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CIA|SOV ----- 88-14448 -----

# Dollar Costing of Foreign Defense Activities: A Primer on Methodology and Use of the Data

A Research Paper

CIA HISTORICAL REVIEW PROGRAM  
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SOV 88-10046  
July 1988  
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# Dollar Costing of Foreign Defense Activities: A Primer on Methodology and Use of the Data

A Research Paper

This report was prepared by \_\_\_\_\_, Central  
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SOV RR-10048  
July 1988

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Dollar Costing of Foreign  
Defense Activities: A Primer on  
Methodology and Use of the Data

Scope Note

This primer expands on and provides technical detail for the Interagency  
Intelligence Memorandum **E** **7**

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## Dollar Costing of Foreign Defense Activities: A Primer on Methodology and Use of the Data

### Summary

*Information available  
as of 1 July 1988  
was used in this report.*

Dollar valuations of the defense activities of different countries provide a useful summary comparison of the scale of these activities. Physical measures such as order of battle, although important, cannot be aggregated without some common unit of measurement. Dollar costs are often used for this purpose because they take into account both quantitative and qualitative differences. They reflect the number and mix of weapons procured, the technical characteristics of military hardware, manpower strengths, and the operating and training levels of the forces

The dollar value of the defense activities of a foreign country is calculated by estimating the cost of each activity in the prices and wages prevailing in the United States. For Warsaw Pact countries, each activity is directly costed in US prices and wages. For example, the dollar cost assigned to a year's production of T-80 tanks in the Soviet Union would be found by estimating the cost to produce the same tanks, at Soviet production rates, using US material and labor costs and US manufacturing practices—and, therefore, US manufacturing efficiencies. The dollar cost of maintaining the Soviet Union's large inventory of tanks for a year would be found by applying US prices and wages to the Soviets' maintenance practices. For non-US NATO countries, personnel costs are directly calculated at US rates; for the remaining activities, appropriate conversion factors are developed and applied to expenditures in national currencies.

Dollar costs of defense activities are estimated in five major resource categories: procurement, construction, military pay and allowances, operations and maintenance (O&M), and research, development, testing, and evaluation (RDT&E). For the Warsaw Pact, thousands of individual estimates are made for each resource category, such as annual production numbers for each weapon system for every year, detailed breakdowns of the number and rank structure of military personnel, and estimates of military construction activities.

There are no direct measures of the accuracy of aggregate dollar costs of foreign defense activities. Such dollar costs are a theoretical construct for which no objective "truth" exists. There are some subjective and indirect objective measures of accuracy, however. For the Warsaw Pact, the levels and trends depicted by dollar costs roughly reflect our observations of forces in the field. Moreover, although applications of the methodology have been revised over the years, and the data are changed annually to incorporate new information, no radical changes in the aggregate results

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*Guide to Using Dollar Cost Valuations of Foreign Defense Activities\**

*Dollar valuations of another country's defense activities estimate the cost, using prevailing US prices and wages, to produce and man a military force of the same size, armed with the same weapons, and operated in the same manner as that of the foreign country. They provide a common denominator to summarize the diverse activities associated with military programs, allowing portrayal of the relative magnitudes and general trends in these programs in terms that take account of both quantitative and qualitative differences*

*Dollar valuations, however, should not be used in isolation. They should be considered together with order of battle, production levels, and other information relevant to the issues being addressed. Dollar valuations should not be used as measures of (a) actual foreign defense spending, (b) the impact of defense on a foreign economy, or (c) a foreign leader's perception of his defense activities. Valuations in indigenous currencies are appropriate for these purposes.*

*Finally, dollar valuations should not be used to compare military capabilities. Such assessments must take account of accumulated stocks of military weapons, equipment, and supplies; military doctrine and battle scenarios; the tactical proficiency, readiness, and morale of forces; the effectiveness of weapons; logistic factors; and a host of other considerations*

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have occurred. Further, the changes reveal no underlying upward or downward bias in the estimates. On balance, we believe the overall estimating error amounts to no more than 10 percent for any one year.

But some significant weaknesses in the estimates for Warsaw Pact countries remain. While we have high confidence in the estimates for some resource categories, such as procurement, others are more uncertain. The dollar estimates of Soviet RDT&E are particularly uncertain, with no immediate prospects for improvement. Lags in data collection are also troubling, resulting in greater uncertainty in the estimates for recent years than for earlier ones. This weakness is particularly acute for O&M and RDT&E activities. A number of years might pass before any change in their trend would be detected

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July 1988

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The dollar value comparisons, especially of US and Soviet defense activities, are used by US policymakers and the Congress. When properly used in conjunction with detailed information about force capabilities and requirements, the comparisons provide summary indications not otherwise available. However, perhaps because dollar costs are used in many ways in the analysis of US programs, dollar cost data on foreign military programs seem to convey to many readers information beyond the limited uses for which they are applicable. Most questions relating to Warsaw Pact-NATO military issues are best answered using other measures. Although misuse of dollar comparisons cannot be prevented, the guidelines in the inset are intended to promote an accurate understanding of their proper use.



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## Dollar Costing of Foreign Defense Activities: A Primer on Methodology and Use of the Data

### Introduction

Monetary measures have been used for centuries in the analysis of foreign and domestic trade. In this century it has become common to see the entire collection of goods and services provided within a country summarized in a single value, GNP, which is then translated into dollars for comparison with the GNP of other countries. These international comparisons of GNP are also broken down to provide comparisons of major categories of interest, such as industrial output and consumption. The dollar valuations of defense activities of foreign countries have been developed within this tradition and are based on the same economic theory and practice used in international economic comparisons, although their development is more detailed and complex (see inset).

Physical measures of defense activities include data on the quantity of weapons and equipment produced and delivered to military units, the inventories of major weapon systems, and military manpower levels. Such measures are useful in portraying the mix of weapons and the relative sizes of various forces and their components. They cannot, however, be used to produce *summary* measures of diverse kinds of defense programs and military units such as tank divisions, tactical aircraft regiments, and infantry battalions

To aggregate such diverse activities, some value must be assigned that captures the relative worth of each—in terms of its physical and operational characteristics, resource costs, or some other quality. Because prices are a useful way to combine otherwise incommensurable quantities and because trends in defense activities are often related to overall developments in the economy, it has become the practice to develop aggregate measures based on the costs of resources devoted to various defense activities. These costs can be calculated in any currency, but dollars are the frame of reference for US policymakers and military force planners who are familiar with what a "defense dollar" can buy

### Proper and Improper Uses of Dollar Costs

The primary purpose of valuing foreign defense activities in US dollar terms is to compare them with corresponding US defense activities.<sup>1</sup> Dollar costs provide an appreciation of the size, quality, and trend of these activities. The comparisons provide the best available indicator of this sort. The dollar costs are calculated using prevailing US wages and prices. For example, in weapons procurement they represent the cost in the United States to manufacture the weapons, using the foreign designs, material specifications, and production rates and schedules, but with US manufacturing practices and efficiencies.

Dollar valuations of foreign programs, in conjunction with US defense program data, capture differences in the technical characteristics of military hardware, in the number and mix of weapons procured, in manpower strengths, and in the operations and training of the forces being compared. They can be used to portray the relative magnitudes of similar programs and compare trends.

The utility of dollar costs as a common denominator of defense activities is particularly evident when dealing with more complex international comparisons—for example, the total defense effort of the seven Warsaw Pact nations. Each of these countries has an indigenous currency, which, for a variety of political and economic reasons, is not directly convertible into any other currency. Therefore, any attempt to aggregate these disparate efforts must be made using some common denominator. Appendix D discusses in detail the dollar costing of the defense activities of the non-Soviet Warsaw Pact countries

A similar situation exists in the non-US NATO arena. Each of the 15 countries involved uses a

<sup>1</sup> The dollar values of US defense activities are defined here as the annual dollar outlays for these activities. See appendix M

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### Measuring Soviet Defense Activities

Dollar costs of Soviet defense activities were first developed within the Intelligence Community in the late 1950s. In the early 1960s, CIA began annual publication of the dollar value of Soviet defense activities. This material has been widely used within the US Government, particularly by the Legislative Branch, by the Secretary of Defense and the Chairman of the Joint Chiefs of Staff in their annual reports to Congress, and, on occasion, by the President in his State of the Union address. In 1965, the Director of Central Intelligence (DCI) and the Secretary of Defense agreed to coordinate their work "... relating to the cost and resource impact of foreign military and space programs; and because of the increasing importance of these economic studies ... agree[d] that they should be centrally directed, monitored, and evaluated." In a series of communications between CIA and the Department of Defense, in which the greater availability of resources at CIA was acknowledged, CIA was assigned primary responsibility for such analysis. In the early 1970s, the DCI established the Military-Economic Advisory Panel.

\* Secretary of Defense Memorandum to the Director of Central Intelligence, dated 5 February 1965. DCID 3/1, 23 April 1965, assigns major responsibilities for military-economic intelligence to the Department of Defense as well.

medium of exchange that can, for some purposes, be readily converted into other currencies. However, the simple use of exchange rates—especially the highly volatile rates of the past few years—has led to sharp year-to-year changes in the dollar value of defense programs that distort comparisons. More important, exchange rates are driven by a host of factors unrelated to the relative costs of providing defense activities. The method used to overcome the problems with exchange rates and to place the dollar value of non-US NATO defense activities in terms comparable to that of the Warsaw Pact activities is described in detail in appendix E

If the objective is to compare the size of foreign military programs with corresponding US programs,

consisting of experts from academe and business, to review all relevant Intelligence Community work, advise him on its quality, and suggest areas for improvement. At about the same time, the Joint Military Costing Review Board was established to coordinate CIA and DIA work in this field.

The estimates have at times been controversial, with critics charging they are too high, too low, and often used inappropriately. In 1982 the Deputy Director for Intelligence, CIA, established a panel of outside experts to examine the methodologies employed in preparing the estimates, usage of the estimates, and the wishes of policymakers regarding their continued production. The panel held numerous hearings and took testimony from all interested parties, including many critics. It concluded that the methodologies were essentially sound, that the estimates could be properly used to inform decisionmakers, and that their continued production was essential.<sup>1</sup>

<sup>1</sup> See the summary "Report of the Working Group on Soviet Military-Economic Analysis" and the more detailed "Report of the Methodology Panel of the Working Group on Soviet Military-Economic Analysis," dated 20 July and 5 July 1983, respectively.

then the best measure is dollars (see table 1).<sup>2</sup> Dollar valuations of foreign defense activities have the following important limitations, however. If these are ignored or misinterpreted, the valuations provide measures and comparisons that are not valid:

- Dollar valuations do not measure actual foreign defense spending, the impact of defense on the economy, or the foreign perception of defense activities. The foreign country does not spend US dollars.

<sup>2</sup> Both countries' programs could be measured in terms of the foreign currency, but that is not generally satisfactory because: detailed cost information in indigenous terms is not usually available, particularly for Warsaw Pact countries; US data are already available in dollars; and, finally, US policymakers, the primary consumers of such data, prefer measures that are in familiar and understandable—and, therefore, useful—terms.

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Table 1  
Measures To Use in Addressing Military-Economic Questions <sup>a</sup>

How much is the United States spending on defense?	Dollar costs
What is the trend in the size of Warsaw Pact defense programs?	Dollar costs
How do Soviet defense economic activities compare with US activities?	Dollar costs
How do non-US NATO defense activities compare with US activities?	Dollar costs
How much are the Soviets spending on defense?	Indigenous prices
What is the impact of defense on the Soviet economy?	Indigenous prices
What are the trends in Soviet defense spending over time?	Indigenous prices
What share of Hungarian GNP goes to defense?	Indigenous prices
How do the East Germans allocate defense resources?	Indigenous prices
Are Soviet military capabilities greater than those of the United States?	Nonmonetary measures
Is a MIG-29 better than an F-18?	Nonmonetary measures

<sup>a</sup> See DI Reference Aid SOV 87-10069 (Unclassified), November 1987, *A Guide to Monetary Measures of Soviet Defense Activities*, for a detailed discussion of this issue.

Issues of defense burden are properly analyzed with estimates of defense expenditures in the domestic currency.

- They do not reflect the foreign country's view of the distribution of its defense effort. The price structures in two countries are often very different. For example, the costs of Soviet defense activities are distributed quite differently among the resource categories when measured in dollars than when measured in rubles. The effects of different price structures are significant; for example, Soviet military procurement in rubles accounts for about one-half of total defense costs, but measured in dollars it accounts for only about one-fourth.
- They do not measure the overall capabilities of military forces. One of the strongest temptations in using the dollar value estimates is to interpret them in terms of military capabilities—either foreign

capabilities relative to those of the United States, or changes in foreign capabilities over time. These estimates are not intended to and cannot support such interpretations. Because dollar valuations only measure the annual production of defense goods and services, they capture only a small part of a country's military stockpile. Moreover, assessments of capability must take into account military doctrine and battle scenarios; the tactical proficiency, readiness, and morale of forces; the effectiveness of weapons; logistic factors; and a host of other considerations. Dollar valuations of defense activities do not provide a reliable measure of these disparate factors.

A final note of caution regarding the use of dollar cost data centers on the need to make costs in a given year comparable with those of another year. The usual

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practice to assure comparability is to "standardize" the costs to a base year. Such standardization removes the inflationary effects of changes in price levels. In other words, it eliminates the changes in costs over time that have nothing to do with the quantity or quality of the goods or services. These standardized costs are usually called "constant" costs. A number of conceptual and methodological decisions have been made in standardizing the dollar costs; the more important of these decisions are discussed in appendix B.

In summary, dollar costs are well suited for comparisons of the relative sizes and trends of different countries' defense activities. They provide a common summary measure that is needed for any comparison of the diverse and dissimilar activities of two or more countries. The dollar cost measures are in terms familiar to US policymakers and reflect:

- The size of armed forces.
- The quantities and qualities of weapons procured.
- Operating and maintenance practices.

Other measures are available and more appropriate for addressing issues other than the comparative sizes of and trends in defense activities. Measures in indigenous prices are more appropriate for examining issues such as:

- How much a country is spending on its defense.
- The share of national output going to defense.
- The relative share of resources going to the various components of defense.
- Internal perceptions of spending trends.

Moreover, monetary measures, whether in dollars or indigenous prices, are inappropriate for the analysis of relative force or weapon capabilities

#### Estimating Dollar Costs

Having decided to provide a summary measure of foreign defense activities in US dollar terms (that is, the hypothetical costs of the goods and services if they had been purchased in the United States), it is essential to establish an appropriate conceptual framework that will take into account the many differences between a foreign way of doing things and the US way. Such a framework is also necessary to ensure the consistent application of measurement methods to the available information on the various

components of a foreign military program, so that the final results are both internally consistent and comparable

The Intelligence Community, after considering a variety of options, has chosen to use a concept that, in effect, estimates the cost—at prevailing US prices, wages, and efficiencies—to develop, deploy, and maintain a military force of the same size and with the same weapons as the foreign country and to operate that force as that country does. For procurement, this means the cost of building the same design as that of the foreign system at the foreign production rate, but using US prices and wages and US industrial practices and, therefore, US efficiencies at that rate. It is assumed that the requisite production base is in place, complete with a trained work force, qualified suppliers, and all other ingredients necessary to replicate the foreign output at US manufacturing efficiencies. This concept is termed "comparable dollars."

Other concepts are available that, if applied, would produce different estimates (see appendix A). For example, at one extreme, US manufacturers could be asked to design systems from scratch to carry out a particular mission, and then estimate the dollar cost of doing so. The resulting costs would then be used for the actual systems chosen by the foreign country for the mission. At the other extreme, the starting point would be to take the foreign country's detailed work plans for producing a weapon system and then apply US prices for each labor hour, piece of material, and so forth, used by the foreign manufacturer.

Within the comparable dollar concept, six different methods are used to develop the dollar cost of procuring a particular foreign weapon system or to value the other activities that constitute defense. The actual method used depends on the availability of data. (Confidence in price estimates is highest for those components that are nearly identical to US components.) Appendix B shows the degree to which each of the methods is used in estimating Soviet procurement. The following five methods are described in descending order of preference. Examples of actual applications of some of these methods are given in table 2

**Table 2**  
**Examples of Dollar Cost Methods**  
**Applied to Soviet Weapons**

Method	Equipment Type	Date	Notes
Product-specific industrial cost estimates	Small arms (rifles and machineguns)	1980	Cost estimates are based on detailed examination of hardware.
Detailed CERs	Aircraft:		CERs are based on a detailed exploitation of both hardware and equipment manuals.
	Airframe	1984	
	Engines	1987	
	Avionics	1986	
General CERs	Naval destroyers	1982	This is a computer model that estimates dollar costs of Soviet destroyers based on estimates of the weight of nine major subsystems. Values are based on "Sovietized" versions of two US destroyers (redesign of US ships to reflect Soviet naval design practices) and adjusted to reflect individual Soviet ship characteristics.

**US Price List.** This method is used when the foreign good or service is judged identical, or nearly so, to a US good or service. For example, US prices are applied directly to military manpower billets, POL (petroleum, oil, and lubricants), food, and similar consumables.<sup>3</sup> It can seldom be used for weapon systems procurement because foreign designs are different.

**Product-Specific Industrial Cost Estimates.** This method is used when we have hands-on access to a foreign good or detailed design specifications. For example, about 40 percent of the procurement costs of Soviet land arms are generated by this method. A US manufacturer of similar items is asked to make a detailed engineering cost estimate for producing the good. He is able to make a fairly accurate estimate because, by the time we obtain the good or its detailed

<sup>3</sup> The judgment is made that, on a billet-for-billet basis, any qualitative differences between a US serviceman and a foreign serviceman stem from their equipment and training rather than innate characteristics.

specifications, the US manufacturer has had considerable experience in producing items like it. The practice is akin to asking General Motors to estimate the cost of producing a particular five-year-old Fiat design.

**Product-Group Cost-Estimating Relationships (CERs).** The costs of weapon systems within a particular product group, such as major surface combatants or tactical aircraft, can be approximated reasonably well by associating costs with various major characteristics of the systems. This technique, also called parametric costing, uses actual historical costs for weapons and regression analysis to develop the appropriate factors relating these costs to the system's characteristics. When adapting this technique for foreign systems, the resulting cost factors need to reflect the foreign design characteristics—for example, a typical pound of Soviet avionics has a different composition and is less costly to produce than a typical pound of US avionics. This step is taken in one of two ways. The preferred way—resulting in a

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*detailed CER*—is to develop the factors from product-specific industrial cost estimates of *foreign systems* within a particular product group. For example, about 85 percent of Soviet aircraft procurement costs are based on detailed CERs. The second way—resulting in a *general CER*—is to adjust the factors developed from *US systems* in a product group to reflect known design differences. For example, about 80 percent of Soviet ship procurement costs are based on general CERs.

*US Analogue.* When the data do not permit any of the above methods to be used, the cost of the most similar US good or service is taken if the differences are not too great. For example, most stand-alone electronics procurement costs are based on US analogues. If the US good is too dissimilar, the US price is *adjusted* to compensate for the differences. Half of Soviet nuclear weapons procurement costs are derived from adjusted analogues

*General Factors.* Many defense activities are individually too small to warrant the time or effort to develop costs by any of the above methods. For example, all military organizations use a variety of small items such as furniture and office equipment and supplies. Costs of these items for a foreign military unit are estimated by finding the ratio of such costs in a similar organization in the US military to the number of personnel and applying that ratio to the number of personnel in the foreign unit. Maintenance costs are usually estimated by applying factors to the procurement cost of the item being maintained

At times, none of the above methods are used. Instead, the value of a foreign country's activities is first estimated (or provided in the case of the non-US NATO countries) in its own currency and then converted to US dollars using either currency exchange rates or special measures called purchasing power parities (PPPs). PPPs are used for Warsaw Pact RDT&E (see appendixes C and D) and the costs of non-US NATO defense other than personnel (see appendix E). Conversions using currency exchange rates are not used within the Intelligence Community for valuing Pact defense activities, although at least one critic has argued that the dollar value of Soviet defense activities can be calculated by applying a

ruble-dollar exchange rate to the estimate of their value in rubles. Because of the substantial differences in price structure between the United States and the USSR and the controlled, artificial nature of the ruble-dollar exchange rate, this approach has little merit considering the available alternatives. Exchange rates have often been used, however, to value NATO defense spending in dollars. The relative advantages of PPPs over exchange rates for this purpose are addressed in appendix E.

#### Confidence in the Estimates

A definitive assessment of the overall confidence one should have in the estimates is difficult. We are dealing with an analytical construct for which there is no objective truth. A substantial effort goes into the development of the estimates, however, and they make use of a broad range of military and economic inputs. All-source intelligence is used to estimate the physical numbers that constitute foreign defense activities—order of battle, production quantities going to the military, manning levels, operating and maintenance practices, military construction, and RDT&E activities. Although there is general Community agreement on most of these data, the data are still subject to errors, which are then reflected in the dollar estimates based upon them. This paper does not explicitly assess our confidence in these physical data, as such assessments are provided in other documents. For example, the annual Interagency Intelligence Memorandum on weapons production indicates a broad range of uncertainties (from "high" to "low") in the production estimates of individual weapon systems. When dollar costs are used to aggregate the individual systems, however, approximately 80 percent of the total dollar cost is accounted for by systems assigned "high" and "high-moderate" confidence

Dealing with technologies that cannot or have not been produced in the country whose currency is used for valuation is a problem. The USSR has not and probably could not produce some items in the US arsenal; the United States has not manufactured a submarine with a titanium hull as the Soviets have. In such cases, it is assumed that the technology can be

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produced and costs are increased by a subjective amount. Although subject to large errors, such judgments form only a small portion of the overall estimate. Finally, the results and, in a sense, the "accuracy" of the estimates are affected by the prices used in making the valuation because the relative efficiencies of economic sectors vary among countries (see inset on the "index number problem").

Any discussion of confidence must be framed in terms of how well the estimates serve the stated purpose of providing a summary measure of the comparative size of two or more countries' defense activities over time. Several standards should be met for such comparisons:

- Comparable coverage for each side.
- Consistency of results.
- Quality control in the calculations and reproducibility of the measures.
- Robustness of the estimates as new information and methodologies are incorporated

*Comparability of Coverage.* With one exception, the US accounting scheme has been chosen as the standard for categorizing defense activities and costs (see inset on next page). The exception is that costs for both US and foreign defense activities are presented for calendar instead of fiscal years. Cost estimates represent actual outlays with total costs usually broken down by one of two schemes—by resource category or by military mission. The resource scheme follows the standard Department of Defense definitions of RDT&E, procurement, construction, military personnel, and operations and maintenance. The mission breakouts are by the definitions contained in the Defense Planning and Programming Categories (DPPC). Considerable care has been taken to ensure that foreign military activities are placed in the proper categories.<sup>7</sup>

*Consistency of Results.* The individual estimates have been reviewed repeatedly to ensure consistency of results. Many of these reviews have been prompted by intuitive judgments that the estimated dollar costs of

<sup>7</sup> In the early 1970s there was some confusion in the estimates as to the proper split of the costs of spare parts between the procurement and operations and maintenance categories, but this was corrected in the mid-1970s. Since then, no substantial errors in coverage have been discovered.

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#### The "Index Number Problem"

*A frequently heard criticism of dollar cost estimates, based on the so-called index number problem, is that comparisons in US prices distort the size of a foreign military program. It is true that shifting the price base can dramatically change the picture of a country's defense activities. For example, the share of total Soviet defense attributable to procurement is twice as large measured in ruble prices as it is in dollar prices. This change does not mean that any one view—based on any one country's prices—is wrong. Rather, any difference in results reflects the fact that in another country certain economic activities are relatively more expensive (that is, use more scarce resources) than the same levels of activity in the United States; others are relatively less expensive.*

*To determine whether a change in currency causes a major change in the comparison of US and Soviet defense activities, we have estimated the cost of US defense activities in rubles, and compared the ratio of Soviet to US defense activities measured in rubles with the ratio in dollars. For each major resource category, such as procurement, the ratios differ by only a few percentage points. However, procuring a weapon system is relatively more expensive in ruble prices than in dollar prices. As the United States increased the share of its defense outlays for procurement during the 1980s, the ratios for total defense activities diverged. During the 1970s the two ratios differed by only a few percentage points. By the mid-1980s the ratio of Soviet to US activities measured in rubles was about 15 percent lower than the ratio measured in dollars. (Appendix F discusses the index number problem in more detail.)*

individual Soviet systems are too low. The argument, often called the procurement paradox, is that, although the Soviets are able to procure many more weapons and equipment than the United States, in total they have only a slightly greater dollar value; therefore, the individual dollar values must be too low

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#### *Defense Activities Covered by Dollar Costs*

*The defense activities covered by dollar valuations are usually defined in Intelligence Community publications to include the foreign counterparts of the following US activities:*

- *National security activities funded by the Department of Defense.*
- *Defense-related nuclear programs funded by the Department of Energy.*
- *Selective Service activities.*
- *The defense-related activities of the Coast Guard.*
- *Pensions.*

*In addition, they include border security forces in foreign countries that have a wartime mission of border defense; premilitary training performed by civilian schools; and pay for reservists funded by civilian enterprises.* \*

*They exclude:*

- *Civilian space activities that in the United States would be performed by the National Aeronautics and Space Administration.*
- *Military assistance to foreign nations (except for border defense; premilitary training performed by civilian schools; and pay for reservists funded by civilian enterprises).*
- *Civil defense programs.*
- *Internal security or uniformed labor troops who do not have wartime defense missions.*
- *The cost of increasing and maintaining stockpiles of strategic reserves such as fuel, spare parts, and raw materials.*
- *Industrial mobilization preparations.*
- *Dual-use infrastructure such as communications lines, reinforced bridges, and wider roads.*

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(see inset). But repeated examinations have confirmed that the individual costs are not understated when the detailed characteristics of the Soviet items are considered. This issue was recently explained in considerable detail by the CIA, using examples of specific weapon system comparisons.'

\* See DI Research Paper SOV 87-10077/EUR 87-10032  
December 1987. *A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86*

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#### *The Procurement Paradox*

*A wide variety of factors influence the cost of producing a specific weapon system. These factors explain what has been called the procurement paradox: that is, the riddle of how the Soviet Union and its Warsaw Pact allies can procure substantially larger numbers of weapons than the United States and its NATO allies, but these weapons can have an equivalent or even smaller dollar value.*

*First, the Warsaw Pact achieves an economic advantage by opting for long, high-volume production runs. Short-run political uncertainties probably do not affect production decisions. In addition, the Soviet Union dominates the Warsaw Pact. It accounts for nearly 90 percent of the dollar value of weapons procurement within the Pact.*

*Furthermore, Warsaw Pact weapon designs have generally been simpler and less costly to produce than those of NATO countries. Pact designs usually:*

- *Are less sophisticated.*
- *Are designed for a short mission life with few redundant subsystems.*
- *Lack mission flexibility.*
- *Use commercial-grade components.*
- *Have poor habitability.*
- *Are maintainable by low-skilled personnel in the field or else require factory repair.*

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*Quality Control.* The production of dollar cost estimates is institutionalized in both CIA and DIA. The joint Military Costing Review Board and the DCI's Military-Economic Advisory Panel periodically review the cost methodologies and the resulting estimates. All data processing is done by computer with numerous quality control checks built into the software. Each annual estimate is carefully compared with previous estimates, and changes are reviewed and explained. No estimate is released until it has been presented to and approved by senior intelligence officials

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*Robustness of the Estimates.* We believe that errors in our dollar valuation of the total defense activities of the Soviet Union amount to less than 10 percent for any year from 1970 to 1986.<sup>7</sup> This belief is based on various statistical techniques and our past experience, including the monitoring of our annual revisions. (Appendix G discusses this evidence.) The margin of error can be much wider for some individual items and categories than for the total because, with the large number of components involved, errors at lower levels of aggregation tend to partially offset each other. We also believe that our estimates of the dollar valuations of the other Warsaw Pact countries and of non-US NATO countries are of comparable accuracy.

Every year we revise the estimate of the dollar value of Soviet defense activities using new information on costs, production quantities, operating practices, and order of battle. Our estimates for any one year can be expected to improve over time as we learn more about the quantities and characteristics of the weapon systems and facilities produced in that year. The changes resulting from these annual revisions provide a method of assessing how well we estimate the dollar costs of Soviet defense activities. If estimates for a given year changed sharply with every review—indicating that improved data, different analysts, and new methodologies produced very different results—we would have little confidence that we had an accurate estimate of military activities in that year. In fact, the estimates have fluctuated only by a small amount, and no bias has been detected.

Figure 1 illustrates the range of variation in the cost estimates. It shows the largest percentage difference between the average estimate for a given year of total Soviet defense costs and all of the other estimates that have been made for the same year. For example, the estimate for 1971 has been revised 13 times since 1973. Some revisions increased the 1971 estimate; some decreased it; but at no time did the 1971 estimate differ from the average estimate by more than 7 percent. The results show that inclusion of new

<sup>7</sup> Projections of the dollar valuations of future Soviet defense activities are less certain. See DI Technical Intelligence Report SOV 87-10066, November 1987, *Projecting Soviet Military Forces and Weapons Procurement*.

information on deployments, weapons characteristics, and operating practices does not lead to large changes in the total dollar cost estimates. In some instances, our understanding of the deployment or design and performance characteristics of individual items has changed significantly. The effects of these changes on total costs, however, have tended to be offsetting.

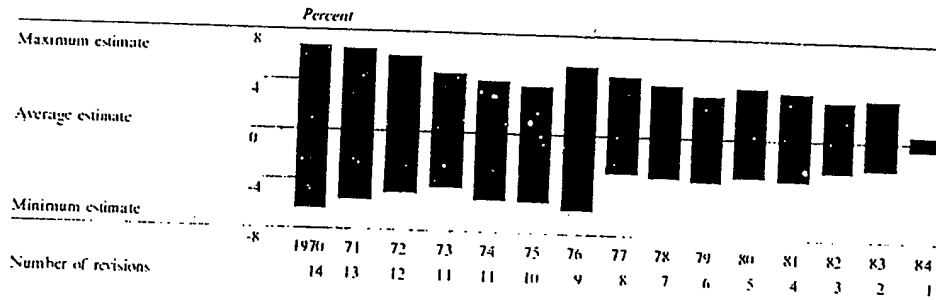
Figure 2 illustrates the lack of trend in revisions, indicating that the introduction of new information and techniques did not reveal a bias in the results. Each graph tracks the estimates made over time for Soviet defense activities in a given year. For example, "Estimates for 1970" tracks the revisions made each year to the original estimate of dollar costs for Soviet defense activities in 1970.

*Prospects for Improvement in the Estimates for the Soviet Union.* Although analyses of past dollar cost estimates suggest that they are reasonably reliable, the degree of confidence is always lower for recent years and for short-term trends. Subsequent refinements and improvements in the basic dollar costing methodology will not change this, because the largest gaps and uncertainties in our knowledge of Soviet military activities are always for the most current period. There are inevitable lags in collecting information on recent systems and their characteristics. Until the technical characteristics of weapon systems are reasonably well known, estimates of their costs remain uncertain. Detecting changing patterns in RDT&E or in operating or maintenance practices also usually requires several years of data accumulation. As time passes and more intelligence is collected, these gaps are at least partially filled, and the uncertainties diminish.

Some specific efforts would, however, reduce uncertainties and improve our confidence:

- The annual Interagency Intelligence Memorandum on Soviet weapons production has already contributed significantly. As the agencies continue this work, with particular emphasis on expanding the number

Figure 1  
Variations in Estimates of the Dollar Costs of  
Soviet Defense Activities

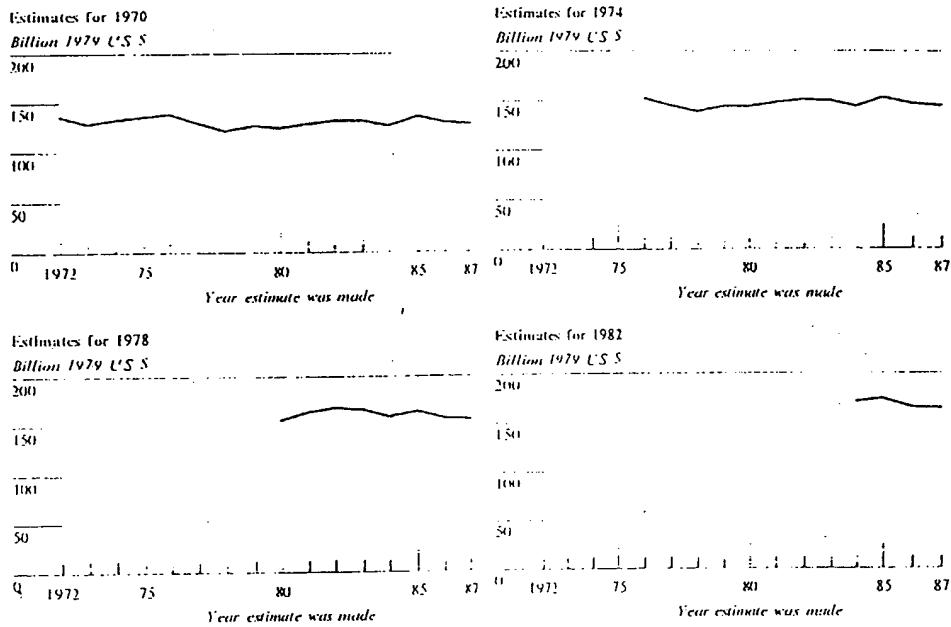


of weapon systems included and refining the methodologies used to estimate production quantities, the procurement component of the cost estimate will become even more accurate and instill a higher degree of confidence.

- A better estimate of the exports of Soviet weapons would also improve estimates of procurement. These exports must be subtracted from the estimates of total production to arrive at an estimate of the total number of weapons being procured by the Soviet forces.
- About one-third of the dollar value of Soviet procurement is now estimated using less desirable cost methods. The overall quality of the procurement estimate will improve as this share is reduced. The estimates of the costs of advanced electronics will particularly benefit.
- To improve the comparability of the estimated dollar costs to US outlays, additional work is required on the phasing of both recurring and non-recurring Soviet weapon system costs

Finally, there is the possibility the Soviets may provide data that will aid our estimates. Recently, senior Soviet officials, including General Secretary Gorbachev, have acknowledged that the announced Soviet defense budget does not include major components of defense spending. They indicated that, after price reforms in 1989-90, during which they say Soviet defense spending is to be made comparable to US outlays, the full Soviet defense budget will be released. Any outlay data could be helpful. Depending on the types and amounts of such information provided, the dollar cost estimates could benefit, particularly from disclosures about those components for which ruble data are most lacking, such as weapon prices.

Figure 2  
Dollar Costs of Soviet Defense Activities



## Appendix A

### Alternative Concepts of Dollar Costs of Foreign Weapon Systems

There are no actual dollar prices for most components of foreign defense activities because the United States does not design, produce, man, operate, or maintain a foreign country's military forces, and foreign countries do not use US prices. Therefore, we estimate the hypothetical costs of the goods and services if they were to be purchased in the United States. Over the years four different concepts have evolved for developing appropriate dollar costs for weapon systems that have never been produced in the United States. They are summarized in table 3.

The Intelligence Community has selected "comparable dollar costs" as its preferred choice. This concept and the methods used to implement it are explained in detail in the text. In brief, the concept calls for estimating the cost of replicating a set of foreign weapon systems using US prices and wages, US industrial practices, and US manufacturing efficiencies.<sup>4</sup> For some items, the necessary data are not available to apply this concept. In those instances alternative 2, described below, is used.

The four concepts—comparable dollars and alternatives 1, 2, and 3—differ in the degree to which they "Americanize" the foreign activities.<sup>5</sup> For this purpose, a given foreign activity can be described in terms of:

<sup>4</sup> The one exception is the case in which the Soviet design uses parts that are obsolete in the United States and for which cheaper replacements have been developed—for example, vacuum tubes. For such a case, alternative 2 is used to avoid overvaluing the Soviet product.

<sup>5</sup> A foreign country and the United States have different industrial bases and experiences. For example, a US aircraft manufacturer could not today manufacture a Soviet aircraft. The manufacturer would first have to develop plans, identify suppliers who could begin producing subcomponents, train its labor force, retool its assembly line, and so forth. Most US manufacturers could not even produce on the large scale that the Soviets do without first constructing additional plant floorspace. But the purpose of valuing foreign goods in dollar terms is to gain an appreciation of the size of the foreign production output rather than the effort involved in transforming US industry to produce those goods. Therefore, all of the concepts assume that the requisite production base is in place, complete with a trained work force, qualified suppliers, and all other ingredients necessary to replicate the foreign output.

- *Its mission, purpose, or objective.* For example, defend the homeland against bomber attack.
- *The mechanism or means chosen to carry out the mission.* For example, acquire, operate, and maintain an air defense force of 100 interceptor regiments and 50 surface-to-air (SAM) battalions.
- *The specific system or unit designs selected to provide the means.* For example, in 1985 procure 10 SA-10 SAM launchers with associated missiles, electronics, and support equipment.
- *The organization and technologies employed in producing the specific designs.* For example, the SA-10 missiles will be manufactured in a particular plant using the production technology and labor force in place in 1985.

At one end of the spectrum, *alternative 1*, each foreign activity is broadly defined as to how it contributes to fulfilling mission requirements. An estimate is then made of how the United States would carry out that activity—from choice of mission means through the procurement of the requisite personnel and hardware. For example, if US planners had been tasked with carrying out the Soviet air defense mission as effectively as the Soviets, they might have chosen a different doctrine or mix of weapon systems than did the Soviets. Once the mission means was decided, they might have designed a different SAM system. After the missile was designed, it would have been produced in a US plant. In essence, this concept calls for measuring the costs the United States would incur if it had another country's military requirements and were about as effective as that country in meeting them. This concept is difficult to apply, however, because its first step—specifying the means US planners would choose to carry out the mission—is quite subjective. Nevertheless, this concept is appropriate if

Table 3  
Alternative Concepts for Valuing Foreign Programs  
in US Dollars

	Comparable Dollar Costs	Alternative 1	Alternative 2	Alternative 3
Ways to fulfill military mission	Foreign choice	US choice	Foreign choice	Foreign choice
System or unit design	Foreign choice	US choice	US choice	Foreign choice
Production technology and organization	US choice	US choice	US choice	Foreign choice
Advantages	For US policymakers, the most appropriate monetary measure for comparing US defense activities with those of another country.	Once the mission and the means to accomplish it are specified, it is relatively easy to cost because most components will have already been procured in the United States.	US cost-estimating methodologies are well developed for US designs.	Measures the cost of a foreign country's defense activities, if its price and wage structure were identical to that of the United States.
Disadvantages	Requires developing costing methodologies for foreign designs.	The choice of means is highly subjective. Judgment of the degree to which the foreign country has been successful in meeting its mission objectives is required.	Must design many new US weapon systems for foreign choice of force mix.	Large amounts of foreign data required. It is not clear the answer is of any interest.

one wishes a summary measure of the relative magnitude of two or more countries' overall defense postures.

*Alternative 2* is the same as *alternative 1* except that it accepts the foreign choice of mission means. It then uses US designs and production efficiencies. The concept measures the cost the United States would incur if it were to procure, operate, and maintain military forces with the same general kinds and amounts of weapons, equipment, and personnel as those of the foreign country. Because the application of this concept requires the redesign of foreign weapons to meet US standards and specifications, it is costly to apply. Moreover, the application of US design standards and specifications (for example, redundant subsystems for reliability, habitability features, military specifications for soldering of electronics) to a foreign force generally results in a force of higher quality and, hence, higher cost. The concept, however, is appropriate if one wishes a measure of the

costs the United States would have incurred if it had procured the foreign force mix instead of the US force mix.

*Alternative 3* uses all foreign designs and efficiencies but at US prices for material inputs and US wages for labor hours. For example, the dollar cost of producing an SA-10 missile would be calculated by applying US cost factors to all of the physical resources actually used by the Soviets when they produce the missile. Applying this concept requires detailed data on the manufacturing practices of the foreign country. For the foreseeable future, the Intelligence Community will lack the data to apply this concept to Warsaw Pact countries. If practical difficulties could be overcome, *alternative 3* would provide a measure of the cost of a foreign country's defense activities if its price and wage structure were identical to that of the United States.

## Appendix B

### Estimating Dollar Costs of Soviet Defense Procurement

Figure 3 and table 4 show the distribution of all procurement costs for Soviet weapon systems and equipment by type and the method used in estimating them (the methods are defined in "Estimating Dollar Costs"). The share for a particular method is the ratio of the dollar value of all programs based on it to the dollar value of all procurement in the CIA's data base (covering the period 1965 through 1996). Almost two-fifths of the procurement costs are based on the highest quality methods (product-specific industrial cost estimates and detailed CERs) and only one-sixth are based on unadjusted US analogues or general factors.

Each year the joint CIA-DIA Military Costing Review Board reviews the status of the dollar cost estimates for Soviet weapon systems and recommends where external research funds should be applied to improve the estimates. The Intelligence Community let \$5 million in contracts for this purpose during fiscal 1982-87. Some contracts result in improved CERs for a class of weapons, others in improved costs for a major subsystem. On occasion two different contractors are asked to estimate independently the costs for the same system to provide a check on the quality of the estimates. Table 5 shows, by major weapon category, the date of the latest cost study and indicates those areas in which work is expected to be completed in 1988 but is not yet incorporated into Community estimates. The studies may address one or more systems or major components thereof.

A final methodological note concerns the practice of using constant costs both to remove the effects of changes in price level and to assure that costs in a given year are comparable with those of other years. The constant dollar costs chosen for all foreign goods and services are based on the average prices and wages prevailing in the United States in the base year. If the good or service is identical to a US good or

service, then the average price or wage for that good is used. For example, fuel consumed by Soviet forces would be valued by applying the average prices of the same fuels in the United States; the valuation of a Soviet military person is taken as the average pay and allowances for a US military person with the same job description or billet. If an identical good or service is not available in the United States, then it is valued by estimating what the good or item would cost if it were available. Such estimates are usually based on a detailed analysis of the physical elements that would be needed to produce the good or service and then summing the individual component prices plus an average profit. In all cases, prices and wages are taken as unaffected by the additional demands that would be placed on the markets for labor or industrial materials if the foreign items were actually to be procured in the United States. The fixing of a base year not only fixes the average price level for valuations but also fixes the levels of manufacturing technology and general productivity to those of the base year.

From the foregoing description, one might infer that two identical products would be assigned the same dollar value. However, as desirable as this might be, it is not always possible to do so consistently. The difficulty arises for goods whose cost to manufacture is systematically reduced over time because of "product-specific learning." Product-specific learning refers to the fact that, as a good continues to be manufactured in the same facility, the managers and workers of the facility find cheaper ways to produce the product. The degree of cost reduction experienced as more items of a good are produced is termed a "learning curve." This learning is achieved through a wide variety of mechanisms, including better organization of the assembly process, better handling of supplies, minor design changes to speed assembly, and



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Figure 3  
Relative Use of Different Costing Methods in  
Estimating Dollar Costs of Soviet Procurement

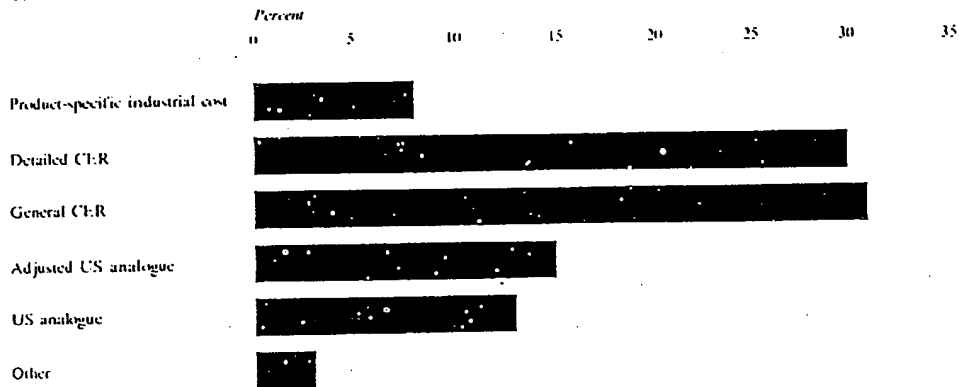


Table 4  
Distribution of Soviet Procurement Estimates  
by Type and Method

Percent

	Aircraft	Ammunition	Electronics	Land Arms	Missiles	Nuclear Weapons	Ships	Other	Total*
Share of total costs	30	6	4	18	16	2	15	10	100
Product-specific industrial cost				40	2				8
Detailed CER	84	3		4	5			32	30
General CER	12	18	2	30	52		82		31
Adjusted US analogue				22	26	48	8	53	15
US analogue	5	74	88	3	12		10	3	13
Other		5	11		3	52		12	3
Better quality*	95	21	2	75	59		82	32	68
Lesser quality*	5	79	98	25	41	100	18	68	32

\* Because of rounding, data may not add to totals shown.

\* The sum of the shares for industrial cost, detailed CER, and general CER.

\* The sum of the shares for adjusted US analogue, US analogue, and other.

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**Table 5**  
**Dates of Latest Dollar Cost Studies**

Weapons Category	Date of Latest Cost Study	Cost Studies To Be Completed in 1988
<b>Land arms</b>		
Tanks	1979	X
Armored personnel carriers/ infantry fighting vehicles	1981	
Artillery	1980	
Multiple rocket launchers	1985	
Antiaircraft artillery	1974	
Trucks	1976	X
<b>Naval</b>		
Ships	1982	X
Submarines	1980	X
<b>Aircraft</b>		
Airframes	1984	X
Engines	1987	X
Avionics	1986	X
<b>Strategic missiles</b>		
Airframes	1976*	X
Engines	1976*	X
Guidance	1976*	X
Reentry vehicles	1986	
Ground support equipment	1976*	X
<b>Short-range ballistic missiles</b>		
Cruise missiles	1986	
Air-to-surface missiles/tactical air-to-surface missiles	1986	
Surface-to-air missiles	1976	X
Antitank guided missiles	1985	
Air-to-air missiles	1976	X
Space	1984	X
Electronics	1978	X
<b>Nuclear weapons</b>		
Ammunition	1978	X

\* The 1976 study was reviewed and updated in the summer of 1986.

so forth.<sup>14</sup> Thus, even though the prices of inputs—material and labor—are held constant to a base year, fewer inputs are required over time as learning takes place. There is no completely satisfactory way, then, to assign a base-year price that remains constant over time. Two approaches to the problem are usually taken.

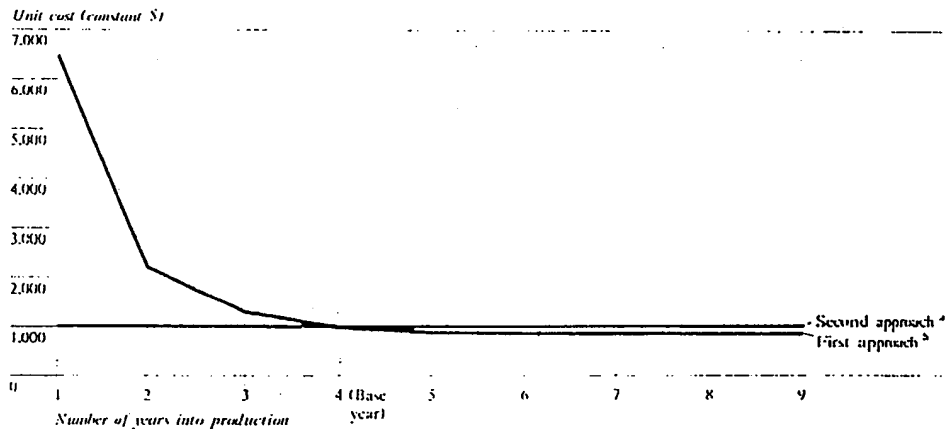
One approach, favored by CIA, is to assign to a good produced in any given year the cost that the good would have had in the base year had it been at the same point on the learning curve in the base year as it was in the given year. The effect is to use the prices and wages of the base year for the resources required to produce the good, but to apply those costs to the amount of resources implied by the amount of learning realized in the given year. Figure 4 illustrates the reduction in constant resource costs that can occur. This method results in the same kind of costs as those that are obtained by applying standard price indexes to US defense outlays expressed in current dollars. The prices of resources used to produce the final goods are thus constant. The principal objection to this method is that the same good does not have the same price from year to year.

The second approach, favored by DIA, uses for any given system the average unit cost of the production run in the base year. This price is applied to all units produced. For systems that end production before the base year, the base-year price is taken as the average cost assigned by the first approach to the last year of production; this price is selected because no further learning is possible after completion of production. For systems that start production after the base year, the price used is the average cost assigned by the first approach to the first year of production. This method not only maintains the price of the material and labor

<sup>14</sup> Product-specific learning should not be confused with general industrial productivity. General productivity comes with the evolution of manufacturing technology and equipment. The bulk of these savings will occur between production runs when plants are being retooled. The constant prices are all based on the general productivity of the base year.

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Figure 4  
An Illustration of the Difference Between the  
Two Approaches to Constant Costs



<sup>a</sup> The second approach assigns the value (1,000) in year four, the base year, for all years.

<sup>b</sup> The first approach assigns the price shown by the curve for each year. (The price changes as learning occurs.)

inputs at a constant level, but also retains the product-specific productivity for that product in the base year. This method results in a constant cost series comparable to the series used by the Department of Commerce's Bureau of Economic Analysis for use in Department of Defense budget documents. A final good thus has the same price from year to year. The principal objection to this method is that the price relationship between two goods that appear to be similar and are produced at identical rates is determined primarily by when each began production. This effect is particularly significant when the base year occurs near the beginning of a system's production run

Compared with the first approach, the second approach results in somewhat higher growth rates (see figure 4) because:

- For the years before the base year, the second approach assigns prices that are lower than the first approach because the prices are not affected by a learning curve.

- For the years after the base year, the first approach assigns prices that are lower than the second approach because the prices move down a learning curve.

Despite the theoretical differences in the two approaches, the practical effects are slight. Estimates using each approach show similar magnitudes and general trends for the procurement of a common set of weapon systems.

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## Appendix C

### The Special Problem of the Dollar Costs of Soviet RDT&E

Costing research, development, testing, and evaluation activities in dollars presents a serious problem, largely because of difficulties in defining the product.<sup>11</sup> At one extreme, the product could be taken as the Soviet military RDT&E establishment. Dollar prices and wages could then be applied to each cost element in that establishment. This would result in a huge estimate because the Soviets generally employ far more personnel and use more materials and facilities than the United States to achieve similar advances. At the other extreme, the product could be the final results of the Soviet RDT&E establishment—the knowledge and designs that allow advances in weapon systems. The cost in the United States to perform the RDT&E required to produce the Soviet weapons would be relatively small, however, because the Soviets generally lag the United States by some years, and minimal US RDT&E would be required to produce many Soviet designs. As a result, the method now used to estimate the dollar cost of Soviet RDT&E tries to take into account differences in the productivity of the RDT&E process in the two countries.

In the 1970s we attempted to estimate what RDT&E cost was incurred in the United States to make advances in knowledge similar to those the Soviets made when they developed new weapon systems. This approach was quite difficult to implement and after

several years was abandoned as impractical. Even if it had been feasible, it would not have covered the costs of basic research and other activities that are not directly related to a final product. We now use a more general method

First, Soviet facilities involved in military RDT&E are identified and all-source data on resource costs—including wages, materials, equipment, training, operating, and capital costs—are used to calculate total expenditures in rubles for these activities. Although data gaps make this ruble cost estimate more uncertain than ruble cost estimates for other components, the error in rubles probably is within plus or minus 15 to 20 percent.

This ruble estimate is converted to dollars by using a ruble-dollar ratio that reflects relative Soviet and US efficiencies in producing Soviet weapon systems. Use of this conversion factor assumes that the Soviets have about the same difficulty performing RDT&E compared with the United States as they do procuring weapons. Despite substantial past and continuing efforts to refine and improve our estimative methodology for Soviet RDT&E, it remains the weakest component of the aggregate dollar cost of Soviet defense activities.

<sup>11</sup> See DI Technical Intelligence Report SOV 86-1003C [ ] July 1986, *Estimating Soviet Military RDT&E Expenditures*.

## Appendix D

### Estimating Dollar Costs of NSWP Defense Activities

Dollar costs for non-Soviet Warsaw Pact countries are estimated in almost the same way as those for the Soviet Union. Dollar values of Pact defense activities are developed by identifying and listing distinct components of the forces such as individual classes of surface ships, ground forces divisions (divided into categories on the basis of type and readiness level), and air regiments (categorized by aircraft type for each service). The listing also contains for each component an estimate of order of battle, manning levels, equipment inventories, and new equipment purchases. US prices and wage rates are then applied to these detailed estimates of activities.

#### Procurement

Because most NSWP weapons and equipment are imported from the Soviet Union, the average unit dollar costs derived for the relevant Soviet production runs are used for NSWP items. For indigenous production, the methods used for the USSR are applied. Because most NSWP equipment is one or more design generations behind the latest Soviet equipment, we have had an opportunity to thoroughly research these cost estimates and we consider them quite reliable. Our estimate of procurement of support equipment—which accounts for roughly one-half of total procurement in the NSWP—is more uncertain than our estimate of procurement of major weapon systems because support equipment is difficult to monitor on an item-specific basis.<sup>11</sup>

#### Operations and Maintenance

We calculate Soviet maintenance costs as a ratio of the procurement cost of a particular weapon; the ratio is based on operating rates and costs of spare parts. Except for land arms, for which operating rates are adjusted for known differences in levels of readiness, we assume that NSWP and Soviet O&M practices

<sup>11</sup> Support equipment includes electronics, vehicles, engineering equipment, naval supplies and equipment, organizational equipment, and aircraft ground support equipment.

are the same. This is a good assumption for maintenance practices because NSWP equipment is Soviet designed or produced, but a weaker assumption for operating practices because NSWP training and exercise rates differ from those in the Soviet Union. Although we know that NSWP operating rates have declined since the mid-1970s, we presently are unable to estimate the extent of the decline and, therefore, still base costs on the mid-1970s' levels. Civilian pay is calculated by multiplying the number of civilian defense workers by the average pay of their US counterparts.

#### Military Personnel

The dollar values of pay for Soviet personnel are based on the estimated rank of the person the United States would assign to carry out similar functions. Because we do not have detailed data on NSWP rank and billet structure, we are only able to apply US pay rates to categories of personnel rather than to each individual billet as is done for the Soviet personnel estimates. The categories in each branch of service are officers, warrant officers, career enlisted men, conscript sergeants, conscript privates, and cadets.

#### Research, Development, Testing, and Evaluation

These costs are first estimated in domestic currencies for the countries for which we have sufficient data to do so—Poland, Czechoslovakia, and East Germany. We then convert these expenditures into dollars at the same rate of conversion as implied by the other military expenditures. RDT&E costs for the other NSWP countries, for which we do not have RDT&E data, are assumed to be in the same ratio to total military outlays in dollar terms as for the former countries.<sup>12</sup>

<sup>12</sup> Joint Economic Committee, US Congress, *East European Economies: Slow Growth in the 1980s* (Washington, D.C.: US Government Printing Office, 1985), pp. 475-495.

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**Confidence in the NSWP Dollar Cost Estimates**

In general, we believe the estimate of the total dollar cost of NSWP defense activities represents a reasonable measure of their aggregate level. Among individual NSWP countries, however, the confidence in the estimate varies. We are more confident for the northern-tier countries and Hungary. We are less confident for Romania and Bulgaria because we lack specific information on operating rates and have a lower level of confidence in manpower estimates for them.

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## Appendix E

### Estimating Dollar Costs of Other NATO Countries' Defense Activities

The most desirable method of deriving the dollar value of non-US NATO defense activities would be to directly cost in dollars each piece of hardware, each man, and each activity—as is done for the Warsaw Pact forces. Enough data are available to cost non-US NATO pay and allowances directly in dollars. In recent years, these categories account for about half of the total dollar value of non-US NATO activities.

We are unable, however, to use the direct-costing methodology for non-US NATO investment, O&M, and RDT&E because of the very large research effort that would be required. Instead, we convert expenditures for these purposes in national currencies to US dollars in the following steps:

- Obtain the expenditure data from NATO's Defense Planning Questionnaire (DPQ) for each NATO country in national currencies.
- Develop a set of appropriate conversion factors, which are applied to expenditures in national currencies, to produce estimates in dollars for the goods and services being compared.
- Apply US defense price indexes to remove price-level changes from the dollar estimate. To these constant dollar estimates, add estimates of pay and allowances derived by applying US wage rates to NATO personnel.

**Defense Expenditures in National Currencies**  
NATO's DPQ is the basic source of information on each country's defense expenditures expressed in national currencies. Its standardized format provides the best available assurance of consistent reporting. Every non-US NATO country except France uses the DPQ format, allowing us to convert to dollars at a low level of aggregation. For France, we use budget data broken down by major resource categories and convert aggregate subtotals for procurement, construction, O&M, and RDT&E.

**Developing Appropriate Conversion Factors  
Problems With Using Exchange Rates.** We do not use exchange rates as a basis for conversion for two primary reasons:

- Exchange rates reflect one country's demand for another's currency, not the amounts of each country's currency required for equivalent domestic purchasing power. One unit of a given country's currency may be exchangeable for one unit of another's, but the prices of equivalent goods and services in the two countries may still differ greatly.
- Use of exchange rates is especially inappropriate because of the misleading distortions caused by fluctuations that have occurred since the late 1970s under floating exchange rates.

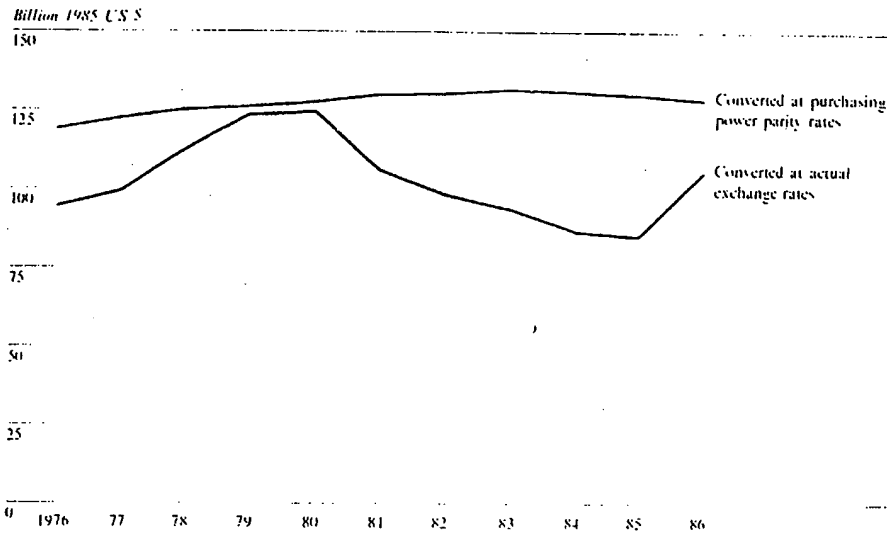
**The PPP Concept.** "A better way to derive a representative conversion of the value of goods and services from one currency to another is to use a method that reflects the relative prices of the same good or service in different countries. In one such method, the relative purchasing power of national currencies is measured by price ratios called purchasing-power parities. A PPP is an international price index indicating the number of units of a foreign currency required to purchase the same quantity of a good or service in that country as one US dollar will buy in the United States.

We use PPPs from the general economies of the non-US NATO countries as proxies for military PPPs because of the lack of unique military PPPs. In the early 1980s, NATO established a Group of Experts to study the feasibility of developing military PPPs. The Group concluded that to construct a useful set of

"See DI Research Paper SOV 87-10077/EUR 87-1003; December 1987. *A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86.* for additional details on this concept.

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Figure 5  
Dollar Costs of Non-US NATO Defense Activities



military PPPs, countries would have to divulge extensive defense data. Although few NATO countries have provided such data, the limited data released to date have been consistent with our estimates

Our PPPs are based on PPPs for three benchmark years—1975, 1980, and 1985—calculated by the International Comparison Project of the United Nations.<sup>19</sup> We interpolate between benchmark years according to the relative rates of inflation in each country using disaggregated gross-domestic-product deflator indexes from an Organization for Economic

Cooperation and Development (OECD) study.<sup>20</sup> A dollar series in current prices is derived by dividing each NATO country's expenditures for investment, O&M, and RDT&E in current domestic prices by these PPPs. These figures are then converted to constant dollars using disaggregated US dollar price indexes for military goods and services. Figure 5 compares the results of this PPP methodology with results obtained by applying exchange rates

<sup>19</sup> Organization of Economic Cooperation and Development, *National Accounts, Main Aggregates, 1960-84*, Vols. 1 and 2 (Paris: OECD, 1986).

<sup>20</sup> See Irving Kravis, et al., *World Product and Income (Phase III)* (Baltimore, Md.: Johns Hopkins University Press, 1982), and United Nations, *World Comparisons of Purchasing Power and Real Product for 1980 (Phase IV)* (New York: United Nations, 1986).

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**Methods for Estimating NATO Military  
and Civilian Pay**

Pay and allowances, a large portion of NATO defense expenditures, are priced directly in dollars without using PPPs. Military pay and allowances in dollars are based on the pay of personnel the United States would assign to carry out functions similar to those in non-US NATO military forces. The concept is to match pay to positions or jobs, not ranks. For civilian pay and allowances, the annual number of civilians reported by the DPQ for each country is multiplied by the average cost of pay and benefits for civilians working for the US Department of Defense.

## Appendix F

### The So-Called Index Number Problem

The "index number problem" is a term that covers two different concepts—the effects of picking a particular set of prices and the artificial inefficiencies assigned to a country when valuing its output in another country's prices. This appendix addresses both concepts as they apply to comparisons of US and Soviet defense activities.

#### Choice of Prices

Dollar prices are not the only economic measure that could be applied to measuring resources devoted to defense activities. One could also use ruble prices, Swiss francs, or a host of other value systems. For the reasons outlined in the text, we believe dollars<sup>11</sup> to be the most suitable for a US audience, but the reader should be aware that a different economic valuation would change the comparisons somewhat.

Statistics describing Soviet defense activities can change dramatically when the currency base is shifted. For example, procurement is about 25 percent of the total costs of defense when defense is valued in dollars; in rubles, the corresponding figure is almost 50 percent. This does not mean one estimate is in error. Nor does it mean that dollar costs underestimate "true" Soviet procurement. It merely reflects the fact that in terms of Soviet economic relationships, defense procurement is relatively more expensive (uses more scarce resources) than the same level of activity in the United States. Both statements of shares are correct within their own context.

<sup>11</sup> Even when dollars are chosen, the question of which base year to choose remains. We usually choose the latest year for which detailed price information is available and, hence, the results are the closest possible to today's values and presumably to our readers' economic frame of reference. For example, the joint CIA/DIA testimony to the Joint Economic Committee of Congress in the spring of 1988 used a base year of 1986. Had an earlier year been chosen, growth rates for both the United States and the USSR probably would have been greater because both are now buying more technologically advanced systems whose prices relative to other goods are decreasing over time. Similarly, ratio comparisons of Soviet to US defense activities probably would be somewhat different.

The same factors that change the value of Soviet activities when moving from one currency to another would also affect the value of US activities when measured in another currency besides dollars. Thus, the structure of US defense activities, as measured by shares of total outlays devoted to each resource category, is different when measured in rubles. Comparisons of the ratio of valuations of US and Soviet defense activities in rubles and in dollars do not change as much as shares within a country do, however. We have estimated the costs of US defense activities in rubles.<sup>12</sup> Although this estimate is substantially less accurate than our measure of Soviet activities in dollars, it indicates the potential magnitude of change in the comparisons. It turns out that the relationships between the two countries change little whether the activities are measured in dollars or rubles. For example, the ratio of total Soviet defense activities to US activities over the past two decades decreases by about 10 percent when measured in rubles instead of dollars (see figure 6).

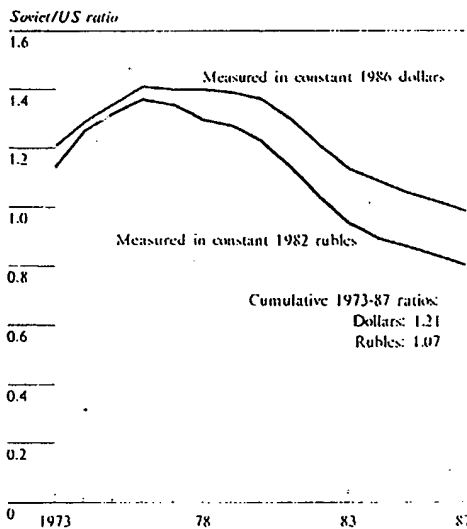
#### Artificial Inefficiencies

Two types of distortion theoretically could affect our estimates of the dollar cost of Soviet defense activities. Our methodologies estimate the costs in dollars of buying the particular assortment of goods and services the Soviets bought. The Soviets, however, did not decide on their particular mix in the framework of dollar costs. To the extent that their choices were

<sup>12</sup> Applying the "dollar" methodology in reverse to estimate the costs of US defense activities in rubles would require access to Soviet cost factors to calculate how much it would cost the Soviets to produce each US weapon system. We are unable to do this. Instead, we apply the same techniques used in most international comparisons. These techniques involve estimating currency (or purchasing power parity) ratios for various product groups and then converting, in this case, dollar outlays to equivalent ruble outlays within each group and summing to arrive at a total. For military pay and allowances, we apply ruble pay rates directly to US manpower. For all other defense activities we develop value-weighted parity ratios.

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Figure 6  
Ruble and Dollar Comparisons of  
Soviet and US Defense Activities



influenced by costs, they were influenced by ruble prices.<sup>18</sup> Thus, the Soviets might well have chosen a different array of goods and services if they had been working in the context of the US economy with its different relative prices.<sup>19</sup> By the same token, if the Soviet activities were being performed by the United

<sup>18</sup> Soviet prices are administratively set and may not reflect the relative scarcity of resources. However, when goods are priced in a constant resource ruble price base, they are reasonable approximations of true economic cost. See DI Reference Aid SOV 87-10069 November 1987, *A Guide to Monetary Measures of Soviet Defense Activities*, for more on this issue.

<sup>19</sup> A similar problem exists when comparing the activities of a single country from one time period to another. For example, the relative prices for defense goods in the United States were different in 1980 than they were in 1970. Hence applying 1980 prices to both imparts an inefficiency to the 1970 decisions.

States, the mix also might have been different—not only because of different resource costs, but also because US decisionmakers might place different military value on various activities than do the Soviets. Thus, when viewing Soviet activities on the basis of dollar costs, two apparent inefficiencies may result:

- The Soviets could have procured a different set of activities having equal military merit in Soviet eyes, but at a lower total dollar cost (and higher ruble cost).
- The Soviets could have procured a different set of activities having an equal military threat in US eyes, but at a lower total dollar cost (and a different ruble cost—perhaps higher, perhaps lower).

These inefficiencies are artificial, not real, because the Soviets do not pay dollar prices. But there is legitimate concern that comparisons in dollars inflate the value of Soviet activities by imposing these artificial inefficiencies on them.<sup>20</sup>

The degree of inefficiency (paying more dollars than required for equal military output) that is reflected in our dollar costs of Soviet defense activities is impossible to measure precisely because the military merit or threat of diverse defense activities cannot be measured precisely in either US or Soviet terms. The degree of inefficiency, however, is small for the following reasons:

- The mix of defense activities chosen by either the United States or the Soviet Union appears to be driven primarily by national security objectives, military doctrine, perceptions of threats, existing forces, and other noneconomic considerations. With the sole exception of the past few years of the US buildup of procurement, within each major mission the dollar value of equipment procured per man is

<sup>20</sup> There are similar theoretical inefficiencies when US activities are measured in rubles.

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similar for both the United States and the USSR. Yet relative prices for men and equipment differ markedly in the two countries. Thus there are reasons to believe the Soviets would choose about the same mix of goods and services if they were paying dollar prices as they did when paying rubles.<sup>21</sup>

- The dollar cost assigned to a particular piece of Soviet hardware is based on US production technology and efficiencies (for example, labor/capital ratios, sophistication of machine tools) applied to Soviet production rates, so no artificial inefficiencies are introduced at the production level. The effects are confined to the basic choice of mix only.

In summary, the Soviets' choices about defense activities would be substantially the same if they were somehow confronted with US prices for military goods and services (but remained Soviets in all other respects). Therefore, our dollar estimates of Soviet defense activities contain little distortion because of these potential inefficiencies and cost ratios (USSR to United States) provide generally valid measures in US resource values of the two countries' relative costs of defense activities.

<sup>21</sup> This is not to say they would not buy a different mix if they had full access to US technology, or if they were in the US geopolitical position, or if they had the US culture. The statement is limited to the hypothetical situation in which only the prices of available Soviet products are different.

## Appendix G

## Analysis of the Range of Error in the Dollar Estimates of Soviet Defense Activities

Table 6 presents CIA's estimates for the dollar cost of Soviet defense activities as they were made in each of the years 1972 through 1987 (no estimate was made in 1975). The only adjustment made to these historical estimates is to convert them all into constant 1979 dollars for ease of comparison.<sup>23</sup> Each column of the table corresponds to the estimate made in that year for the years indicated by the row labels. By reading across the columns, it is seen that the annual updates do not dramatically change the estimated dollar costs for any given year. A comparison of the changing estimates for a given year is a rough indication of the quality of the estimates because each additional year yields new data and improved methodologies to refine the old estimates. Moreover, the frequent turnover of analysts increases the chances that any individual's blindspots or biases will in time be removed from the estimates. It can be seen that, although each year's estimate differs from the others, they are relatively stable and show no indication of uncovered bias.

The bottom part of table 6 indexes the dollar values to the latest estimate, made in 1987. If one assumes that this estimate represents the best available, then it provides a suitable benchmark for the preceding estimates. Earlier estimates having indexed values greater than 100 are now seen as having been too high while values under 100 are seen as having been too low. Examination of the table indicates that the track record of the past 16 years is consistent with the claim that the estimates for the total dollar value of past Soviet defense activities are subject to no more than 10-percent error for any given year.

<sup>23</sup> The year 1979 is chosen as the common base year because it is about in the middle of the base years actually used in the various comparisons.

The relative stability in the aggregate estimates over time is partly explained by the fact that, although there may be a considerable amount of error in individual cost estimates, these do not necessarily propagate into large errors in the aggregate estimates. The reason for this is that errors in components of a total tend to cancel each other as the components are summed. For example, suppose that 10 component estimates of roughly equal magnitude are added together to form a total, with each of the 10 subject to an individual error of  $\pm 10$  percent. If the errors are independent of each other, then the error in the total would be expected to be  $\pm 3$  percent.<sup>24</sup> As a numerical illustration of this principle, suppose each of the individual values were in truth 100, giving a total of 1,000. Suppose, however, the individual estimates were 91, 107, 98, 105, 102, 98, 90, 99, 97, and 108. The total would be 995, for a total error of 0.5 percent, even though the average error of the individual estimates was 4.9 percent. Figure 7 shows the reduction in overall error as the number of individual estimates increases for the case in which the individual estimates are of the same magnitude, with individual errors of  $\pm 50$  percent.

<sup>24</sup> Let  $T = \sum_{i=1}^n s_i$ , where  $T$  is the total estimate,  $n$  is the number of individual estimates, and  $s_i$  is the  $i$ th estimate. If each of the  $s_i$  is subject to a proportional error of  $\pm p$ , then statistical theory

$$\sqrt{\sum_{i=1}^n (p s_i)^2}$$

indicates  $T$  will have a proportional error of  $\pm \frac{\sqrt{\sum_{i=1}^n (p s_i)^2}}{T}$ . If the  $s_i$  are all equal to  $s$  and the  $p_i$  are all equal to  $p$ , this error reduces to  $\pm \frac{\sqrt{ns^2 p^2}}{ns} = \pm \frac{p}{\sqrt{n}}$ .

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**Table 6**  
**CIA's Historical Estimates of the Dollar Value of**  
**Soviet Defense Activities**

Estimate for Year	Year Estimate Was Made															
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	<i>Billion 1979 \$</i>															
1970	136	129	133	No estimate	139	130	122	127	125	129	132	132	127	136	130	128
1971		129	134	No estimate	141	134	125	129	128	133	135	134	129	139	133	131
1972			135	No estimate	144	136	129	133	132	137	139	138	133	141	135	134
1973				No estimate	148	142	135	140	138	142	145	143	136	147	141	139
1974					152	145	139	144	144	148	151	150	144	153	147	145
1975						149	142	148	149	152	156	155	149	156	149	149
1976							146	153	149	159	164	162	156	160	153	152
1977								156	155	161	166	163	156	161	154	154
1978									156	164	168	166	159	164	157	156
1979										169	171	169	162	167	160	160
1980											175	172	165	171	163	163
1981												174	167	172	163	162
1982													171	174	165	164
1983														176	168	166
1984															170	168
1985																173
	<i>Indexed Values (estimates made in 1987 = 100)</i>															
1970	106	101	104		109	102	95	99	98	101	103	103	99	106	102	100
1971		98	102		107	102	95	98	98	101	103	102	98	106	101	100
1972			101		108	102	97	100	99	103	104	103	100	106	101	100
1973					106	102	97	101	99	102	104	103	98	106	101	100
1974					105	100	96	99	99	102	104	103	99	105	101	100
1975						100	96	100	100	102	105	104	100	105	100	100
1976							96	101	98	105	108	107	103	105	101	100
1977								102	101	105	108	106	102	105	100	100
1978									100	105	107	106	102	105	100	100
1979										106	107	106	102	105	100	100
1980											107	106	101	105	100	100
1981												107	103	106	101	100
1982													104	106	100	100
1983														106	101	100
1984															101	100
1985																100
Maximum	106	101	104		109	102	97	102	101	106	108	107	104	106	102	
Minimum	105	98	101		105	100	95	98	98	101	103	102	98	105	100	
Average	106	100	102		107	101	96	100	99	103	106	105	101	105	101	

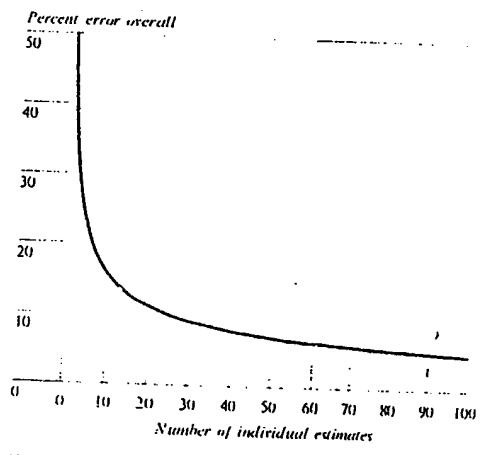
Summary 1972-87  
 Average = 102  
 Minimum = 95  
 Maximum = 109  
 Standard deviation = 3.1  
 ± Error (95% C. I.) = 6%  
 Number of values = 131

Note: If the population mean is assumed to be 100, then the standard deviation becomes 3.7 and the ± error becomes 7%.

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**Figure 7**  
**Reduction in Overall Error as**  
**Estimates Are Aggregated**



Note: Each individual estimate has an uncertainty factor of plus or minus 50 percent.

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### Appendix H Sources of Comparable US Data

Dollar cost comparisons of foreign defense activities with US defense activities require appropriate US data. For such comparisons, US data are derived from the *Five-Year Defense Program (FYDP)* of the Department of Defense and from the US budget. The detailed Total Obligational Authority (TOA) data, listed in the FYDP by program element, are first translated into outlays by using Department of Defense historical spendout rates. They are then adjusted to match published annual outlays by Department of Defense resource identification code (RIC). These outlay data are next converted from fiscal to calendar year terms and then converted to constant dollars using detailed price indexes for each type of military expenditure. Figure 8 shows the difference between

US TOA and outlays by fiscal years since 1970. Notice that, while TOA has been declining in real terms since fiscal year 1985, outlays have continued to rise.

The final US figures thus reflect the years the expenditures actually take place and have had inflationary effects removed. As such, they no longer match actual budget authorizations or appropriations, but they are on the same basis as the estimates for foreign defense activities.

**Figure 8**  
Relationship Between Total Obligational  
Authority and Outlays for US Defense Activities

