** (2.35)
D·CSP	0.329** (3.44)	-0.003 (-1.38)	0.004 (0.87)	-0.0004 (-0.28)
USPRO		-0.059 (-0.42)	-0.427* (-1.82)	0.027 (0.33)
D·USPRO		-0.151 (-0.93)	0.508 (1.77)	0.031 (0.31)
Constant	48.783 (1.10)	-11.221** (-3.86)	11.125* (1.87)	-1.049 (-0.62)
DW[b]	1.094	1.648	2.455	1.936
R-square	0.82	0.99	0.96	0.95
Rho				

[a]Autocorrelation corrected using AR(1).

[b]Durbin-Watson test significant points at .05 level: $d_L = 0.685$ $d_U = 1.977$, for U.S. equation $d_L = 0.946$ $d_U = 1.543$.

**Statistically significant two tail t-test at .05 level: t=2.262: for U.S. equation t=2.201; for Netherlands equation t=2.306.

*Statistically significant two tail t-test at .10 level: t=1.833: for U.S. equation t=1.796; for Netherlands equation t=1.860.

Belgium	Nether-lands[a]	Denmark	Norway	West Germany	Italy
0.048**	0.024**	0.020**	0.025**	0.022**	0.016**
(8.44)	(12.27)	(3.52)	(5.51)	(4.45)	(6.15)
0.004	0.003	0.004*	-0.00006	-0.002	-0.003
(0.99)	(0.96)	(2.06)	(-0.03)	(-0.08)	(-0.27)
-0.001	-0.0002	-0.0007	0.0002	-0.0009	0.005**
(-1.43)	(-0.38)	(-1.75)	(0.44)	(-0.17)	(2.33)
-0.020	-0.021	-0.028	0.020	-0.223	0.316**
(-0.38)	(-0.51)	(-1.19)	(0.66)	(-0.77)	(2.24)
0.007	0.011	0.010	-0.015	0.160	-0.318*
(0.11)	(0.24)	(0.33)	(-0.40)	(0.46)	(-1.92)
-2.638**	0.824	-0.504	0.216	10.057	2.686
(-2.29)	(1.02)	(-0.91)	(0.37)	(1.61)	(1.01)
2.109	2.662	2.021	2.503	1.037	2.744
0.96	0.96	0.92	0.94	0.90	0.91
	-0.754**				
	(-3.22)				

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