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Comparison Of Military Research  
And Development Expenditures Of  
The United States And  
The Soviet Union B-172553

Department of Defense

Part II --Declassified version

Department of Defense Methodology  
For Assessing United States  
And Soviet Union Military  
Research And Development Efforts

BY THE COMPTROLLER GENERAL  
OF THE UNITED STATES

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PART II

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ABBREVIATIONS

AEC	Atomic Energy Commission
DOD	Department of Defense
GNP	gross national product
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
ODDR&E	Office of the Director of Defense Research and Engineering
OECD	Organisation for Economic Co-operation and Development
R&D	research and development
RDT&E	research, development, test, and evaluation
SIPRI	Stockholm International Peace Research In- stitute

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## CHAPTER 3

### DEPARTMENT OF DEFENSE METHODOLOGY FOR ASSESSING

#### UNITED STATES AND SOVIET UNION

#### MILITARY RESEARCH AND DEVELOPMENT EFFORTS

This is a declassified version of part II of a General Accounting Office staff study previously issued in response to a request dated April 1, 1971, from the Chairman of the Subcommittee on Research and Development, Senate Committee on Armed Services.<sup>1</sup> The classified version of part II of the staff study was issued in conjunction with a report dated July 23, 1971 (B-172553), to the Chairman. At the request of Representative Michael J. Harrington, a declassified version has been prepared and is being issued to all recipients of the classified part II.

This part describes and evaluates the methodology developed and the data used by the Department of Defense (DOD) to assess the current military R&D efforts of the Soviet Union relative to those of the United States. Because of the limited time available, we have been unable to review, in detail, many judgmental factors used by DOD in developing the data and in arriving at its conclusions; however, we are presenting tentative evaluations where possible.

In general the DOD methodology is designed to quantify the Soviet Union military R&D efforts in terms of their equivalents for comparison with United States efforts. First, to accomplish this end, the intelligence community made studies of Soviet Union budgetary science data, to estimate the financial inputs into Soviet Union military R&D activities and to compare these estimates with their known United States equivalents. Second, DOD made comparative technological assessments of United States and Soviet Union weapons systems, to estimate the relative level of their

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<sup>1</sup>Part I provides an introduction to the study and an analysis of U.S. military-related research and development (R&D) expenditures.

technological outputs. Third, the resulting estimates of relative financial inputs and technological outputs were correlated by DOD, to test the reliability of the estimates of Soviet Union financial inputs as expressed in dollar equivalents.

On the basis of a reported correlation between the estimated financial inputs and technological outputs, the Office of the Director of Defense Research and Engineering (ODDR&E) expressed confidence in the intelligence community's estimates of Soviet Union military R&D budgets. By comparing these Soviet Union budget estimates with similar United States financial data, ODDR&E determined that the Soviet Union military R&D expenditures had been exceeding those of the United States in increasing amounts from 1968.

ODDR&E has stated that its best estimates indicate that the Soviet Union currently has an annual \$3 billion spending advantage in military R&D and that, if current trends continue in likely ways, the United States technological lead of 2 to 3 years could be reduced to zero or even minus several years (a technological lag) by 1976.

The DOD methodology and its supporting data are discussed in further detail in subsequent sections.

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ESTIMATING SOVIET UNION  
MILITARY R&D EXPENDITURES

ODDR&E officials reported that the U.S. intelligence community had performed studies to determine the Soviet Union's military R&D expenditures in rubles from 1950 through 1970 and to translate these ruble expenditures into their dollar equivalents. We were not permitted to review the intelligence community's supporting documentation for its determinations or estimates.

As discussed below, however, we were advised that these estimates had been derived from the Soviet Union's budgets and the intelligence community's estimates of the equivalent costs of Soviet Union efforts in military and space technology. Also our study showed that the estimates had a direct and consistent relationship with the Soviet Union series of national science expenditures based on estimated budgeted outlays.

In particular ODDR&E officials informed us that the Soviet Union military-related R&D activities were funded primarily from the classified part of the so-called all-union science budget. The all-union category refers to those science activities having national significance. The classified subcategory refers to the unitemized or secret part of the all-union category.

ODDR&E officials reported that, on the basis of an assumed conversion rate of \$2 for 1 ruble,<sup>1</sup> the classified part of the all-union science budget increased steadily from about \$5 billion in 1960 to about \$13 billion in 1968. The officials believed that expenditures of such amounts for R&D efforts would show impressive results. Since spectacular

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<sup>1</sup>Conversion rate used by the intelligence community to provide an appreciation of the physical size of the budgeted program by showing the level of effort--measured in dollars--that would be required to reproduce the Soviet Union programs in the United States. Dollar values derived in this way are expected to provide the basis for comparing United States and Soviet Union programs.

results were observed only in the areas of military weapons, space, and atomic energy, they concluded that the classified part of the all-union science budget had provided the funds for the high-priority and secret R&D activities in these areas. The officials also stated their belief that it would be difficult to find another place in the Soviet Union budget for military, space, and atomic energy R&D.

ODDR&E officials reported also that, after identifying the funding for military, space, and atomic energy R&D activities, the data were refined to separate out the civil space program. By using a National Aeronautics and Space Administration (NASA) formula, the Soviet Union civil space program was costed on the basis of what the United States would have to spend to duplicate the Soviet Union's civil space facilities and accomplishments. The estimates then were subtracted from the estimated funding for military, space, and atomic energy R&D activities; these activities are collectively referred to as military-related R&D. The residual is, by definition, the military R&D funds and includes R&D funding in both weapons systems and atomic energy.

Because of Soviet Union secrecy, there is presently no way to estimate R&D funding or expenditures for weapons systems under development exclusive of civil atomic energy.

ODDR&E officials acknowledged that another, more complex, analytical approach recognized the possibility that part of the Soviet Union R&D costs might be borne elsewhere in the Soviet Union budgets. They added:

"However, since most of the necessary cost does seem supportable by the All Union Science Budget, the remainder seems unlikely to amount to more than 20 to 30 percent of the total. Assuming only that the total program is 'balanced,' this remainder is likely over the years to stay at about the same percentage of the total; that is, it is likely to be portional to the All Union Science Budget portion and thus to follow the same trends. \*\*\* The principal advantage of this more complex model is that it makes the 'justification' \*\*\* of some kinds of expenses somewhat easier elsewhere than merely in the All Union

Science Budget. Examples are pay for military support people, general-purpose support facilities on test ranges, etc."

In view of the alleged relationship between the Soviet Union's budgets and the intelligence community's estimates of R&D expenditures, we compared the latter's estimates with the published financial and budgetary data on Soviet Union science for calendar years 1960 to 1966.<sup>1</sup> We found that the intelligence community's estimates of total Soviet Union R&D expenditures and of the part referred to as military-related R&D had a direct and consistent relationship to the Soviet Union series of national science expenditures, as discussed below.

The outlays shown in the Soviet Union State Budget under the heading "Science" (referred to as the Soviet Union science budget) make up only 70 to 80 percent of the national science expenditures. The remaining 20 to 30 percent of expenditures are thought by many to be funded from (1) the various economic organizations' own funds, probably under contractual arrangements, and (2) other Soviet Union State Budget headings, such as "Ministry of Defense," "National economy," and "Cadre training."

As shown below the intelligence community's estimated total R&D expenditures (col. 4) are equal to total national science expenditures plus capital investments in science (col. 1 plus col. 2). The small differences may be attributed to rounding errors.

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<sup>1</sup>Science Policy in the U.S.S.R., Organisation for Economic Co-operation and Development (OECD), Paris: 1969, pp. 95 to 107.

Figure 1

Estimated Soviet Union R&D Expenditures (note a)

Calendar year	Total science expenditures (budget and other expenditures) (note b) (1)	Capital investment in science (note b) (2)	Column 1 plus column 2 (3)	Estimated total Soviet Union R&D expenditures in constant 1968 dollars (note c) (4)
----- (billions) -----				
1960	\$ 6.6	\$1.0	\$ 7.6	\$ 8
1961	7.6	1.4	9.0	9
1962	8.6	1.8	10.4	10
1963	9.4	1.8	11.2	11
1964	10.2	2.0	12.2	12
1965	11.8 <sup>d</sup>	2.2	14.0	14
1966	13.0 <sup>d</sup>	2.4	15.4	15
1967	(e)	(e)	(e)	16
1968	(e)	(e)	(e)	17
1969	(e)	(e)	(e)	19
1970	(e)	(e)	(e)	21

<sup>a</sup>Conversion rate: \$2 for 1 ruble.

<sup>b</sup>Science Policy in the U.S.S.R., OECD, Paris: 1969, pp. 98-100.

<sup>c</sup>Intelligence community's estimates using the same conversion rate of \$2 for 1 ruble. Estimates are rounded to nearest billion for security classification purposes.

<sup>d</sup>Estimated, not actual expenditures from cited reference source.

<sup>e</sup>Not available from cited reference source.

Our study showed that the intelligence community's estimates of military-related R&D expenditures bore practically the same relationship to total R&D expenditures as the classified part of the all-union budget outlay bore to the total Soviet Union science budget. In noting the possibility of these relationships, ODDR&E officials stated



that, assuming the Soviet Union R&D program was balanced, any additional R&D expenditures outside the science category of the Soviet Union State Budget were likely to be proportional to the all-union science budget part and to follow the same trends. (See p. 6.) The relationships are illustrated below--column 2 is to column 1 what columns 5 and/or 6 are to column 4.

Figure 2

Relationship of Military-Related  
R&D Expenditures to  
Published Soviet Science Data (note a)

Calendar year	Soviet Science Budget (note b) (1)	Classified all- union budget		Total national science expendi- tures, including capital invest- ment for science (note d) (4)	Column 3 times column 4 (5)	Estimated military- related R&D (military, space, and atomic energy) (note e) (6)
	Estimated Amount (note c) (2)	Percent of column 1 (3)				
	(billions)			(billions)		
1960	\$4.6	\$3.2	70	\$ 7.6	\$ 5.3	\$ 5.3
1961	5.4	3.7	69	9.0	6.2	6.3
1962	6.0	4.2	70	10.4	7.3	7.4
1963	6.9	5.0	72	11.2	8.1	8.3
1964	7.9	5.9	75	12.2	9.2	9.2
1965	8.4	6.4	76	14.0	10.6	10.5

<sup>a</sup>Conversion rate: \$2 for 1 ruble.

<sup>b</sup>These budgeted expenditures for science consist of all-union expenditures and Republican expenditures.

<sup>c</sup>Soviet Union financial data have not shown this breakdown since 1958; consequently the intelligence community's estimates were extrapolated upwards on the basis of the 1950-57 trend. The above estimates are based on applying a consistent percentage to all-union budgeted outlays in accordance with our calculations of the trend.

<sup>d</sup>See figure 1, column 3.

<sup>e</sup>Intelligence community's estimates stated in constant 1968 dollars.

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SIPRI<sup>1</sup> analysis of estimates

In an article entitled "U.S. Estimates of Soviet Expenditures for Military Research" in the SIPRI Yearbook of World Armaments and Disarmament 1969-70, the author surmised relationships between U.S. estimates of Soviet Union military-related R&D and published Soviet Union science data similar to those reported above. The author stated:

"\*\*\* Dr. Foster's estimates<sup>[2]</sup> show a trend so close to the trend in the published Soviet science expenditure series that it must be assumed that Soviet science data have been used in their construction."

\* \* \* \* \*

"Dr. Foster's estimates of total Soviet R&D and space expenditure can be made to equal total Soviet science expenditures (new series) if an exchange-rate of about \$2 per rouble is used. (Judging from the range of exchange rates chosen by experts, this is not an unreasonable exchange rate, and does not exaggerate the dollar equivalent of Soviet science expenditure). It therefore seems possible that Dr. Foster's estimates are drawn directly from the science expenditure data, and that the estimates of military-space R&D expenditure have been obtained simply by taking a large and rising percentage of total science expenditures and converting the estimates at \$2 per rouble (with some allowance for inflation). In this case, practically all capital investment, All-union and 'other' expenditures for science would be included in the estimates of military-space R&D expenditure."<sup>3</sup>

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<sup>1</sup>Stockholm International Peace Research Institute.

<sup>2</sup>Dr. John S. Foster, Jr., Director of Defense Research and Engineering, estimates of military-space R&D expenditures.

<sup>3</sup>SIPRI Yearbook of World Armaments and Disarmament 1969-70, pp. 303 to 305.

The author reported that experts who had made detailed studies of Soviet Union science data either had made no estimates or had made only rough order-of-magnitude estimates. Even those experts who made order-of-magnitude estimates differed among themselves by as much as 50 to 100 percent or more. The author concluded, after reviewing the available "open" literature, that "reliable estimates of Soviet military R&D expenditure cannot be inferred from Soviet science data."<sup>1</sup>

In commenting on the SIPRI article,<sup>2</sup> ODDR&E officials pointed out that the data available to the author had consisted of published budget data and unclassified statements by various officials up to mid-1970. Nevertheless ODDR&E officials stated:

"The SIPRI conclusion that valid estimates of Soviet RDT&E [research, development, test, and evaluation] are not possible (with that data base) is probably correct. Missing data includes the dollar pricing of the space program, the quantification of technological positions with time for space and military RDT&E, the manpower and facilities crosschecks, and an appreciation of the overall magnitude of the Soviet effort."

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<sup>1</sup>Ibid., p. 289.

<sup>2</sup>Response dated May 26, 1971, to questions raised by Representative Michael J. Harrington.

### Questionable conversion rates

As reported previously the dollar estimates of Soviet Union expenditures represent the conversion of rubles to dollars using a consistent exchange rate of \$2 for 1 ruble. There is no generally accepted rate, however, for converting rubles expended for R&D into their dollar equivalents--the dollars needed to buy a comparable R&D effort in the United States.

The SIPRI article stated:

"\*\*\* R&D exchange rates, in current expert use, which attempt to allow for the differences in wages and other costs in the two countries, vary between \$1.30 per rouble and \$3.50 per rouble. The uncertainty of the appropriate exchange rate is such that most studies drawing on Soviet data \*\*\* do not attempt to convert rouble estimates into dollars at all."<sup>1</sup>

Although the official exchange rate is about \$1.11 for 1 ruble, authorities generally agree that use of the official rate would seriously underestimate the magnitude of the Soviet Union R&D effort. Further, many, if not most, experts believe that a reasonable conversion rate for Soviet Union military R&D work would be from \$2 to \$3 for 1 ruble. Consequently the use of the \$2 rate may raise a question of whether it underestimates the dollar equivalent of the Soviet Union R&D effort.

ODDR&E officials, however, indicated that the exchange rate would be adjusted to match the number of identified rubles with the dollar cost estimates of observed outputs. In recognizing the possibility that Soviet Union R&D costs may be borne elsewhere than in the classified part of the all-union science budget,<sup>2</sup> these officials observed that the

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<sup>1</sup>Op. cit., SIPRI Yearbook of World Armaments and Disarmament 1969-70, p. 305.

<sup>2</sup>See p. 4.)

dollar-to-ruble ratio depended on ruble input because the output results remained the same.

"\*\*\* in analytic terms, because the output results are fixed, the dollar to ruble ratio and the fractions of the All Union Science Budget for military and space RDT&E are coupled. Knowing one determines the other; \*\*\*."

#### Direct costing of space program

ODDR&E officials reported that direct costing of the Soviet Union space program had reduced uncertainty about the financial inputs, including the rubles-to-dollars conversion factor, for defense and space R&D. They stated that, by looking at the more open Soviet Union space program, it was possible to compare Soviet Union budgets and results with those of the United States. The officials added that:

"The analysts could reasonably calculate what it would cost the United States to do what the Russians had done in space and consequently could get a reasonably good average conversion factor from rubles to dollars for this kind of aerospace work."

We noted that, during recent congressional testimony,<sup>1</sup> Dr. George M. Low, the then-Acting Administrator of NASA, submitted the following comments for the record.

"First, I would like to point out that we have no easy way to compare the total R.&D. programs of the U.S. and the U.S.S.R., much less the specific elements which make them up, such as the space program; the economies of the two societies

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<sup>1</sup>Hearings before the Senate Committee on Aeronautical and Space Sciences on "Space Cooperation Between the United States and the Soviet Union," 92d Cong., 1st sess., March 17, 1971, p. 29.

are far from parallel and we have little solid information from the Soviets about their internal program structure, objectives, on decision-making framework. Therefore, we have to rely on what are often subjective assessments and scattered data points for our comparisons.

"What we *can* say is that there appears to be a well defined long-term Soviet R.&D. investment policy that has been consistently followed and supported for both pragmatic and ideological reasons. An example of that policy is the trend in Soviet R.&D. expenditures over the past decade: \*\*\* and increase of 325%. And this increase has come about through a steady, year-by-year build-up of the national resources devoted to R.&D. rather than through a single large jump in any one year or for any one program. \*\*\*

"In terms of their total space program, both civil and military, we believe they are investing at least as much effort as is the U.S. and probably more; one measure is their record of successful space launches which first exceeded that of the U.S. in 1968 and continues to do so through the present, when they are launching two or more vehicles to every one of ours. It seems fair to say that they are maintaining and increasing their program effort and that this effort exceeds that of the U.S. \*\*\*

"For this comparison, I am dealing with the combined civil and military space programs of both nations; to try to differentiate between civil and military activities of the U.S.S.R. would be speculative at best."

We were not permitted to review the intelligence community's direct costing of the Soviet Union space program. Assuming, however, that the Soviet Union civil space program is sufficiently open for reliable direct costing in dollars, we do not know how the analysts were able to determine the amount of rubles in the science budget for the civil space program to establish the conversion factor for aerospace

work. Also there is a question about the extent to which a conversion factor for aerospace work is applicable to the broad range of military R&D work. Finally, regardless of how accurate direct costing of the Soviet Union space program may be, the accuracy of the residual military R&D is still largely dependent on the accuracy of the total estimates for the military-related R&D expenditures. The residual military R&D cannot be directly costed, because not enough of the individual programs are visible to permit an accumulation of program costs that will yield a reliable total.

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## TECHNOLOGICAL ASSESSMENT OF OUTPUTS

In fiscal year 1970 ODDR&E initiated a study to compare the military and space technological outputs of the United States with those of the Soviet Union during the period 1960 to 1968; ODDR&E officials stated that 1968 was the last year for which reasonably firm intelligence data existed on Soviet Union weapons systems. The study involved technical comparisons of the two countries' space achievements and about 100 of their military weapons systems. According to ODDR&E officials, the study, by making the comparisons over a period of years, was able to time technological improvements and to estimate how many years it took the Soviet Union to reach given levels of United States weapons technology.

The study found that in 1960 the United States had a 2- to 3-year technological lead in military weapons systems and was about even with the Soviet Union in space technology. The study found also that by 1968 the United States had established a 2- to 3-year lead in space technology but had only maintained its 2- to 3-year lead in weapons technology.

ODDR&E reasoned that technological leads were correlated with greater relative efforts. Accordingly its study concluded that, during the period 1960-68, the United States military R&D effort must have been roughly equivalent to that of the Soviet Union and that the United States space effort must have been 10 to 20 percent greater than that of the Soviet Union.

The technological-lead assessments which compared similar weapons systems were based on intelligence data, discussions with specialists, and subjective judgments of ODDR&E. Subjective judgments were used when the data were incomplete or controversial. ODDR&E officials stated, however, that differences, when they occurred, were seldom larger than plus or minus 1 year.

The assessments were presented in individual meetings to groups of DOD managers, weapons specialists, advisors, and operations employees. After comparisons of individual weapons systems were discussed, the United States technological positions relative to the Soviet Union were summarized



into five major systems categories. The proposed summaries then were modified to better reflect the consensus of informed opinions.

ODDR&E officials reported that the summaries were not specific weighted averagings of the comparisons of the individual weapons systems but were consistent with them and correlated with broader impressions and experiences of informed persons. We had neither the expertise nor the time to independently test and evaluate the individual or summarized technological-lead assessments.

#### CORRELATION OF INPUTS WITH OUTPUTS

ODDR&E officials reported that they were able to find a clear correlation between the results of their technological-lead assessments and the estimates of the two countries' military and space R&D expenditures for the period 1960 to 1968. (See fig. 3.) Recognizing that there was some question about the ruble-to-dollar conversion ratio, they added that the rate of 0.5 ruble to \$1 (or \$2 for 1 ruble) could vary as much as 20 percent (shaded area in fig. 3 represents about a 10-percent variance) and that the estimated space and military expenditures still would fit the observed hardware results.

Because the United States advanced its technological lead in the space program by several years in the period 1960 to 1968, ODDR&E reasoned that the cost of the United States space effort should have been 10- to 20-percent greater than that of the Soviet Union during the same period. Using a NASA formula the intelligence community and ODDR&E produced the following expenditure data to support this reasoning.

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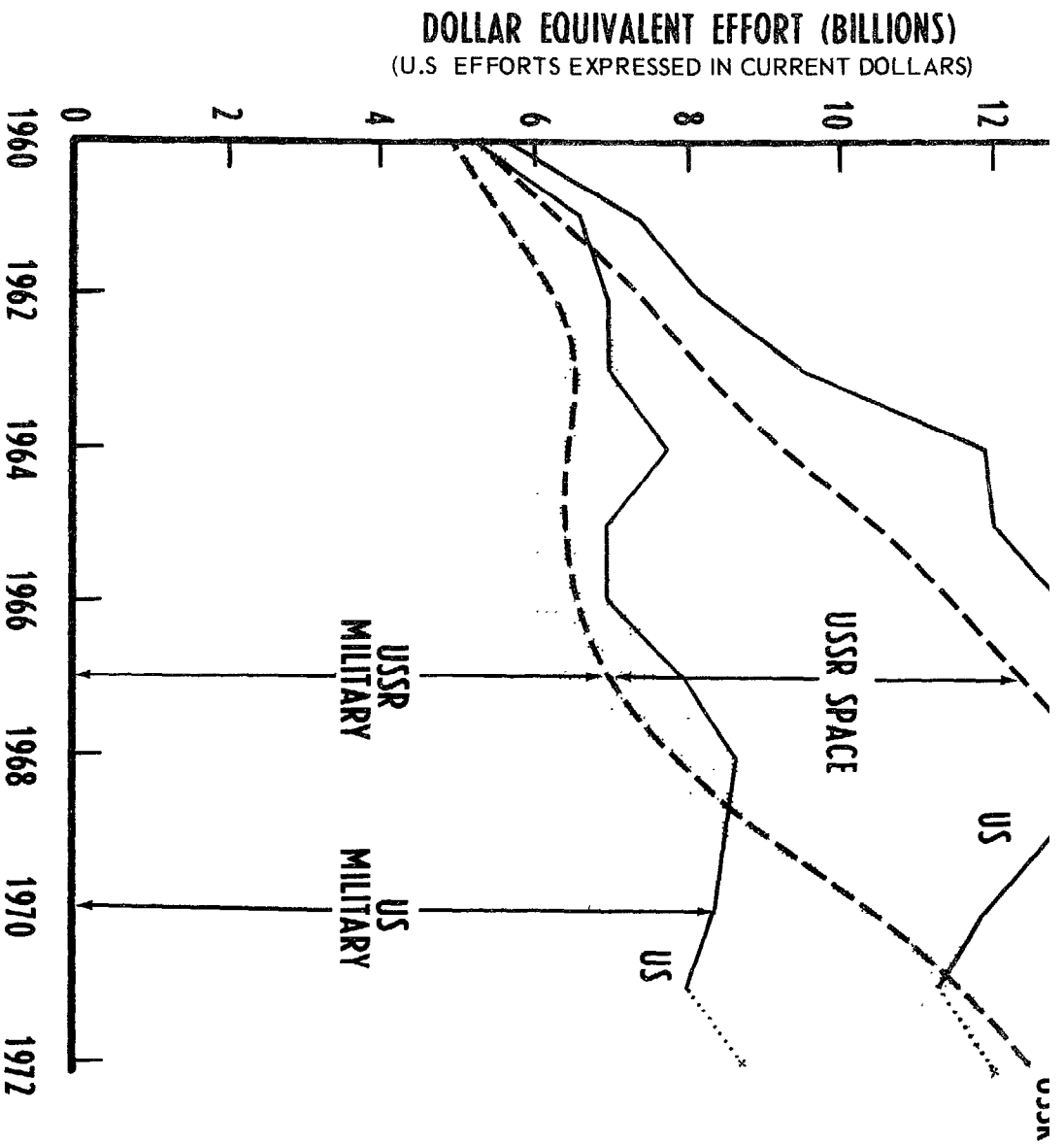


FIGURE 3

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Civil Space Expenditures (note a)

	Soviet Union	United States			United States over Soviet Union		
		Current dollars	GNP		Current dollars	GNP	
			deflator (note b)	R&D deflator		deflator	deflator
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
----- (billions) -----							
1960	\$ 0.5	\$ 0.4	\$ 0.5	\$ 0.5	-\$0.1	\$ -	\$ -
1961	.7	.7	.9	1.0	-	0.2	0.3
1962	1.1	1.3	1.5	1.6	.2	.4	.5
1963	1.7	2.6	2.9	3.2	.9	1.2	1.5
1964	2.8	4.2	4.7	5.0	1.4	1.9	2.2
1965	4.0	5.1	5.6	6.0	1.1	1.6	2.0
1966	5.0	5.9	6.4	6.7	.9	1.4	1.7
1967	5.5	5.4	5.6	5.8	-.1	.1	.3
1968 <sup>c</sup>	<u>5.5</u>	<u>4.7</u>	<u>4.7</u>	<u>4.7</u>	<u>-.8</u>	<u>-.8</u>	<u>-.8</u>
Total	<u>\$26.8</u>	<u>\$30.3</u>	<u>\$32.8</u>	<u>\$34.5</u>	<u>\$3.5</u>	<u>\$6.0</u>	<u>\$7.7</u>

<sup>a</sup>Soviet Union expenditures are on a calendar-year basis, using the conversion rate of \$2 for 1 ruble, and United States expenditures are on a fiscal-year basis.

<sup>b</sup>Gross national product deflator.

<sup>c</sup>Base year for use of deflators.

The above schedule shows that, from 1960 through 1968, the total United States expenditures for civil space actually exceeded equivalent Soviet Union expenditures of \$26.8 billion by about (1) \$3.5 billion, or 13.6 percent, in current dollars, (2) \$6 billion, or 22.4 percent, in constant 1968 dollars using the GNP deflator,<sup>1</sup> or (3) \$7.7 billion, or 28.7 percent, in 1968 dollars using a special R&D deflator.<sup>2</sup>

<sup>1</sup>U.S. estimates in fig. 3 are stated in current dollars. A prime uncertainty in describing the U.S. level of effort over the 9-year period is the need to convert current dollars to constant dollars to avoid the effects of inflation. The GNP deflator, which uses the fiscal year 1968 dollar as its base, applies to the economy as a whole--all final goods and services produced in the Nation during a year.

<sup>2</sup>The R&D deflator applies to R&D hardware and services. Methodology was derived from "Defense Planning in a High Inflation Economy," a paper by J. H. Augusta and C. L. Snyder, Jr., presented at the 26th Military Operation Research Symposium, Monterey, California, November 1970.

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ODDR&E officials stated that technological-lead assessments of about 100 weapons systems visible in 1960-68 showed that the "Soviet RDT&E produced about the same number of major weapons systems prototypes at about the same rate of improvement as the U.S." Although the technological lead changed for some individual weapons systems and even for some weapons systems categories, on the average the relative positions of the two countries were found by ODDR&E to be the same in 1968 as in 1960; over the 8- to 9-year period the United States had retained its 2- to 3-year technological lead.

Since output results indicated that both countries had expended about the same effective effort, ODDR&E officials reasoned that both countries should have expended about the same amount of equivalent funds in military R&D. As illustrated by figure 3, however, the United States is estimated to have expended about \$6.5 billion, or 11 percent, more in equivalent funds for military R&D from 1960 through 1968 than the Soviet Union. If the GNP deflator is used to express the estimated United States inputs in constant 1968 dollars, figure 3 then would show United States military R&D expenditures as exceeding those of the Soviet Union by about \$13 billion, or approximately 23 percent. If a special R&D deflator is used, the difference is \$18.1 billion, or approximately 31 percent.<sup>1</sup>

ODDR&E officials stated that they believed:

\*\*\* their costing estimates in both civil space and military weapons \*\*\* to be accurate to about \$1 billion per year in equivalent effort. A greater difference, over an eight-year span, should have produced measurable differences in results \*\*\* these differences do not appear to exist."

The difference of \$13 billion over the 8- to 9-year period, resulting from use of the GNP deflator, represents about \$1.5 billion a year. Use of the R&D deflator shows an even greater difference, amounting to about \$2 billion a year.

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<sup>1</sup>For ODDR&E officials' comments on the use of the deflators, see p. 24.

DETERMINING RELATIVE FINANCIAL INPUTS  
SINCE 1968

ODDR&E officials state that all the preceding analyses and comparisons "really have only one purpose: to quantify the Soviet military RDT&E effort in U.S. terms and identify it in the Soviet Budget." These officials believe that proof that this purpose has been achieved is the clear correlation between the United States' and the Soviet Union's relative financial inputs and technological outputs. Therefore these officials look to the intelligence community to estimate the Soviet Union's current military R&D funding on the basis of the latter's budgetary data.

As shown below the intelligence community's estimates of current Soviet Union military-related expenditures (col. 3) show a steady increase from about \$13 billion in 1968 to \$17 billion in 1972, an annual increase of 7 to 8 percent. Its estimates of Soviet Union civil space expenditures (col. 4) show a steady decrease from about \$5 billion to about \$4 billion. Consequently its estimates for the residual military R&D expenditures (col. 5) show a sharp increase from about \$8 billion to about \$13 billion, a total increase of about 60 percent during the 4 years. ODDR&E officials state that these estimates show the Soviet Union's return to allocating R&D growth to the military sector, after a period of about 6 years (1961-67) in which growth went to the space sector.

Soviet Union R&D Expenditures (notes a and b)

<u>Calendar year</u> (1)	<u>Total R&amp;D</u> (2)	<u>Total military- related R&amp;D</u> (3)	<u>Civil space</u> (note c) (4)	<u>Total mili- tary R&amp;D</u> (5)
(billions)				
1968	\$17	\$13	\$5	\$ 8
1969	19	14	5	9
1970	21	16	5	11
1971	24	16	5	11
1972	24	17	4	13

<sup>a</sup>Conversion rate: \$2 for 1 ruble.

<sup>b</sup>In constant 1968 dollars. Rounded off to nearest billion for security classification purposes.

<sup>c</sup>Soviet Union civil space estimates are based on a NASA formula for estimating the dollar expenditures that would be required to produce similar results. Therefore these estimates are not based on identifying ruble outlays in the Soviet Union budgets or expenditure data or on the ruble-to-dollar conversion rate.

The intelligence community's estimates of U.S. R&D expenditures since 1968 are shown below.

U.S. R&D Expenditures (note a)

Infla- tionary factor (note b) (1)	Fiscal year (2)	Total R&D (note c) (3)	Total military- related R&D (note d) (4)	NASA space (note d) (5)	Total military R&D (including military AEC) (note d) (6)
----- (billions) -----					
1.000	1968	\$25.3	\$13.2	\$4.7	\$8.7
1.080	1969	24.3	11.8	3.9	7.9
1.172	1970	23.3	10.1	3.2	6.9
1.267	1971	22.5	8.7	2.6	6.1
1.267	1972	(e)	9.3 <sup>f</sup>	2.6 <sup>f</sup>	6.7 <sup>f</sup>

<sup>a</sup>In constant 1968 dollars.

<sup>b</sup>This is the R&D deflator. It is used to convert current-year dollars to constant 1968 R&D dollars. The index basis is weighted (0.6) for changes in the cost per R&D scientist and (0.4) for changes in procurement costs of R&D hardware.

<sup>c</sup>Source: National Science Foundation (NSF). 1970 and 1971 data not for attribution until release by NSF.

<sup>d</sup>Source: Special Analysis Q, Budget of United States 1970, p. 250, and Division of Military Affairs, Atomic Energy Commission (AEC); all columns converted (deflated) to constant 1968 dollars.

<sup>e</sup>Not available.

<sup>f</sup>Programmed; not actual expenditures.

The intelligence community's estimates of Soviet Union military-related R&D accounted for 70 to 75 percent of total R&D expenditures, including capital investments in

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science.<sup>1</sup> By contrast, its estimates of United States military-related R&D accounted for only 52 percent of total R&D expenditures in 1968 and for only 39 percent in 1971.

As noted previously military-related estimates include R&D for military, space, and atomic energy activities. The estimates for the United States, however, do not include all R&D in the field of atomic energy but only that part related to military applications. To have included all atomic energy expenditures, as apparently was done for the Soviet Union estimates, would have added another \$0.8 billion to \$1 billion a year to both the United States military-related R&D and the United States military R&D. In addition, we believe that the U.S. figures are understated, as reported in chapter 2, part I.

The intelligence community, having estimated both the Soviet Union and the United States military R&D efforts in constant 1968 dollars, made the following comparisons.

Military R&D Expenditures (note a)

	<u>Soviet Union</u>	<u>United States</u>	<u>Soviet Union over United States</u>
	(billions)		
1968	\$ 8	\$9	-\$1
1969	9	8	1
1970	11	7	4
1971	11	6	5

<sup>a</sup>In constant 1968 dollars. Rounded off to nearest billion for security classification purposes.

<sup>1</sup>Non-military-related R&D expenditures include:

- a. All-union civil R&D which is the itemized portion of the all-union budgetary outlays and expenditures for science. ODDR&E officials believe that this accounts for 15 to 20 percent of the all-union expenditures or 12 to 18 percent of the total State Science Budget.
- b. Republican R&D which finances research having a local, as opposed to national, significance. In 1965 the Republican budget was about 12 percent of the total State Science Budget.
- c. Proportional share of capital investments in science.

The above comparisons show that the crossover in military R&D spending was estimated to have occurred after 1968. The Soviet Union was estimated to be spending approximately 50 percent more in military R&D by 1970 and 92 percent more in 1971.

Using the smaller GNP deflator and a slightly different mix of expenditure categories for estimating the U.S. military R&D expenditures, ODDR&E made the following comparisons.

Military R&D Expenditures (note a)

	<u>Soviet Union</u>	<u>United States</u>	Soviet Union over <u>United States</u>
	-----(billions)-----		
1968	\$ 8	\$9	-\$1
1969	9	8	1
1970	11	8	3
1971	11	7	4

<sup>a</sup>In constant 1968 dollars. Rounded off to nearest billion for security classification purposes.

ODDR&E officials report that the uncertainty in the rate of increase of the Soviet Union effort compared with the United States effort is due largely to the present uncertainty of how inflation affects the two countries. They report also that the ruble generally is assumed not to inflate due to the Soviet Union system of controlled prices and wages; however, they have stated that:

"\*\*\* The choice of the deflator for the U.S. effort \*\*\* does affect the conclusion of how much difference there probably is between the Soviet effort and the U.S. effort in 1971. \*\*\* [Use of current-year dollars] leads to the smallest difference between the U.S. and the U.S.S.R. in 1971 but is hardest to justify on economic grounds. The R&D deflator leads to the maximum difference but implies that there is no inflation in the Soviet R&D sector. The GNP deflator would seem to account for the differences



in the general U.S. and Soviet economic systems and would imply no inflation in Soviet RDT&E relative to the general Soviet economy comparable to that of the U.S.

"Hence, the general conclusions \*\*\* that the Soviet RDT&E effort in 1971 is probably (at least) \$3 B [billion] more than that of the U.S."

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Manpower, facilities, and prototypes

ODDR&E officials state that the increasing difference in the two countries' military R&D efforts should be consistent with the differences in employed manpower, facilities being used, and numbers of weapons systems brought to the prototype stage. They add that these effects are now under study but that it takes time before such differences become clear and apparent.

ODDR&E has cited the following statistics, over the past 2 years, to illustrate the developing differences in manpower between the two countries.

	Engineering and natural science graduates (note a)		Full-time R&D scientists in 1969	Number of engineers and scientists employed in R&D in 1968
	1960 (note b)	1970 (note b)	(notes c and d)	(notes b and d)
Soviet Union	145,000	247,000	550,000	745,000
United States	83,000	142,000	540,000	515,000 <sup>e</sup>

<sup>a</sup>Mathematics, physics, and chemistry.

<sup>b</sup>DOD fiscal year 1972 posture statement on R&D.

<sup>c</sup>DOD fiscal year 1971 posture statement on R&D.

<sup>d</sup>Apparent conflict may be due, in part, to differences between full-time equivalents and numbers employed. When used alone the term "scientists" apparently includes engineers.

<sup>e</sup>Reference (NSF) cited by ODDR&E shows 565,000.

The above manpower statistics, however, need further study and analysis before they will be particularly meaningful. For example, the OECD publication of 1969 commented that:

"\*\*\* Soviet engineering graduation figures are considerably inflated by the addition of extension-correspondence and evening school graduates, who in many years comprise over 40 percent of the engineering graduates. \*\*\* Soviet annual engineering graduation statistics have to be viewed with a somewhat jaundiced eye."

The numbers of scientists and engineers cannot be considered separately from their (1) particular skills, (2) allocation or utilization, and (3) productivity.

In regard to productivity ODDR&E officials report that recent studies performed by the Department of the Navy and by the Department of the Air Force, Foreign Technology Division indicate that the Soviet Union is continuing to improve the quality and the quantity of its major research facilities. They report also that the United States is not making similar improvements and is not effectively using its existing R&D facilities.

As to differences in numbers of new weapons systems brought to the prototype stage, ODDR&E predicts that, starting about 1971, we can reasonably expect several technological surprises from the Soviet Union. Officials explain that Soviet Union decisions concerning the use of the additional moneys normally precede the conspicuous testing of the resulting prototypes (or their presence in the Moscow May Day Parade) by 3 to 4 years. They add that it frequently takes several more years before critical aspects of prototypes are understood enough to assess their advanced technologies.

In summary ODDR&E officials noted that the comparative manpower and facilities "data is in rather raw, unstructured form, and as a consequence has been used to support, not determine our conclusions." They explained that the data had been used as a cross-check to help answer the question of whether the Soviet Union had committed the other assets, in addition to funding, needed to produce increased military and space R&D results.

#### Projecting R&D expenditures through 1976

After estimating current R&D efforts, ODDR&E projected the military R&D funding for both countries from 1970 to 1976. For the United States ODDR&E stated that it had used simply the fiscal guidance numbers provided by the Office of the Secretary of Defense planning system. For the Soviet Union ODDR&E considered three possible alternatives.

1. Project, in a simple straight line, the trend developed over the past 20 years. This would result in

annual increases due to (a) a steady 5-percent increase in GNP each year and (b) an increasing portion of GNP devoted to military R&D.

2. Peg future increases to the 3 percent of GNP that existed in 1970. This would produce annual increases resulting from the steadily growing GNP.
3. Freeze funding at the 1970 level of \$10.5 billion.

ODDR&E chose to define "base line Soviet Strategy" as a \$10.5 billion annual military RDT&E effort from 1970 and 1971 onward. Consequently ODDR&E believes that, if the United States stays within its fiscal guidance, the Soviet Union will be investing about \$3 billion more a year in equivalent effort. Under these circumstances ODDR&E reasons that an annual Soviet Union expenditure of \$10.5 billion not only is the most conservative alternative but also is both attractive and practicable to Soviet Union planners. It would allow them to assign future R&D growth to the civilian section and, according to ODDR&E, to still reach military technological supremacy by the mid-1970's.

#### SUMMARY AND CONCLUSION

ODDR&E contends that the Soviet Union is exerting relatively greater efforts than the United States is in the area of military R&D. ODDR&E is convinced that this crossover occurred in 1969, the first year of a decreasing U.S. military R&D budget. To demonstrate the crossover and to communicate its significance, ODDR&E developed a judgmental model for comparing the two countries' past military R&D inputs with their outputs and for projecting possible future outputs on the basis of present and possible future resource inputs.

We found that extreme secretiveness by the Soviet Union resulted in data insufficient for realistic estimates of its military R&D efforts. At best, dollar valuations of Soviet Union military R&D programs are only rough guides to the Soviet Union's relative level of effort. In our opinion the general technological assessments can provide only general support for these rough guides; they cannot refine them. Consequently we believe that the usefulness of the pioneering

methodology with its limited data base may be to indicate trends and the apparent magnitude of the Soviet Union military R&D threat. We have reservations, however, as to the usefulness of this methodology in quantifying relative efforts or spending gaps between the two countries.

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