

**TWO METHODS OF PROJECTING FUTURE NEEDS FOR
DEFENSE OPERATIONS AND SUPPORT FUNDS**

Staff Working Paper

September 1986

The Congress of the United States
Congressional Budget Office

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE SEP 1986		2. REPORT TYPE		3. DATES COVERED 00-00-1986 to 00-00-1986	
4. TITLE AND SUBTITLE Two Methods of Projecting Future Needs for Defense Operations and Support Funds				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Congressional Budget Office,Ford House Office Building, 4th Floor ,Second and D Streets, SW ,Washington,DC,20515-6925				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 34	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

PREFACE

Rapid increases in defense spending during the past six years (1981-1986) have been accompanied by changes in the composition of the defense budget. The shares of procurement, military construction, and research and development--so-called "investment" spending--have increased at the expense of appropriations for military personnel and operation and maintenance.

Some analysts have questioned whether Administration plans provide sufficient funds for manning, operating, and maintaining the military services' weapons and facilities. Lacking measures of readiness that can be linked to support funding, this Congressional Budget Office (CBO) study is limited to exploring whether the historical relation between appropriations for defense investment and support provides a basis for projecting likely future support needs. In accordance with CBO's mandate to provide objective analysis, the report offers no recommendations.

This paper was prepared initially by Randall Kish, a civilian employee of the U.S. Navy on temporary detail to CBO, under the general supervision of Robert F. Hale and Neil M. Singer. Neil Singer later revised and extended the original study. Helpful comments were received from Edward M. Gramlich and R. William Thomas of CBO. The manuscript was edited by Sherry Snyder and prepared for publication by G. William Darr.

September 1986

CONTENTS

CHAPTER I	OVERVIEW	1
	Evaluating the Hypotheses	2
	Limitations of the Analysis	4
CHAPTER II	THE OPERATIONS AND SUPPORT BUDGET	5
	Overview of Budget Categories	5
	Budgeting for Operations and Support	6
CHAPTER III	O&S AS A PERCENTAGE OF THE VALUE OF DoD CAPITAL STOCK	9
	The Capital Stock Proportionality Hypothesis	9
	Other Evidence	18
CHAPTER IV	O&S BUDGETS AS A PERCENTAGE OF DoD INVESTMENT	21
	The Constant Budget Shares Hypothesis	21
	Evaluating the Theory	22

CHAPTER I. OVERVIEW

In 1980 the United States embarked on the most extensive and prolonged peacetime defense buildup in its history. Since then, over \$500 billion in constant 1987 dollars has been appropriated for military equipment and facilities, resulting in an annual real rate of increase in the investment appropriations accounts--military procurement and construction--of 10 percent. Although the 1986 procurement appropriation was smaller (in real terms) than that for 1985, further increases are projected by the Administration for the remainder of this decade.

As these weapon systems and support facilities enter the Defense Department's inventory, they will require additional funds for operations and support. In fact, appropriations for military personnel and operations and maintenance have also increased since 1980, but at less than half the rate of the investment accounts. The Administration's latest five-year defense plans project that investment will continue to grow more rapidly than support.

These trends have led some critics to charge that the Administration's plans overemphasize the acquisition of new equipment and facilities, with little regard to the cost of using and maintaining them. These critics maintain that the Administration has failed to budget adequately for future support costs. Eventually, they believe, the Defense Department will be confronted with a choice between adding support funds to its budget or accepting sharply reduced capabilities. Indeed, they claim, recent patterns of funding have already penalized military readiness.

Two variations of this thesis, as advanced separately by William Kaufmann, of the Brookings Institution, and Franklin C. Spinney, of the Department of Defense, are examined in this study. Kaufmann asserts that operating and support (O&S) costs--defined as the sum of spending for personnel, day-to-day operations, and maintenance--are proportional to the value of equipment and facilities for each weapon system. Thus, in the long run, O&S funding must be proportional to the value of the Defense Department's capital stock. Inasmuch as appropriations for the investment accounts largely translate into growth in the capital value of weapon systems (net of an allowance for the attrition and replacement of obsolete systems), Kaufmann's hypothesis implies that ultimately O&S funds must grow at about the same rate as investment in order to remain proportional to total capital stock. ^{1/}

-
1. In practice, most replacement investment is related to attrition. Older items of capital equipment typically "trickle down" to reserve units and thus remain in the overall DoD inventory.

Spinney contends that, historically, appropriations for investment and support have maintained approximately constant shares of the overall defense budget. More recently, however, the share of the O&S accounts has fallen, and Administration plans project tht it will stay at its new, lower level through at least the end of the decade. ^{2/} Spinney's thesis is that unless O&S appropriations maintain their share of the overall defense budget, readiness activities--training, operations, modernization, and maintenance, for example--will have to be curtailed and overall capability will fall.

EVALUATING THE HYPOTHESES

Testing either hypothesis is difficult because of the implicit assumption linking military readiness on operations and support. The Congressional Budget Office (CBO) has no comprehensive measure of readiness, let alone any quantitative link between readiness and levels of O&S funding. A common assertion by military and civilian officials of the Defense Department, in connection with the overall defense buildup, is that readiness has improved since 1980. Yet, apart from the dramatic improvements in military manpower, CBO has found the evidence for increased readiness to be mixed. ^{3/} In this analysis, CBO assumed that increases in O&S funding have occurred against a backdrop of roughly constant overall force readiness.

Kaufmann's Proportionality Theory

Analysis of Kaufmann's hypothesis--that O&S costs are proportional to the value of capital stock for each weapon system--is complicated by two factors. First, Kaufmann's estimates of capital stock are difficult to replicate for many weapon systems because of problems in estimating attrition from the inventory and the effect of modernization. Second, O&S costs cannot be apportioned to individual systems except in a minority of the activities funded through the O&S accounts.

Kaufmann's hypothesis can be tested for a limited sample of systems--specifically, strategic missiles and ballistic missile submarines--but the test is not conclusive. Kaufmann's proportionality hypothesis generally is satisfied for missiles, but appears not to be for submarines. Moreover, in both

-
2. The Administration's budget request for fiscal year 1987, however, provides for a one-year increase in the share of O&S.
 3. See Congressional Budget Office, "Defense Spending: What Has Been Accomplished?" (Staff Working Paper, April 1985), pp. 17-19.

cases, O&S requirements estimated in this paper are much lower--no more than half as great--as those underlying Kaufmann's published estimates. On balance, the historical trends appear to be generally consistent with the capital stock proportionality hypothesis, but the specific O&S projections made by Kaufmann are not supported.

Spinney's Theory of Constant Budget Shares

Spinney's theory holds that, to maintain military readiness, O&S appropriations must account for a constant share of the total defense budget. But analysis shows that budget shares for investment and for operations and support have not remained stable historically; instead, they have fluctuated within stable ranges. Investment consumed a large proportion of the defense budget in the 1960s and 1980s, but a smaller one during the 1950s and 1970s. O&S exhibited the opposite pattern by definition. O&S funding presumably affects day-to-day military readiness, and changes in O&S could simply reflect periods of poorer and better readiness. But today, when the share of the budget devoted to O&S has fallen to a historical low, testimony by senior military commanders suggests that readiness is high and improving. Thus, history does not appear to support the need for constant budget shares.

A separate analysis of the shares devoted to the components of O&S--military personnel and operation and maintenance (O&M)--also fails to support Spinney's hypothesis. In the military personnel account, which has shown the most dramatic change, sharp reductions in budget share have occurred even though most service requirements for numbers of personnel have been met and despite a major improvement in the quality and experience of military personnel. Thus, it is not clear that appropriations for military personnel require a constant share of the budget.

The analysis of the O&M accounts leads to the same finding, though less conclusively. Because it is plausible that increases in investment will generate increases in O&M as new systems impose new support needs, the Spinney hypothesis was examined in the light of 20 years of historical data. This analysis incorporated the assumption--which cannot be verified with precision--that O&M and related readiness programs have not been under- or overfunded for prolonged periods. In most comparisons, the history suggests a statistical relationship between changes in the budget shares of investment and O&M, but O&M does not appear to increase by the same percentage as investment. Thus, while Spinney's hypothesis appears to receive weak support from this empirical investigation, his conclusion that O&M must maintain a constant share of the budget is not supported.

LIMITATIONS OF THE ANALYSIS

The conclusions of this study are limited by the difficulty of constructing complete and comparable data and, in some cases, by the need to limit the analysis to particular types of weapon systems. Despite these limitations, the analysis suggests some relationship between spending for operations and support and spending on investment. But the relationships are not nearly as strong as implied by either the Kaufmann or Spinney claims, and the relationships established here fail to provide a basis for forecasting O&S requirements precisely.

In general, it seems plausible that funds to support defense activities should increase by some amount as the force increases in size and complexity. But the specific techniques used by Kaufmann and Spinney appear to be problematic with regard to both the assumptions made and the data used. At best, these techniques provide approximate guidance in forecasting future O&S requirements.

CHAPTER II. THE OPERATIONS AND SUPPORT BUDGET

During the past three years (1984-1986), the Congress has appropriated over \$300 billion (in constant 1987 dollars) for military equipment and facilities. ^{1/} As these weapon systems and support facilities join the Department of Defense (DoD) inventory, they require additional funds for operation and support. Such activities, though highly complex and specialized at times, are analogous to the routine maintenance a car or house needs. Tune-ups, replacement parts, and paint must be provided for military equipment and facilities just as for civilian ones; in both cases, breakdowns, rot or rust, and early retirement or condemnation result from inadequate maintenance. In the Defense Department, however, operation and support needs are particularly critical. Military missions require equipment that is operationally available and troops who are trained to use the equipment properly. Mission failure and even loss of life may result from inadequate funding for operations and support.

OVERVIEW OF BUDGET CATEGORIES

The appropriations for military personnel and operation and maintenance in the DoD budget are usually considered the operations and support funds. ^{2/} The military personnel accounts pay almost exclusively for salaries and subsistence for officers and enlisted personnel. Operation and maintenance is the "catchall" of DoD appropriations and, as such, is more diverse. Civilian employment (through either direct government hire or contract) constitutes about 40 percent of the appropriation. Labor and material to overhaul and service equipment, purchased through so-called "industrial funds," account for 20 percent of the budget. Supplies, such as spare parts and fuel, make up an additional 20 percent. The remaining 20 percent of the appropriation pays for such items as transportation and utilities.

A more detailed picture of appropriations for operations and maintenance can be gained by examining the Navy's O&M account. Over 20 per-

-
1. This sum is the total of appropriations for procurement and military construction.
 2. Although the "spares" portion of certain procurement accounts (10 percent to 20 percent of these accounts) sometimes is included in the O&S category, it is excluded here because of the difficulty of obtaining historical data on spares costs.

cent of the Navy's O&M funding provides for supplies, such as fuel, which directly support ships and planes deployed on security and training missions throughout the world. Basic skill and specialized training of Navy personnel, also included in this category, emphasizes the link between readiness and O&M appropriations. Depot maintenance and modernization of equipment, 30 percent of the budget, pay for labor (both blue-collar and engineering) and small parts to overhaul equipment and retrofit product improvements. Logistic and supply functions (for example, packing and inspecting material, air- or sealifting it, and coordinating the timing and destination of these shipments among the hundreds of military bases worldwide) make up about 13 percent of the budget. Base operating support (BOS) and maintenance of real property (RPM) constitute 11 percent of Navy O&M and pay for services such as utilities, physical security, and repair of buildings and roads. The cost of maintaining and modernizing the Navy's fleet of strategic submarines--which is shown separately in the Navy's budget, though it encompasses many of the categories tabulated above--accounts for another 8 percent. Other Navy programs--such as maintaining worldwide communications, medical facilities, and intelligence activities--make up the final 18 percent of the service's budget for operation and maintenance.

BUDGETING FOR OPERATIONS AND SUPPORT

Accurate planning and budgeting for the diverse items within the operations and support appropriations is a difficult task. Several methods exist to budget for operating and support costs.

Constant Operating Level

The simplest way to estimate O&S costs is the "constant operating level" approach, which assumes that the same level of activity performed this year will be required next year, and thus that the O&S budget will be the same, except for projected price changes and modifications in force levels. While this technique yields a reasonable baseline for projecting the next year's costs, it does not take into account changes in activity--such as improvements in military readiness--that occur from year to year. Some of these annual changes include adjustments in flying and steaming hours, the up-and-down pattern of the depot maintenance and overhaul cycle, and the introduction of new weapon systems and accompanying support cost requirements. During the past 20 years, year-to-year changes in the O&S budget have been as great as 20 percent and as little as 1 percent. This experience suggests that the "constant operating level" approach is not satisfactory for projecting detailed O&S costs, although this approach can provide a useful baseline for judging the cost of changes in O&S policies.

"Bottom-Up" Budgeting

The Department of Defense takes the opposite approach from the current services method. The DoD Planning, Programming, and Budgeting System (PPBS) annually builds from the bottom up. After initial goals are set, each program manager budgets according to the best-known workload estimates or "performance criteria"--the number and types of equipment scheduled for overhaul, or manpower recruiting goals, for example. Performance criteria for each of the many activities funded through the O&M accounts are reviewed and adjusted by higher levels of authority to comport with overall spending priorities. This annual process, which takes many months and thousands of workyears, is appropriate for developing a detailed budget but is less useful for estimating long-run O&S funding needs.

Models of O&S Costs

To estimate DoD's operating and support requirements without this enormous, detailed effort, many analysts employ simple mathematical models of DoD resources and how they are used. ^{3/} For example, models to estimate the Navy's manpower, fuel, and maintenance needs can be based on the number, size, and deployment patterns of Navy ships. Thus, as the mix and use of ships change over time, estimated support requirements also will change. Such models could be made more complex; for example, increased ship activity with insufficient manpower might be linked to increased requirements for depot maintenance in the future. These models can help to clarify the relationships between O&S components, and they are used by the individual military services for some components of their overall operations and support activities. Unfortunately, there is no currently operational, comprehensive model of overall DoD requirements based on actual data, and development of such a model would require a massive analytic effort.

A second modeling technique to predict O&S requirements starts with a detailed analysis of the support needs of a relatively new weapon system. These needs are then compared with the support costs of the previous-generation system to see if the costs have increased or decreased. Several of these comparisons may illuminate a trend for the total O&S budget. ^{4/}

-
3. See, for example, Congressional Budget Office, Future Budget Requirements for the 600-Ship Navy (September 1985), p.39.
 4. Such comparisons may be misleading, however. A 1981 report by the Defense Science Board reported a lower ratio of O&S to procurement costs for an M1 tank compared with its predecessor, the M60A3. A

But because new systems account for only a small fraction of overall O&S costs in any given planning period, these trends provide, at most, only partial indications of total O&S funding needs.

A third modeling approach links requirements for operations and support funding to the amounts spent to procure weapon systems. Historical trends can then be used to estimate future O&S needs. William Kaufmann and Franklin Spinney are two analysts who have used this technique. Both assume a relationship between the procurement costs of defense systems and the funds needed to support and maintain them. Kaufmann argues that annual operating and support requirements will ultimately consume a constant percentage of a weapon system's capital stock value. Spinney, on the other hand, states that operating and support budgets in the long run should change in the same proportion as investment budgets.

Because these "linkage" approaches yield estimates of total projected O&S requirements, they have been used to assess the adequacy of planned O&S funding. These models have become the basis of concern that O&S is underfunded in future defense budgets. The remainder of this paper assesses the validity of the linkage models and judges their utility in projecting O&S funding needs.

(continued)

CBO study, completed in 1982 and using updated information, shows that the M1 has substantially greater support costs than the M60A3. Congressional Budget Office, Army Ground Combat Modernization for the 1980s (November 1982).

CHAPTER III. O&S BUDGETS AS A PERCENTAGE OF THE VALUE OF DoD CAPITAL STOCK

In his study, The 1985 Defense Budget, William Kaufmann claims that historical trends show annual operating and support costs to be proportional to the value of the stock of capital goods. ^{1/} He asserts that the sum of the appropriations for military personnel and operation and maintenance has been about 11 percent of the value of the capital stock of 45 categories of major weapon systems, which make up most of the defense force structure. (Three examples of these categories are the 16 Army divisions, 297 Air Force strategic bombers, and 94 Navy attack submarines.) Kaufmann allocates to each weapon system its own share of the operations and support budget, which ranges from 30 percent of the value of weapon systems for Army and Marine divisions to 5 percent for reserve air wings. These ratios vary with factors such as number of personnel and equipment usage.

THE CAPITAL STOCK PROPORTIONALITY HYPOTHESIS

Kaufmann's basic assumption is that O&S costs are related to the value of the capital stock: "As the value of the defense stock increases, the cost of the personnel to operate and maintain it goes up, more maintenance tends to be required, training costs increase, and the amenities needed to attract and retain personnel become more expensive." ^{2/} An example might be the recent introduction of highly complex, electronics-intensive systems, which appears to have increased the requirements for highly trained, experienced, and costly personnel, even as the value of the capital stock of these systems has also increased. Similarly, the advent of nuclear power plants in ships has resulted in nuclear engineers supplanting some boiler technicians. New complex equipment also appears to have increased maintenance costs. Although new equipment may be easier to maintain at the organization (front-line) level because of features such as components that can be replaced, this cost saving generally may be outweighed by higher costs stemming from increased frequency of component repair at the intermediate and depot-maintenance levels.

-
1. William Kaufmann, The 1985 Defense Budget (Washington, D.C.: Brookings Institution, 1984).
 2. Kaufmann, The 1985 Defense Budget, p. 38.

Difficulties in Evaluating the Hypothesis

One problem with Kaufmann's hypothesis is the difficulty of replicating his estimates of the value of capital stock. ^{3/} Kaufmann determines the value of each category of weapon system by calculating the replacement value for the weapon system if it were purchased today. It is not clear, however, if his estimates are based on the original (constant dollar) cost of the weapon, the cost of that weapon including subsequent modifications, or the cost of a completely new replacement weapon system.

The range of possible values can be illustrated for strategic bomber weapon systems. On the low end of the range, the average "flyaway cost" of the B-52G in its last year of production was about \$31 million in fiscal year 1985 dollars. ^{4/} The comparable cost of the B-1B, the next-generation system, is \$235 million. Kaufmann's capital stock estimate is based on a unit cost of \$165 million, which may include a mix of B-52s and B-1Bs, or which might be an estimate of the cost of the B-52 fleet including spares and subsequent modifications. Tracking all of these costs for all weapon categories would be a lengthy task.

Changes in the inventory of weapon systems are another problem in verifying Kaufmann's stock value. Weapon systems leave the inventory for one of two reasons--retirement after normal service or attrition resulting from accidents, combat, or exhaustive testing. An accurate inventory can be maintained for a small number of large systems like ships, but items such as aircraft and missiles are more difficult to track. Several attempts have been made to estimate an average retirement and attrition rate of equipment, but these efforts have been hampered by high attrition rates during the Vietnam War and the military services' policy of block retirements instead of the smooth retirement schedule a model would predict. ^{5/} Other problems with estimating changes in inventory include the value and composition of the initial stock and the assignment of retirement schedules for such diverse appropriation categories as "Procurement, Defense Agencies" or "Other Procurement, Navy."

-
3. The disaggregated data that underlie Kaufmann's published projections of O&S funding needs were supplied informally to CBO.
 4. Flyaway cost excludes costs of ground equipment and initial spare parts.
 5. For a recent attempt, see Congressional Budget Office, "Project Report: A Data Base for Defense Capital Research" (Staff Working Paper, August 1984).

A third problem arises in assigning O&S dollars to Kaufmann's weapon system categories. Operation and support funds are divided in several ways: the two appropriation titles of military personnel and operation and maintenance; the 10 major programs used by DoD for programming and budgeting; and detailed categories (program elements) within each major program. ^{6/} Program 1 (strategic forces) and Program 2 (general purpose forces) include the weapon systems that Kaufmann uses to build his estimates of capital stock. Programs 1 and 2, however, account for less than half of all O&S funds. The remaining funds are organized into general support categories--such as engineering, depot maintenance, and training and medical costs--that cannot easily be apportioned among the weapon systems in the two programs. Allocating these remaining funds to weapon system categories according to some fixed proportion is not satisfactory because it assumes a relationship between O&S and weapons costs that may not exist. There is no obvious alternative, however, for apportioning 100 percent of O&S costs, as Kaufmann has done.

For some elements of operating and maintenance costs, an alternative method for apportioning costs might be to apply the "square-root rule," a decision rule that relates to the existence of economies of scale. ^{7/} By extension, the rule can be used to imply a relationship between growth in the value of capital stock and the cost of operation and support. Whenever an O&S activity can be expected to yield economies of scale, that O&S cost can be projected as being proportional to the square root of the value of the capital stock. Examples of such O&S activities might include the stocking of spare parts, depot maintenance, and general administration and record keeping. Other O&S activities, such as direct training or operating programs, might not fit the "square-root rule" as well.

-
6. The ten major programs are as follows: (1) Strategic Forces, (2) General Purpose Forces, (3) Intelligence and Communications, (4) Airlift and Sealift, (5) Guard and Reserve Forces, (6) Research and Development, (7) Central Supply and Maintenance, (8) Training, Medical, and Other Personnel Activities, (9) Administration, and (10) Support to Other Nations.
 7. This decision rule holds that the optimal size of inventory is proportional to the square root of the level of consumption of the inventoried item. For example, the size of stocks of spare parts for tactical aircraft should be proportional to the square root of the number of planes. A derivation and explanation of the rule can be found in William J. Baumol, Economic Theory and Operations Analysis, 2nd ed. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965), pp. 7-10.

Verifying the Hypothesis

Strategic missile and submarine systems are possible candidates for testing Kaufmann's proportionality hypothesis in that they are not susceptible to many of the problems outlined above. The capital cost of the Titan and Minuteman missiles and fleet ballistic missile submarines (SSBNs) can be estimated because:

- o Investment and most O&S costs (with the exception of some indirect support categories such as basic training and medical support costs) tend to be accounted for separately within Program I categories.
- o The initial stock value is zero (that is, no similar U.S. forces existed before the initial acquisition of Titan and Polaris).
- o Until recently, attrition and retirement have been minimal since initial deployment in the early 1960s.

While the analysis of strategic forces may not extend to general-purpose weapon systems, on balance the strategic systems provide a good initial test of the proportionality hypothesis.

All three systems had large initial costs. Figure 1 shows the annual investment budget (in constant 1985 dollars) for the three systems from 1962-1983, including the cost of modifications. Titan investment costs decreased to almost zero after initial deployment. Minuteman costs peaked in 1963, then decreased until 1967, when the initial force of 1,000 Minuteman I and II missiles was fully deployed. Production of Minuteman III continued until 1964. Conversion of 31 of the 41 ships from the Polaris to Poseidon missile configuration began in 1968 and was completed in 1975. The lower-cost conversion of 12 Poseidon boats to carry Trident missiles was funded from 1979 through 1981.

The annual operating and support costs for the same three systems, again in constant 1985 dollars, are shown in Figure 2. Funds for all three systems rose as the weapons were deployed, and declined somewhat after deployment was completed. Titan and Minuteman budgets then remained almost constant. SSBN support, however, was more erratic and increased an average of about 5 percent per year. Costs are shown separately for the Trident boats to permit an analysis of the link between O&S costs and capital stock, defined to include or exclude modifications.

The ratio of annual O&S costs (Figure 2) to the cumulative (gross) investment costs of these systems--that is, the value of their capital stock--

FIGURE 1.

Investment Costs of Strategic Systems

(Billions of constant 1985 dollars)

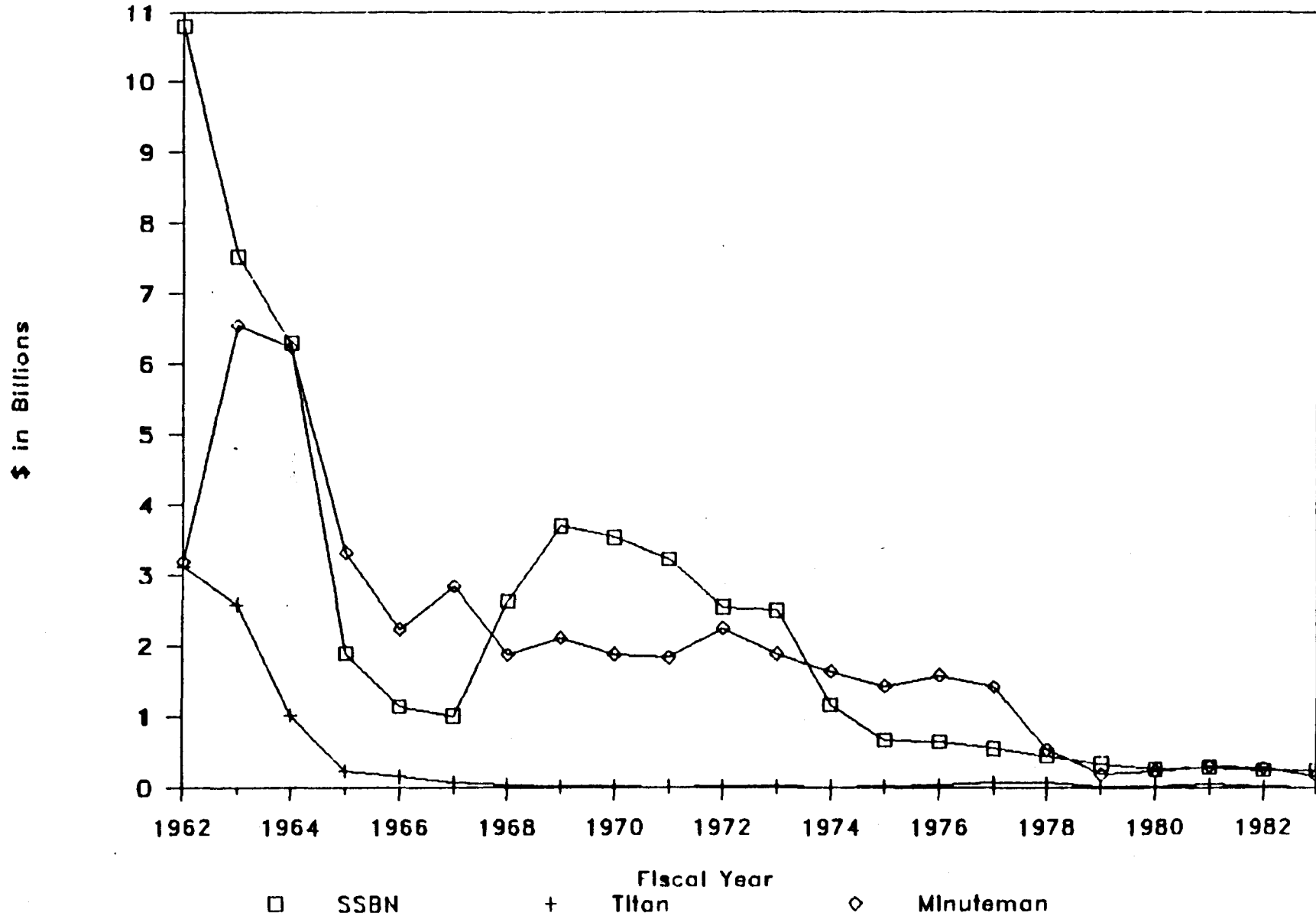
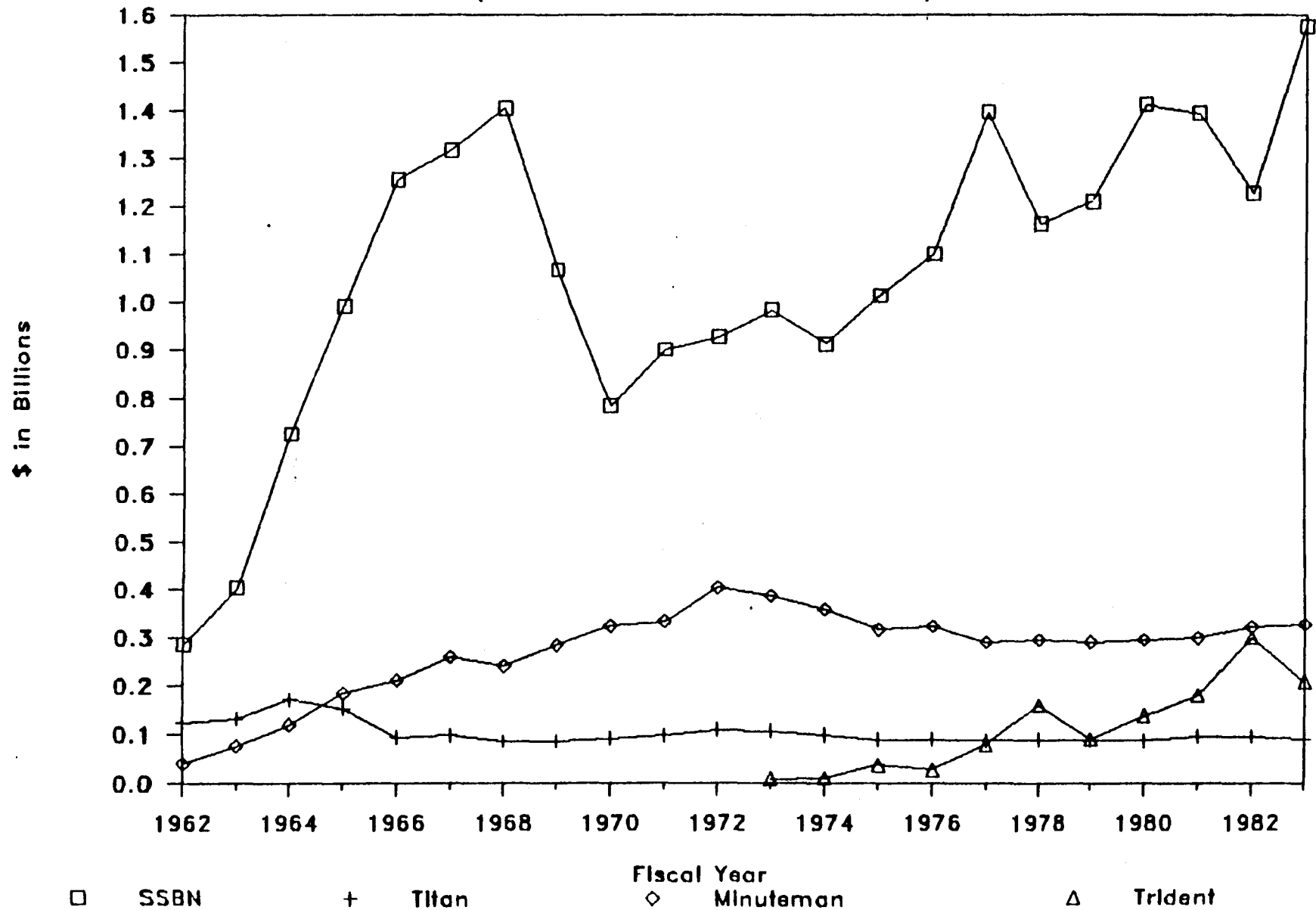


FIGURE 2.

Annual O&S Costs of Strategic Systems

(In billions of constant 1985 dollars)



is shown in Figures 3 and 4. Kaufmann estimates that the ratio should be about 5 percent for missiles and 10 percent for submarines. CBO's analysis, however, yielded different results. Figure 3 shows the ratio if investment funds for modifications are not included; that is, no increases in capital stock are provided for Titan after 1966, Minuteman after 1967, and SSBN after 1967. The ratio of O&S to cumulative investment rises until initial deployment is complete and then declines, with the ratio for missiles stabilizing and that for submarines rising erratically. The average ratio of O&S to cumulative investment stabilizes at 1 percent for missiles and ranges from 2 percent to about 4 percent for SSBNs.

Two conclusions may be drawn from this analysis. First, these new systems require proportionally more O&S funds at the beginning of their life cycle. These additional funds probably relate to the start-up logistics and supply requirements and maintenance problems that new systems commonly encounter. Second, the pattern of O&S spending does not fit Kaufmann's hypothesis. The ratio for submarines is higher than that for missiles, as Kaufmann predicts, but both types of systems have lower ratios than the 10 percent and 5 percent he estimates, and the ratio for submarines does not approach a stable value as the system matures.

A more rigorous test of the proportionality hypothesis can be made by subjecting these data to regression analysis. In keeping with the hypothesis, data for the investment period for each system have been excluded from the analysis. For the Titan missile, the excluded period is 1962 through 1966; for the Minuteman and SSBN, it is 1962 through 1967. A simple linear regression then shows that for the Titan and Minuteman, the trend in O&S ratios is not significantly different from zero. This result is consistent with Kaufmann's proportionality hypothesis, though the ratio is lower than his estimate. For the SSBN, however, the trend coefficient of .075 was significantly different from zero (with a t-ratio of 2.88), contradicting the predictions of the proportionality hypothesis.

The ratio of annual O&S to cumulative investment costs, including all modifications, is shown in Figure 4. According to Kaufmann's hypothesis, this ratio should be constant, since investments plus modifications approximate total capital stock. But the pattern depicted in Figure 4 is similar to that in Figure 3, in which modifications are excluded. The Titan missile line is almost identical, and the percentage of O&S spending for Minuteman and submarines is lower in later years. (Modifications to these two systems increase the original investment cost by about 70 percent for Minuteman and 60 percent for SSBN.) The submarine line is reduced to an average of about 2 percent—twice the level of the missiles, as Kaufmann predicts. But the ratios of O&S to investment are far lower than Kaufmann's estimated 10 percent (for submarines) and 5 percent (for missiles), implying that these systems can be maintained with a much lower level of total O&S spending.

FIGURE 3.

Ratios of Annual O&S/Total Investment

(Excluding Modifications)

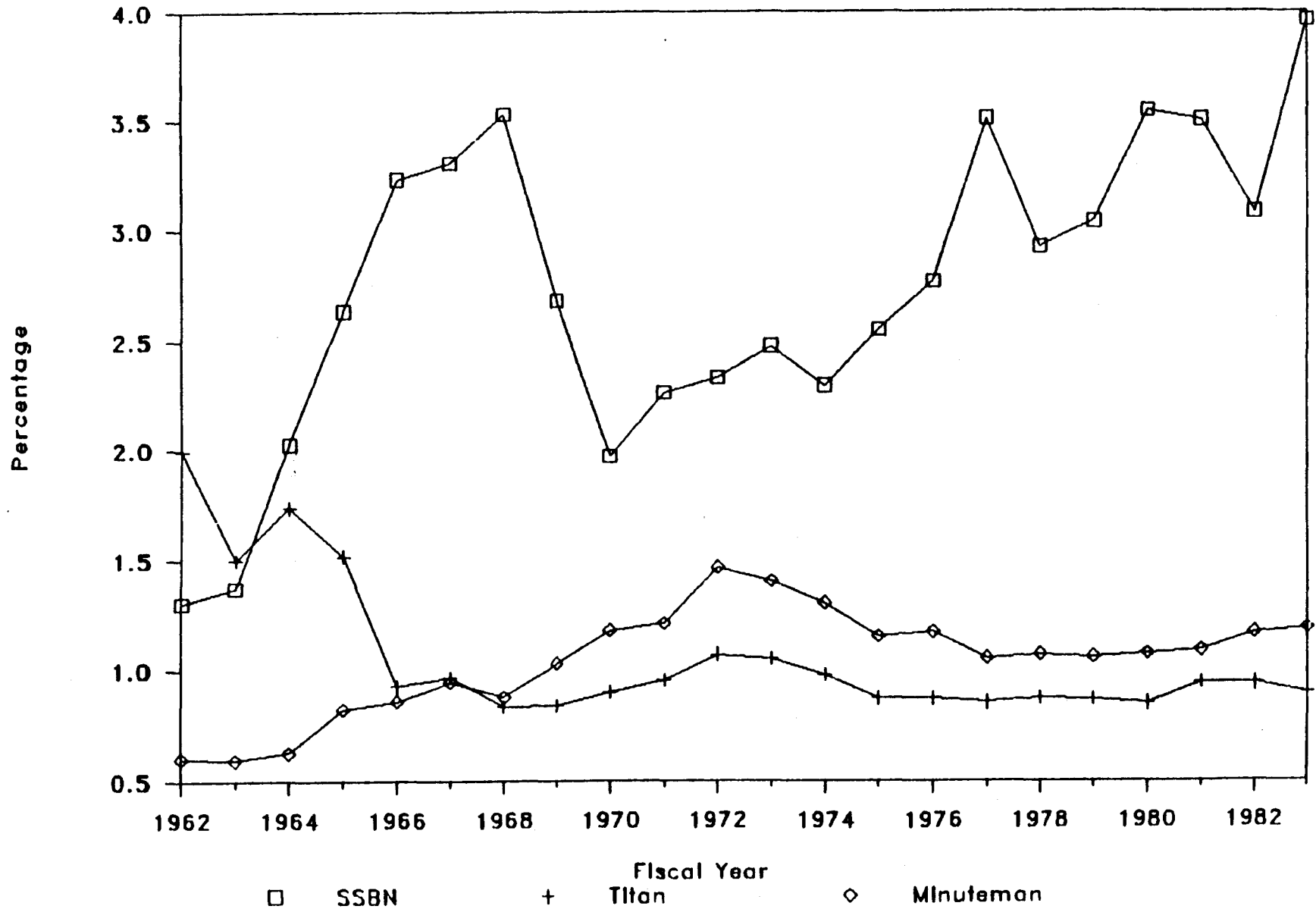
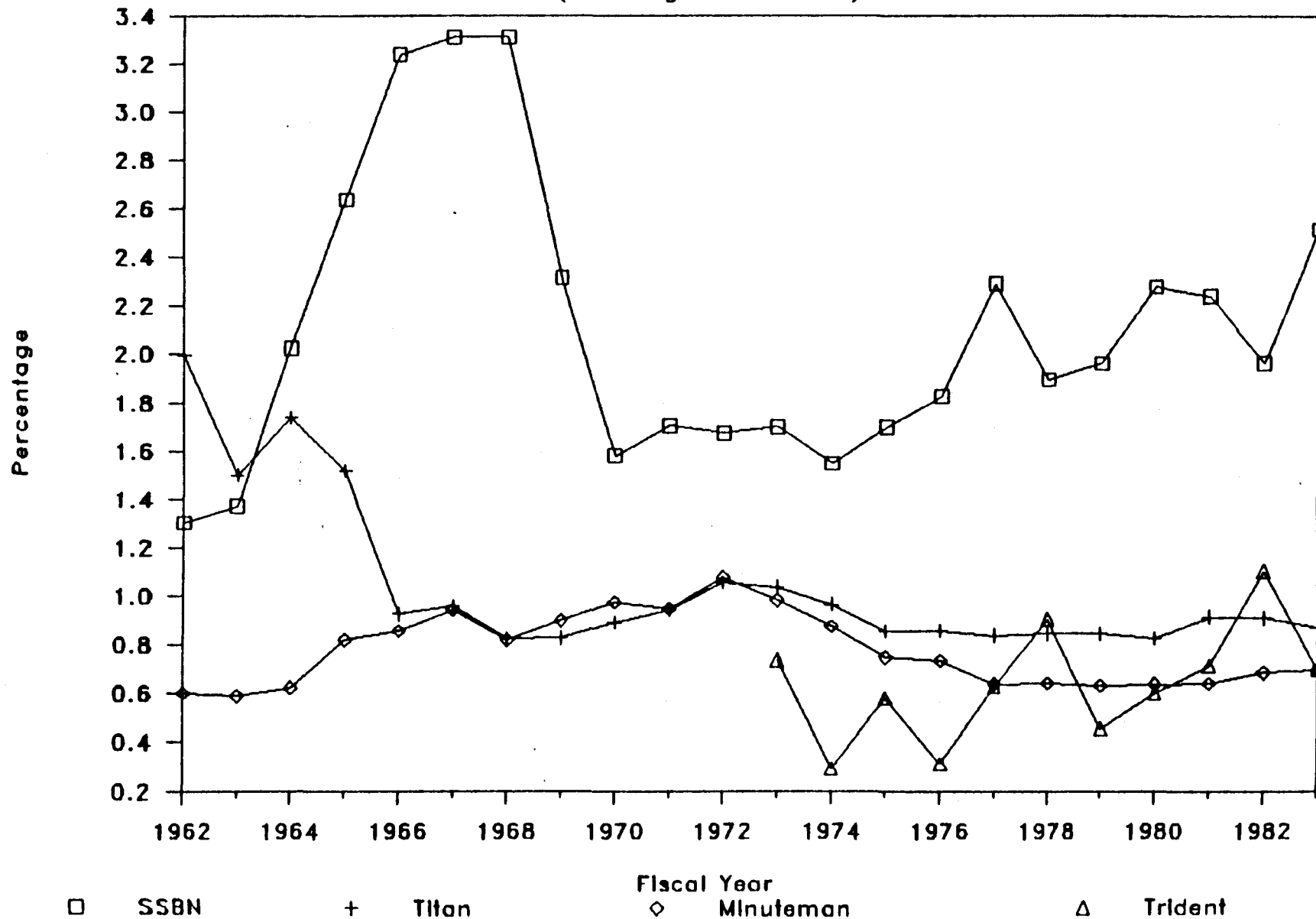


FIGURE 4.

Ratios of Annual O&S/Total Investment

(Including Modifications)



The preceding analysis focused on the relationship between cumulative investment, or capital stock, and O&S costs for individual strategic systems. A broader definition of O&S costs might include other support costs besides those assigned to particular strategic systems in the DoD program structure. This possibility was tested for the Navy by using total Program 1 (strategic forces) O&S costs instead of the SSBN support costs incorporated in Figure 4. The rationale for this broader interpretation of the proportionality hypothesis might be that all Navy strategic forces are acquired and operated in support of its submarines, so that the entire Navy budget for strategic O&S can be attributed to SSBN support. ^{8/} But the ratio of the Navy's total Program 1 O&S to cumulative investment (see Figure 5) shows a pattern very similar to that in Figure 4. Adding the other Program 1 support costs to the direct O&S costs of the submarine fleet, therefore, neither changes the overall pattern nor raises the ratio much closer to Kaufmann's estimated 10 percent.

A further possibility is that the O&S/investment ratio might be affected by the vagaries of budgetary politics that could lead to under- or overfunding of operation and support. But observed fluctuations in O&S funding for submarines do not seem to result from the budgeting of insufficient resources to meet requirements; instead, evidence indicates that strategic systems may, in fact, receive adequate funds. And if the ratio of O&S to investment is not stable for the well-funded SSBNs, the ratio for other weapon systems will probably fluctuate considerably more from year to year because of the additional variation introduced by budgetary constraints.

OTHER EVIDENCE

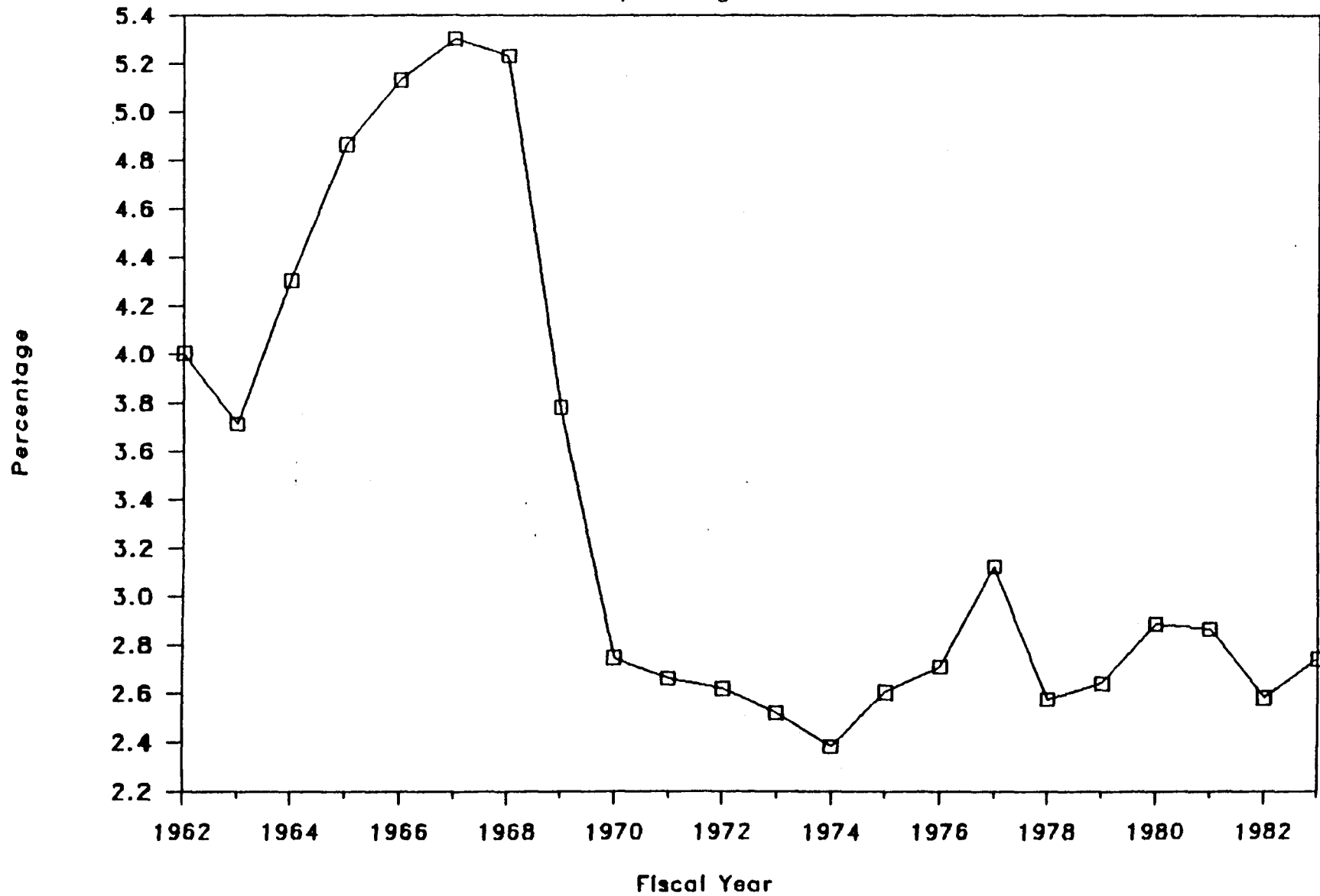
A recent CBO analysis of budget projections for other Navy ships and aircraft yields results more nearly consistent with Kaufmann's hypothesis. ^{9/} CBO tabulated the ratio of total support costs to estimated total fleet

-
8. Additional Navy Program 1 (strategic forces) elements include space surveillance and radar ships. Air Force Program 1 forces, in contrast, include such diverse elements as bombers, tankers, and early warning radar systems. The fact that many of these items have been retired creates problems of calculating capital stock in addition to the difficulty of apportioning overall strategic O&S costs to individual systems or program elements.
 9. Congressional Budget Office, Future Budget Requirements for the 600-Ship Navy (September 1985), p. 42.

FIGURE 5.

Ratio of Annual O&S/Total Investment

Navy Strategic Forces



value, defined as the cost of all ships and aircraft including the cost of major modifications. Unlike the preceding discussion of support costs for strategic systems, this tabulation did not attempt to relate support costs to the value of individual systems.

The results of this exercise indicate that the ratio of support costs to capital value of the fleet has varied within a fairly narrow band. From 1970 through 1984, the maximum value of the ratio was approximately 20 percent, the minimum was roughly 17 percent, and the average was slightly over 18 percent. Thus, Kaufmann's proportionality hypothesis cannot be dismissed on the basis of this analysis.

CHAPTER IV. O&S BUDGETS AS A PERCENTAGE OF DoD INVESTMENT

Like Kaufmann's, Franklin C. Spinney's analysis of the defense budget also relates operating and support funds to procurement funds. Spinney contends that during the last 30 years, the O&S budget has maintained a stable or even rising share of the total DoD budget. ^{1/} This has been the case even though the number of major weapon systems has decreased substantially (for example, the number of Air Force aircraft and Navy ships has declined by more than half). More recently, however, the share of the defense budget dedicated to O&S has shrunk. The detailed budget projections in the President's fiscal year 1985 budget indicate that O&S funding will continue to grow at a slower rate than the total defense budget. ^{2/}

THE CONSTANT BUDGET SHARES HYPOTHESIS

Spinney is concerned that the slow rate of increase in the O&S budget may not be sufficient to maintain the large number of complex weapons currently being procured:

... the Program Objective Memorandum (POM) projects a decreasing rate of growth in the operating budget.... the best thing that can be said about this assumption of a decreasing rate of growth is that it is an optimistic assumption. We may be able to do it, but there are reasons to suspect that we might not. ^{3/}

His argument is based on several factors that add to the cost of operations and support: the planned increase in force size of the Navy (from 525 to 600 ships) and Air Force (from 36 to 40 wings); increased combat readiness requirements; and increased complexity of weapon systems, which requires a

-
1. Prepared statement of Franklin C. Spinney in Defense Plans/Reality Mismatch Study: An Update, Hearings before the House Committee on the Budget, Committee Serial No. 98-9, February 8, 1984, p. 35.
 2. The fiscal year 1985 budget was the latest one available at the time of Spinney's "Update" testimony. The 1987 budget, in contrast, shows a one-year increase in the share of O&S.
 3. Spinney, Defense Plans/Reality Mismatch Study, p. 9.

greater support "tail" (increased maintenance, more highly skilled maintenance personnel, more complex test equipment).

Spinney's analysis is descriptive. While it provides a general warning that the defense budget shares for procurement and support may be out of balance, it differs from Kaufmann's analysis in that it does not specify a particular level of support. Spinney notes the dynamic changes in the defense inventory (that is, a slightly larger, more complex force) but does not prescribe the level of operating appropriations needed to support this changing inventory. He only observes that budget shares have changed in the past few years and that there is no indication from the Administration of an eventual shift back to the historical balance.

EVALUATING THE THEORY

Certain aspects of Spinney's hypothesis can be tested against historical data. These data show, for example, that the increase in the O&S share of the defense budget has not been constant over the last 30 years. Table 1 shows the actual percentage of the defense budget allocated to O&S from 1955 through 1985. This percentage oscillates, with highs (at or above 60 percent) during the 1950s and 1970s and lows (of 45 percent to 55 percent) in the 1960s and 1980s.

These low percentages do not necessarily indicate that the O&S appropriations are underfunded. Although the share of O&S funding is currently at a 30-year low, the Chairman of the Joint Chiefs of Staff has testified before the Congress that "Our forces are well trained....Support and sustainability programs are on-hand as new equipment is fielded...." ⁴/ In the judgment of the United States' senior military leader, O&S clearly is receiving sufficient funding, whatever its share of the overall DoD budget.

Military Personnel Costs

Disaggregated analysis also does not lend much support to Spinney's budget shares hypothesis. In 1985, the appropriation for military personnel fell to its lowest share of the defense budget since 1955. Despite this recent de-

-
4. Statement by General John W. Vessey, Jr., U.S. Army, Chairman of the Joint Chiefs of Staff, before the Senate Committee on Armed Services, on S.674, Department of Defense Authorization for Fiscal Year 1986, 99:1 (February 4, 1985), pt. 1, p. 48.

crease, however, there are no indications of shortfalls in either the quantity or quality of military personnel.

In all of the military services, plans call for future increases in numbers of personnel. During the past several years, the Navy and Air Force have maintained their requests for increased end strength in the face of repeated Congressional reductions. The Army, which has recently decided to limit its active-duty strength to roughly 781,000, has instead planned for growth in the number of full-time support personnel in the reserve components.

In practice, planned manpower growth commonly is deferred as the result of other budgetary constraints. Even granting the validity of the services' long-run planned increases, however, unmet requirements for additional personnel are probably not responsible for the current low share of appropriations for military personnel in the defense budget. Even if all of the personnel growth requested in the services' budgets had been approved by the Congress for 1986, at the expense of the investment accounts' share, the portion of the defense budget devoted to military personnel (exclusive of

TABLE 1. DEPARTMENT OF DEFENSE INVESTMENT AND
O&S BUDGET SHARES
(As a percentage of total defense budget)

	1955	1960	1965	1970	1975	1980	1985
Investment <u>a/</u>	25	32	30	25	22	26	34
Operations and Support	63	52	53	60	60	54	46
Military personnel <u>b/</u>	37	27	27	31	29	22	18
Operation and maintenance	26	25	26	29	31	32	27

SOURCE: Congressional Budget Office from data in National Defense Budget Estimates for 1985, Office of the Assistant Secretary of Defense (Comptroller), Fiscal Year 1985 Continuing Resolution.

- a. Includes appropriations for procurement and military construction.
- b. Does not include retirement pay.

retirement pay) would have been only about 19 percent, still lower than in most years since 1955. 5/

Nor has the decline in the budget share for personnel been accompanied by any deterioration in personnel quality. Quite the contrary, indicators of personnel quality have shown marked improvement since 1980. For example, the percentage of Army enlistees holding high-school diplomas has risen from below 50 percent to over 90 percent, and the proportion scoring in the lowest acceptable category on the entrance test has declined from over 50 percent to under 10 percent. Experience levels also have improved, with the percentage of first-term reenlistees rising above 70 percent during the past eight years. Career personnel (those with more than four years of service) make up a larger proportion of each service than ever before.

Contrary to Spinney's hypothesis, these improvements in personnel quantity and quality have been achieved with a declining share of the overall defense budget. 6/ Nor are these trends necessarily about to end. The five-year defense plan submitted in February 1986 proposed a nominal increase of 40 percent in the defense budget between 1986 and 1991. Funds for military personnel, however, were planned to increase by only 7 percent, compared with 39 percent for investment. This implicit projection that the services can continue to hold down the manpower budget share while meet-

-
5. Some evidence exists that budgetary pressures have constrained recent military manpower requests, especially in the Army. In all services, despite the projected growth of active-duty units, some substitution of reserve personnel for active personnel has occurred. But the same pressures that limit manpower requests also apply to other components of service budgets, so that the "true" budget share of personnel is not obviously different from its "constrained" share.
 6. To some extent, manpower costs have been held down by the introduction of personnel-efficient military systems. For example, the Air Force's F-15 and F-16 fighter aircraft, both single-pilot aircraft, are replacing the prior-generation, two-seat F-4. Similarly, Naval vessels bought in recent years require fewer personnel per displacement ton, a rough but reasonable measure of labor intensity. Trends in the Army are less clear. An example of increasing Army labor intensity at the level of individual systems is the M-2 infantry fighting vehicle, which holds an infantry squad of only 9 members rather than the 11-member squad of its predecessor, the M-113. At a more aggregated level, the Army is currently manning two new divisions with no increase in active-duty end strength.

ing personnel goals reinforces the conclusion that budget shares do not reflect manpower needs.

Operation and Maintenance Costs

One explanation of why personnel costs account for a disproportionately small share of the defense budget is that military manpower costs might have been held down by substituting federal civilian workers or private-sector labor hired under contract. Funding for either type of labor would fall under the appropriation for operation and maintenance, the other broad category within overall O&S. Clearly, then, any assessment of the budget shares hypothesis requires an analysis of the share of O&M.

The O&M budget share has varied within a rather narrow range over the last three decades--rising from about 25 percent of the defense budget in 1955-1965 to over 30 percent by 1980, and then falling back to 27 percent by 1985 (see Table 1). But the adequacy of O&M funding during this period is more difficult to assess than that of the military personnel budget, owing to the diversity of the O&M accounts and the multitude of indicators used by DoD and the Congress to measure readiness and performance.

Some of these indicators, as well as the trends shown in Table 1, suggest that O&M funding has not always been sufficient to meet readiness and performance objectives. In the late 1970s, for example, backlogs of depot and real property maintenance were generally increasing, and training indicators (flying and steaming hours, for example) were falling. More recently, some (but by no means all) of these indicators suggest that improvements have occurred in many dimensions of readiness. 7/

Over a period of several decades, these ebbs and flows might reasonably be expected to balance out. Statistically, such an assumption implies that the average level of O&M funding will bear a stable relationship to the average level of investment. Under this assumption, therefore, statistical regression analysis can be used to test Spinney's hypothesis that in the long run, the O&M and procurement budgets must change at about the same rate. The elasticity, defined as the percentage change in the operating budget resulting from a change of 1 percent in the procurement budget, illustrates whether the operating budget has changed a lot or a little in response to changes in procurement.

7. See Congressional Budget Office, "Defense Spending: What Has Been Accomplished?" (Staff Working Paper, April 1985), pp. 17-19.

Any relation between spending on investment and O&M must take account of lags in the production process. Because high-cost procurement items such as ships, tanks, and planes take anywhere from one to seven years or longer to build, large changes in the O&M budget will probably lag behind large changes in the procurement accounts. Lagging the procurement budget one or more years should increase the degree to which the procurement and operating budgets vary together.

The actual funding levels of both the procurement and O&M budgets for general purpose forces (Program 2) for fiscal years 1962-1983 are shown in Figure 6. The funding levels of the two budgets tend to vary together, but the lesser volatility of the O&M appropriations implies an elasticity smaller than 1.0. Also, the two lines appear to be more in phase when the procurement line is shifted to the right. This visually confirms the notion that O&M changes lag procurement changes.

To test Spinney's hypothesis, CBO compared the procurement and military construction accounts of the general purpose forces (Program 2) with the O&M account totals for Program 2 and related programs in each service. ^{8/} Using standard statistical techniques, regression equations then were estimated between the various measures of O&M and the appropriation totals for the investment accounts. In such equations, the overall "goodness of fit" is indicated by the coefficient of correlation (R^2). The regression coefficient of the independent variable is the estimate of the percentage change in the dependent variable--O&M--in response to a 1 percent change in investment appropriations.

The investment proportionality hypothesis implies both a high correlation coefficient (that is, a value close to 1.0) and a statistically significant regression coefficient, or elasticity. The results of the analysis, however, are mixed. Table 2 presents the "best" regression equations for each department and for DoD as a whole. The estimated correlation coefficients typically are near or below 0.6, meaning that 60 percent or less of the variation in O&M from year to year is related statistically to variation in investment. And the estimates of the elasticity coefficients indicate that a 10 percent change in investment typically results in a change of anywhere from 3 per-

-
8. Operation and maintenance costs were tabulated for Program 2 (general purpose forces), Program 7 (central supply and maintenance), and Program 8 (training, medical, and other personnel activities). These costs were also aggregated for Programs 2 and 7 and Programs 2, 7, and 8. These various measures of O&M were tabulated individually by military department (Army, Navy--including Marine Corps--and Air Force) and were summed to DoD-wide totals.

FIGURE 6.

DoD Investment and Total O&M Spending

(In Billions of Constant 1985 Dollars)

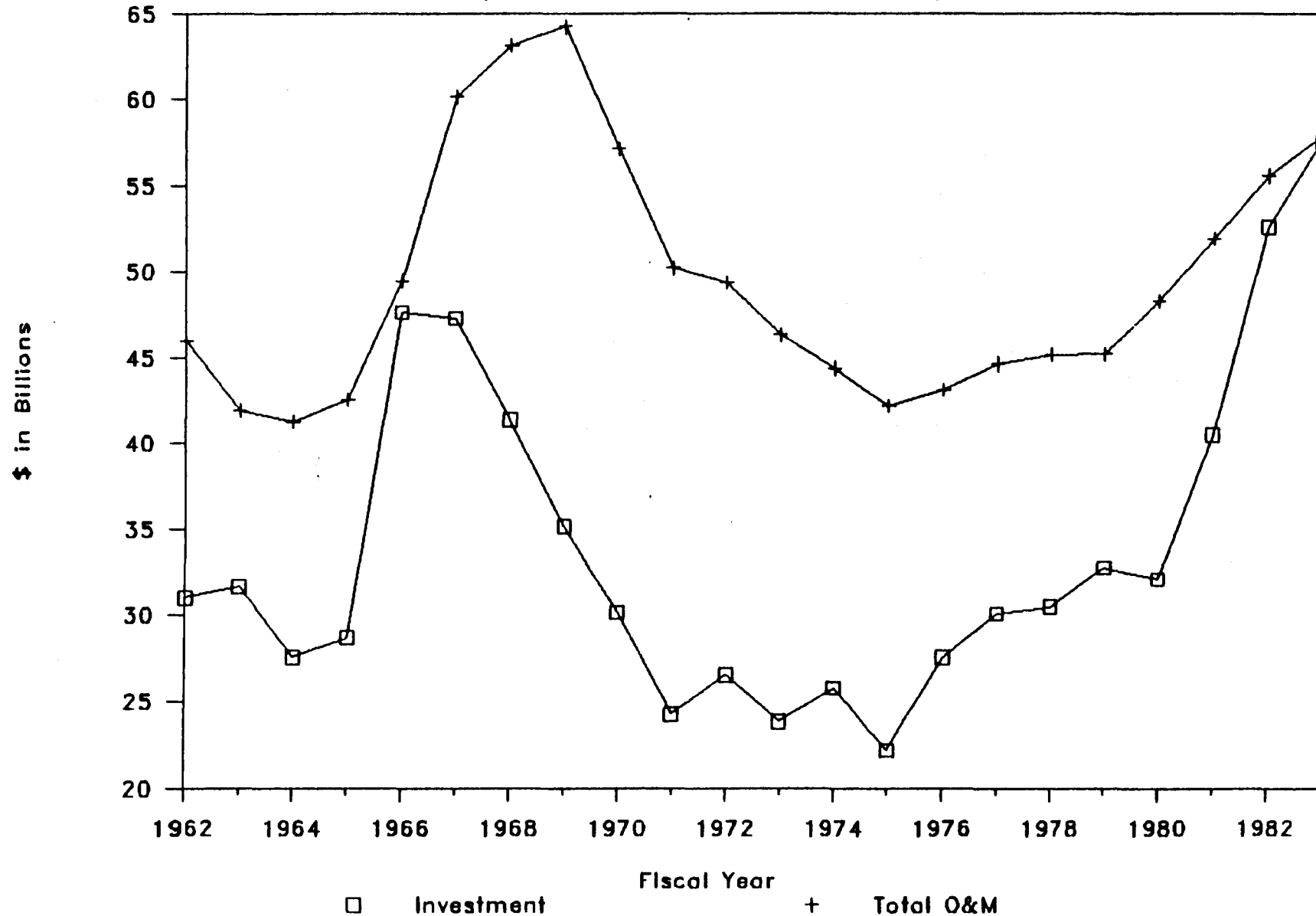


TABLE 2. STATISTICAL RELATION OF O&M TO INVESTMENT,
FISCAL YEARS 1962-1983

O&M Category <u>a/</u>	Lag Between Investments and O&M (In years)	Coefficient of Correlation (R ²)	Elasticity
Army			
Program 2	1	.60	.44
Programs 2 and 7	2	.52	.38
Programs 2, 7, and 8	2	.42	.30
Navy			
Program 2	0	.29	.84
Programs 2 and 7	0	.26	.56
Programs 2, 7, and 8	0	.28	.52
Air Force			
Program 2	1	.63	.57
Programs 2 and 7	2	.57	.36
Programs 2, 7, and 8	3	.28	.28
DoD Total			
Program 2	1	.60	.76
Programs 2 and 7	1	.68	.59
Programs 2, 7, and 8	1	.64	.48

SOURCE: Congressional Budget Office, using data from the Five-Year Defense Plan (Fiscal Years 1962-1983).

NOTE: "Best-fit" log-linear regression equations.

- a. Program 2 = general purpose forces; Program 7 = central supply and maintenance; Program 8 = training, medical, and other personnel activities.

cent to 8 percent, depending on which department and which elements of the O&M budget are being examined. Such variable results conflict with the investment proportionality hypothesis (although they are not inconsistent with the "square-root rule" discussed in Chapter II).

As suggested by Figure 6, the correlation between investment and O&M is highest when O&M is lagged one or two years (that is, when O&M is linked to procurement one or two years earlier). This finding indicates that the budgets have not followed a strict budget share ratio but are more clearly related to the value of the newly procured equipment as it enters service. (Note that since investment is only the change in capital stock, this correlation does not bear on Kaufmann's capital stock proportionality hypothesis.) The other budgets for the Army and Air Force and for DoD as a whole show a significant degree of proportionality with the lagged procurement accounts. The Navy is the only department whose budgets do not correlate well--perhaps because of the long lag time (five to nine years) between the initial procurement and final delivery of ships.

The degree of correlation varies with both the portion of the O&M budget examined and the service. The part of the budget that pays for day-to-day operations such as fuel and routine maintenance of general purpose forces equipment (Program 2) shows the highest correlation with procurement, with a zero or one-year lag. Adding Program 7 (central supply and maintenance) tends to lower the correlation with procurement and lengthens the lag. The combination of Programs 2, 7, and 8 (training and medical) O&M funds, which account for almost 80 percent of the non-strategic O&M budget, yields a moderately high correlation coefficient, but generally not as high as that of the Program 2 regression.

Measuring the elasticity of O&M funding in response to changes in procurement funding provides a check of Spinney's statement that the operation and maintenance budget may not be increasing sufficiently to match the increased procurement budget. Since elasticity measures the ratio of the percentage change of one variable in response to the change in another, a ratio that has a value close to 1.0 means that one variable changes at approximately the same rate as the other. If the ratio is greater than 1.0, one variable--in this case the O&M budget--has a higher percentage change than the other--the procurement budget. If the ratio is less than 1.0, the converse is true.

In the past 22 years, the O&M budget for each category has tended to change less than the procurement budget (see Table 2). ^{9/} The total of the

-
9. For some examples of how different categories of support costs have been affected by the added complexity of modern weapons, see Les

O&M budgets for Programs 2, 7, and 8 shows an elasticity of somewhat less than 0.5; that is, the percentage change in the O&M budget has historically been about half as great as that of the procurement budget. This is understandable since many fixed O&M costs do not change in direct proportion to procurement. Especially if increases in procurement costs reflect greater complexity rather than larger numbers of weapons, many categories of support costs probably should not vary--the same bases must be maintained and the same headquarters personnel must be paid, for example.

In recent years (fiscal years 1981-1983), the elasticity of the O&M budget to changes in the procurement budget has been lower than in prior years--about 0.3 for the combined O&M accounts for Programs 2, 7, and 8. The relatively low growth in O&M during these years, however, may be an aberration caused by the "front-loading" of procurement during the early 1980s. Spinney has presented projections for the combined operations and maintenance and military personnel budgets. ^{10/} These DoD projections for fiscal years 1985-1989 show a much higher elasticity for the entire O&S budget--about 0.65--than was the case during the early 1980s. ^{11/} This relatively high rate of planned increases in the total O&S budget indicates that overall changes in levels of support during the 1980s may not be inconsistent with changes during the 1960s and 1970s.

(continued)

Aspin, "The Mayaguez Stumper, or, How to Figure What's Enough for Military Readiness" (U.S. House of Representatives, April 1984), p.2.

10. Spinney, Statement for House Budget Committee, December 31, 1983, Fig. 4, p. 32.
11. The low amount of growth that will be required in the out-years for the military personnel portion of the O&S budget means that the elasticity of the O&M budget will no doubt exceed 0.65.