N-1000-AF

February 1979

THE SIGNIFICANCE OF DIVERGENT U.S.-USSR MILITARY EXPENDITURE

Arthur J. Alexander, Abraham S. Becker, William E. Hoehn, Jr.

A Rand Note

prepared for the

United States Air Force

Rand
SANTA MONICA, CA. 90406

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

The research reported here was sponsored by the Directorate of Operational Requirements, Deputy Chief of Staff/Research, Development, and Acquisition, Hq USAF, under Contract F49620-77-C-0023. The United States Government is authorized to reproduce and distribute reprints for governmental purposes notwithstanding any copyright notation hereon.

The Rand Publications Series: The Report is the principal publication documenting and transmitting Rand's major research findings and final research results. The Rand Note reports other outputs of sponsored research for general distribution. Publications of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

Published by The Rand Corporation

N-1000-AF

February 1979

THE SIGNIFICANCE OF DIVERGENT U.S.-USSR MILITARY EXPENDITURE

Arthur J. Alexander, Abraham S. Becker, William E. Hoehn, Jr.

A Rand Note

prepared for the

United States Air Force

Rand

SANTA MONICA, CA. 90406

PREFACE

This note responds to an inquiry to Rand from Lt. Gen. Thomas P. Stafford, Deputy Chief of Staff for Research, Development and Acquisition, Headquarters USAF, raising a number of questions on the significance of recent estimates of comparative U.S./USSR military expenditure, the style and efficiency of Soviet weapons acquisition, and the criteria for determining U.S. military expenditure needs.

Part I, written by Abraham Becker, discusses the size of the Soviet military effort and the volume of military goods and services produced. It seeks to clarify the main "rules of the game" of estimating Soviet military expenditure and drawing comparisons with U.S. outlays. One of the elementary rules is that comparisons of military expenditure are not directly equivalent to comparisons of military capability. A major intervening variable--although certainly not the only one--is the relative efficiency of weapons developments. Therefore, Part II, by Arthur Alexander, takes up what we know about Soviet weapons acquisition and how it contrasts with that of the United States. Part III, by William Hoehn, provides force-posture context to the military expenditure disparities summarized in Part I and then considers the relevance of these issues to determination of U.S. military requirements.

SUMMARY

Military expenditure (ME) cannot be an indicator of national security or even of military security, because these concepts incorporate many other factors besides the development, preparation, or use of military forces. At best, ME is an indicator of national capability to apply physical force--military force potential. Moreover, it is inputs to force potential, not output, that ME actually measures--the potential to produce military goods and services.

Soviet ME figures in four kinds of measures: comparative (U.S./USSR) size of ME, rate of growth of ME, the burden of ME, and comparative (U.S./USSR) size of ME and GNP. The theoretical requirements for each measure are outlined and attention is drawn to the chief methodological pitfalls. The CIA's "building-block" approach to estimating Soviet ME is distinguished from the alternative of manipulating Soviet economic and financial statistics. Only the former is currently able to provide the detail we need. However, the latter could, in principle, provide checks on the major aggregates of Soviet military outlays. Thus, the two approaches should be regarded as complementary rather than competitive.

This conceptual-methodological discussion provides the basis for understanding available estimates of Soviet ME. For the CIA estimates, the most significant finding is that steady increases in Soviet ME over a decade and a half, plus sharp decreases in U.S. outlays in the first part of the 1970s, have caused Soviet programs for several years to exceed those of the United States in aggregate size; and the margin has been widening considerably. Alternative estimates of the size of total Soviet ME in rubles and its rate of growth over the past decade or two diverge from the CIA figures for various reasons, but they all agree that a sharp increase has taken place in annual Soviet ME, adjusted for inflation. This is certainly not true of American defense outlays.

The dollar value of Soviet activities, net of military pensions, currently exceeds comparable U.S. expenditures by 45 percent (if all

personnel costs are excluded from both valuations, the USSR/U.S. ratio is still 1.25 to 1); the comparable valuation of U.S. military activities in rubles (an inherently less certain valuation) leads to an estimated Soviet margin in ruble terms of 25 percent. Thus, whether valued in dollars or rubles, the current Soviet expenditure margin over the U.S. expenditures is substantial and is forecast to continue into the future.

CIA projects a continued increase of Soviet ME until the early or mid-1980s, perhaps at a slightly slower pace than observed over the last 10 or 15 years. The burden of Soviet defense, in terms of the share of GNP allocated to ME, is also likely to continue at roughly the same high level estimated for the recent past.

Clearly, a wide disparity has developed between the size of Soviet military programs and those of the United States. As indicated, this is a gap of inputs of military goods and services. But given the size and duration of this disparity, it must have resulted in a change in comparative military capability in favor of the USSR. Continuation of this trend would most probably result in further Soviet gains in military power.

A major link between resource mobilization and military effectiveness is weapons development, transforming resources into future weapons systems. The characteristic pattern of Soviet weapon design is simplicity of equipment, common use of subsystems and components, and improved performance through incremental change. Compared with similar U.S. systems, this approach yields weapons with restricted technical performance and fewer mission capabilities. High-level political intervention has been the means for breaking out of this pattern for important selected systems--ICBMs, nuclear weapons, and, possibly, high-powered lasers and directed energy devices.

The Soviets' design pattern is consistent with their doctrine calling for massive armed forces. The rigid, planned economy, which reduces the flexibility of designers and producers, is also a strong, driving force for the Soviet weapons R&D pattern.

These design practices result in lower life-cycle costs than for similar American systems, with production costs of several examined systems lower by factors of 2 or 3, and maintenance requirements lower

by up to an order of magnitude. However, the lagging Soviet technology can make some systems much more expensive than U.S. equipment. Restricted mission capabilities may also make it necessary to field more systems to cover a giv t of requirements. It is thus not possible to assess efficiency of Soviet weapons acquisition by examination of R&D styles.

Despite less sophisticated technology and constrained weapon performance, the military value of deployed Soviet weapons is often judged not inferior to that of U.S. weapons. This may be related to continuity of research and design organizations; use of training and maneuvers to generate doctrinal, tactical, and design feedback to developers; and evaluation of new weapons as an integrated part of the total fighting force. Large-scale political intervention can also energize new areas, but that seems more successful when the USSR is catching up than when it attempts to be in the vanguard.

There are many advantages inherent in the Soviet approach to military R&D. However, the U.S. retains great strength in its flexible, adaptive, and innovative industry. The fragmented, nonmonolithic U.S. military R&D establishment, which creates many problems, may nonetheless be more open to innovation than the closed Soviet system. Furthermore, if future weapons incorporate increasingly diverse technologies drawing on the total breadth of the economy, the Soviets may find it increasingly difficult to keep up their past levels of performance.

Even so, the disparity between the size of the United States and USSR annual military programs may continue to grow. This divergence is another indicator that the United States needs added effort in military preparation. The magnitude of the disparity in many of the mission areas is impressively large: a three-to-one advantage to the Soviet Union in Strategic Forces spending over the past half-decade; about 75 percent more than U.S. spending for General Purpose Forces over the same period; and near-parity with the United States in Support Forces spending. From a resources perspective, the dollar values of Soviet operating activities were about 25 percent above those of the United States, partly reflecting the costing of Soviet military manpower at U.S. pay rates. In military investment--procurement and construction--the Soviet margin has been 50 to 80 percent above the United States over

the last half-decade. The aggregate margin since 1973 in this category is about $100 billion. The size of this gap is difficult to comprehend in terms of hardware and systems. As a hypothetical illustration, suppose that sum had been available to the United States for investment; as additions to our existing force structure, it could have covered all of the following: the entire B-1 program; the baseline M-X program (missiles and shelters); all of the currently programmed Trident submarines and missiles; the roughly 7000 XM-1 tanks we now plan to acquire, together with a matching number of infantry fighting vehicles and the once-planned buy of AMSTs to provide them with intra-theater mobility; and still left enough to buy all of the F-14s, F-15s, F-16s, F-18s, and A-10s now planned for Air Force and Navy tactical air modernization. This example, hardly a recommended program, would have sufficed to modernize all three legs of the Triad at once, strengthen our ground combat capability, and fully modernize Air Force and Navy tactical airpower. Of course, it is not clear that these could all have been produced in the six year interval, nor has any consideration been given to the economic consequences of such large U.S. military expenditures.

However, the so-called "defense spending gap" cannot be a measure of the U.S. effort required, except by chance; the required U.S. ME rate might be larger or smaller than the measured "gap." Determination of the desirable rate of spending depends on the mix of military capabilities necessary to meet peacetime, crisis, and long-term competition criteria. Assessments of these needs are difficult to perform, and current high-level U.S. strategic balance evaluations tend to be simplistic. In particular, they reflect mirror-image assumptions about Soviet objectives and behavior. To define how much ME is enough for the United States requires major doctrinal, methodological, and analytical progress.

In the interim, informed judgment must suffice. The current DoD assessments continue to express satisfaction with the state of the military balance today. However, they suggest that confidence in maintaining the balance in the future is somewhat lower, and that we may be accepting a somewhat larger degree of risk than has been deemed acceptable heretofore.

CONTENTS

PREFACE iii

SUMMARY v

Part
I. THE MEANING AND MEASURE OF SOVIET MILITARY EXPENDITURE .. 1
A. Military Expenditure and Military Power 1
B. Soviet Military Expenditure 4
1. Conceptual Issues of Measurement 5
2. Measurement Approaches 11
3. CIA Estimates 12
4. Alternative Estimates 15
5. Projections of Soviet Military Expenditure 21
C. Conclusions 22

II. STYLE AND EFFICIENCY OF SOVIET WEAPONS ACQUISITION AND THE LONG-TERM COMPETITION 26
A. Soviet Style 26
B. Reasons for Common Design Patterns 33
C. "New in Principle" Weapons 36
D. Implications for Efficiency 38
E. Soviet Advantages in the Long-Term Competition 39
F. U.S. Advantages in the Long-Term Competition 41

III. TOWARD A BETTER UNDERSTANDING OF U.S. MILITARY EXPENDITURE REQUIREMENTS 44

I. THE MEANING AND MEASURE OF SOVIET MILITARY EXPENDITURE

A. MILITARY EXPENDITURE AND MILITARY POWER

An appraisal of the comparative record of Soviet and American military expenditure (ME) must begin by posing the question of the meaning and usefulness of a comparison of outlays. After all, interest in such analysis does not reside in financial issues but in the relations of ME to the military power of the two states. What are the connections between ME and military power? Are we justified in interpreting ME in power terms? What concept of power is appropriate?

It would be desirable if ME could be interpreted as an indicator of national security. However, this concept embraces many other factors besides military forces--in particular, the whole complex of international economic and political developments, whose changes may run counter to those in military force levels. To avoid this difficulty, one might narrow the focus to military security--the aspect of national security that can be effected by military means. Unfortunately, this concept, too, is unmanageable for measurement, because it requires specification of the external threat and the degree to which military force can be utilized to counter the threat. It involves identification of relevant scenarios and quantification of such intangibles as morale and national determination. Thus, the effect of a change in a country's ME on its own military security is not determinable without reference to a complex set of exogenous factors.

To surmount this difficulty, consider a measure based only on the national capabilities to apply physical force against external opponents--that is, without any reference to the external context. This may be dubbed military force potential. Evidently, this is a major component of military or national security, but it is not the only one, or even in many cases the decisive one. However, force potential lends itself to interpretive linkage with ME, because it

is independent of the opponent's capabilities and intentions or of the multiplicity of possible conflict scenarios.

Nevertheless, the interpretation of ME in the sense of force potential is problematic in two senses. First, ME is a "flow" concept, but force potential is derived from the "stock" of military forces. In any period, potential military power is a function of the forces in being at the beginning and of those added during the given interval, net of withdrawals and unintentional losses. ME takes no account of the contribution of the existing equipment inventory except in terms of maintenance and repair costs; and the additions to the weapons, equipment, and structure inventory constitute gross, rather than net, investment. In a single period, ME represents the value of current gross capital additions to force potential plus the costs of operating and maintaining existing and added forces (along with outlays on R&D--the addition to future knowledge and capability). The important missing element is the value of the services of pre-existing capital during the interval. The shorter the interval, the greater this obvious shortcoming of ME as a measure of force potential. For any state with longstanding armed forces, annual ME is generally a sharp underestimate of national force potential; cumulative ME over a decade or so more closely approaches an appropriate value of force inventories.

The second problem relates to the value units underlying ME figures. If the figures are to be interpreted in terms of force potential, even in the limited sense indicated above, the relative prices of military goods and services must be roughly proportional to the rates at which these goods and services can be substituted for each other to yield given quantums of force potential. This would be the case if reality had the properties of the textbook mathematical model, where military planners, taking prices as given, maximize a military utility function under a fixed budget (or minimize costs for a fixed utility level). However, reality diverges from model simplicities:

(1) Inconsistent choices. Military utility functions are difficult to specify, especially with respect to present contributions to future force potential. Moreover, choices may be guided by nonmaximizing criteria, such as "satisficing" or compromising conflict among significant interest groups in the society.

(2) Prices not parameters. The military establishment of a major power is often so large relative to its supplying industry that procurement choices inevitably affect prices, thereby limiting the applicability of a maximization model.

If ME is difficult to relate to force potential "output," the linkage must be sought in "inputs." Such an interpretation recognizes that prices of military goods and services reflect production costs rather than military utilities. ME would therefore be interpreted in terms of potential to produce military goods and services, analogous to the economist's view of national income as potential to produce economic goods and services, an alternative to the welfare interpretation in terms of utilities.

The noneconomist may wonder at this point whether the game is worth the candle. If ME has such a qualified connection to military power, why bother with value measurement at all? Why not stick to physical indicators of force levels and power potential? For many purposes, the physical indicators are indeed appropriate and necessary. No effort to develop an intercountry balance of military forces should content itself with comparative ME. Analysts will want to compare numbers of men and weapons, levels of firepower, readiness states, etc. However, physical units of heterogeneous elements cannot be added or subtracted unless converted to a common denominator. The most general of all metrics is money; therefore, the simplest means of aggregating physical forces across the board of services, missions, and programs is money prices. This is particularly useful if the prices used as weights to combine physical goods and services can be given a conceptual interpretation that provides specific, if

second-best, meaning to the value measures. Such a modest but definably relevant meaning should not be dismissed, given the often considerable hazards and doubtful benefits of manipulating a variety of physical indicators.*

B. SOVIET ME

Given this understanding of the meaning of ME in its relation to military power, we turn now to consider the measures of Soviet ME. Despite periodic belaboring, the issues involved in the measurement of Soviet military outlays are still confused in public discussion. As Rush V. Greenslade lamented a decade ago:

> Rubles, dollars
> Computer, collars,
>
> Engineers, chemists
> Male or femist,
>
> Capital and labor
> For plough or saber,
>
> Opportunity cost,
> Steel capacity lost;
>
> We'd choose a measure if we knew how!
> Burden, burden, who's got the burden now?

Before taking up the available estimates (the most comprehensive of which originate in CIA), we must consider the nature and applicability of the measures in common use. In view of the continuing controversy over the reliability and accuracy of CIA's estimates, it also seems desirable to summarize the alternative approaches to measurement of Soviet ME.

---

*A particular and major case in point is strategic offense, where a careful study concluded that "in terms of indices of the balance or of dynamic calculations of strategic attack capabilities . . . [all the existing] methods and measures suffered from severe limitations." James L. Foster, "Essential Equivalence: What Is It and How Should It Be Measured?" in Equivalence, Sufficiency and the International Balance. Proceedings of the National Security Affairs Conference, July 17-19, 1978, National Defense University, August 1978, pp. 49-50.

1. Conceptual Issues of Measurement

There are four kinds of measures required for particular objectives: comparative (U.S./USSR) size of ME, rate of growth of Soviet ME, the "burden" of Soviet ME, and comparative (U.S./USSR) size of ME and GNP.

The measurement of comparative size of Soviet ME relative to that of the United States is a special case of the general class of binary international economic comparisons and is treated in the same way as other cases--by reevaluation of the outlays of one of the pair of countries in the prices and costs of the other. Thus, the standard method for sizing Soviet ME involves its transformation into dollar values.

Some observers are very uneasy about the seemingly artificial nature of the dollar valuation methodology, which asks, in effect, what would it cost the United States to train, maintain, procure, etc. the Soviet force? Some are upset that the large number of Soviet men under arms, obtained by conscription and paid at nominal rates, is costed at the higher U.S. pay rates. When U.S. military pay rates were sharply increased in the late 1960s, Soviet ME in dollar valuation suddenly (and, it is alleged, unjustifiably) shot up. Of course, U.S. ME also increased as a consequence of the pay hikes, so that the ratio of Soviet to American ME was affected only by the structural effect. Moreover, it may be counterargued, alternative calculations can be made using U.S. conscript force pay rates. These calculations show an expected reduction in the relative size of Soviet ME, but by a much smaller margin than the critics suggested. In any event, the value of comparative size measurements is contained not in the reading at any point but in the time trend. We return to this issue shortly.

The more general and somewhat more sophisticated objection to dollar measurement as an approach emphasizes the artificiality of the sizing question. If the Soviets were confronted by dollar relative

prices, they would probably develop a substantially different force from that observed, which is a response to a different set of scarcity relations. By the same token, it would not be rational for the United States to imitate Soviet force posture decisions under U.S. cost conditions. Actually, there may be well-founded arguments why U.S. military planners might wish to consider at least parts of the Soviet force as alternatives to our own. However, the basic response to this objection is that it points to the need for a parallel ruble measurement. Along with the valuation of Soviet ME in dollars for comparison with that of the United States, it is necessary to develop a valuation of U.S. ME in rubles for comparison with the counterpart Soviet ruble outlays. This comparison poses the equally awkward question, What would it cost the USSR to train, maintain, procure, etc. the American force? Both ratios represent equally valid readings on the difficult measure of the relative national capacities to produce military goods and services. No other readings are possible, because any other set of price weights would be irrelevant.

Each country tends to emphasize activities that are relatively cheaper than in the other country, so valuation at U.S. prices emphasizes Soviet manpower-intensiveness; conversely, the ruble valuation attaches high ruble price weights to the more advanced American technology. The consequence is that the ruble-weighted USSR/U.S. ratio is lower than the counterpart dollar comparison. The difference in results is the consequence of different relative prices and quantities produced in the two countries. In general, in any international comparison, the greater the structural differences between the two economies, the wider the probable gap between the two ratios and the more misleading is an average of the two ratios in concealing the important information about structural divergence. There is some evidence that the structural disparities between the United States and the USSR have narrowed over the past two decades, so the difference between ruble and dollar-based size ratios is probably smaller now than it was in the 1950s.

Earlier it was stated that size ratios at any one time have a restricted utility. If we wish to view ME in terms of military capabilities, we must recognize that the distinction between stock and flow is greatest for the single annual snapshot. If ME is to be accepted as a reasonable proxy for inventory values, this can be only for a cumulative time series and over a reasonably lengthy period--say, a decade or more. In this report, we stress a somewhat different view of ME, in terms of potential to produce military goods and services--an interpretation oriented toward cost rather than effect. Although such an interpretation provides a more defensible basis for size comparisons at one time, we should recognize that relative production potential is best pictured as a process in time. Therefore, the focus should be on the time change in size ratios.

This leads directly to consideration of the measure of the rate of growth of Soviet ME. The main issue is whether the rates of change are to be measured on the basis of ruble or dollar values. Comparison of outlays by a single country in two time periods is formally identical as a measurement problem to comparison between two countries in a single interval. The passage of time brings structural change within a country analogous to the structural differences of international comparisons. Thus, it may be expected that the measurements using each period's prices as weights will yield different results. Generally, earlier period weights enhance the observed change relative to later period weights, and the greater the degree of structural change between the two periods, the wider will be the gap.*

Two corollaries flow from this principle:

(1) In terms of modernization or structural sophistication, U.S. dollar prices may be viewed as constituting late period, and ruble prices as early period, price weights.

*The principles stated here apply whether rates of growth are calculated as the implied average annual change between initial and terminal points of a series or whether the calculation takes into account, by any of a number of different formulae, intervening changes.

Hence, the rate of growth of Soviet ME in rubles should be larger than that of the counterpart series valued in dollars. However, the legitimacy of the dollar-weighted series in this case is not self-evident but depends on the assumption that the expansion path of Soviet production is headed roughly in the general direction of the U.S. quantity mix and set of cost relations. If that were not the case, dollar prices would have no higher standing as a set of index weights than any other country's prices equally distant from the USSR's growth path.

(2) Just as the sizing objective required two equally valid complementary measurements, so, in principle, does the objective of assessing the rate of growth of Soviet ME require alternative measures with price inputs drawn from different periods. On the assumption indicated, dollar price weights are an appropriate complement to ruble price weights. In addition, depending on the length of the period considered, it may be useful to introduce a second set of Soviet price weights. It would be expected that Soviet ME over, say, the past two decades grew faster when measured in 1955 than in 1978 prices. The differences between the two calculated rates of growth would reflect the degree to which relative prices and quantities changed between the measurement points. This prediction is based on known changes in the Soviet price system, from which it may also be hazarded that the effect of changing from 1970 to 1978 prices is likely to be considerably smaller than a switch from 1955 to 1970 prices. The sharper the transformation of economic structure, the more difficult it is to evaluate late period growth in terms of early period prices, because of the difficulty of framing appropriate weights for sophisticated goods not produced in the early period.

The third measurement objective is the effect of ME on the Soviet economy. This is generally described as the measurement of the "burden of defense" in the USSR, and the conventional indicator is the share of GNP devoted to ME. The issues involved in assessing economic effects are far broader than the defense share of GNP. It is also generally recognized that the policy relevance of the defense burden can only be to its perceived effect, which may bear no relation to the crude objective indicator of Defense/GNP. However, some evaluation of the extent of the military drain on national resources and the penalty paid in terms of civilian alternatives forgone is probably made at some level of Soviet decisionmaking. A simple aggregated comparison of ME and total output may be a starting point for Soviet policy formulation as well as for Western analysis.

What are the appropriate values for the simple burden measurement? Clearly not dollar prices, which bear no necessary relation to the tradeoffs among the Soviet national bill of goods and services that are intended to be summarized in the ME/GNP ratio. Only ruble prices could satisfy that requirement. Also, prices of the year of the calculation, rather than any set drawn from the past, are the most appropriate mirrors of production alternatives in the interval of interest. A time series of such ratios should be based on current-price ruble values of each year.

It is well known that the administered nature of Soviet prices makes them deficient tools for analysis of real costs. The problem of appraising the Soviet price system and its utility for economic measurements and analysis preoccupied Western analysis of the Soviet economy for many years. The consensual resolution of the difficulty has involved adjustment of reported Soviet magnitudes for the major deficiencies of the price system. The results, as far as national output and its components are concerned, are viewed as approximations to factor cost valuations sufficiently close to bear the weight of economic analysis. The same criterion of valuation is applicable to the measurement of ME and its share of GNP.

It is also generally known that Soviet planners and statisticians operate with a different set of national accounting concepts than is used in the West. Gross and net material product are ideologically preferred to the West's gross and net national product, and the two sets of aggregates differ substantially in concept and definition. It is not clear to what extent such calculations figure in the Soviet decisionmaking process, but it seems likely that it is the Soviet, not the Western, accounting framework that would be used.

More sophisticated efforts at measuring the economic effects of ME on the national economy involve various econometric approaches, ranging from regression analysis to simulations with complex models of the economy. The pricing principles discussed briefly here generally also apply to the econometric approaches.

Finally, there has also been interest in simultaneous U.S./USSR comparisons of ME and GNP. Such calculations are seldom made but when they are they have been subject to methodological abuse, so that the public has been confused by the results. The typical layman's question is: If the Soviet economy is only half as large as ours, how can they spend half again as much on defense as we do and still devote only one-eighth of their GNP to defense? The reason for the confusion is that the three elements of this comparison are constructed with different price weights and therefore cannot be legitimately juxtaposed.

The ratio of Soviet to American defense is based on a dollar valuation of both sides' ME, and the Soviet ratio of defense to GNP is a ruble calculation. However, the GNP ratio is an average of the ruble and dollar sizings, implying a set of weights for both countries that is neither rubles nor dollars. The illegitimacy of this comparison is underscored by the numerical absurdities to which it can lead.* The appropriate formulation of this problem would note that

*See A. S. Becker, "Comparison of United States and USSR National Output: Some Rules of the Game," World Politics, 13:1, October 1960, pp. 99-111.

Soviet ME is half again as large as ours when the dollar valuation shows Soviet GNP as much as two-thirds of the American. In the complementary ruble sizing, the Soviet-American gap is wider but the Soviet/U.S. ME ratio is also smaller.

2. Measurement Approaches

The issue of alternative ways of measuring Soviet ME arises, of course, because of unanimity in the West that official Soviet figures are unreliable. The Soviet government reports only a single number, allegedly total outlays for "defense." However, the discussion in Soviet sources of the scope and coverage of this datum is ambiguous, the reported time series displays obvious inconsistencies with known increases in the physical numbers of Soviet forces, and the recent absolute levels of "defense" seem impossibly small for the size of the increments of Soviet armed power. Moreover, there is substantial reason to believe that important ME components are concealed under other headings in the Soviet state budget.

The evident unreliability of the official Soviet claims and the concealment of all structural detail necessitates independent estimates of Soviet ME. There are two different approaches to independent estimation. The first manipulates Soviet economic data to uncover concealed military elements in the published statements on the state budget, national income, and machinery production (for an estimate of procurement). The task of identifying and pulling away the concealment imposes severe methodological and data problems, and it is doubtful that these problems have been successfully resolved. Estimates of total Soviet ME obtained in these ways remain subject to an unknown but possibly wide margin of error.

In view of the major data difficulties attached to manipulating Soviet financial and production statistics, CIA has long relied on the second, so-called "building block" approach, in which total military expenditures other than R&D are obtained by aggregating Soviet military activities in physical units weighted by appropriate prices. Because this approach depends upon accumulating massive detail on Soviet military activities, prices, and costs, it has proved feasible

only for the government; analysts outside the government have not had access to either the resources or the intelligence apparatus necessary to compete effectively. However, the two categories should not be viewed as exclusively competitive. Estimates derived from budgetary national income and production statistics cannot detail the structure of Soviet expenditure by program, mission, and military organization. But the statistical approaches could, in principle, provide valuable checks on the major aggregates of Soviet military outlays, thereby helping to identify part of the estimating error inherent in building block calculations. It is of national importance to maintain adequate, mutually supporting levels of effort along both lines.

3. CIA Estimates*

In CIA estimation, the cumulative total of U.S. ME since the mid-1960s is roughly equal to the cumulated sums of dollar valuation of all Soviet military programs in the same period. However, where the dollar-costed Soviet aggregate defense basket seems to have been growing monotonically since 1965, U.S. outlays rose steeply until 1968, then declined steadily through 1976. The crossover point of the two national value lines came in 1971, and the Soviet margin widened until 1978. By now, the dollar value of Soviet activities, net of military pensions, exceeds U.S. ME, comparably defined, by about 45 percent. Soviet military manpower levels substantially exceed those of U.S. forces, and dollar costs per man are high; so exclusion of all personnel costs from both U.S. and Soviet valuations reduces the current USSR/U.S. ratio, but only to about 1.25 to 1.

Dollar costing suggests that the cumulative gross additions to military forces of the two powers were roughly the same over the past 12-13 years but increasingly divergent during the early and middle 1970s. Another way of expressing this result is by breaking down the

---

*A Dollar Cost Comparison of Soviet and U.S. Defense Activities ... : 1966-1976, SR 77-10001U, January 1977; 1967-77, SR 78-10002, January 1978; 1968-78, SR 79-10004, January 1979. Estimated Soviet Defense Spending in Rubles, 1970-1975, SR 76-10121U, May 1976; and Estimated Soviet Defense Spending: Trends and Prospects, SR 78-10121, June 1978.

aggregates into their resource category elements. Such a distribution of costs indicates that whereas the USSR/U.S. ratio for cumulative total operating outlays (including personnel costs) over the past decade was only somewhat greater than unity, the ratio was about 1.25 for cumulated investment (procurement and construction). These value data take no account of depreciation or of losses and their replacement, a fact that, in light of U.S. involvement in the Vietnam War, may understate the Soviet/American ratio. There is little doubt, however, that in the 1970s the ratio was increasing markedly. On the average in the last three or four years, the dollar value of annual Soviet investment was roughly 75 percent greater than counterpart U.S. outlays. Because the comparison of RDT&E is a much less firmly based estimate, CIA will say only that "Soviet RDT&E activities in 1978 were substantially larger than those of the United States." Soviet operating activities in dollar terms are now 25 percent larger than U.S. operating outlays.

The conclusion of a substantial growth in the aggregate size of Soviet programs relative to those of the United States holds not only in dollars but apparently also in ruble valuation. Methodological and empirical problems still stand in the way of systematic ruble costing of U.S. programs, but the calculations that have been made indicate that the ratio of Soviet ME to the ruble value of U.S. activities is also greater than 1, though observably less than in dollars (1.25 rather than 1.45). Ruble sizing would probably show a later crossover point and, of course, a smaller cumulative Soviet than U.S. total.

The dollar cost of Soviet strategic forces programs since the mid-1960s has been considerably and significantly larger than U.S. outlays on this set of missions. The margin of difference has varied, but over the period as a whole it has been roughly 150 percent. In 1978, the Soviet package measured three times as large as the American. Part of the gap is accounted for by the fact that the United States has no counterpart to Soviet peripheral attack forces. Moreover, the United States devotes far less attention and fewer resources to strategic defense. However, U.S. outlays on intercontinental attack (the

strategic offensive component of strategic forces) are only two-thirds as large as the dollar cost of Soviet activities in this category.

The dollar value of Soviet GPF programs began to exceed U.S. outlays for this purpose in 1971 and since 1973 has been more than 50 percent greater in each year. The USSR/U.S. ratio for support forces was only about 0.5 in the mid-1960s and is just now reaching unity. Because of the sharp decrease in U.S. expenditures on land forces since the peak of the Vietnam involvement and the steady increase of Soviet outlays, the dollar value of Soviet land force activities is now more than two and a half times the value of U.S. land force activities. All U.S. naval expenditures are larger than the dollar-costed Soviet programs; if attack carriers and their associated aircraft are excluded, the sign of the ratio reverses and the Soviet naval basket appears about one-quarter larger. U.S. outlays on tactical air have generally trended downward, and Soviet outlays have grown considerably. The result is that from a level five times as large, U.S. tacair expenditure is now only about 50 percent greater than the dollar-valued Soviet tacair programs.

An important observation about these impressive changes in comparative size levels is that by and large they were not the result of dramatic spurts in Soviet spending. They resulted from American post-Vietnam downturns and generally moderate but steady rates of buildup on the Soviet side. Over the past decade or more, Soviet ME valued at 1970 ruble prices is estimated to have grown at 4-5 percent per year, roughly apace with the increase in GNP.* Measured in dollars, the rate of growth appears smaller, about 3 percent. As suggested earlier, this direction of difference is to be expected, when dollar prices are viewed as comparable in their effect to a set of "early-year" ruble prices.

The Soviet expansion has tended to be comprehensive and "balanced" in terms of service distribution, as can be seem from Table 1. Owing probably to the existence of RDT&E and procurement cycles in

*The fastest growing resource elements of Soviet ME, in ruble valuation, are RDT&E and investment; at 2-3 percent, operating costs have been increasing less rapidly than the aggregate average.

Table 1

PERCENTAGE SHARES OF SOVIET SERVICES IN ESTIMATED ME (INVESTMENT AND OPERATING) AT 1970 RUBLE PRICES

Service	1967	1970	1973	1977
Strategic rocket forces	10	7	5	8
PVO	14	15	12	12
Ground forces	21	22	22	22
Navy	22	22	19	20
Air Force	17	19	26	22
Command and support	16	15	16	16

strategic offensive programs, the SRF share in investment and operating outlays is somewhat volatile. Also, the Air Force's share has risen considerably; there were compensating small declines in the shares of the SRF, PVO, and Navy. Despite these changes, the general pattern is one of stability in the outlay distribution over the ten-year period.

4. Alternative Estimates

The complexity, costliness, and intelligence-dependence of the "building block" system effectively prevents its use outside of the U.S. government, which means that nongovernmental size comparisons are also precluded. Instead, the challengers concentrate on the ruble value of Soviet ME, derived through manipulation of Soviet economic and financial statistics. Table 2 below assembles the most prominent recent calculations by two Americans, Stanley H. Cohn and William T. Lee; an anonymous (possibly government-origin) French effort; and a widely noted but still mysterious Chinese set of figures.* For

*The methodology of the Chinese figures has not been explained. Some observers have suggested that the numbers are reflections of Western estimates; others believe the figures are independently derived, perhaps based on knowledge obtained before the Sino-Soviet break in 1960.

Table 2

ALTERNATIVE ESTIMATES OF SOVIET MILITARY EXPENDITURES, 1955-1976

(Billions of rubles, current prices, except as indicated)

Estimate	1955	1960	1965	1970	1975	1976
Official Soviet: "Defense"	10.74	9.30	12.78	17.85	17.43	17.4
CIA (1970 prices)	--	--	31-41	40-50	50-60	52-62
Cohn (1970 prices)	--	18.40	29.1	35.4	40.6[a]	--
French	--	--	--	34	42.3	--
Lee	14.0	16.0	26.0	46.0	71.5	--
Chinese	--	19.0	29.2	49.6	69.4[a]	--

"--" means not available.

[a]1974.

SOURCES:

"Defense:" Soviet government statistics.

CIA: 1965, projected backward from 1970 at the annual rate of 4.5 percent, CIA's estimate of average annual growth in the decade 1967-77; 1970, 1975 from CIA, Estimated Soviet Defense Spending in Rubles, 1970-1975, SR 76-10121U, May 1976; 1976 from Allocation of Resources in the Soviet Union and China--1977, Hearings Before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, U.S. Congress, Part 3, Washington, D.C., 1977, pp. 18-19. With respect to the published figures, the lower end of the range corresponds to the scope of U.S. defense outlays and the upper end to an enlarged scope intended to cover activities that the Soviets may include in their estimates of military expenditure (e.g., civil space).

Cohn: Stanley H. Cohn, "A Re-Evaluation of Soviet Defense Expenditure Estimates," submission to the Stanford Research Institute, revised August 1976, cited in Robert E. Leggett and Sheldon T. Rabin, "A Note on the Meaning of the Soviet Defense Budget," Soviet Studies, 30:4, October 1978, p. 561.

French: "X.X.X," "Combien de Roubles pour la Défense?" Défense Nationale (Paris), November 1976, p. 54. The source provides absolute figures for each year in 1971-75 and percentage increases over the previous year, as well as the aggregate increase between 1970 and 1975. There is a slight difference between the implied 1970 figures that may be calculated from these percentages; therefore, the 1970 entry is rounded.

Lee: William T. Lee, The Estimation of Soviet Defense Expenditures, 1955-1975. An Unconventional Approach, New York, Praeger, 1977. Table 6.2, p. 98. The numbers are rounded midpoints of estimated ranges.

Chinese: Peking Review, November 28, 1975, p. 9 and January 30, 1976, pp. 10-11. The following data are provided relative to Soviet military expenditure: as a share of "national income," 13.1 percent in 1960, 17.1 percent in 1970 and 19.6 percent in 1974; as a share of "government expenditure," about 35 percent in 1974; average annual rates of growth, 9.7 percent in 1961-1974, 9 percent in 1961-1965, 11.1 percent in 1966-1970 and 11.9 percent 1971-1974. The product of the subperiod aggregate growth factors is 4.0834 whereas the implied compounded total over the 14-year period is 3.6550. Consideration of the absolute ruble values implied by these data (using "produced" national income totals at current prices from TsSU, Narodnoe khoziaistvo SSSR v 1970 g., Statistika, 1971, p. 533 and Narodnoe khoziaistvo SSSR v 1975 g., Statistika, 1976, p. 563) suggests that the problem lies with the 11.9 percent growth rate figure for 1971-74. This datum is, therefore, ignored (it is possible that the figure should be 8.9 percent). The source does not indicate whether the estimates are based on constant or current prices. From the nature of the figures supplied, current prices seem probable.

contrast, the table also includes Soviet official claims and the CIA estimates.

Sharp differences are apparent among the non-Soviet series, only some of which may be traceable to variant price weights. However, the methodology of the estimates cannot be reviewed here. They do have one common feature: In the 1970s, the non-Soviet estimates are all twice or more as high as the official "defense" figure. A similar statement could probably also be made for the 1960s, if the non-Soviet estimates were available for the two benchmark years in current price valuation.

The variant series may also be compared in terms of the implied or indicated rates of growth. CIA suggests that Soviet military expenditures have been rising by 4 to 5 percent annually and more or less steadily since the early or mid-1960s.* Cohn's series, with a somewhat higher average rate of growth, 5.8 percent, displays sharp deceleration in the 1960s, from about 10 percent in the first half to 4 percent in the latter half; for 1971-74, the rate is 3-1/2 percent. Judging by observed force developments, the time pattern of the first two subperiods seems dubious.

Lee's estimates quintuple over the two decades, averaging out at about 8-1/2 percent per year. These values are, of course, at prices of each year. Lee does provide figures at "1955" prices for the subperiod 1955-1966 and at "1970" prices for the subperiod 1966-1975. However, the difference between his estimates for 1966 at "1955" prices and at current prices is less than half a billion rubles, or about 1 percent. The corresponding difference for 1975 (comparing the current-price value with that at "1970" prices) is larger, 4-5 billion rubles and 6-7 percent, but in the reverse direction: Lee seems to believe that the military price level fell by that difference between 1970 and 1975,† which is quite unlikely. The 1955-1970 entries of Lee's series in Table 2 apparently reflect his view of the

---

*CIA, Soviet Economic Problems and Prospects, ER-77-10436U, July 1977, p. 1.

†Lee, The Estimation of Soviet Defense Expenditures, 1955-75, Tables 4.5 and 4.6, pp. 65, 66.

real growth of the Soviet military outlays--in excess of 8 percent per year. He also finds a real increase of close to 11 percent annually for 1971-75. The results seem unacceptably high.

The figures released by the Peking Review parallel Lee's estimates and also seem to downplay the distinction between current and constant prices. In testimony before the Joint Economic Committee of the Congress, Lt. General Samuel V. Wilson, then Director of the DIA, declared:

> While we agree with the community estimate for 1970-76 when valued in constant 1970 ruble prices, we believe that an estimate of Soviet defense spending published in the People's Republic of China weekly Peking Review, a magazine, may accurately represent the growth rate and total expressed in current prices.
>
> The Peking Review series is supported by information from [security deletion] and others. This data indicate a 1975 Soviet defense total of over 70 billion rubles and an economic burden of between 14 and 15 percent.*

General Wilson's remarks imply a DIA estimate of the rate of inflation of Soviet military prices of something like 6-7 percent per year between 1965 and 1970 and perhaps 3-4 percent in the first half of the 1970s.† The rate of price change probably slowed in the 1970s, although the indicated size of the change seems high. However, no evidence has been presented to support these estimates, and General Wilson implied lack of agreement on the part of CIA.

Note that the official Soviet "defense" figures indicate an average annual rate of increase (at current prices) of near 7 percent in each of the two subperiods of the 1960s. This is faster than the

---

*Allocation of Resources in the Soviet Union and China--1977, Part 3, p. 78.

†Derived by juxtaposition of the rate of change of the Chinese series and the 4-5 percent estimate of the U.S. intelligence community. A 1975 figure for the Chinese series is assumed at a level 4-1/2 percent greater than the 1974 entry.

CIA and Cohn estimates for the latter half of the 1960s but not as fast as the Lee estimate for either subperiod and Cohn's for the first half of the decade. All the non-Soviet calculations reject the Soviet claim of zero or negative growth of ME during the 1970s.

Finally, the alternative (to CIA) estimates of Soviet ME probably also imply somewhat different views of the Soviet burden of defense, as measured by the ME/GNP ratio. This may be seen most readily in the Lee estimates, for he provides an explicit ruble GNP series. According to his reconstruction, the ratio fell sharply in 1955-57, from 11.5 to 8.5 percent, then rose steadily in 1960-62 (to 10.5 percent), dropped again in 1964-66 (to 10.0 percent), rose sharply in 1967-68 (to 12.0 percent) and dropped off half a point in 1970; Lee projected a GNP share of 14-15 percent in 1975.* CIA's estimate is only 11-13 percent, measured in 1970 prices, and roughly constant for the past decade or more.

Lee's estimate of GNP for 1970, which is at established prices rather than factor cost, is slightly higher than CIA's for that benchmark year. His 1975 estimate assumes GNP growth at 4-5 percent per year after 1970, equivalent to the CIA estimate. However, for the latter half of the 1960s, Lee's series shows 9 percent annual growth of GNP and 12 percent for ME, all at current prices. It is difficult to believe that Lee accepts 9 percent as both the real and the nominal GNP growth rate. If, instead, he believes that real growth of Soviet GNP approximated the CIA's estimated 4-5 percent, he implies an equivalent GNP inflation rate. However, the details of his GNP calculations have not been published.

To sum up: Alternative estimates of total Soviet ME diverge more or less markedly from CIA's for various reasons, some of which are unknown because of insufficient detail in the available explanation of the different series. However, all reject the official Soviet "defense" claims and agree that a considerable increase has

---

*Lee, The Estimation of Soviet Defense Expenditures, 1955-75, Table 6.2, p. 98.

taken place in the annual level of Soviet ME, adjusted for inflation, over at least the last decade and a half. That is not true of American defense outlays.

5. Projections of Soviet ME

CIA has been reluctant to undertake or make public detailed projections of Soviet ME. Those released so far are mainly general statements about the probable change in aggregate ME. The recently issued "dollar" report declares that available evidence "indicates that the long-term growth trend in Soviet defense activities will probably continue into the 1980s." In the next two years, the dollar cost of Soviet investment activities is expected to accelerate in growth, helping to push the aggregate total up by perhaps 7-10 percent.

As of mid-1978, the Agency projected continued increases in Soviet ruble spending over roughly the next five years--at a rate "slightly lower than the long run average" of 4-5 percent a year in the "next two or three years" (as some current programs near completion), and "to a pace more in keeping with the long-term growth trend" during the early 1980s. No decelerating effect was seen as a result of the conclusion of SALT II. This careful language suggested a projected rate of growth for the period from 1978 through "the early 1980s" of slightly below the 4-5 percent "long-term" trend. On the whole, CIA expected that Moscow's concerns about the health of the Soviet economy were likely to affect the continuing pace of increase of Soviet ME "only marginally."

In 1977, Lee attempted to replicate planned Soviet ME in the current 10th Five Year Plan from Soviet sources. His calculations indicated a rate of growth in 1976-1980 of almost 10 percent per year at either "1970" or "1976" prices. The absolute values involved are extremely large, reaching 108-128 billion rubles in 1980. Lee noted:

> These are very large sums that may seem impossibly large to some readers, and quite understandably so. After all ... we are talking about (roughly) 20 to 23 percent of GNP being devoted to the military in 1980.*

Evidently, Lee saw Soviet GNP growing no faster than 3 percent per year and perhaps as slowly as 1-1/2 or 2 percent in 1976-1980. Nevertheless, the "burden," in terms of ME/GNP, was supposedly planned to increase in these five years by one-third to almost two-thirds.

Whatever the likelihood of Lee's reconstruction of plan intentions, the record of most of the 10th Five Year Plan is already complete. CIA estimates that GNP rose 10 percent in the first three years† with little or no change in the ME/GNP ratio. The recent harvest may have raised the GNP relative increase in 1978, but the last two years of the Plan period may not be as bountiful. The pattern of change in the defense burden is unlikely to be substantially affected by 1980.

C. CONCLUSIONS

Contrary to the newspaper headlines, the U.S. government estimates do not show that the Soviets "outspend" the United States, because Soviet military spending does not take place in dollars, nor do Soviet military planners respond to U.S. relative costs and prices. The same conclusion would hold in a ruble comparison with the actors' roles reversed. However, there is little question that the aggregate of Soviet military programs as well as most of the major components are larger in size than those of the United States, and have been so for most of this decade. The Kremlin has maintained a fairly steady pace of increase in Soviet military outlays for 10-15 years, and U.S. ME declined during the first part of the 1970s.

---

*William T. Lee, "Soviet Defense Expenditures in the 10th FYP," Osteuropa Wirtschaft, 22:4, December 1977, pp. 287-288.

†CIA, NFAC, Handbook of Economic Statistics 1978, p. 46.

But, so what? Does it matter?

The problematic connection between ME and military power was stressed at the outset of Part I. However, two conclusions from the available estimates must temper the observer's agnosticism:

1. Given the duration of the Soviet ME buildup and the only somewhat shorter period of decline in American ME, a change must have taken place in comparative capability relative to the situation of the early 1960s. Only two factors could negate that result--substantial diversion of Soviet energies in directions that do not bear on the U.S.-USSR military balance or increasing inefficiency of Soviet relative to U.S. ME.

Critics of the allegedly "alarmist" view of the Soviet buildup have pointed to the massing of Soviet forces along the Sino-Soviet frontier as evidence of the operation of the first factor. However, apart from the fact that Soviet Asian forces can be used in a variety of other contingencies that do affect the central superpower balance, it appears that deduction of the estimated cost of Soviet programs with a primary mission against China would lower the dollar value of total Soviet activities in 1978 by only 15 percent. Moreover, a significant portion of U.S. outlays may also be deemed peripheral in this sense.

As for the second factor, the possibility of increasing gaps between resource costs and military capability, this may be understood in two senses. The first is the ordinary idea of productivity, relating input to output, and on this no hard evidence is yet available. True, the corollary of the CIA's 1976 change in ruble estimates was a downward revision of the implicit estimate of Soviet military productivity, but this was a one-time change with no implications for the trend--that is, it represented a parallel shift downward of the trend line, not a change in its inclination. It seems likely that Soviet military production costs have been rising (based on a variety of evidence, including the increased complexity of certain categories of Soviet hardware). So have the costs of U.S. weapons procurement.

The comparative rates of change in cost appreciation are unclear. This is certainly true of the change in comparative military efficiency.

A second sense of the cost-capability gap raises the familiar question, How much is enough? As William Hoehn notes in Part III, the United States and the Soviet Union have had sharply different strategic perspectives. The Soviet commitment to "war-fighting" is expectably costly, but perhaps the Kremlin is misguided and is simply wasting resources. This is not the place to enter into that question, but it must be noted that U.S. government views are apparently changing and drawing closer to the Soviet perspective, as signalled in Defense Secretary Harold Brown's recent "posture statement," which in turn may be connected with the change in Congressional and public attitudes.

2. Continuation of the outlay trends of the early and mid-1970s into the 1980s is likely to result in additional capability changes in the same direction. As noted, there are no signs of a halt to the Soviet buildup; CIA forecasts "business as usual" for the next few years. SALT II, if it comes into operation, will probably have only a marginal effect on either side's military effort. Much has been made of the recent turnaround in U.S. outlays and the 3 percent annual increase promised our NATO allies. However, many observers doubt that U.S. ME in aggregate will achieve a sustained real rate of increase of as much as 3 percent annually, because of the pressures of competing domestic U.S. interests.

How long the USSR will be able to maintain the steady pace of enlargement of its military might cannot, of course, be predicted. The Western perspective has been substantially altered by the sharp revision in 1976 of CIA's estimates of Soviet ruble ME, which resulted in raising the estimated ME share of Soviet GNP from 6-10 to 11-13 percent. Also, major economic problems--related to energy, demography, and productivity--are on the Soviet horizon, the first symptoms of which are already being experienced. However, a judgment on how heavy a "burden" the current defense/GNP ratio constitutes must take into account Soviet historical experience, not just the contemporary

record of other nations. Above all else, the judgment depends on appreciation of the perceptions of various Soviet leadership groups. This is a very large subject and cannot be attempted here.

Unless internal economic and political pressures act to slow down the Soviet military buildup, the United States must expect that stabilization of American ME will mean a continued lag in improvement of military capability relative to that of the USSR.

II. STYLE AND EFFICIENCY OF SOVIET WEAPONS ACQUISITION AND THE LONG-TERM COMPETITION

Part I has dealt with the scale of the Soviet defense effort, of the USSR's increasing potential to produce military goods and services. The military utility of the goods and services produced depends on a number of factors, including national will, personnel morale, skill of officers, relevance of doctrine, etc. A major link between resource mobilization and military effectiveness is military RDT&E, which transforms economic resources into new weapons. The United States and the Soviet Union approach weapons R&D in substantially different ways, significantly influencing the characteristics of the weapons produced as well as their life-cycle costs. In this part, we review the dominant tendencies of Soviet weapons design, suggest several reasons for their behavior, and assess the effects of both Soviet and U.S. R&D styles on the long-term competition.

A. SOVIET STYLE

Soviet weapons exhibit similarities in their designs across very different types of systems. Aircraft, for example, share many of the same attributes as armor, ships, submarines, and missiles. This pattern can be summarized by its most outstanding features: simplicity in equipment; common use of subsystems, components, and parts; incremental growth; and limited performance and mission capabilities. Despite the strong evidence of this pattern, however, not all Soviet weapons include each of the features just mentioned. Rather, the evidence is better viewed as a distribution of possibilities; American systems (in comparison) have a larger proportion of new and advanced features. Hypothetical distributions are shown in Fig. 1. Although the central tendencies of the two countries are distinctly different, there is still considerable overlap between them.

Despite the pervasiveness of the above pattern, rare exceptions to it have occurred that have affected military capabilities in

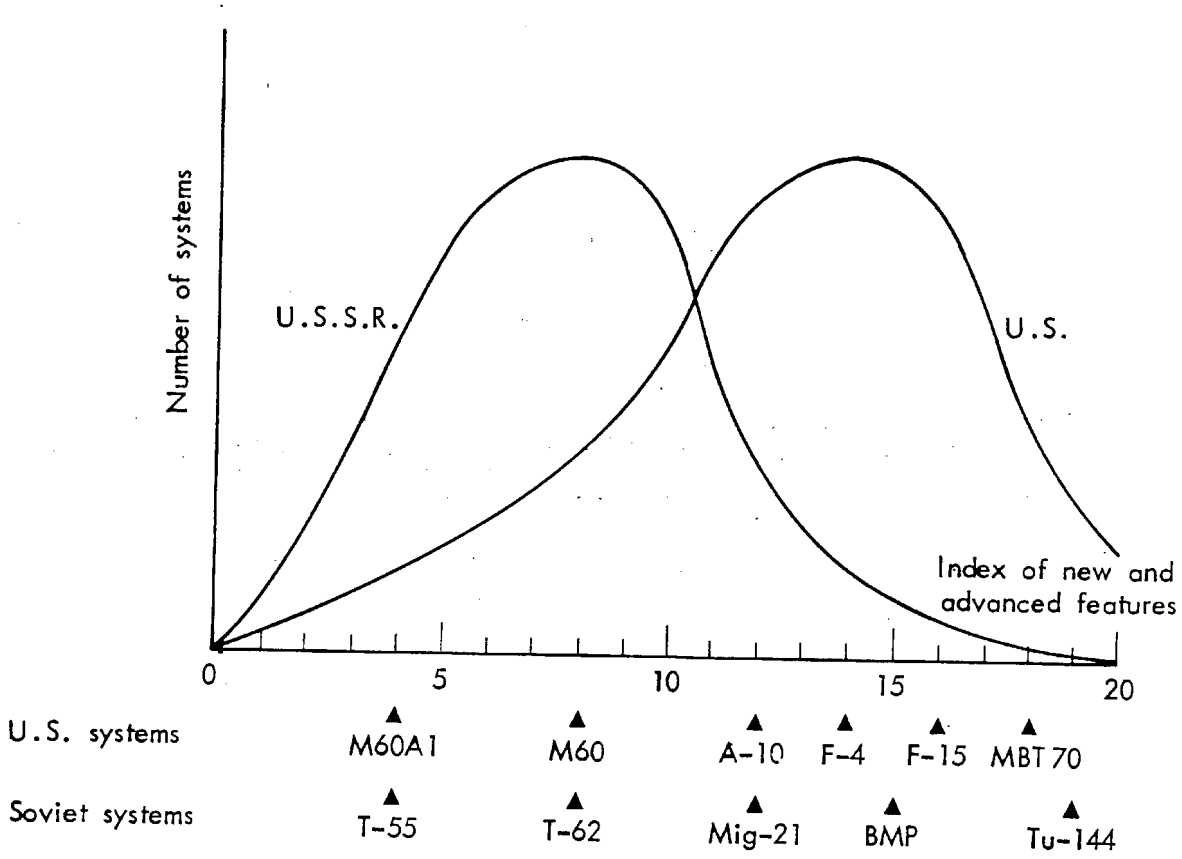

Fig. 1--Hypothesized distributions of U.S. and Soviet weapons by index of new and advanced features

important ways. These exceptions have included nuclear weapons and long-range ballistic missiles in the past and perhaps directed energy beams today. Because the development and creation of fundamentally new weapon systems have come to have special significance to the Soviet military and science communities, this subject must also be considered for a more complete understanding of Soviet weapons development practices.

The widespread presence of the dominant Soviet pattern suggests that a common set of forces operates across military services and technologies. These forces are identified here as arising, for the most part, from Soviet doctrine on the mass use of force, from the pressures of the economy, and from a bureaucratic inertia supported by a general satisfaction with the process.

Simplicity

In general, Soviet weapons are uncomplicated compared with similar Western equipment. Soviet warships, for example, require 25 to 40 percent less propulsion and auxiliary machinery per horsepower than U.S. ships, and proportionately less space in which to house it, largely because of a smaller requirement for electrical power, fresh water distillation, and shipwide air conditioning. This pattern is duplicated in Soviet shipborne electronic equipment, which operates to lower performance standards than U.S. equipment. Soviet warships can therefore be smaller and yet carry greater armament.

The T-62 tank is less complex in almost every subsystem than its American counterpart, the M60A1. It has a manual transmission and a manual, lever type of steering system. (The M60A1 has an automatic transmission and power steering.) The engine of the T-62 is a 40-year-old design. The tank lacks a rangefinder and has only a fraction of the vision devices found in the American tank. The T-62 also costs perhaps one-third to one-half less than the M60A1, which is not an example of goldplated U.S. equipment.

One of the best examples of design simplicity comes from a detailed comparison between a Russian engine and an American engine of about the same vintage and having roughly comparable performance. Although

the Soviet engine was acknowledged to be an outstanding design, atypical of Soviet engines in general, the design philosophy and approach were quite similar to that found in other engine examples of Soviet origin.

The Russian engine had only about 10 percent of the total number of parts of the American engine, and 18 percent of the parts requiring detailed drawings. It was designed, according to the analysts, for utmost simplicity and concern for costs. Engine idle, for example, was a simple throttle stop; idling RPM therefore varied with ambient conditions, whereas the U.S. engine had a fixed RPM requirement (for no apparent good reason) necessitating sensors, servomechanisms, increased complexity, and greater cost. Standard gauge materials throughout increased weight but reduced materials cost. Lower turbine inlet temperatures allowed use of conventional materials. As a result of these and other practices, raw materials cost per pound for the U.S. engine was 2-1/2 times greater than for the Soviet.

Open clearances reduced manufacturing cost and resulted in some test-stand performance degradation, but these levels did not degrade further in operations, as was the case for the more precisely manufactured U.S. engine. Although the Soviet engine was highly innovative in concept, it was rather conservative in execution. Parts were stressed to about half the level of the U.S. example. The Soviet engine was demonstrated to be unusually reliable and required only one-twelfth the maintenance hours per flight hour of the comparable U.S. engine. Furthermore, estimated production cost was one-third that of the American, and crude estimates of life-cycle costs indicated a Russian advantage of about 50 percent.

Commonality

Multiple use of subsystems, components, and parts across equipment of the same vintage, together with repeated use of the same subsystems in succeeding generations, is another typical feature of Soviet weapons development.

In aircraft, the same turboprop engine (NK-12M) was used on the long-range Bear bomber (Tu-95) in 1955 and on the large cargo aircraft AN-22 10 years later, on the Tu-114, and the derivative Tu-126 (Moss)

early-warning aircraft. Another engine (the Lyulka AL-7) appeared in some eight different aircraft, from fighters to bombers to seaplanes.

The chassis of the PT-76 reconnaissance tank, which appeared in the early 1950s, was modified for use 15 years later as the transporter for both an anti-aircraft gun (ZSU-23/4) and the SA-6 anti-aircraft missile.

The Su-7 (Fitter) attack aircraft and Su-9 (Fishpot) interceptor originally had common fuselage, tail, and engine; the wings, armament, and equipment were chosen for their different roles. The Su-7 was later fitted with variable-sweep wings (the first Soviet use of this technology), a new engine, and other changes to increase its range and payload, thus extending its design life from the early 1950s to the present.

The same 12-cylinder diesel engine or 6-cylinder derivative has been used on almost all Soviet tanks since 1939, and it continues to power the T-62, which will form the bulk of the tank force well into the 1980s.

For decades all Soviet tank guns had seen earlier service as towed artillery or on ships until the adoption of the innovative smooth-bore, high-velocity gun on the T-62. This gun is an interesting counterexample to the general Soviet tendency to avoid technological risk. The use of smooth-bore techniques at least 20 years before any other country is one fruit of the Soviet Union's large military R&D effort. It is interesting that the gun's very high muzzle velocity permitted a considerable simplification of the fire control system. The Soviet tank designer thus accepted technological risk in one subsystem to reduce complexity and cost elsewhere. And this was the only subsystem changed between the T-62 and its predecessor, the T-55.

Incremental Change

Technological change and improved weapons result primarily from the process of cumulative product improvement and evolutionary growth. The all-new system, with newly developed subsystems, is rare. This

is in sharp contrast to American behavior where the "weapon system" concept dominated development practices for at least two decades.

The MiG-21 fighter aircraft, first developed in the mid-1950s, has undergone continuous change in its engine, aerodynamics, armament, avionics, and structure. It has been improved from a simple, clear-weather interceptor to an all-weather fighter with ground-attack capabilities. Range and payload have doubled, and flying qualities have been considerably enhanced over a 20-year period.

In ships, similar patterns of evolutionary change have been noted. The Kildin missile ship was a conversion of the last four Kotlin destroyers, and the Krupnyj class missile ships were based on the hull and propulsion unit of a cancelled class of destroyers.

The first large Soviet rocket booster, used as both an inter-continental ballistic missile (SS-6) and space launcher, can be traced back through several generations of modifications and growth in size to the period after World War II when German and Soviet scientists worked on extending the capability of the German V2 rocket. The propulsion unit of the Soviet rocket consisted of a central core surrounded by four strap-on units, each of which consisted of four rocket motors apiece--or 20 altogether. Rather than develop a new, large engine, the designer chose to use proven components. The SS-6 had only indifferent success an an ICBM, but as a space launcher it continues in use to the present.

Designs with no known antecedents are rare. However, even in these systems, many of the subsystems are based on proven components. This is the case, for example, of the ZSU-23/4 anti-aircraft gun that was first seen in the mid-1960s. The vehicle's chassis is derived from the PT-76 light tank of the early 1950s. The engine is the 6-cylinder version of the tank diesel produced in the late 1930s. The electronics are vacuum tube components of 1950s vintage. The guns are slightly modified World War II models. There is little new in this weapon--except its design as a system.

Restricted Technical Performance and Mission Capabilities

One could continue in this vein and describe, for example, the evolution of the T-62 tank, subsystem by subsystem, from a 1930 American design by J. Walter Christie; or the development of the solid-fuel mobile ICBM SS-16 and IRBM SS-20 from the SS-13 ballistic missile; or the evolution of the rocket-assisted projectile gun system on the BMP from an early 1940s German design. However, a fuller evaluation of the Soviet process must also note the limitations implied by this approach as well as the advantages alluded to above. The pattern of simplicity, commonality, and incremental change is generally associated with lower levels of performance and a restricted range of mission capabilities. These limitations are illustrated by the MiG-25 (Foxbat) and the SA-6 surface-to-air missile.

The design of the MiG-25 exhibits the characteristic pattern described earlier. For example, its air-to-air missile, the ejection seat, cockpit instruments, and engine were off-the-shelf hardware that had been used in the MiG-21 and earlier aircraft. The avionics, for the most part, used vacuum tubes. The radar, although based on a technology that is out of date by American standards, is one of the most powerful ever seen in an aircraft and therefore less vulnerable to jamming. It has half as many cockpit instruments as the same vintage American F4, and the cockpit layout and instruments were adapted from the MiG-21. Extensive use of ground control for interception considerably reduced the need for on-board aircraft systems. Through the use of proven technology, the designers achieved a high degree of reliability. American aerospace analysts describe the MiG-25 as "unsurpassed in the ease of maintenance and servicing" and a "masterpiece of standardization."

The MiG-25 was intended originally to perform a single mission--interception of high-altitude, high-speed targets--although it has since been adapted to a short-range reconnaissance mission. This focus on a narrow task considerably eased the job of the designer and lessened the demands on the required technology. Long range, high turning rate, ground target acquisition, look-down radar, and

large ordnance payload and delivery capacity could be ignored. Advanced electronics, exotic materials, precise manufacturing techniques, and complex structures were not required. Stainless steel and aluminum were the primary airframe materials instead of the more expensive and difficult-to-handle titanium or synthetic materials. Rivets were left unground (except in aerodynamically critical areas), and welding was crude but adequate. The resulting heavy structure and drag penalties were dealt with by powerful fuel-hungry engines and by large fuel tankage. Most important, the Soviets accepted the aircraft's limited range and payload. At other than the high-altitude, high-speed design point, performance was significantly degraded.

In a quite different field, the SA-6 surface-to-air missile was described by U.S. defense analysts as "unbelievably simple but effective." Its solid-fuel integral rocket/ram-jet engine (considered inferior in some applications to U.S. liquid-fuel designs under development) permits such simplifications as the elimination of a fuel control system. The SA-6 contains no moving parts; this type of propulsive system has been estimated to cost 40 percent less than the alternative liquid-fuel design. However, the performance of the SA-6 degrades away from its design point as the propulsion system loses oxidative efficiency at high altitude, and the engine cannot be modulated for speed and altitude at other points in the flight regime. Simplicity is therefore exchanged for flexibility and performance over the entire mission envelope.

B. REASONS FOR COMMON DESIGN PATTERNS

The pervasiveness over time and technologies of the design pattern described above suggests that the causes are less circumscribed than particular missions, requirements, or threats. Indeed, the principal reasons identified here--doctrine and economic pressures--are deeply rooted in Soviet history and institutions.

Doctrine

Military doctrine has much to do with the way the Soviet Union develops its weapons. A historical Russian doctrine of mass armies has influenced the organization of the development effort, the procedures by which it is accomplished, and the values by which it is judged. This doctrine precedes the Soviet era, but it became more or less codified in the late 1920s and refined--one might even say sanctified--in World War II. A modern doctrine that entertains the possibility of fighting and the necessity of winning a war in the nuclear era also requires masses of men and equipment to survive nuclear exchanges and to fight globally on continent-wide fronts.

This doctrine firmly constrains weapons design. Simple designs are easier to produce and are usually cheaper than complex designs. These weapons should be both simple in design and easy to operate by large conscript armies; they should be reliable and not markedly inferior to enemy weapons. Standardization of parts, multiple use of components in different models of the same generation, limited change between models of succeeding generations, and a disciplined selection of functions and performance levels have been the means for achieving the Soviet design goals.

Economic Pressures

The pattern of weapons design and development is also in part a response to economic system incentives and constraints. The Soviet economy is fairly efficient in the development of mass-produced systems and fairly inefficient in the production of more complex, high-technology weapons, thereby validating the economic rationality of the doctrine. The weakness of innovation in the Soviet Union flows mainly from the structure of the economy--the price system, decision rules, incentives, and other organizational arrangements. In the centrally planned Soviet economy, supplies are allocated far in advance of actual need. Optimistic planning targets generate a shortage of materials--a seller's market in which demand exceeds supply, where a buyer may be required to accept an inferior product or go without. Because supplies are allocated in detail, resources are not fungible;

a simple money budget is not adequate to guarantee the availability of resources that have not been planned and allocated in advance. New products and production techniques must be deliberately planned and introduced by bureaucratized administrative bodies. Attempts to reform the system have only increased the regulatory constraints, made the managerial job more complex, and further bureaucratized the planning and management of innovation. Although many of these economic problems were more severe in the past than they are today, such shifts as have taken place are only partial. The basic system of the past 45 years continues.

Unreliability of supply imposes a reluctance on designers to ask for new components, or to go to suppliers with whom they have not dealt in the past. Supply problems create incentives to use previously developed components that may not be optimal from an overall systems standpoint but that can be counted on to perform to known specifications. The rigidities of the planning process allow little flexibility in substituting one material or device for another or in making reallocations within a given budget level. All of these conditions encourage a conservative, evolutionary approach that minimizes the necessity for flexibility and reallocation. The employment stability of R&D organizations, the detailed plans and regulations, the great difficulty for new organizations to break into established fields, the penalties for failure, and the practices and procedures by which R&D is managed are forces leading to military technological conservatism.*

Military industry has been insulated from the worst vicissitudes of the civilian economy by a variety of methods including priorities over materials, equipment, and personnel, and coordination by the Military-Industrial Commission. Although more favored than the civilian sector, the Soviet military cannot entirely escape from the perversities

---

*It must be emphasized that this conservatism refers to decision processes and technology and not to design. Over the years, the Soviet Union has been a producer of innovative weapons designs--from the T-34 tank, to the BMP infantry combat vehicle, to the Kiev aircraft carrier. They have managed to achieve some innovative outcomes through conservative processes.

and inefficiencies of the rest of the economy, and the very techniques that contribute to the success of the military-production sector also impose costs on the rest of the economy--costs that do not show up in conventional accounting practices. Furthermore, with the increasing complexity of modern weapon systems that incorporate a broader range of technologies and inputs than in the past, the military is likely to become increasingly dependent on the rest of the economy and will find it more difficult in the future to avoid the effects of the civilian sector's patterns of behavior.

C. "NEW IN PRINCIPLE" WEAPONS

Because of the forces of conservatism, major nonincremental change must often come from high-level political intervention in the R&D process. In aviation, for example, the Party leadership has been the key force behind the development of the first generation of jet fighters, heavy helicopters, and VTOL aircraft. For major systems that are new in principle with neither technical nor institutional precedents, leadership intervention is even more necessary. Although generalizations of such interventions are hindered by their rarity, nevertheless some tentative conclusions seem warranted on the basis of case studies of nuclear weapons and ICBM development. These conclusions are also applicable (in a tentative, conjectural way) to the case of high-energy lasers and directed energy beams.

Nuclear Weapons

In the development of nuclear weapons, research was initiated and carried out by physicists in the 1930s who paid no attention to weapons applications. However, when the 1940 publication of a highly significant Soviet discovery of spontaneous fission resulted in a complete lack of American response, the Russians became convinced that a big secret project must be underway in the United States. In late 1941, a small group of physicists wrote to the State Defense Committee "urging that no time be lost in making a uranium bomb."

After seeking advice from key scientists, the Party and government formed an *ad hoc* scientific-technical committee to oversee developments. Work proceeded on a small scale until American explosion of a nuclear weapon, whereupon Stalin called for a massive acceleration of Soviet efforts directed by a super-ministerial agency. Russian work on the hydrogen bomb proceeded independently of American efforts, relying mainly on domestic research and findings. The Ministry of Medium Machine Building was established in 1954 to take over most nuclear responsibilities.

ICBMs and Sputniks

Rocket research in the Soviet Union in the 1930s, like nuclear physics, was mainly the work of enthusiasts, with some financing by the Red Army. In World War II, their efforts were devoted to projects with short-term payoffs, but toward the end of the war the Soviet rocket specialists recognized the potential for long-range rocketry of the German activities and alerted the government, which subsequently organized the collection of German equipment and technicians in the wake of the Red Army. The crucial stimulus to the development of long-range rockets came in late 1946 and early 1947 through Stalin's insistence on the strategic importance of long-range weapons. *Ad hoc* groups of experts were formed to advise the political leaders and supervise development. In 1955, the Ministry of General Machine Building was formed to consolidate ballistic missile development and production activities. Upon development of the SS-6 in 1957, rocket designer Korolev approached the Central Committee apparatus with plans (approved after a few months of testing) to launch a sputnik. Space activities from the time of the first sputnik have been supervised by a high-level coordinating committee rather than by a unified authority.

Pattern for Fundamentally New Weapons

The pattern that can be abstracted from these two cases includes the following steps. Initial research is promoted by scientists who notice, on their own or through foreign example, potential military

applications. These perceptions are transmitted to a high-level authority, which then provides the political stimulus required to gather and coordinate resources from dispersed organizations. *Ad hoc* scientific advisory groups and scientific-managerial supervisory committees provide expert advice, analysis, and project direction. When the new activity achieves a sufficient level of continuity and maturity, a conventional ministry is established to carry on the work.

D. IMPLICATIONS FOR EFFICIENCY

Close examination and comparison of many types of similar Soviet and U.S. systems indicates lower production costs for the Soviet products. The jet engine mentioned above, for example, was estimated to have a production cost one-third that of a comparable U.S. engine; the production cost of the T-62 tank was approximately half the cost of the U.S. M60A1; and the SA-6 surface-to-air missile showed a similar relationship to its American counterpart. Maintenance hours per operating hour differed in the same direction even more strikingly: For the jet engine, the Soviet advantage was better by a factor of approximately 12; maintenance for surface-to-air missiles favors the Soviet models by factors of two and three; and some recent fighter aircraft demonstrate American maintenance requirements an order of magnitude or more greater than the Soviet's.

Use of mature subsystems, repeated use of components in models spanning a decade or more in deployment dates, fewer parts, and simpler equipment reduce both acquisition costs and maintenance resource needs. Rather than engineering the solutions to cost problems, the Soviet weapons designers solve the problems by avoiding them.

In some instances lagging Soviet technology can generate higher costs than found in U.S. equipment. The electronics of the ZSU-23/4 antiaircraft gun, with its vacuum-tube components and hand-wired circuitry, would cost considerably more than U.S. equipment that incorporates solid-state circuitry. Restricted performance and missions of Soviet weapons can also lead to higher costs as more than one type of system may be necessary to cover the missions assigned to a single U.S. system. This is seen, for example, in air defense where the Soviet

Union deploys about a dozen ground-to-air missiles and guns compared with less than half that number on the U.S. side. It may also be necessary for the Soviets to deploy more types of systems to take advantage of incremental changes in technology that take place after the primary system is first produced. The many models of the MiG-21 aircraft illustrate this point.

Because of the mix of both positive and negative forces on costs described above, the costs and efficiency of the entire Soviet weapons procurement system are uncertain. The Soviet Union is more likely to develop and produce any single item of equipment at lower life-cycle costs than would the United States, but it is not necessarily true that they are more efficient across the board. It is not necessarily untrue, either.

E. SOVIET ADVANTAGES IN THE LONG-TERM COMPETITION

Soviet weapons technology, on the whole, is less advanced than comparable U.S. weapons technology. Nevertheless, these technological shortcomings do not always result in lesser military value. A dilemma for analysts is thus raised: How does the Soviet Union manage to field presumably capable and effective military weapons even though it suffers a general technological inferiority with respect to the United States? Answers to this question, based on hints and fragments, remain conjectural.

The simplest answer is that the Soviet Union compensates for its technological inferiority by fielding masses of men and equipment and by spending more on its military might than potential adversaries. This answer is only partial, for in many cases, Soviet weapons are comparable in military value to those of their Western rivals. Additional reasons for Soviet weapons effectiveness lie in design continuity, operational testing, and the criteria used to evaluate the weapons.

A feature of Soviet weapons development often disregarded in the United States is the function of design, in the sense of creatively bringing together and adapting existing elements into a unified construction. The art of design is promoted in the Soviet Union by

the continuity of design teams and the continuous construction and test of prototypes. Budgets and manpower levels of defense industry research institutes and design bureaus are stable and fairly independent of short-run production trends. Soviet institutions exhibit much less of the cyclical ups and downs of American weapons development teams as they follow the award, completion, or cancellation of contracts. The stability results in a regular progression of designs and prototypes yielding a level and quality of experience that comes only from the actual creation and test of new ideas in working hardware. The availability of improved weapons in prototype form may also make the follow-on production decision more likely than does the American military-political process of promoting a plan instead of a product.

Not only is the designer educated by the development of new models, so too is the user. Fragmentary evidence suggests that extensive field testing of new equipment is an essential part of the Soviet weapons acquisition process whereby feedback is generated for the next design iteration. Requirements generation, design, and development are thus abetted by troop testing in large-scale exercises and in more routine training activities. Western analysts first saw evidence of a preliminary version of the T-72 tank, for example, in the 1970 Dvina exercises, and over the next few years several other versions were apparently produced and issued for troop testing. Similarly, test examples of the VTOL Yak-36 (Forger) were operated aboard the helicopter cruiser *Moskva* in early 1974 before later deployment of about a half dozen pre-production versions in service test aboard the *Kiev* two years later. Operational testing is especially important in the Soviet context where the constraints on technology and performance demand careful consideration of design tradeoffs.

The Soviet military evaluates equipment as an integrated and complementary part of the total fighting force and not as, in the American context, a collection of specifications or, in the extreme, a single index number. Thus, the Soviets evaluate tanks and anti-tank weapons on how they affect the rate of advance of military units, whereas the American measure of effectiveness is the probability of destroying an enemy tank. The Soviet measure requires consideration

of the weapon in its full tactical environment. This is a difficult and complex task, but its accomplishment may be aided by an experimental approach to exercises and training where alternatives are examined in a realistic operational framework.

Despite a general Soviet technological inferiority, large-scale political intervention can energize new areas by infusing them with talented scientists and managers, resources, priorities, and coordination, as was the case in the nuclear weapons and ballistic missile examples. This approach, however, may not be working as well today. The high-powered laser and directed energy areas have been the recipients of high-level attention for more than a decade now, with little observable success beyond the realm of science. The Tu-144 supersonic transport is a civil example (though produced in the military-industrial aviation industry) with similar unfruitful results. In particular, past Soviet successes have followed Western results, whereas in the high-energy areas and the SST, the Soviets have been in the vanguard. These examples are limited, but the implications deserve further consideration.

F. U.S. ADVANTAGES IN THE LONG-TERM COMPETITION

The strength of American military R&D lies in the technical competence, productive capacity, and innovative nature of American industry. In the attention paid to the industrial giants, the thousands of small firms and semi-autonomous corporate divisions that support the larger establishments are often overlooked; and it is these organizations that are missing in the Soviet Union. They provide alternative sources of supply of old and new products, and they can respond to the shifting opportunities of new technology (as well as create the opportunities) in ways that are not possible for centrally planned ministries.

Not only is U.S. industry freer of monolithic tendencies, so too is government and the military. It is probably correct to ascribe many of the deficiencies of U.S. weapons acquisition to the fragmentation of power in a proliferation of agencies and bureaus, but this very

proliferation both generates alternatives and promotes technologies in a way that is almost completely absent in the Soviet Union. Similarly, the openness of the U.S. military establishment to influence from outside organizations such as universities (or even "think tanks,") has a similar beneficial result on the adoption by the uniformed services of new technologies, techniques, and weapons. The Soviet Union therefore has greater grounds to fear surprising and confounding new systems from the United States than vice versa.

These advantages must be set against problems of American weapons acquisition that are overly familiar to users, developers, and the American public: high and rising costs, unreliability, excessive maintenance requirements. Although the sources of the U.S. pattern are not well understood, a striking difference is apparent between the long-run Soviet approach to military R&D and the dominant American style. Funding for military systems technology in U.S. industry has been dependent on the appropriations for specific weapons developments, especially in recent decades when explicit policies have restricted independent subsystem development.

Because the development of new systems tends to be episodic rather than regular, R&D is subject to cycles of boom and bust with little continuity in design organizations. A major complaint of manufacturers is that experience gained during a particular project is dissipated when that project draws to a close. Because of this absence of experience derived from continuity in design, construction, and trial of new equipment and technologies, the creative design sometimes observed in Soviet weapons is often difficult to attain in the U.S. environment. This drawback is partly compensated for by a highly educated technical and production workforce. However, in the absence of experience, this technical virtuosity generates new problems, as designs may be prized more for their technological content than for their practical value in use.

The forces influencing funding continuity in particular, and the entire weapons acquisition process in general, in both the United States and the Soviet Union, are deeply rooted in each country's social, political, and economic system. Policies intended to alter behavior

are likely to have only marginal effect, unless crises disrupt existing patterns in a major way. Nonetheless, marginal change applied consistently over extended periods can yield substantial cumulative effects. Threat assessments and policy analyses, therefore, cannot remain static, but must also adjust to the continually changing environment.

III. TOWARD A BETTER UNDERSTANDING OF U.S. MILITARY EXPENDITURE REQUIREMENTS

Part I of this report explored many of the issues of defining and estimating military expenditure (ME). Although the interpretation of data on comparative ME is not easy, some important trends were underscored. In particular: There is little question that the aggregate of Soviet military programs as well as most of the major components are larger than those of the United States and have been so for most of this decade. Part II pointed out, among other things, that much Soviet weaponry is approaching the quality of U.S. weapons, despite reliance on generally less sophisticated technology, which may be traced to characteristics of the Soviet weapons acquisition process.

This part attempts to evaluate the implications for force structure and policy of the past and possibly continued imbalance in the size of the superpowers' aggregate military effort. It does so by developing a context for understanding some of the characteristics of the growing disparity. It then considers the light such comparisons cast on the question of how much ME the United States needs to meet its national security objectives.

In attempting to understand the meaning of the disparities between values of Soviet and American military activity, we may begin with strategic forces: Over the full ten-year period considered by the CIA,* Soviet activities measured in constant 1978 dollars averaged two and one-half times those of the United States; the ratio was roughly two during the first half of the decade but increased to nearly three times the U.S. level during the latter half. This "latter half" encompasses both the period of strategic arms limitations (SALT I and Vladivostok Accords). Only a few short years ago, Secretary of Defense

*All comparisons involving CIA estimates presented in this section are drawn from the NFAC report, A Dollar Cost Comparison of Soviet and U.S. Defense Activities, 1968-1978, SR-79-10004, January 1979.

Melvin Laird forecast in his "Final Report to the Congress" in January 1973:

> The historic ABM Treaty and Interim Agreement on Strategic Offensive Arms concluded in Moscow last May are the first steps toward mutually agreed restraint and arms limitation between the nuclear superpowers. Through them the United States and the USSR have enhanced strategic stability, reduced world tension, precluded a significant upturn in the strategic arms race in the near term, and laid the foundation for the follow-on negotiations which began last November. In terms of United States strategic objectives, SALT I improved our deterrent posture, braked the rapid build-up of Soviet strategic forces, and permitted us to continue those programs that are essential to maintaining the sufficiency of our long-term strategic nuclear deterrent.*

In Contrast to that rather glowing projection, we now find the current Secretary of Defense observing:

> Unfortunately, longer-term stability is not fully assured, and the future competition in strategic capabilities is likely to become more dynamic than need be the case. As I pointed out last year, the main impulse for this dynamism comes from the Soviet Union in the form of a large ICBM force with an expanding hard target kill capability, a much-publicized civil defense effort, and the likelihood of significantly upgraded air defense capabilities.†

The CIA analysis offers much the same picture in terms of General Purpose Forces (GPF). Although for the decade in question the dollar value of Soviet GPF activities was only 35 percent higher than the U.S. total, the latter included some expenditures for the wind-down of Vietnam activities in the early part of the decade. The Soviet total for GPF during the latter half of the decade quite consistently exceeded the U.S. total by about 75 percent.

---

*Final Report to Congress of Secretary of Defense Melvin R. Laird, 8 January 1973, p. 21.

†Department of Defense Annual Report, Fiscal Year 1980, 25 January 1979, pp. 79-80.

Only in Support Forces did U.S. spending exceed the estimated Soviet effort costed in dollars--by about 35 percent for the decade. Again, however, the margin diminished throughout, moving from 50 percent more than the Soviet Union initially to near parity at the end of 1978.

Although the above breakdowns of comparative size by major mission category are striking, they could perhaps be deemed to somewhat overstate the real disparity in military capabilities, because Soviet manpower associated with the mission elements is priced at comparable U.S. costs.* Nonetheless, the above picture is not fundamentally altered by an examination of the trends on a resource rather than mission basis. The CIA's resource approach provides estimates on three categories--operating costs, military investment, and RDT&E.

The time series data on operating costs, the component inflated by the costing of Soviet personnel at U.S. prices, require some interpretations. In the early part of the decade, the wind-down of Vietnam activities causes U.S. expenditures to begin from a high base and decline into the early 1970s, after which they are fairly stable. Soviet activities in dollar terms rise throughout the decade, from a level well below U.S. activities in 1968, through a crossover in 1971, to a steady divergence from the U.S. figures through the latter part of the decade. By 1978 the dollar equivalent of Soviet operating costs was about 25 percent above U.S. expenditures. Thus, at least for the latter half of the decade, the Soviet "lead" was modest but expanding. Even pricing Soviet manpower in U.S. terms does not lead to huge differences in the relative value of operating costs (see p. 12), so we must look elsewhere to find the major source of the disparity.

The major gap is found in the military investment category, which encompasses procurement of new weapons systems, major spares, and

---

*Military retirement pay is excluded from comparisons by the CIA. The U.S. costs for pay are much higher than those for Soviet military manpower, especially in the enlisted ranks. Soviet enlisted pay is reminiscent of U.S. pay for conscripts before "comparability" legislation and the institution of an All-Volunteer Force. (See Part I, p. 5, for additional calculations.)

military construction. This category represents the gross additions to existing military capability over time. Here again the data require some interpretation. U.S. military investment expenditures show a steep decline* of nearly 50 percent during the first half of the decade (again in part reflecting the Vietnam experience), with a shallower decline and then recovery to about the 1973 level by 1978.

In contrast to the U.S. case, Soviet military investment shows a fairly continuous upward trend, somewhat more pronounced in the second half of the decade. The end result is that "the estimated dollar cost of Soviet military investment exceeded comparable U.S. spending by about 80 percent in 1975-77 and by about 65 percent in 1978."† The investment margin in dollar terms in the Soviet Union's favor over the latter half of the decade examined ranges from a low of about $15 billion per year to a high of nearly $20 billion per year; the aggregate margin of Soviet military investment over that of the United States since 1973 is nearly $100 billion.

Although that total may seem astonishing at first glance, no one who has read about new deployed Soviet weapons systems--four new ICBMs, the Backfire, SS-20, new missile submarines and SLBMs, new tanks, new armored combat fighting vehicles, the wholesale modernization of tactical air forces, new air defense systems, and the emergence of substantial surface naval capabilities--can be surprised that the sums the Soviets have invested have been enormous by any accounting.

It is difficult to envision what these impressive investment margins mean in terms of military hardware. Although it is impossible to compress the production time-intervals for major U.S. weapons systems, the reader may get some feel for the implications of Soviet accumulation rates by noting that if the DoD had at its disposal the funds representing the peak-year Soviet margin over the United States of nearly $20 billion, in the Strategic Forces are it could have:‡

---

*These data are calculated in constant 1978 dollars, so the earlier years are also inflated in the process.

†Cost Comparison..., p. 9.

‡These illustrative calculations are based primarily on March 1978 Selected Acquisition Reports (adjusted to Fiscal Year 1980 dollars), or equivalent programmatic cost estimates.

- o Acquired all 241 B-1 bombers (investment cost of about $16 billion in FY 1980 dollars) in one year; or
- o Acquired the full baseline MX system (investment cost of about $18 billion in FY 1980 dollars for 340 missiles and 5000 vertical shelters) in one year; or
- o Acquired the 13 TRIDENT submarines programmed to date as well as all the TRIDENT 1 missiles to go with them (about $17 billion in FY 1980 dollars).

Alternatively, in the General Purpose Forces area, it could have:

- o Improved land forces by acquiring the programmed objective of 7000 XM-1 tanks and 500-plus Advanced Attack Helicopters, acquiring 7000 new Infantry Fighting Vehicles to accompany the tanks, and a fleet of some 300 AMSTs to provide intra-theater mobility (about $15 billion in FY 1980 dollars); or
- o Bought about 400 F-14s and 800 F-18s to fully modernize naval air for the carrier forces (about $20 billion in FY 1980 dollars); or
- o Completed the modernization of USAF tactical air by adding 400 F-15s, 1250 F-16s, and 400 A-10s (about $16 billion in FY 1980 dollars).

Indeed, the disparity in investment between the Soviet Union and United States over the last half-dozen years of almost $100 billion encompasses nearly all of the above items in the listed quantities. Of course, this is a hypothetical illustration of some of the hardware implications of the disparities and certainly should not be interpreted as a suggested allocation of funds or of force structure buildup.* As noted later, the required level of U.S. ME cannot be defined by such disparities. Nonetheless, a force structure that had added all of the above to our existing posture would be perceived, both at home and abroad, by friend, foe, and nonaligned alike, as much more robust than our present circumstance. Actual military capability would also have been increased.

*Among other omitted factors, it ignores the economic consequences of higher U.S. military expenditures (e.g., budget deficits and inflationary pressures).

The third resource category in the CIA analysis is RDT&E, for which dollar-cost estimates of the Soviet aggregate are even more difficult:

> Estimates of the dollar cost of reproducing Soviet RDT&E activities are derived in the aggregate using a less certain methodology and are less reliable than the other estimates in this paper. Nonetheless, it is clear from the number and increasing complexity of the weapon systems that the Soviet activities were both large and growing during the period under review. U.S. outlays for RDT&E, on the other hand, declined steadily over the period before turning up in 1977. As a result, Soviet RDT&E activities in 1978 were substantially larger than those of the United States.*

A bar chart in the CIA report shows the now familiar pattern--U.S. RDT&E expenditures above the dollar-costed Soviet effort at the beginning of the decade, a crossover in the early 1970s, and a widening gap thereafter. A derivation from aggregate data in the report suggests a cumulative margin over the decade of some $35 billion in RDT&E in the Soviet Union's favor. In conjunction with the information on the bar charts, this suggests an RDT&E margin of at least $40 billion in the Soviets' favor over the latter half of the decade. This would represent almost a 50 percent greater dollar-equivalent level of effort in RDT&E by the Soviets over the latter half of the decade.

The implications of the trend in this component are worrisome on two counts. First, the fruits of RDT&E become translated into new weapon programs or improved performance capabilities only with some developmental time-lag, so that the products of the most recent Soviet R&D may not yet be visible to us. Second, it is now widely conceded that past Soviet RDT&E expenditures have led to marked improvements in the quality of current Soviet weapons: "Moreover, the quality of their equipment is much closer to ours than it was ten years ago; in some cases it is even better than our own."†

---

*Cost Comparison..., p. 9.

†Annual Report, Fiscal Year 1980, p. 6.

If this is the accomplishment of Soviet RDT&E expenditures no larger than our own over the first half of the decade, what should we expect as the future product of the much larger relative and absolute Soviet RDT&E investments of the last five years.

There is some indirect evidence to support these concerns. One need only recall that as recently as two years ago the major strategic concerns were whether Minuteman would really become vulnerable during the coming decade (and if so, whether that would occur in the late or perhaps the mid-1980s) and whether prospective improvements to Soviet air defenses over the planned lifetime of the B-1 bomber were so great that the likelihood of its enjoying a prolonged service life made its cost seem too large for a prudent investor. Now, a scant two years later we find the following assessments offered:

- The Soviets are now estimated to be introducing new missiles with more warheads and improving the accuracy of their warheads more rapidly than we had expected a year ago.*
- Analysis of intelligence data on new versions of the SS-18 and SS-19 missiles indicates a substantial threat to our Minuteman by the early 1980s.†
- Such an AWACS aircraft is unlikely to become operational even in small numbers before 1982, although a lookdown shootdown fighter with a capability against bombers and fighters could begin to enter the force in 1981.‡

The extent to which our apparent surprise at the rapid evolution of Soviet threats is attributable to a less-than-adequate R&D base from which to estimate the rate of Soviet technical progress (rather than simple failings of intelligence estimation and forecasting) is beyond

---

*Ibid., p. 116, emphasis added.

†Ibid., emphasis added.

‡Ibid., p. 73, emphasis added. The projection cited is of some interest, because the same reference notes (p. 123) that it will be December 1982 before the first squadron of B-52s (16 aircraft) will achieve Initial Operational Capability with the Air launched cruise missile (ALCM).

the scope of this report. What is noteworthy is that this failing has had serious consequences. Only two years ago the defense establishment was confident that responses to potential Soviet threats would be available to the United States in timely fashion. The MX, in a survivable basing mode, was planned to be available by 1984, somewhat in advance of even the earliest projections of severe Minuteman vulnerability. The B-1, with its combination of lower radar signature, lower penetration altitude, higher penetration speed, and advanced defensive avionics, would clearly have greatly complicated the task of even improved Soviet air defenses, and the ALCMs would be yet another confounding factor. The effect of the Soviet lookdown capabilities described above on the larger, slower, higher penetration altitude B-52s with their less capable ECM remains to be determined. In the interim, two years of U.S. inaction in terms of development and deployment decisions, coupled with what is apparently an accelerated Soviet threat, leaves us looking ahead to the 1980s from a significantly less comfortable position:

> The increasing vulnerability of our ICBMs means that by 1982 the balance calculated to result after a Soviet first strike and a U.S. retaliation would be less favorable than we would wish, though remaining U.S. forces would be enough to wreak enormous damage. Thereafter improvements in our SLBM and bomber forces will, if resolutely pursued, correct this imbalance, and deployment of a new survivable ICBM will reverse it. We should not lose sight of the fact that until survivable ICBMs are deployed, the relative outcome of these exchanges will be more sensitive to uncertainties associated with the possibility of attrition of SLBM and bomber forces being greater than expected, and to command and control uncertainties.*

These factors strongly suggest a higher degree of risk over the next several years should the adequacy of our strategic posture be challenged. Assessments of the general purpose force balance are much more complex--too complex to treat in detail here. But the Secretary's assessment here also has overtones of increased risks:

---

*Ibid., p. 116, emphasis added.

> The result of thse actions by the two sides is an ambiguous situation. Even today, the Soviets cannot be confident of a rapid conventional victory in Europe. But NATO, despite its basic strengths, cannot have as much confidence in its non-nuclear deterrent as I consider prudent.*

The suggestion that the Soviets cannot be confident of a quick win is not entirely reassuring in the absence of some clarification of the modifier "rapid."

In the light of these assessments, one might ask whether the United States has programmed an increase in ME sufficient to offset these trends. It is clear that the Soviet/U.S. "defense spending gap" so identified does not define the requirement for current or future U.S. ME. The gap is unlikely to be a measure of the U.S. effort required, except by chance. The required U.S. ME rate might be larger than the measured gap, or vice versa. Some reasons why the required investment might exceed a measured ME gap include the need to catch up, to overcome the adverse consequences of previous year trends; or to compete in selected new areas not now receiving sufficient emphasis; or to develop hedges against possible future adverse developments by the Soviets; or to have more robust capabilities to deter the Soviets than they require to deter the United States because of doctrinal and strategy differences.

The required ME rate might turn out to be less than the measured gap because the Soviet Union is less efficient than the United States in translating ME inputs into output; therefore, so the argument goes, the United States should be able to keep pace with less ME. Second, the Soviets act as though they regard the Chinese Peoples Republic as a serious "second front" competitor, allocating significant forces and resources to that theater. The United States has no such second front problem and presumably requires less ME to satisfy its security requirements. Third, in terms of cumulative ME, some portion of Soviet expenditures has gone to reducing the U.S. strategic advantage of the early 1960s; unless the United States were to attempt to restore its earlier comparative advantage, not all the cumulative gap need be offset.

---

*Ibid., p. 16.

Fourth, some prospective problems for the Soviet Union can be derived from economic and demographic trends that may make it difficult for the Soviets to continue to devote as many resources to ME as in the recent past; if that were the case, then presumably U.S. ME requirements would be lessened.* Finally, if U.S. ME were increased, the resources could be invested in ways that would drive Soviet ME requirements particularly hard, so that the United States would get some leverage for its ME. (The cruise missile is often cited as an example of this "leveraged" ME.)

Many similar factors, both pro and con, could be developed as well. What the above sampler merely confirms is that the precision of the CIA's estimates of Soviet ME is not the issue. Even more exacting estimates of Soviet ME will not give us the answer to the question, "How much more should the United States allocate to ME?" To answer this question will be difficult; the measures of merit are poorly defined, and the answers are dependent on factors exogenous to U.S. decision-makers. In principle, the process is straightforward; we seek a mix of military capabilities adequate to meet several criteria:

- o For peacetime--Does the United States have enough capability (in concert with our allies) to deter hostile use of military forces across a spectrum of contingencies? This requires evaluation of sets of "war outcome" measures, from both U.S. and Soviet perspectives.
- o In time of crisis--Do these forces strengthen or weaken stability and the incentives for escalation?
- o For the long-term competition--Does the sum of forces in being and under development assure the maintenance over time of the conditions above?

If these questions could be answered with some precision, we would have defined the set of required forces in being and R&D initiatives the United States needs, from which we could derive the U.S. ME required to

*This issue is addressed in one of the Project AIR FORCE research projects in the strategic program, Soviet Economic Competitiveness.

provide those capabilities. The question of whether that ME requirement was larger or smaller than Soviet ME would become of interest principally in the analysis of the efficiency of resource use and similar matters.

Although straightforward in principle, these assessments in practice are difficult to perform, involve a multiplicity of assumptions and judgments, and are beset with uncertainties (many of which are incapable of resolution in peacetime). In addition, many of the factors required in such analyses are not quantifiable and, therefore, not amenable to computer simulation, the customary U.S. assessment tool. The result is that high-level U.S. strategic balance assessments tend to be simplistic, obscuring many of the risks and uncertainties, examining a limited set of scenarios, and implicitly using mirror-image asssumptions about Soviet objectives and behavior. Yet it is clear that the Soviets do have different perspectives than the United States on many important strategic matters.

Take, for instance, the concept of deterrence: The U.S. focus is on deterrence through threat of punishment, and the Soviet focus is on what might be called deterrence through denial. The former threatens to impose unacceptably large costs on an aggressor, so that his calculus of gain versus cost will be negative and he will (in theory) be deterred. The latter, through direct opposition, requires the capability to prevent the aggressor from achieving his objective. Hence, the United States has various "Assured Destruction" criteria, addressing a calculus of gain versus cost, and the Soviets have selected "warfighting" capabilities intended to defeat "aggression" directly.*

The U.S. approach has long been held to have the happy properties of cheapness and crisis stability and is oriented toward preventing hostilities from occurring; deterrence through denial has more open-ended (and thus potentially more expensive) force requirements and is oriented more toward achieving a favorable outcome if deterrence should fail. Although this is not the place for an extended analysis of doctrinal disparities and the extent to which each side pursues its

*And the forces procured to "defeat aggression" have impressive offensive/aggressive potential also.

doctrinal maxims, the U.S. approach pays little attention to what might happen should deterrence fail despite our best efforts, and the Soviet approach emphasizes preparation for that eventuality. Moreover, most U.S. high-level strategic assessments implicitly attribute our view of deterrence to the Soviets, leading to official professions of "bafflement" that the Soviets appear to be amassing strategic power in excess of "reasonable" levels for maintenance of deterrence. But by Soviet standards, their strategic power may still be short of their requirements for deterrence as they define it.

Clearly, major doctrinal, methodological, and analytic progress must be made before we will be better able to define answers to the question of how much military expenditure is enough.* In the interim, the best substitute available continues to be informed judgment about the adequacy of our forces.

Currently, the DoD assessment is that a greater effort is needed, as indicated in the Secretary of Defense's recent Annual Report:

> I see no grounds for believing that today--and I emphasize today--we have fallen into an unacceptable military posture. Even so, I must stress that the gap between U.S. and Soviet defense expenditures cannot continue to expand without a dangerous tilt in the relevant balances of power and a weakening of the overall U.S. deterrent. The United States is certainly more ingenious and efficient than the Soviet Union. It is not so much more ingenious and efficient that it can, without increased budgets, make up for increasing disparities between the two defense efforts.†

Unfortunately, the negative phrasing of this passage leaves unclear the question of whether the gap in military spending must be reduced or merely not allowed to grow larger than at present. If the former, then the current defense budget proposed to the Congress fails the test. It will not reduce the magnitude of the present gap in the aggregate, or in the RDT&E account, or in procurement of new systems,

---

*This is a major focus of strategic analysis at Rand at present, both for USAF and OSD clients; the Project AIR FORCE project is entitled "Red Campaign Analysis."

†Annual Report, FY 1980, p. 17.

when compared with the CIA's projections of Soviet spending in those categories (see p. 21 above). Moreover, the requests for this year are lower than last year's view of what would be needed this year:

> Our requests for FY 1980 are somewhat lower than we had projected a year ago, and our Long-Range Defense Projection runs slightly below the path forecast in the FY 1979 budget.*

This reduction in estimated needs occurs despite the evidence cited above that last year's estimates of the seriousness of the threat apparently underestimated Soviet progress in the intervening year.

Of course, viewed in yet another light, such criticisms are too narrow; as the Secretary's report suggests, budgetary guidance from the President strongly shapes the process,† rather than a building-block approach considering the requirements needed to meet specific contingencies. Nonetheless, that cannot and does not obviate the need to review carefully whether the budget guidance provides an adequate aggregate sum--this year as well as next year. And that brings us full circle to the question of tests of adequacy.

In the end, in reviewing the comparative trends in U.S. and Soviet ME, force postures, weapons inventories, and capabilities and estimates of intentions, it is the decisionmakers who must decide whether the U.S. effort is enough. The major and widening disparity for at least the last half-dozen years in nearly all ME comparisons, together with the forecasts of continued increases on the Soviet side, raises a basic question of whether our ability to compete with the Soviet Union is undergoing gradual erosion. This possibility raises two concerns: first, that in some future crisis the somewhat muffled doubts and uncertainties about the prospective adequacy of our military capabilities will weigh more starkly on our decisionmakers' perceptions of available options than they do at present; and, second, whether a future clearer

---

*Ibid., p. 3.

†Ibid., pp. 27-28.

realization of inadequacy may not require a major effort to rebuild capability necessitating much higher military expenditures, with all the turmoil for orderly planning that would entail.