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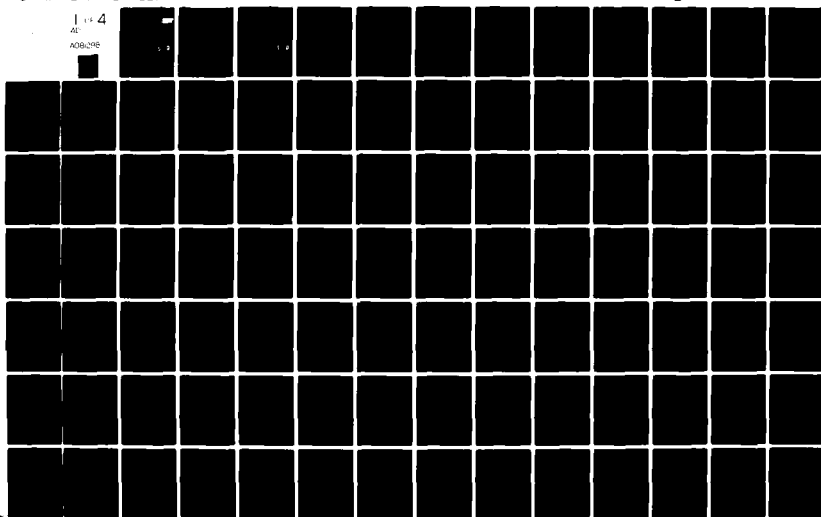
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R&D RESOURCE ALLOCATIONS
BY SELECTED FOREIGN COUNTRIES

John K. Moriarty
Nathan N. White

January 1974

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This study is one of a number done by academic and other research institutions for the Department of State as part of the Department's external research program. These studies are designed to supplement the Department's own research capabilities and provide independent, expert views to policy officers and analysts on key questions with important policy implications.

The idea for this study was proposed by the Bureau of Intelligence and Research (INR) and developed in discussions with officers in several Department Bureaus. Overall monitoring of the project within the Department was under the direction of Warren H. Reynolds, Senior Program Officer in the Bureau of Intelligence and Research.

The External Research Program is planned and coordinated by the Department of State Research Council and managed by INR's Office of External Research. Comments on the study or queries about the program may be addressed to:

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John K. Moriarty
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PREFACE

This study was performed by the Institute for Defense Analyses (IDA) for the Department of State. In its Project Work Statement, the Department set forth the following study purpose:

The immediate objective of the project is to analyze the R&D expenditures of selected foreign countries during the past 3-5 years, to estimate current annual expenditures, and to project future expenditures for the next 3-5 years. The results of the project would provide the statistical underpinning for making assessments, within the Department or elsewhere in the US government, of foreign scientific capabilities.

It was subsequently decided that this project, because of the fragmentary nature of data pertaining to future R&D expenditures, would concentrate chiefly on presenting and analyzing the past experience of selected foreign nations in their allocation of resources to research and development, while estimates of current and future R&D expenditures would perforce be limited to tentative projections for several major countries.

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SUMMARY INTERNATIONAL COMPARISONS OF R&D EXPENDITURES

A. GENERAL

During the decade of the 1960s, gross expenditures on research and development (GERD) within the OECD area (i.e., virtually all of the industrially advanced countries of the non-Communist world) as a whole nearly doubled, from \$21 billion in 1961 to \$41 billion in 1969. By that year, GERD in the Warsaw Pact area appears to have reached almost \$28 billion (in current dollars).¹ Thus, R&D expenditures for the two areas in 1969 probably totaled some \$68 billion, which is by far the greatest part of the research and development accomplished in the world.²

Given the fact that the Warsaw Pact and the OECD are very different in nature, there is little point in any further comparison of the

1. See Table A-1, in Part Two, "Statistical Data." The year 1969 is the latest year for which reliable OECD data exist. Warsaw Pact figures are based on UNESCO data, which are considerably less precise (for reasons discussed in Chapter II), and also rarely go beyond 1969.

Unless otherwise noted, all references to expenditures should be understood to reflect expenditures in US dollars. Also, unless otherwise noted, all data on expenditures are given in terms of current prices. The effect of inflation on national and regional GERD is discussed in Chapter II.

The reader's attention is called to the fact that this and subsequent discussions of financial allocations to R&D are in terms of inputs only; the question of outputs--i.e., the quality of the products gained through the national R&D effort--is not addressed in this paper.

The exchange rates used in preparing the data in this study are discussed in the "Series J" appendix, which begins on page 317.

2. The allocation of financial resources to research and development by OECD countries and by non-OECD countries, including the Third World, is discussed in Chapters III and V, respectively. The statistical data on which these chapters are based may be found in the table Series A-E (OECD) and Series G (non-OECD) in Part Two.

R&D resource allocations of the two organizations. The Warsaw Pact is a military alliance and a "center of power," at least in a strategic sense, while the OECD is a loose association of countries that collectively dispose of immense economic power but rarely act in a coordinated fashion.

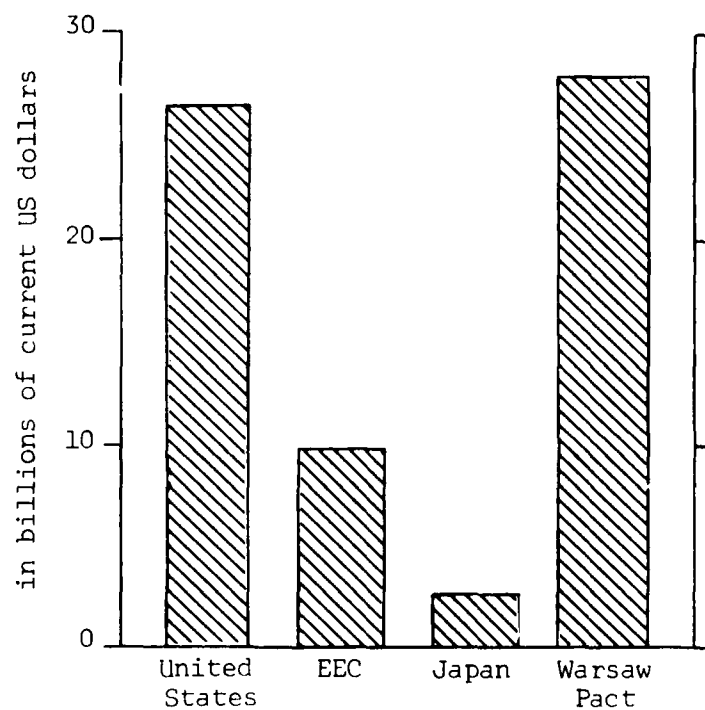
What is of considerable interest in regard to the Warsaw Pact is its relation to other present or potential "centers of power." Three such centers appear to stand out. Two--the United States and Japan--are nation states.³ The third--the European Economic Community or EEC--already functions for some purposes as a collectivity and may constitute an incipient independent center of political-military power.⁴ The 1969 levels of expenditure on research and development in these four centers of power are displayed in Figure S-1. The United States and the Warsaw Pact allocated approximately the same amount of funds to R&D in 1969--\$26.6 and \$27.6 billion, respectively. The EEC allocated slightly more than one-third of these amounts: \$9.5 billion. Support for R&D in Japan was much smaller: \$2.6 billion, one-tenth of the amount generated by the two major centers of power.

As for the question of which states are the principal performers of research and development, Figure S-2 shows that, just as the Warsaw Pact and the OECD account for most of the world's R&D, each of these two areas is in turn dominated by a small number of states that account for the great bulk of expenditures within that area. In 1969, more than 86 percent of the funds devoted to R&D within the Warsaw Pact was supplied by the Soviet Union.⁵ In the same year, 91 percent of R&D expenditures in the OECD originated in five states. One, the

3. China is not considered here because information on Chinese expenditures on R&D was not available.

4. It should be noted that the EEC discussed here is the expanded nine-nation organization created in January 1973. Reference to EEC expenditures on R&D in 1969 consequently reflect the sum of expenditures in the six-nation EEC that existed at the time of the OECD surveys and expenditures in the three nations that subsequently joined the Community.

5. Table A-3.



Source: Table A-1, in Part Two: "Statistical Data."

Figure S-1. GROSS EXPENDITURES ON R&D IN
FOUR WORLD CENTERS OF POWER, 1969

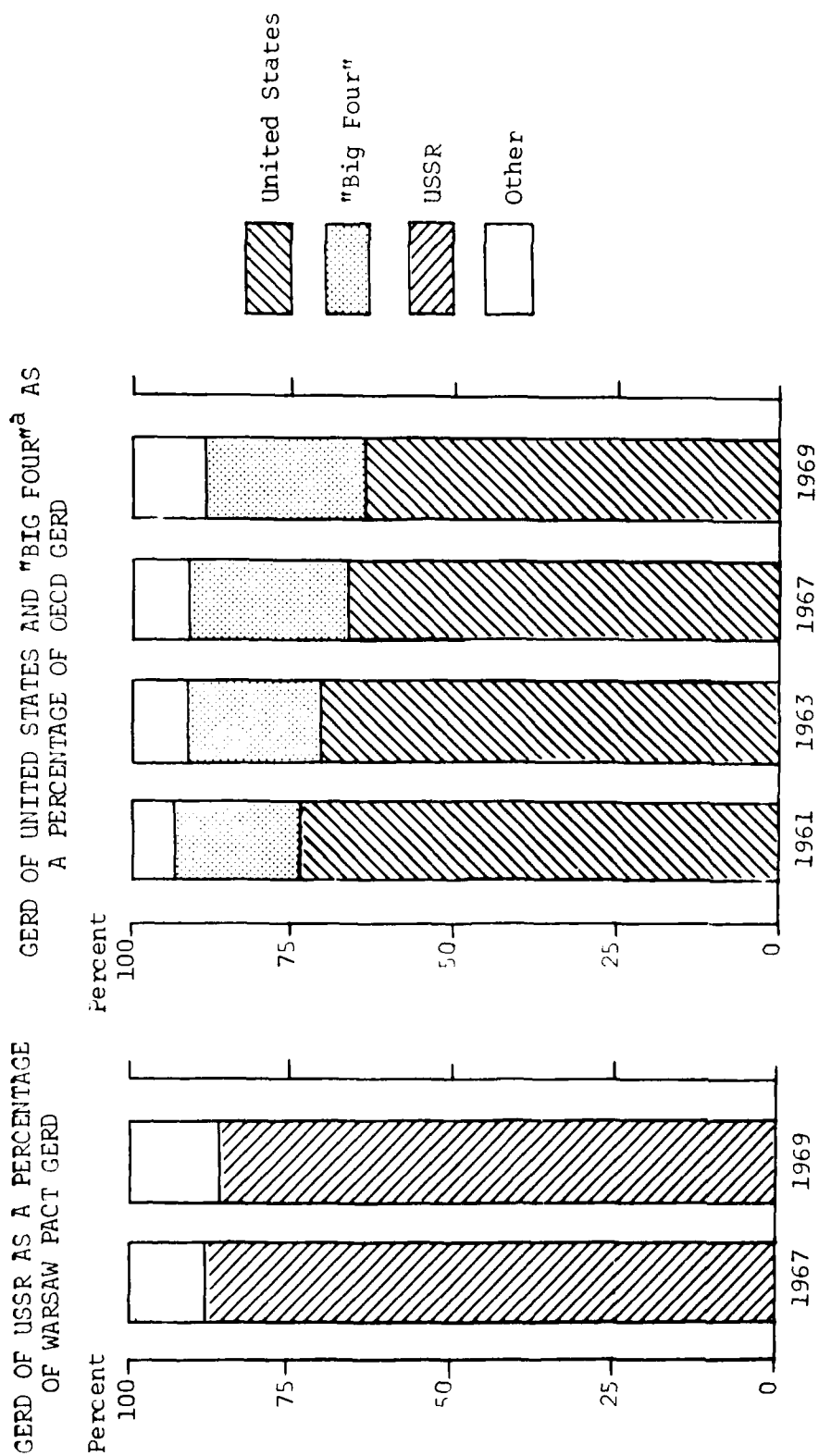
United States, accounted for 65 percent of the total for the area, while four others--France, West Germany, the United Kingdom, and Japan--supplied another 25 percent.⁶

A second conclusion that may be drawn from Figure S-2 is that the relative position of the big power that dominates R&D in each area is tending to decline over time. Between 1967 and 1969 the share of the USSR in Warsaw Pact GERD fell from 88 to 86.5 percent. The change in the status of the United States in relation to the rest of the OECD was more dramatic. Whereas in 1961 the United States funded three-quarters of OECD research and development, by 1969 its share had contracted to two-thirds of the total. The trend was accompanied by a parallel expansion of the share held by what are referred to in this report as the "Big Four": between 1961 and 1969, the portion of GERD provided collectively by France, West Germany, the United Kingdom, and Japan grew from one-fifth to one-quarter. It is because of the important role played by these four countries and the United States that they have been accorded special attention throughout those sections of this paper that deal with R&D expenditures in the OECD.

During the 1960s, the relative positions of the Big Four in the total resources they allocated to R&D also changed. In 1961 the United Kingdom was clearly far in the lead with GERD at least twice as large as that of France, West Germany, or Japan. By 1969 all four countries were clustered close together--with the United Kingdom in last rather than first place and Japan on the verge of moving past France and West Germany.

It will be noted that we have so far discussed the R&D allocations of different "centers of power," or of particular countries, in relation to each other and not in relation to some overall total, or "World GERD." There are, as explained in some detail in Chapter II, serious problems in comparing the R&D resource allocations of different countries with each other; these problems are compounded if one totals all the statistical imperfections into some sort of "World GERD."

6. Ibid.



a. The "Big Four" are France, West Germany, the United Kingdom, and Japan.
Source: Table A-3.

Figure S-2. GERD OF MAJOR POWERS IN RELATION TO LARGER INTERNATIONAL GROUPINGS

Even without attempting to develop a precise overall figure for world R&D expenditures, however, it is nonetheless possible to make some gross estimates of the relationship of the figures discussed above with the amounts of R&D probably accomplished in the remainder of the world. (The "remainder of the world" will again have to exclude China, for the reason stated previously. It is conceivable that Chinese R&D expenditures in, say, 1969 were in the neighborhood of those of Japan or the United Kingdom, or more likely less, but we have no statistical basis for making any estimate.)

It was noted that the R&D expenditures of the OECD and the Warsaw Pact countries in 1969 probably totaled some \$68 billion. If we take into consideration what figures we do have for the R&D resource allocations of the countries of the Third World, along with what we know of their economies and general state of development, we can probably safely say that the total R&D expenditures in 1969 for all these remaining countries was little if any over \$1 billion.⁷ Thus, it appears likely that over 98 percent of the world's R&D (again excluding China) was accomplished in the OECD and Warsaw Pact countries, with little over 1 percent in the remainder. Moreover, if we total the R&D expenditures in 1969 of only the six leading countries--the United States, the Soviet Union, France, the United Kingdom, Germany, and Japan--the figure is some \$61 billion, or perhaps 88 percent of the world's R&D. In any event, the conclusion is inescapable that the vast preponderance of the world's research and development is performed in a very few advanced countries.

B. SOURCES OF R&D FUNDS IN OECD NATIONS

In almost all of the nations surveyed by the OECD in 1969,⁸ the Business Enterprise and Government sectors together supplied more

7. See Table G-1.

8. The number of OECD countries responding to the 1969 survey varied from twelve to twenty, depending on the subject area being addressed.

than nine-tenths of the funds allocated to R&D; the Higher Education, Private Non-profit, and Abroad sectors accounted for the remaining one-tenth of GERD. The member nations of the OECD may be divided into two groups, depending on whether it was the Government or Business Enterprise sector that supplied more than half of GERD. The group of "government-funded" countries was composed of nine states, including France, the United States, and the United Kingdom. The last two countries had Business Enterprise sectors that also spent large sums on R&D, but the Government sector had ambitious R&D programs and spent even more, both in absolute terms and as a percentage of GNP and total government resources. In France, Canada, and Norway, the Government was also heavily involved in R&D, and Business provided relatively little support. Finally, in Portugal, Greece, Ireland, and Spain, Government spent comparatively little on R&D, but Business Enterprise spent even less.

There were seven "private-funded" countries, including West Germany and Japan. In these two states and the Netherlands, Business Enterprise expenditures were relatively high, both in absolute terms and as a percentage of GNP. Government spending was comparatively low in the first two, but high in the Netherlands. In Sweden, Belgium, Italy, and Austria, Business spending on R&D was moderate in absolute and relative terms, and Government spending was even lower.

C. SECTORS OF R&D PERFORMANCE IN OECD NATIONS

The performance of R&D is much less concentrated than is the funding. In almost half of the responding countries, the combined share of Business Enterprise and Government R&D performance was less than 80 percent in 1969. The most important other sector of performance was Higher Education.

In all of the five Major States (the United States plus the "Big Four"), the Government sector performed far less, both absolutely and as a percentage of GERD, than it generated. Only in the United Kingdom and France was as much as one-quarter of R&D conducted in this sector. The four countries that expended one-half or more of

their national R&D effort in the Government sector were all small, relatively underdeveloped countries with weak private enterprise sectors. Out of nineteen responding nations, twelve, including all of the Major States, conducted most of their research and development in the Business Enterprise sector.

D. INTER-SECTORAL TRANSFERS IN OECD NATIONS

The Government sector in OECD countries finances from its own funds all or almost all of the R&D it performs and is the only important outside contributor to Business Enterprise R&D. In addition, it is usually the principal source of support for research and development conducted in Private Non-profit institutions and finances the great bulk of Higher Education R&D. Thus, Government is the source of most of the funds moving between sectors. Government R&D expenditures tend to be concentrated in one or two sectors of performance, of which the primary one is itself and the other is Higher Education.

E. OBJECTIVES OF GOVERNMENT-FUNDED R&D IN OECD NATIONS

The OECD has formulated a set of fourteen objectives under which all Government R&D expenditures can be subsumed.⁹ These objectives in turn are organized into five groups:

<u>Groups</u>	<u>Objectives</u>
I National Security and Big Science	Defense Civil Space Civil Nuclear
II Economic Development	Agriculture Mining and Manufacturing Economic Services

9. This section discusses the objectives of only Government-funded R&D within the OECD. While it would be desirable to have total national R&D expenditures broken down by objective for both OECD and non-OECD countries, the necessary data were not available. See Chapter IV and the Series F tables for a detailed discussion and statistical data on "Government R&D Objectives in OECD Member Nations."

III Community Services

Health
Pollution
Public Welfare
Other Community Services

IV Advancement of Science

Advancement of Research
Advancement of Science via
General University Funds

V Other Activities

Developing Countries
Miscellaneous

Between 1961 and 1971, the position of National Security and Big Science in Government R&D weakened in all OECD states. In 1961 this objective ranked first in seven countries, including all of the Major States except Japan, and second in another two. By 1971, however, it ranked first in only four; in West Germany and two smaller states it slipped down one level, and in Belgium it dropped two levels from second to fourth.

Advancement of Science (i.e., Government support of research in universities) improved its position, so that by the early 1970s it had probably supplanted National Security and Big Science as the most important group of objectives. Between 1961 and 1971, Government in West Germany, Italy, Japan, and three smaller states accorded this group the highest priority. In three other states, including France and the United Kingdom, this objective received second priority.

Whatever the relative position of Groups I and II, there is no doubt about the order in which Government ranked the remaining three groups. In 1971 as in 1961, seven out of twelve countries, including four of the five Major States, ranked Economic Development third. Seven states in 1961 and eight states in 1971, including in that year three Major States, ranked Community Services fourth. As for Other Activities (chiefly aid to developing countries), its position, already low in 1961, was even lower by 1971, when it ranked last in no less than eleven of the twelve countries.

To consider Group I in somewhat more detail, over the decade of the 1960s, the shares of both Defense and Civil Nuclear in Government funding generally tended to contract, while that of Civil Space tended to expand (except in the United States where the program peaked in

1965 and has steadily declined ever since). In ten out of the responding twelve states, the relative importance of both Defense and Civil Nuclear decreased between 1961 and 1971, with the difference that the share of the latter at the beginning of the period tended to be much lower and the decrease tended to be much less dramatic.

As for Civil Space, it began the 1960s with a very small share of Government R&D funds (little or nothing in half the states surveyed) and by 1971, even after years of steady growth, still accounted for 7 percent or less of the total in eleven out of the twelve countries. The exception was the United States, where in 1971 this objective still absorbed almost one-fifth of Government spending on research and development.

F. ESTIMATES OF GERD IN THE FIVE MAJOR STATES FOR 1973 AND 1975

Using projections based both on average annual rates of growth in GERD and on estimates of GERD as a percentage of GNP,¹⁰ the authors made estimates of GERD in 1973 and 1975 for the United States, France, West Germany, Japan, and the United Kingdom. These estimates are summarized in Table S-1.

The estimates suggest that, as a consequence of different rates of growth in GERD and drastic shifts in exchange rates, there have probably taken place important changes in the relative levels of support for R&D in the five Major States since the last OECD survey was conducted in 1969. In that year, the combined expenditures of the Big Four were less than 40 percent of those of the United States. As Table S-1 shows, by 1973 their collective GERD may have reached between 60 and 75 percent of that of the United States. Again, whereas in 1969 US expenditures were ten times larger than those of the second-ranking state (Japan), in 1973 they may have only been four times larger. Thus, although the projections for the individual countries may well be, and indeed probably are, incorrect in detail,

10. For a description of the methodology and more detailed projections, see Chapter VII and Table I-1.

Table S-1

PROJECTIONS OF PRESENT AND FUTURE GERD
IN FIVE SELECTED OECD MEMBER NATIONS
(in billions of current US dollars)

Country ^a	Actual	Projected	
	1969	1973	1975
UNITED STATES	26.6	30.1	32.7-34.1
JAPAN	2.6	7.1-8.4	9.5-11.2
WEST GERMANY	2.7	4.3-6.3	5.5-7.0
FRANCE	2.7	3.6-3.9	3.8-4.2
UNITED KINGDOM	2.4	3.0-4.0	3.2-4.1

a. Countries are ranked in the order of the size of their projected GERD in 1975.

Source: Table A-1 and Sections C through G of Chapter VII.

one major conclusion cannot be avoided: The former US position of vast predominance in R&D expenditures, in comparison with other major non-Communist industrialized states, is steadily eroding

The suddenness of the change in relative position is more apparent than real, however. The dollar was overvalued at the time the OECD surveys were taken, and so the position of the United States was never in reality as overwhelmingly dominant as the statistics indicated. The revaluations and devaluations that have been carried out since 1969 have resulted in figures that represent a much closer approximation to the actual allocations of resources to research and development than was available earlier.

There may also have occurred a change in the relative positions of the Big Four. The year 1969 saw them clustered close together with GERDs of between \$2.4 and \$2.7 billion. By 1973, Japan probably

established a definitive lead over the other three. Its expenditures of from \$7.1 to \$8.4 billion are probably twice as large as those of either France or the United Kingdom (or larger than their combined expenditures) and about one-quarter those of the United States. West Germany probably occupies a position midway between Japan and the other two states. It would appear, therefore, that while the distance between the United States and the Big Four is narrowing, the spread among those states is increasing.

The relative position among the Major States in 1975 is more difficult to estimate. In this instance, the projection for the United States, like that for the other countries, is expressed in terms of a range of values.

Comparing the United States with the Big Four, we find that Japanese GERD may increase from about one-quarter to almost one-third that of the United States and that the collective GERD of the Big Four may amount to approximately 70 to 80 percent of US GERD, depending on whether one compares the lower or higher ends of the ranges of the respective states. This suggests that the trend discerned in the analysis of the present situation will continue. Between 1973 and 1975, the United States will probably lose more ground to the Big Four.

As for the Big Four themselves, France and the United Kingdom should stay close together at the bottom, West Germany should increase the distance between them and itself, and Japan should pull still further into the lead. Its GERD by 1975 may be two-and-one-half times as large as the GERD of either France or the United Kingdom.

I

INTRODUCTION

A. SIGNIFICANCE OF R&D STATISTICS

Within the past two decades, the advanced nations of the world have shown a greatly increased interest in the subject of scientific research and development--most with the objective of stimulating economic growth, but others with an eye chiefly to political and military advantage. There has been a concomitant rise in interest in the techniques for measuring national resources devoted to R&D. An entire literature has grown up on the subject of "national science policy," as governments and international organizations have attempted to improve their understanding of how science could be harnessed to national objectives through deliberate policy decisions and planned research and development. Much of this interest came about, of course, as a result of the dramatic successes, first in military and later in space science, that attended precisely this kind of national commitment to research and development for a preconceived purpose. But a large part of the new approach to research and development had its origins in a more general change in the scientific climate that began as far back as the nineteenth century.

The new approach to scientific research was characterized by an ever closer link between science and technology. As one leading student of modern science has stated, "it is the special characteristic of modern societies to sustain themselves by innovations which have their source in theory."¹ Prior to the second half of the nineteenth century it was rare to find examples of techniques originating

1. Jean-Jacques Salomon, General Introduction to Organisation for Economic Co-operation and Development, The Research System (Paris, 1972), Vol. 1, p. 11.

directly from the progress of pure science; since that time, however, and especially during the twentieth century, technological development has depended ever more closely on the theoretical knowledge acquired from scientific research. At the same time, the progress of science itself has come to depend more and more on instrumentation and equipment that were developed by the science-driven technology. Salomon states:

The resultant consequences, both for the organisation of scientific research and for the influence of research on society, have been so often emphasized that they have become a commonplace. First, the timelag and the geographical distance between the emergence of new ideas and their practical application has greatly diminished; secondly, a new type of organisation has invaded research activities, the old workshop type of laboratory yielding place to modern research institutes relying on large-scale equipment and big research teams, with complex structures and closer links among different disciplines. The organisation age can be said, in sum, to have swept science into the productive age; in other words, science is not indifferent to the institutional context in which it develops.²

One of the chief implications of the new state of affairs, from the standpoint of national policymakers, was the apparent inference that science with all its economic, political, and military benefits could be made responsive to money. A second implication, to some extent working at cross purposes to the first, was the growing realization during the 1960s that the new science was also extremely expensive--especially the "big science" research fields such as aerospace, nuclear energy, sophisticated computers, and high-energy physics.

At the present time, many of the advanced countries within the Organisation for Economic Co-operation and Development (OECD) appear to be experiencing something approaching disillusionment with the promises that ever-expanding research and development programs had

2. Ibid., p. 12.

seemed to hold out to them. As the most recent study of R&D trends by the OECD Directorate for Scientific Affairs states:

At the time of writing, R&D is going through a difficult period. Its stock has fallen in the view both of governments and of public opinion. At worst its basic utility is being questioned. At best it is believed that R&D efforts should be reorganised so that they contribute not only to traditional objectives such as defence, space, atomic energy and industrial growth but also to what are loosely called the "social objectives" which have recently been growing in priority and importance.

This change of attitude has led to attempts to achieve greater selectivity and to orient R&D towards a wider range of better defined problems. It has been accompanied by a relative or absolute reduction in the amount of resources which governments devote to R&D.³

There has been little disillusionment, however, with the general conviction that improved means of measuring R&D resource allocations are necessary. Indeed, the currently perceived necessity for better selectivity and clearer definition of R&D programs has reinforced the requirement for more precise R&D statistics. In this connection, it is worth noting that, until the very recent past, R&D has had little visibility in most national budgets, since governments (the source of more than half of national R&D funds in many countries) have rarely budgeted for it, per se; instead, most governments usually budget by ministry or agency, and it is only recently that some have begun to break out separate R&D categories. As a result, special surveys have been required to estimate R&D expenditures. Improved R&D accounting practices, therefore, to better align proposed government spending programs with national policies and to permit effective followup on previous policy decisions, have become increasingly necessary.

Improved management of a nation's R&D programs and policies has constituted only one aspect of the recent demands for better R&D

3. Organisation for Economic Co-operation and Development, Directorate for Scientific Affairs, Changing Priorities for Government R&D, DAS/SPR/73.35 (Paris, 1973), p. v.

statistics. There has also been a growing interest in other nations' R&D programs, progress, and policies. The chief impetus in this direction has undoubtedly come from international groups, such as the OECD or the European Economic Community (EEC), whose members are attempting to coordinate not only their economic but their scientific development programs, as well.⁴ A further impetus has come from the previously mentioned "second thoughts" of many countries regarding the advantages of their earlier enthusiastic, but sometimes rather undifferentiated, support for R&D.⁵ As a result, most of the advanced countries have developed a keen interest in the way other nations are managing their R&D programs, for purposes of comparison, analysis, and possible improvement of their own science policies and structures. A third source of interest in international R&D statistics has been the large bloc of nations who are not numbered among the advanced countries. While there may be here some holdover of the earlier Western attitude that R&D is a panacea for a nation's economic ills, there is probably even more a genuine conviction, among advanced as well as less developed countries, that the new scientific research can yield benefits for all nations if the techniques and practices learned from the leaders can be intelligently applied.

R&D data are also seen as an additional tool in the overall task of assessing the capabilities, the potential, and the long-term trends

4. Among a few advanced Western nations, in particular the United States, there has also been a strong specialized interest in the scale of foreign military R&D efforts.

5. The same OECD study cited earlier states, for example:

The underlying preoccupation of most Member governments during the 1950s and 1960s was the encouragement of economic growth and this deeply influenced their thoughts on R&D.... The general view was that almost all R&D should be encouraged per se, though there were attempts to identify and support programmes which were thought to have a more immediate impact on economic growth. In this period we find some governments fixing percentages of R&D to GNP not as upper limits of resources available but as targets, often without any clear specification of the purposes to which the new R&D was supposed to contribute. Ibid., p. 1.

in a nation, just as economic, demographic, or military data make their own special contributions to this task. The most basic questions that might be asked in such an analysis, of course, are those of scale: What is the gross amount that a nation devotes to R&D (or what, to use the acronym, is its GERD, that is, Gross Expenditures on Research and Development)? Have its R&D expenditures been increasing or decreasing in recent years? How do these trends compare with those in other countries? While it should be emphasized that such data tell us nothing about the outputs, or productivity, of a nation's R&D, they do supply some gross indicators of overall scientific capability and potential.

A second basic question is that of R&D intensity. What proportion of its available resources does a nation devote to R&D? In other words, while one might expect a large nation with a large GNP to have larger total expenditures for R&D than a small nation (for example, the United States as compared with Switzerland, or India compared with Israel), in which country does GERD constitute a higher percentage of GNP? With an answer to this question, we begin to acquire a somewhat sharper indication of a nation's scientific and technological potential.

The analyst of R&D statistics can also acquire some indicators of the nature of a society and of a government's relationship to the economy--at least from the scientific standpoint. What are the sources of R&D funds within the country? What proportion is funded by the government and what proportion by private enterprise? Or put differently, to what extent is R&D an accepted technique of business management in its quest for innovation and competitiveness, and to what extent is it necessary for the government to assume responsibility for such risk-taking funds? Where is research and development preponderantly performed--in government laboratories, in those of private enterprise, or somewhere else? To what extent does the government make it a policy to support R&D in private enterprise, or in the universities, through transfer of government funds? How does a nation allocate its funds among the various types of R&D activities--

that is, basic research (chiefly university research), applied research, and experimental development? And, lastly, one of the most important questions of all, what appear to be a nation's priorities, or objectives, in R&D? What proportion of its R&D funds does it spend on defense? On a civil space program? A civil nuclear program? To what extent does it emphasize economic and social objectives in its R&D?

To these and other questions, this paper will give some answers for a wide selection of foreign countries, both advanced and less developed. While there is no claim that these answers supply any totally new or revolutionary insights into the policies of other nations, it is believed that the insights furnished are of a different kind and that they add a useful dimension to other available information on these countries.

B. FOCUS OF THIS STUDY

It was not possible within the time constraints of this study to accomplish everything we would otherwise desire in regard to analysis of the available data. Where a choice had to be made between more extensive analysis of specific data and a more complete presentation of pertinent statistics, we have inclined toward the latter choice. This policy was followed in the belief that the most important task at present in this relatively new field of research is to lay out the basic statistical situation as it exists in the various countries. Along with this data presentation, however, we have provided some fairly detailed analysis and then (in Chapter VIII) have posed some hypotheses in regard to the possible implications of some of the findings for future US policy. It must be emphasized, however, that so far these are only hypotheses that will require considerably more study before their significance--and even their appropriateness--can be fully appreciated.

C. ORGANIZATION

This paper opens with a discussion of the sources and problems of R&D statistics (Chapter II),⁶ and then proceeds with two basic parts dealing with the actual data--an analytical section and a back-up section consisting of statistical tables. Part One constitutes the main body of the study, and includes:

- (a) Summary charts and tables depicting the status of selected countries worldwide in the various facets of their R&D activities, along with textual analysis summarizing and highlighting the material displayed (Chapter III, Allocation of Financial Resources to R&D by OECD Member Nations; Chapter IV, Government R&D Objectives in OECD Member Nations; Chapter V, Allocation of Financial Resources to R&D by Selected Non-OECD Nations; and Chapter VI, Allocation of Manpower Resources to R&D by Selected Countries Worldwide);
- (b) Some tentative projections of R&D expenditures for several major countries (Chapter VII);
- (c) A brief section noting some hypotheses regarding potential issues of interest for US policy (Chapter VIII).

Part Two might, in a somewhat different sense, be considered the main part of the study in that it contains all the basic work--that is, the detailed tables--from which the charts and analysis in Part One were later derived. In any event, it is important that the reader be aware that the organization of the charts and analysis in Part One parallels the organization of the tables in Part Two--both of which were essentially based on the structure developed by the OECD:

- (a) Gross financial allocations
- (b) Sources of funds
- (c) Sectors of performance
- (d) Transfers of funds between sectors
- (e) Types of R&D activity
- (f) Governmental objectives.

6. This chapter is not absolutely necessary for the reader who is interested only in the results of the various data compilations. The authors strongly suggest, however, that an appreciation of the data sources and limitations will improve markedly the reader's understanding of the data's significance.

II

R&D STATISTICS: SOURCES AND PROBLEMS

A. SOURCES FOR THE STUDY

1. The Initial Selection Process

Three international organizations, the European Economic Community (EEC), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and the Organisation for Economic Co-operation and Development (OECD) have compiled statistics for a number of nations on the allocation of resources to research and development (R&D).¹ Each of these sources has its special usefulness. At the very beginning of this project, however, it was decided to rely whenever possible upon the reports prepared by the Directorate for Scientific Affairs of the OECD Secretariat. These were found preferable to the studies undertaken at the direction of the PREST Group² of the EEC for three principal reasons.

First, in terms of the number of countries surveyed, the OECD publications provide superior coverage. The set of states responding to the OECD questionnaires included, in addition to the five reporting to the EEC,³ from seven to fifteen other nations. The OECD monitored the activities of all of the five states that, collectively, conduct most of the research and development performed in the non-Communist world; the EEC examined only two (France and West Germany).

1. In addition, according to information available to the OECD as of November 1972, the Scandinavian countries are preparing a special R&D classification for the Nordic area. See OECD, Changing Priorities for Government R&D, DAS/SPR/73.35 (Paris, 1973), p. 128.

2. Working Group on Scientific and Technical Research Policy, appointed by the Medium-Term Economic Policy Committee of the Commission of the European Communities.

3. Germany, Belgium, France, Italy, and the Netherlands.

Second, whereas the data assembled by the EEC refer only to the years 1967 through 1971, the OECD data provide information on the early 1960s--for 1963 and occasionally 1961 (in the case of the subjects investigated in the large-scale surveys) or for the entire decade (in the case of the more detailed studies on governmental R&D objectives).

The third and most important reason, however, is that the OECD attempted to assemble a picture of the total national R&D effort of its member states, while the EEC confined itself to the more narrowly defined issues of the level of government funding for research and development and the distribution of those expenditures among various objectives--issues thoroughly investigated by the OECD.⁴

The UNESCO publications were resorted to only when it was necessary to secure information on countries that are not members of the OECD. For this purpose the UNESCO data were indispensable; otherwise there was little or nothing available on many countries. Where both UNESCO and the OECD provided information on a given country, however,

4. The schemes of classification used by the OECD and the EEC to analyze the objectives of government-funded R&D are very similar. The two are compared and discussed in OECD, Changing Priorities for Government R&D, pp. 113-19 and pp. 128-30, and Commission of the European Communities, Statistical Experts Group, Research and Development: Public Financing of Research and Development in the Community Countries 1967-1971, Analysis by Objectives, pp. I.1-I.2.

As the latter source explains, the main differences in the two schemes are that (a) the EEC's figures relate to appropriations by the central government, while the OECD concentrates on actual expenditures; (b) the EEC studies cover government-funded R&D performed abroad, while the OECD reports do not; and (c) the OECD supplies information on R&D that is performed in the government sector but funded from non-governmental sources, while the EEC does not.

The assertion by the EEC that "funded research projects relating to the social and human sciences are included in the Community system, whereas the OECD gives them only in tabulated annexes" has been overtaken by events. In the latest OECD study, Changing Priorities for Government R&D, the data supplied by the national authorities included the social sciences and the humanities for all countries except Canada and the United Kingdom. This source does not indicate whether the US data included R&D in these categories. Ibid., pp. 136-61.

the OECD was the preferred source for several reasons, all stemming from the fact that (a) the OECD Directorate for Scientific Affairs was earliest on the scene in making systematic international comparisons of R&D effort and (b) the OECD countries in themselves are generally more advanced and more homogeneous, thus permitting more precise reporting instructions and more meaningful comparisons.

Specifically, the OECD's earlier involvement in the development of international R&D statistics has made possible longer time series in the OECD data, and has also provided additional experience for both OECD staff and member countries in working out data and reporting problems--thus making for more reliable data. In addition, the OECD members' relatively greater similarity in interests and economic structure has enabled the OECD surveys to cover both a wider and richer field of information than was possible for UNESCO: for example, UNESCO makes no attempt to break out R&D expenditures by objective--one of the most useful areas for comparison and analysis; the OECD data allow some "third order" comparisons of inter-sectoral transfers of funds, while this is not possible at all with the UNESCO data; and the OECD staff has supplemented its data presentations with an analytical commentary, which has not been undertaken by UNESCO. Moreover, UNESCO expenditure data are in national currencies only, while most of the OECD data have been converted to US dollars for comparative purposes.

Finally, there is a difference between the OECD and the United Nations data that appears to have something to do with differences in the two types of international organization. Generally speaking, UNESCO appears to have handled its members more with kid gloves and reported the data largely as they were received (with some supplementary information from other official sources). The OECD, on the other hand, has attempted to go more deeply into the national scientific structures of its members and has occasionally even rearranged its members' data when this appeared necessary for better comparability.

2. Principal OECD Publications Used

Three sets of materials published by the OECD were relied upon in preparing this paper:

- Research and Development in O.E.C.D. Member Countries: Trends and Objectives, CMS(71)6 (Paris, August 1971), and its companion volume, CMS(71)6, Appendix (September 1971).⁵
- International Survey of the Resources Devoted to R&D in 1969 by OECD Member Countries: Statistical Tables and Notes, in five volumes (Paris, 1972). The first four volumes deal with the individual sectors, are numbered from DAS/SPR/72.22 through 72.25 and appeared in the spring of 1972. The final summary volume is designated DAS/SPR/73.30 and was published a year later in June 1973.⁶
- Changing Priorities for Government R&D, DAS/SPR/73.35 (Paris, July 1973).

The first group of materials, R&D Trends and Objectives, is organized under two main subject headings. The first chapter, devoted to an investigation of overall trends in the national R&D programs of OECD member nations, is based on two surveys conducted by the OECD in 1964/64 and 1967 and, for some countries and some subjects, contains additional data for 1961 and 1969. A third OECD survey, designed to gather more recent information on the subjects covered in the earlier surveys, was carried out in 1969. The final results were published in mid-1973 in the second group of materials, Survey of R&D in 1969. Those sections of this paper that deal with expenditures on research and development at the national level are, therefore, derived from the first chapter of R&D Trends and Objectives and the later Survey of R&D in 1969. Statistics are usually available only for 1963, 1967, and 1969.

5. Hereafter, these publications will be referred to as R&D Trends and Objectives and R&D Trends and Objectives, Appendix, respectively.

6. Hereafter, these publications will be referred to as Survey of R&D in 1969, together with the appropriate volume number.

The second and much longer chapter of R&D Trends and Objectives concentrates on an analysis of the objectives of government R&D. This chapter has been used very sparingly in this paper, largely because it has been superseded by the third publication listed above: Changing Priorities for Government R&D. Those sections of this paper that deal with expenditures on research and development at the government level by objective are consequently derived almost entirely from this last source. Statistics are available in a continuous time series running from a point in the early or mid-1960s (usually 1961) to some time in the late 1960s or early 1970s (usually 1970 or 1971).

3. Principal UNESCO Publications Used

The primary source of R&D statistics for all non-OECD--that is, Communist and Third World--countries was the "Science and Technology" section of the UNESCO Statistical Yearbook 1971, published in 1972 in Paris by the United Nations Educational, Scientific, and Cultural Organization. UNESCO established a Division of Science Statistics in 1965 and began to publish statistics on R&D after its first survey, which covered the year 1967. (The definitions used by UNESCO were largely based on those of the OECD.) A second UNESCO survey was conducted during 1970, and the results were supplemented by material from the earlier survey and from questionnaires that had been sent to different groups of countries, for various specific purposes, between 1966 and 1968. With each succeeding year after 1967, UNESCO coverage of R&D statistics has become more comprehensive and has also usually incorporated the information of previous volumes to provide longer time series.

In a few instances, the UNESCO series of publications on "National Science Policy and Organization of Scientific Research in Various Countries" were consulted, but usually the statistical information contained in these volumes was also incorporated in the Statistical Yearbook.

B. DATA LIMITATIONS

1. The Question of Productivity

The purpose of the Department of State in funding this project was to obtain data that presumably "would provide the statistical underpinning for making assessments ... of foreign scientific capabilities." It is, however, advisable to bear in mind the extent to which these statistics, as they currently exist, actually reflect the absolute and relative strengths and weaknesses of the R&D efforts mounted by foreign countries.

Ideally, the scientific capabilities of a nation should be assessed in terms both of the resources devoted to research and development and the utility of the "products" generated by that activity. To borrow the language of the National Science Board of the US National Science Foundation, these two approaches to the measurement of scientific capabilities involve the development of "intrinsic" and "extrinsic" indices.⁷ The former include both the financial resources devoted to science--an index that probably constitutes the most concrete expression of a nation's science policy--and the human resources mobilized for R&D, a variable more difficult to measure. This paper provides some information on the quantitative aspects of scientific and technological manpower but none on the quality of this resource. There is also a third "intrinsic index" identified by the National Science Board: "the condition of the institutions involved in training, research, and technical innovations"--and, it could be added, the institutions involved in monitoring the nation's scientific activities and shaping its national science policy. There are obviously many more problems associated with measuring the strengths and weaknesses of R&D institutions than there are in measuring such inputs as money and manpower, which are at least partially amenable to

7. The following discussion is based in part on National Science Board, National Science Foundation, Science Indicators, 1972: Report of the National Science Board, 1973 (Washington, D.C.: US Government Printing Office, 1973), p. vii.

quantitative analysis. An exploration of this subject was outside the scope of this paper. Nevertheless, the nature and effectiveness of a nation's R&D institutions clearly have a considerable impact on its scientific activities. It follows that this variable would have to be explored in any comprehensive assessment of foreign scientific capabilities.

Still more difficult to grapple with are the "extrinsic indices," which measure the productivity of a nation's R&D effort. These indices

center around the application of scientific knowledge, and the technology it fosters, to the achievement of national goals ... and the consequent impact on that elusive entity, "the quality of life."⁸

How, indeed, is one to assess the utility of the ideas and products that emerge from research and development? To begin with, large investments of money and manpower in research and development may conceivably yield little in the way of discernible returns--or returns so small as not to justify the investments. There is an additional dilemma inherent in the fact that assessing the utility of a given return is often a very subjective process. Within a country, are the products of defense R&D less valuable than those of health R&D or industrial R&D? Between countries, which has the "stronger" R&D program, that which advances most rapidly in the area of national defense and big science R&D or that which leads the way in economic development R&D? There are, moreover, formidable obstacles to the quantification of these variables. And even if it was possible to gather data that would provide a fairly realistic picture of what was being accomplished in certain areas, the statistical profiles of those accomplishments more often than not would be found to be incommensurable.

The National Science Board has begun to develop a few crude indicators of US R&D productivity--output of scientific reports; international trade in patents, licenses, and manufacturing rights; industrial productivity; and trade in technology-intensive products.⁹ As valuable

8. Ibid.

9. Ibid, pp. 2-17.

a contribution as this pioneering effort is, it provides us with a very imperfect representation of the performance--absolute and relative--of a nation's R&D establishment.

This paper touches not at all on these "extrinsic indices," necessarily so in view of the primitive state of the art in this area. Yet it is necessary to be fully aware of the fact that this paper addresses only that portion of the problem of assessing foreign national scientific capabilities that is related to inputs. No attempt is made to determine what returns the nations derived from their respective investments of money and scientific manpower.

2. The Question of Comprehensiveness

The Work Statement for this project directs that it focus on "selected" foreign countries. The resultant selection process was influenced by two determinants, one related to constraints imposed by time, the other arising from the nature of the available data.

The time available for the study necessitated an approach that sacrificed inclusiveness of lesser countries for depth in the more significant ones. The circle of states investigated had to be restricted in order to permit the construction of a reasonably well-rounded profile of the R&D conducted in each subject country.

The nature of the available statistics further reduced the number of states that could be investigated. The easiest way to approach a discussion of this particular problem is in terms of the three categories into which the countries in this study fall: the member states of the OECD, the Communist countries, and the nations of the Third World.

The OECD membership comprises twenty-three full members and two associate members.¹⁰ Of these twenty-five, only twelve are represented

10. OECD member states include Australia, Austria, Belgium, Canada, Denmark, Finland, France, West Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. In addition to the twenty-three full members, Yugoslavia and New Zealand participate as observers and are sometimes referred to as associate members.

in the OECD's study of governmental R&D objectives,¹¹ and from twelve to twenty in the survey of national R&D efforts. All references to "R&D in the OECD area" consequently should be understood to refer to R&D in the member countries responding to the OECD questionnaires. Furthermore, because the set of responding countries often changed from issue to issue, depending on the data available, the statistical basis for generalizations about R&D in the OECD shifted constantly. Fortunately, the five major performers of R&D--the United States, France, West Germany, Japan, and the United Kingdom--appear in all but a small fraction of the statistical series; and four out of the five next-most-important performers--Canada, Italy, the Netherlands, and Sweden--are well represented. Information on the fifth country, Switzerland, is less adequate. The most significant gap in the data is the absence of Australia, which joined the OECD after the major surveys were conducted.

The Communist states pose special problems. It is very difficult to acquire satisfactory data on their R&D activities (especially military R&D) and what data are available are often highly controversial and usually not comparable with data for non-Communist states. No information exists on R&D in the People's Republic of China. In this study we have usually treated only the Soviet Union, Czechoslovakia, and Poland; some limited summary information on the other members of the Warsaw Pact is occasionally included. For the Soviet Union, however, the non-availability of specific data made impossible even some of the statistical breakouts that were feasible for Poland and Czechoslovakia.¹²

11. The twelve countries represented are Belgium, Canada, France, West Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom, and the United States.

12. Soviet R&D (especially military R&D) is of course a specialized and much debated topic. In view of the considerable effort that is already being devoted to study of this area, both within the US government and outside it, and the controversial nature of the findings, it was agreed early between IDA and the Department of State that this project would make no attempt to explore or reconcile the various points of view. We have simply reported without comment the figures available in UNESCO data.

The Third World states are covered only in the UNESCO surveys. While these are invaluable in that they have made possible the coverage of the R&D activities of a much wider group of countries than the OECD membership, the specific data are much spottier. In short, the countries on which we have data are not always the countries we would like to cover, and vice versa. Thus, for example, we have no information at all on South Africa, though there are fairly good data for Mauritius and Madagascar. Unfortunately, we have no expenditure data on Egypt--and very limited manpower data. While we have fairly good expenditure data on Israel, only one year is covered. We have nothing on Indonesia. There are very poor data on virtually all Latin American countries, but the situation is better for the Falkland Islands. And so on. The net result is that, while we can give a general picture in fairly gross terms of R&D in the Third World, the picture is fuzzy and it has blank spots. On the other hand, by far the greatest part of the world's R&D is performed in the OECD and in a few Soviet bloc countries. Our lack of precise knowledge about Third World R&D, therefore, has little real impact on a world-wide summary such as this.

3. The Question of Comparability

a. General. Implicit in the objective of assessing the R&D efforts of foreign countries is the idea that these efforts should be compared, both with one another and presumably with the R&D effort of the United States. This report has been organized, therefore, so as to facilitate interstate comparisons. It is imperative, however, that there be some awareness of the dangers inherent in such an enterprise. The basic problem is that it has proven to be very difficult to assure that consistent standards, definitions, and concepts pertaining to R&D were used in all countries. The question of whether the statistical description of, say, sources of funding for R&D in a given country is really comparable with the ostensibly similar description of R&D in another country arises more frequently within certain sets of states than within others; but even within groupings such as the OECD, where a great deal of effort has been expended on resolving the formidable

problems involved in developing internationally accepted methods of aggregating R&D data, the fundamental problem remains: there is always the possibility that the statistical profile of research and development generated by the national authorities of one country will be assembled in accordance with criteria that are not consistent with those used in other countries.

The greatest discrepancies exist between the set of states that has been the subject of the OECD surveys and the set of states that has reported only to UNESCO. Here the differences in the reliability and comparability of the data are so great that only a few, heavily qualified summary comparisons have been attempted in this paper. For the most part, the statistical data and the associated analyses of research and development in the OECD and non-OECD areas have been segregated into separate chapters. Analysis of a comparative nature is restricted almost entirely to the states which fall within one or the other of these two groupings, each of which presents peculiar data problems of its own.

b. The OECD area. The criteria developed by the OECD as a guide to its member nations in collecting R&D statistics are to be found in the so-called "Frascati Manual," published in its original form in 1963 and revised in 1969.¹³ While an extended treatment here of the

13. See OECD, Directorate for Scientific Affairs, The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development: "Frascati Manual." DAS/SPR/70.40 (September 1970). The discussion in this section draws heavily on this source, particularly pp. 3-21.

A few words on the Frascati Manual itself might be in order. This publication resulted from a meeting of OECD statistical experts in Frascati, Italy, in June 1963, convened as a study conference on the technical problems of measuring R&D. OECD interest in this question dated back to OEEC (Organization for European Economic Cooperation) days. In 1957, the Committee for Applied Research of the European Productivity Agency of the OEEC began to convene meetings of experts from Member countries to discuss methodological problems.

However, most OECD countries, stimulated by the rapid growth in the amounts of national resources devoted to R&D, started to collect statistical data in this field only around 1960. They followed the pioneering efforts of a small number of countries, (continued)

plethora of data problems discussed in this and other OECD sources is obviously impractical, it is probably desirable to give the reader some idea of the difficulties encountered by the OECD statisticians.

Most of these difficulties are associated with questions of definitions and boundaries. The first task is to distinguish research and development themselves from other closely related activities. Although basic and applied research can usually be identified relatively easily, even here there are intractable problems associated with activities that are sometimes intimately intertwined in practice with research, but which should be excluded from a survey of R&D. For example, as the OECD notes, "in institutions of higher education, research and teaching are always very closely linked, as most teachers do both."¹⁴ Again, "institutions ... whose principal activity is R and D sometimes also have secondary, non-R&D activities."¹⁵ In principle, in each instance, the former should be included and the latter excluded. In practice, the two are usually difficult to disentangle. A more important problem, however, is to determine the boundary between experimental development and production or technical services. As the authors of the Frascati Manual remark,

possibly the greatest source of error in measuring R&D lies in the difficulty of locating the cut-off point between experimental development and other technological activities.... Errors at this point are particularly significant because the costs of experimental development are many times higher than the costs of research per se, and the costs of trial production are higher still.¹⁶

including the United States, Japan, Canada, the United Kingdom, the Netherlands, and France. But differences in scope, methods, and concepts made international comparisons difficult and countries encountered theoretical difficulties in their attempts at R&D surveys. When the Directorate for Scientific Affairs of the OECD took over the work of the European Productivity Agency in 1961, the need was widely felt for some attempt at standardization of the kind undertaken for economic statistics. The Frascati Conference, convened to study a draft document prepared by a consultant, Mr. C. Freeman, was the result.

14. Ibid, p. 15.

15. Ibid, p. 17.

16. Ibid, p. 18.

The construction of prototypes and pilot plants is an example of the kind of borderline activity that often shades over time by insensible degrees from experimental development into commercial application. There is obviously a very real possibility that different national authorities may use differing subjective criteria to resolve the judgmental problems inherent in affixing cutoff points to what is often in reality an uninterrupted process. To the extent that this does in fact occur, the reliability of cross-national comparisons is affected.

At the very beginning, therefore, one encounters serious basic difficulties in defining research and development. Once one proceeds to the next task, that of defining and setting the boundaries of categories within the field of R&D, new problems emerge. Because there is something approaching an infinite regress to these problems, only two general examples will be mentioned here: those associated with boundaries between types of R&D activities and those associated with inter-sectoral transfers of funds.

In accordance with accepted international practice, the OECD distinguishes three categories of R&D: basic research, applied research, and experimental development. After several pages devoted to an explanation of these terms, the authors of the Frascati Manual make the following observation:

The three categories of R and D may sometimes be carried out in the same centre by substantially the same staff. In real life, R and D activities do not necessarily fall into the three successive and distinct categories defined above. For survey purposes, artificial divisions may have to be made in what is more or less a continuous process and the appropriate allocation of a given R&D activity to one of the categories may be neither natural nor obvious.¹⁷

It is not to deprecate the labors of the OECD statisticians or the national authorities that report to them to note that the data they have compiled on types of R&D activity probably constitute a very

17. Ibid, p. 11.

imperfect approximation of reality. Yet this is only one among a host of analogous boundary problems.

As for inter-sectoral transfers of funds, much depends on the initial decisions as to which sector is actually the source of R&D expenditures. One question of no small importance in terms of the magnitude of its impact on the data concerns the flow of financial resources from the Government sector to the Higher Education sector. In some statistical series, funds supplied by the Ministry of Education to the Higher Education sector are considered as that sector's own funds. The result is that the Government sector appears to be the source of less monetary support for R&D, the Higher Education sector appears to supply more, and the inter-sectoral transfer seems to be smaller than would be the case if the series reflected what is actually taking place.¹⁸ When some OECD nations aggregate their statistics on transfers of funds between sectors in accordance with the practice outlined above, while others do not, intra-OECD comparisons may very well lead to erroneous generalizations about how certain states and groups of states allocate their funds.

Perhaps enough has been said to alert the reader to the need to maintain at all times a critical attitude toward what may appear to be, but clearly are not, "hard" data. But if it is best to approach OECD materials with caution and some skepticism, it is also necessary to be reconciled to what is and is not possible. The data gathered by this Organization have been assembled in accordance with the most sophisticated methodology used today in international surveys of research and development. The data are the best available and, considering what is feasible at present and the nature of the activity under investigation, they are reasonably accurate and can be used for comparative purposes--especially in gross terms.

c. The UNESCO Area. The problems of the OECD in regard to definitions and boundaries of R&D categories exist and are compounded in the UNESCO data. The most obvious additional difficulty is the wide range of political and economic systems in the countries covered by

18. For an extended discussion of this particular problem, see Table D-4, note c.

UNESCO--including not only all the OECD countries, but also Communist-governed, industrialized states (such as the Soviet Union or Czechoslovakia), and relatively unsophisticated economies and political systems such as, say, Chad or Ghana. To mention only one example of the kinds of problems stemming from this factor, some new "sector" definition was clearly required to supplant the OECD's Private Enterprise category in order to encompass "productive enterprise" (UNESCO's new category) in Communist and capitalist states.

It is worth quoting here at some length from UNESCO's introduction to its "Science and Technology" section in the Statistical Yearbook 1971, in order to make clearer some of the comparability problems involved in the UNESCO data:

Effectively, the data were collected in several stages utilizing questionnaires which differed somewhat from one another. Most of the data were obtained from replies to the second in a series of annual surveys of manpower and expenditure for research and experimental development sent to the Member States of Unesco during 1970. This material has been completed or supplemented by data collected in the first annual survey and in earlier questionnaires sent to different groups of countries for various specific purposes, between 1966 and 1968.

In utilizing these results the reader should keep in mind the factors which have an obvious bearing on the comparability and the degree of accuracy of the data. Science statistics have not reached the same stage of development in all countries. Whereas some countries have established systems of science data collection by means of regular surveys, others are just beginning to initiate systematic and comprehensive inquiries into their R&D activities and, of course, there are others which have yet to begin such an effort. Additionally, national statistical practices and concepts are not necessarily designed for the specific requirements of international comparisons. Consequently, most countries had to re-arrange their existing national data and often prepare estimates for the specific purposes of the Unesco inquiries. Very few countries were able to organize ad hoc surveys whose classifications and definitions conformed with those proposed in the Unesco questionnaire....

... an important example of inconsistency is the subject coverage, where some countries included R&D in the social sciences and others omitted this significant segment of R&D, whilst for many European countries as

well as countries of other continents the coverage includes not only humanities, in some cases inseparable from social sciences, but other fields such as fine arts, pedagogy and law.

The absolute figures for R&D expenditure should not be compared country by country....

In many instances exceptions are indicated by footnotes. However, the absence of footnotes does not necessarily imply that the figures given agree with the established definitions....¹⁹ (Emphasis added.)

It could be added that the UNESCO footnotes make it clear that all countries did not report fully the R&D activities within their borders. Some countries failed to report private enterprise or higher education; others did not report military R&D expenditures; and others reported for only one or more specific entities (for example, Chad reported for only two specific research institutes; Iraq for only the Council of Scientific Research; and Pakistan for only the Pakistan Atomic Energy Commission and the Pakistan Council of Scientific and Industrial Research).

The dangers in making international comparisons using these data should be very clear, even aside from UNESCO's own insistence that such comparisons should not be made. In this paper we have nevertheless used the UNESCO data to make comparisons between different countries. It is our belief that if the reader is made fully aware of the qualifications involved, as we have attempted to do, he will not draw specific conclusions from these comparisons but will still be assisted in the making of useful general inferences.

Perhaps a word should be said here in defense of the UNESCO data, since the above picture appears to have been painted so blackly. The task undertaken by the UNESCO Division of Science Statistics in assembling worldwide R&D statistics was truly a staggering one, and their accomplishments so far constitute a considerable tribute to their technical skill and persistence. Each year the UNESCO R&D data become more comprehensive and reliable. In the meanwhile, UNESCO is the only international organization attempting to stimulate on a

19. UNESCO, Statistical Yearbook 1971 (Paris, 1972), p. 576-77.

worldwide basis more precise studies of national science policies and national R&D statistics.

4. The Question of Exchange Rates and Deflators

Still another problem complicating the effort to create a reliable statistical basis for cross-national comparisons of expenditures on R&D is that the figures provided by the national authorities to the OECD or UNESCO are denominated in local currency units, units which must be converted into one common unit before international comparisons can be made. Where a unit has been chosen it is the US dollar, and the conversion factor is usually the official rate of exchange between the local and the US currency. This procedure has the advantage of being relatively simple and is the one most often used in making other international comparisons (including the OECD surveys), but it carries with it the danger of seriously distorting the relative levels of support for research and development in the countries being compared. For one thing, the official rates of exchange may reflect very imperfectly the rates that prevail in the open money markets or that would prevail if national authorities did not intervene to support their currencies. Moreover, as indicators of the domestic price structures of countries, the official exchange rates are not refined tools of analysis. The currency realignments of the early 1970s suggest that the cross-national comparisons that are made in this paper based on information published by the OECD in the form of US dollars probably misrepresent the positions of the North American countries, the European countries, and Japan relative to one another. For example, in view of the revaluation of the Japanese yen against the US dollar, it seems very likely that the magnitude of the Japanese R&D effort relative to that of the United States has been seriously understated, at least for the surveys taken in the late 1960s.²⁰ One can also anticipate that future R&D surveys

20. The fact that a comparatively large number of scientists and engineers has been mobilized for research and development in Japan points in the same direction. For a thorough analysis of the manpower issue, see Chapter VI.

of the early 1970s will show a meteoric increase in Japanese expenditures on research and development in terms of US dollars, an increase that will probably be substantial but will certainly be far more moderate when measured in terms of Japanese yen. Thus, the process of converting R&D data into US dollars at official rates of exchange creates distortions even as it facilitates the task of making international comparisons.

These distortions, already a serious problem within the OECD area, are of a much greater magnitude when one attempts to use this procedure in making comparisons between OECD states, Communist states, and Third World states, for the latter two sets of countries frequently maintain completely unrealistic official rates of exchange between their currency and the US dollar. It is probably for this reason that UNESCO has chosen to present its R&D statistics in the national currencies of the responding states. Since, for purposes of international comparison within this paper, we still needed to convert those currencies into US dollars, we resorted to the exchange rates developed by the International Institute of Strategic Studies (London) when we felt the official rates were unrealistic.²¹

What would be needed to avoid these difficulties is a special "research exchange rate" that would accurately reflect the relative costs of labor, materials, equipment, and buildings used in research and development in the countries being surveyed. It is because this information is simply not available that the statisticians have had recourse to the currency exchange rates.²²

It remains to mention the question of inflation. Most information on R&D expenditures is published in current prices, the main exception

21. Official exchange rates were felt to be unrealistic in the case of the Communist countries, and here we have substituted the rates appearing in the annual issues of The Military Balance, published by the International Institute for Strategic Studies, London. See the "Series J" appendix for a complete listing of exchange rates used in this study.

22. See the OECD Frascati Manual, pp. 62-3, and particularly Appendix II, Pioneering Efforts in Calculating Research Exchange Rates, pp. 66-70.

being the OECD's work in the area of governmental objectives. It is hardly necessary to add that the consequence is a systematic exaggeration of the growth in real R&D expenditures over time. Due to constraints imposed by time and resources, this distorting factor could not be removed from most of the data drawn from the OECD and UNESCO sources. Where it was removed--for gross expenditures on R&D in OECD member countries--it was necessary to choose a deflator. Ideally, it would have been desirable to have an "R&D deflator"; but as was the case with the "R&D exchange rate," generally accepted standards were not to be found. In their absence we decided to use a GNP price deflator, as the OECD did in preparing its study of government expenditures on R&D by objectives. This corrected to some extent for the effects of inflation but probably still misrepresented the actual trend of expenditures on R&D.

5. Conclusion

While the cumulative effect of the above data problems and limitations must be to distort seriously our picture of the R&D activities being monitored, these problems differ only in degree from any other statistical enterprise. Specifically, they should engender caution in attempting to make fine-grained comparisons between countries or activities. The greatest value of the following data is probably to be found in their utility as guides to general relationships, broad trends, and orders of magnitude in the allocation of financial and manpower resources for research and development. If viewed in this light, the OECD and UNESCO statistics analyzed in this paper should be of considerable usefulness to those interested in R&D and science policy.

PART ONE

ANALYSIS OF TRENDS IN R&D RESOURCE ALLOCATIONS

III

ALLOCATION OF FINANCIAL RESOURCES TO RESEARCH AND DEVELOPMENT BY OECD MEMBER NATIONS

A. GROSS EXPENDITURES ON RESEARCH AND DEVELOPMENT (GERD)

1. Trends in R&D Expenditures in the OECD Area as a Whole

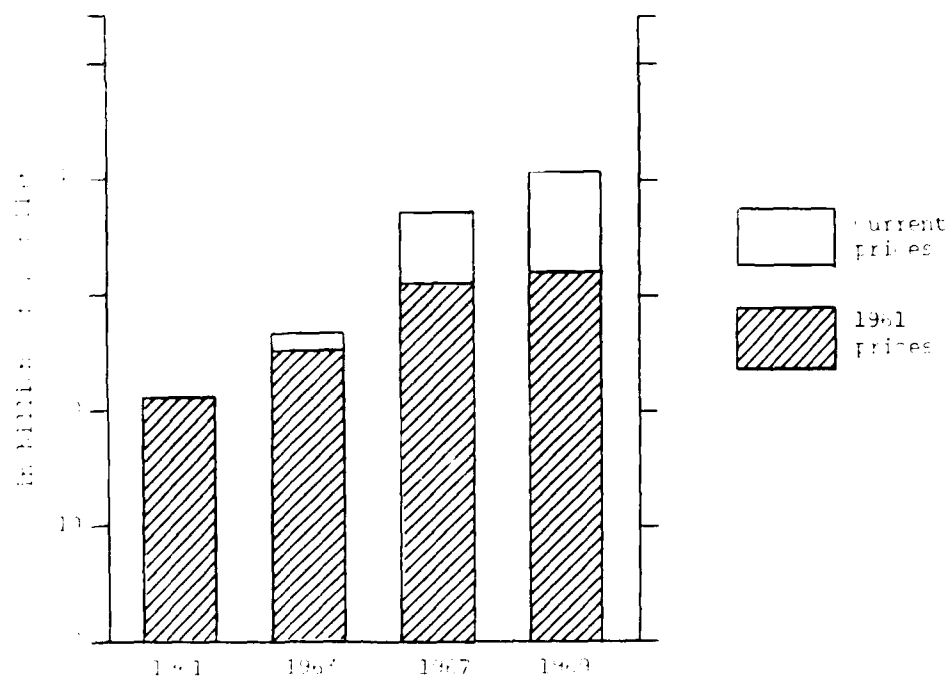
During the eight years between 1961 and 1969, R&D spending in OECD countries doubled from \$21.1 to \$40.8 billion.¹ Much of this increase was, however, more apparent than real. If one discounts the effects of inflation, GERD for the area grew by a little more than one-half as much, from \$21.1 to \$32.2 billion.² The widening gap between the expenditure figures when expressed in current and in fixed prices can be seen in Figure 1, which also shows that spending on R&D in the OECD area in US dollars of constant value was tending to level off in the closing years of the decade. This slackening in the rate of real growth in R&D expenditures is one of the most significant trends to emerge from the data.

2. Major Differences Among OECD Member Nations in Levels of Funding for R&D: The Situation in 1969

The range in the amount of financial support provided for research and development by the member states of the OECD is very great. The twenty countries that responded to the Organization's survey fall naturally into three groups: (1) the United States; (2) France, West Germany, Japan, and the United Kingdom (the so-called "Big Four");

1. See Table A-1. All tables carrying a letter and number designation will be found in Part Two. The exchange rates used in preparing the data for this study are discussed in the Series J appendix, which begins on page 317.

2. Table A-2. The procedure by which the figures on R&D expenditures shown in Table A-1 in current prices were adjusted to account for the effects of inflation is discussed at length in the note on sources appended to Table A-2.



Source: Table A-1.

Figure 1. TOTAL OECD EXPENDITURES ON R&D DURING THE 1960s IN CURRENT AND 1961 PRICES

and (3) all other OECD member nations.³ The United States, as has already been mentioned, is in a class by itself. In 1969 it accounted for no less than 65.2 percent of all R&D expenditures in the OECD area.⁴ The Big Four conducted most of the rest: 25.4 percent in 1969. Collectively, the fifteen remaining OECD respondents supplied only a little more than 9 percent of the regional total. Because the first five countries clearly overshadow the other fifteen, developments in the former will be highlighted in this chapter. These countries will be referred to as the "Major States."

3. The response to the OECD request for data on gross expenditures was very good. Only five countries did not respond: Australia, Iceland, Luxembourg, and the two associate members, Yugoslavia and New Zealand. These five never appear in the more refined breakdowns of GERD. A varying number of other states is also missing from these tabulations.

4. Table A-3.

Table 1

NATIONAL GERD AS A PERCENTAGE OF TOTAL R&D EXPENDITURES
IN THE OECD IN 1969^a

>60	5-7	1-3	0.5-1	0.2-0.5	<0.2
UNITED STATES 65.0	FRANCE 6.6 WEST GERMANY 6.5 JAPAN 6.4 UNITED KINGDOM 6.0				
		Canada 2.4 Italy 1.7 Netherlands 1.4	Switzerland 0.96 Sweden 0.90 Belgium 0.64	Denmark 0.36 Norway 0.24 Austria 0.21	Spain 0.16 Finland 0.16 Turkey 0.12 Ireland 0.05 Greece 0.04 Portugal 0.03

a. Or nearest year available.

Source: Table A-3.

Table 1 provides a more detailed breakdown of the percentage distribution of gross expenditures within the OECD in 1969, the year of the last major R&D survey undertaken by that organization.⁵ It will be seen that the share of the United States was roughly ten times as large as that of any one of the Big Four, all of which fell within a fairly narrow range of from 6.0 to 6.6 percent of the area total. Each of these four, in turn, accounted for a share that was at least two-and-one-half times as large as that of Canada, the next most important performer of R&D. That state and two others (Italy and the Netherlands) were the only ones with shares larger than 1 percent.

The distribution of states according to their shares of total R&D expenditures in the OECD area is a reflection of, and is of course

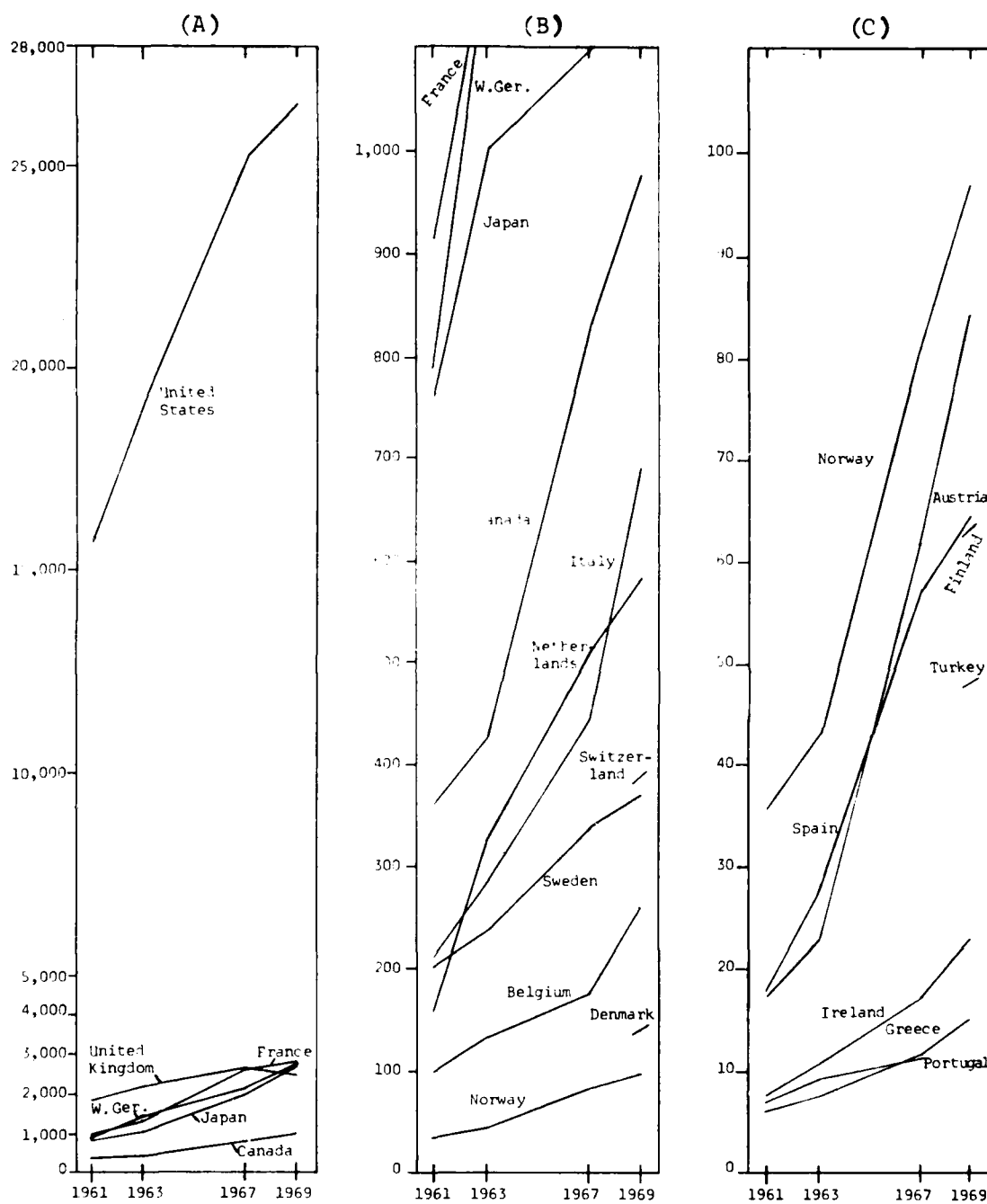
5. Table 1 is the first of the stratified cluster tables to appear in this chapter. Here, and in all other such tables, the responding member states are grouped according to two criteria. First, the five Major States are isolated in the upper part of the table; all others are located in the lower part. Second, the entire group of states is distributed among a number of "cells" defined in terms of ranges of values of the variable under investigation.

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duplicated by, the distribution of states according to the absolute sums of money allocated to R&D. Once again, the range is great, so great that it was necessary to resort to an unusual expedient in constructing the display of national expenditures that appears in Figure 2. The scale on Chart A of Figure 2 runs from zero to \$28 billion (in current prices). The United States soars high above the Big Four, which cluster close together at the bottom. Some distance below them is Canada. And below Canada are crowded the remaining fourteen OECD member states. To show the relative position of these countries, two other charts had to be added. That part of Chart A which falls between zero and one billion dollars was expanded to make Chart B. Here, although there is no gulf analagous to that which separates the United States from the Big Four in the first chart, Canada is shown to be funding approximately ten times as much R&D as Norway, the state at the bottom. Chart C, similarly, is an expanded version of that part of Chart B which falls between zero and \$100 million. In this chart, Norway ranks first and is shown to be funding roughly ten times as much R&D as Portugal, the state which ranks last.

The impression one obtains from Figure 2 of tremendous variations in the level of support for research and development among the OECD nations emerges with greater clarity when one examines the actual figures. These are supplied for 1969 in current US dollars in the upper portion of Table 2. Some \$26.6 billion was expended in the United States; from \$2.4 to \$2.7 billion in each of the Big Four. No other country generated as much as \$1 billion for purposes of research and development. The remaining states cluster together in much the same fashion as they did in Table 1.

In the earlier discussion of trends in expenditures for the OECD area as a whole, a contrast was drawn between the large apparent increase in funding in terms of current US dollars and the more modest real increase in terms of 1961 US dollars. Table 2 has been constructed so as to facilitate the making of a similar contrast for the individual member states of the Organization. For each country there



Source: Table A-1.

Figure 2. GROSS EXPENDITURES ON R&D BY OECD MEMBER NATIONS IN THE 1960s
(in millions of current US dollars)

Table 2

GROSS EXPENDITURES ON R&D IN 1969^a

> 10,000	3,000-3,000	500-2,000	100-500	50-100	< 50
(in millions of current US dollars)					
UNITED STATES 26,000	FRANCE 3,680 WEST GERMANY 3,650 JAPAN 3,500 UNITED KINGDOM 2,440	Canada 980 Italy 690 Netherlands 590	Switzerland 390 Sweden 370 Belgium 260 Denmark 150	Norway 97 Austria 85 Spain 65 Finland 63	Turkey 48 Ireland 22 Greece 15 Portugal 11
(in millions of 1961 US dollars)					
UNITED STATES 21,700	WEST GERMANY 3,120 FRANCE 1,920 UNITED KINGDOM 1,910 JAPAN 1,830 Canada 760				
			Italy 490 Netherlands 390 Switzerland 280 Sweden 270 Belgium 200	Denmark 91 Norway 72 Austria 65	Finland 48 Spain 40 Ireland 15 Greece 12 Portugal 9

a. Or nearest year available.

Source: Tables A-1 and A-2.

is of course a decrease in the level of support, by far the most dramatic being the almost \$5 billion drop in US funding from \$26.6 to \$21.7 billion. The United States, in other words, accounted for more than one-half of the \$8.6 billion drop in total OECD expenditures that occurs when the 1969 figures on GERD for the OECD area as a whole are adjusted to remove the effects of inflation. As one might expect, this decrease has caused a number of countries to fall into a lower funding category. Among the Major States, for example, France, the United Kingdom, and Japan move down one category. In spite of considerable differences in the rates of inflation, the rank order of the responding countries changed very little when the effects of inflation were neutralized. West Germany supplanted France as the leading performer of R&D among the Big Four, and Japan fell below the United Kingdom, but the four leading states were still clustered very close together.

A review of the data just presented on GERD strongly suggests that there is a relationship between the level of a nation's expenditures on R&D and the size and stage of development of its economy. All of the Major States are large, wealthy, highly industrialized countries. The others are either large but less developed (Italy), developed but medium sized (Canada) or small (the Netherlands, Switzerland, Sweden, Belgium, Denmark, Norway, Austria, and Finland), or small and underdeveloped (Ireland, Turkey, Spain, Greece, and Portugal). The small developed states (Switzerland, Belgium, the Netherlands, and the Nordic countries) tend to spend more on R&D than the small underdeveloped states.

One last remark remains to be made before closing this section on major differences in levels of support for R&D. The absolute amounts of resources available for research and development in each country are spread across such a wide range that, in subsequent sections of this chapter that deal with the analytical categories into which GERD is broken down, the same clusters of states will be found to recur over and over again. In most cases, US expenditures are far higher than those of any other state, and the Big Four occupy the

places from second through fifth in the rank order. Among the other fifteen countries, the same six tend to slide toward the bottom reaches of the scale,⁶ and the same nine tend to be located in its middle ranges.⁷ In its general outlines, the pattern described in this opening section will be encountered repeatedly in the following pages of this chapter.

3. Expenditures on R&D Compared with National Wealth

States may be ranked not only in terms of the absolute sums they devote to research and development but also in terms of their relative R&D intensity as reflected in the share of their gross national product (GNP) that is allocated to R&D. As Table 3 shows, the range

Table 3

GERD AS A PERCENTAGE OF GNP AT MARKET PRICES IN 1969^a

>2.0		1.5-1.9		1.0-1.4		0.5-0.9		<0.5	
UNITED STATES	2.8	FRANCE	1.9						
UNITED KINGDOM	2.4	WEST GERMANY	1.7						
		JAPAN	1.5						
Netherlands	2.1			Canada	1.4	Denmark	0.9	Turkey	0.4
Switzerland	2.1			Sweden	1.3	Italy	0.8	Spain	0.2
				Belgium	1.1	Austria	0.7	Greece	0.2
				Norway	1.0	Finland	0.7	Portugal	0.2
						Ireland	0.6		

a. Or nearest year available.

Source: Table A-4

6. Spain, Finland, Turkey, Ireland, Greece, and Portugal. Not all of these responded to every part of the OECD questionnaire.

7. Canada, Italy, the Netherlands, Switzerland, Sweden, Belgium, Denmark, Norway, and Austria.

is very narrow compared with the range in expenditures: from a low of 0.2 percent for Portugal to a high of 2.8 percent for the United States.⁸ In general, it appears that, relatively as well as absolutely, the Major States devote more of their resources to R&D than do the smaller, less developed countries. Of the seven countries that allocate more than 1.5 percent of their GNP to research and development, five are Major States.⁹ The six countries that rank last are the same six countries that rank last in expenditure. Within the group of nine countries that occupy the middle range in the distribution of GERD, Switzerland and the Netherlands move into the highest category of R&D intensity, where they rank just below the United Kingdom and the United States. Otherwise the rank order remains much the same.

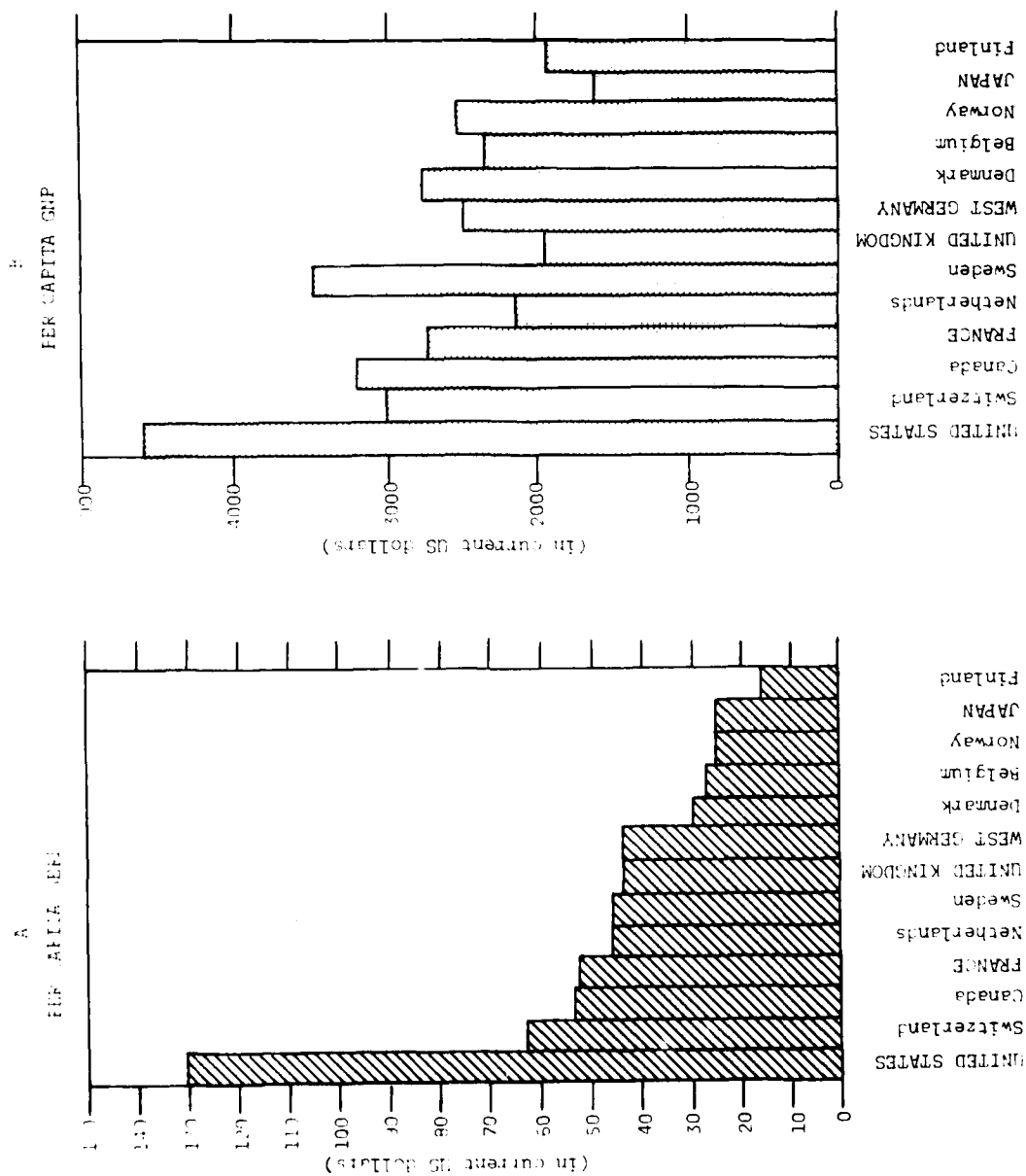
It would appear, therefore, that there is a definite positive correlation between the size of a country's GNP and the portion of national wealth the country is prepared to channel into research and development. When one turns to a second indicator of the degree of R&D intensity--the relationship between per capita GNP and per capita GERD--the correlation is not as easy to establish.

As Figure 3 reveals, there is a much greater divergence among countries in terms of their per capita expenditures on research and development than there is in terms of their per capita GNP.¹⁰ On a per capita basis, the United States in 1969 spent \$131 on R&D, twice as much as did Switzerland, the state which ranked second with \$63.

8. Whereas the percentage of GNP devoted to R&D in the United States is fourteen times as large as the comparable percentage for Portugal, US funding of R&D is 2400 times as large as that of Portugal.

9. Note that--with the exception of the United Kingdom, which moves from fifth to second place--the five Major States are ranked in the same order they were in the upper portion of Table 2, which showed GERD in current US dollars.

10. Only thirteen countries are included in Figure 3. For data on an additional six states, all of which rank below Finland in terms of both per capita GERD and per capita GNP, see Tables A-5 and A-6.



Source: Tables A-5 and A-6.

Figure 3. PER CAPITA GERD AND GNP IN 1969

And Switzerland's per capita expenditures were more than four times as large as the \$14 devoted to R&D by Finland, the state which ranked last. Yet the per capita GNP of the United States was less than two-and-one-half times that of Finland. This divergence in per capita capabilities and per capita commitment to R&D raises questions as to why countries like the United States and the United Kingdom support a disproportionately heavy burden of expenditures on research and development and why other states fund R&D at a lower level than their per capita resources would permit.

This is not to say that there is no relationship between per capita national wealth and per capita spending on R&D, only that the relationship is somewhat imprecise. With the notable exception of the Major States, which are ranked in the same order according to both criteria, it is only possible to order the member countries of the OECD by broad groupings. Sweden, Canada, and Switzerland cluster near the top in terms of both per capita GNP and per capita GERD. Denmark, Norway, and Belgium come next, followed by Finland, Austria, Italy, and Ireland, and then Greece, Spain, and Turkey. The fact that this order, rough as it is, does exist suggests that R&D may be regarded as a luxury, that per capita support for this activity will therefore tend to rise only as per capita income increases, and that once per capita income does begin to rise, spending on R&D may rise even faster.

4. Trends in R&D Expenditures in OECD Member Nations

During the 1960s, as can be seen from Figure 2, R&D expenditures increased in all responding member states of the OECD. This holds true even when the figures are adjusted to remove the effects of inflation.¹¹

Between 1961 and 1969, US expenditures grew by 70 percent from \$15.7 billion to \$26.6 billion. Calculated in 1961 dollars, however, the increase was less impressive: 38 percent to \$21.7 billion.

11. Compare Tables A-1 and A-2.

The most important point to be made here is that US spending on R&D grew at a much more rapid rate in the early 1960s than it did toward the latter part of the decade. Table 4 shows that, in the four years between 1961 and 1965, the average annual rate of increase in R&D

Table 4

COMPARATIVE GROWTH OF GERD AND GNP IN SELECTED MEMBER COUNTRIES
(average annual rate, at 1961 prices)

Country ^a	1961 to 1965		1965 to 1969		1961 to 1969	
	GNP	GERD	GNP	GERD	GNP	GERD
FRANCE	6.0	16.9	8.1	6.7	5.5	12.4
JAPAN	8.4	10.9	10.1	12.4	9.6	11.9
WEST GERMANY	4.9	16.2	1.3	7.6	2.8	11.3
Canada	6.3	12.1	8.1	7.5	7.2	9.7
UNITED STATES	5.5	7.6	4.2	1.5	4.9	4.5
UNITED KINGDOM	3.6	2.5	2.3	3.0	2.8	2.7

a. Ranked in the order of rate of growth of GERD between 1961 and 1969.

Source: OECD, R&D Trends and Objectives, Appendix, p. 6.

expenditures was 7.6 percent, considerably higher than the rate of increase in GNP.¹² The comparable figure for the four years between 1965 and 1969 was only 1.5 percent, considerably lower than the GNP growth rate and far below that of most of the other Major States.

Nevertheless, in 1969, as in 1961, the United States towered above all other countries in terms of the financial support given to research and development. In 1961, US GERD was 8.5 times that of the second-ranking state (the United Kingdom). In 1969 the GERD of the second-ranking state (West Germany) was about one-tenth that of the United States. But the relative position of the United States had deteriorated. Whereas in 1961 the ratio of US expenditures to the collective expenditures of the Big Four was 3.6:1, by 1969 the ratio had declined to 2.6:1. As a consequence of this trend, the US

12. Note that these rates are calculated at 1961 prices.

share of OECD GERD contracted from three-fourths to two-thirds of the total.

Over the eight years under review, the most significant change in the relative position of the Big Four was that, while they began with the United Kingdom clearly far in the lead and the other three states clustered together some distance below, they ended with all four grouped closely together (see Figure 2).¹³ In 1961 the GERD of the United Kingdom was \$1.8 billion, at least twice as large as that of France, West Germany, or Japan, whose respective GERDs ranged from \$765 to \$915 million. In 1969, in contrast, the R&D expenditures of the Big Four all fell within a range of from \$2.4 to \$2.7 billion.

The average annual rate of growth in GERD in the United Kingdom was much lower than that of the other three. Referring again to Table 4, we see that the rate for the period from 1961 to 1969 (calculated in 1961 prices) was 2.7 percent, less than one-fourth that of West Germany, Japan, or France, whose respective rates were 11.3, 11.9, and 12.4 percent. These rates conceal several important trends affecting the relative positions of these last three states. Between 1961 and 1965, expenditures on R&D in France and West Germany increased at very rapid average rates of more than 16 percent per year; that of Japan was much lower--about 11 percent. In the succeeding time period (from 1965 to 1969), the average annual rates of the former two fell dramatically to 6 or 7 percent, while that of Japan increased to more than 12 percent. If this trend continues, Japanese GERD will soon be much larger than that of any other single member of the Big Four.

Perhaps the most important observation to be made about the eight remaining OECD nations for which a time series is available is that, whatever the differences in their relative growth rates may have been, they were not large enough either to change the order in which these countries were ranked or to close the gap between them and the

13. This generalization is not materially affected when the figures on GERD are recalculated in terms of 1961 US dollars.

Major States. The country that consistently had the sixth largest GERD in the OECD was Canada. In 1961, Canadian expenditures were 47 percent of those of the last among the Big Four. By 1969 they were only 40 percent of those of the United Kingdom, the state that replaced Japan as the lowest ranking Major State. The dominant position of these five countries has not been threatened.

B. SOURCES OF FUNDS

The OECD analyzes gross expenditures on research and development in terms of five institutional categories that function both as sources of funds for R&D and as sectors in which R&D is performed. These five are Government, Business Enterprise, Higher Education, Private Non-profit (PNP), and Abroad.

Business Enterprise and Government together supply more than nine-tenths of the money allocated to research and development. For eighteen out of the nineteen respondents to the 1969 survey, the combined shares of the Higher Education, PNP, and Abroad sectors came to less than nine percent of total expenditures.¹⁴ Accordingly, these last three sources of funds have been excluded from the discussion, and the analysis has been focused on the two dominant sectors. For both of these, the OECD has used three indices to compare the relative position of the responding countries: (a) the absolute level of funding originating in the sector, (b) the share of

14. See Table B-1. The exception is Portugal. For six countries (among which are two Major States) the statistics presented in Table B-1 reflect OECD adjustments of national data. These adjustments in each case entail attributing to the Government rather than to the Higher Education sector funds devoted to R&D by colleges and universities but supplied by the Ministry of Education. That the effect on the respective shares of the two sectors is substantial can be shown by considering the data for France and Japan. In France, the share of Government as a source of funds increases from 50 to 63 percent, while that of Higher Education decreases from 13 percent to virtually zero. In Japan, the Government's share expands from 14 to 27 percent, while the share of the Higher Education sector contracts from 18 to 5 percent. See note d to Table B-1 and Table D-4, note c, for a detailed discussion of this problem.

the sector in total national R&D expenditures, and (c) the share of the sector's expenditures in the gross national product. For the Government sector, a fourth index has been devised: the share of government spending on R&D in total government expenditures.

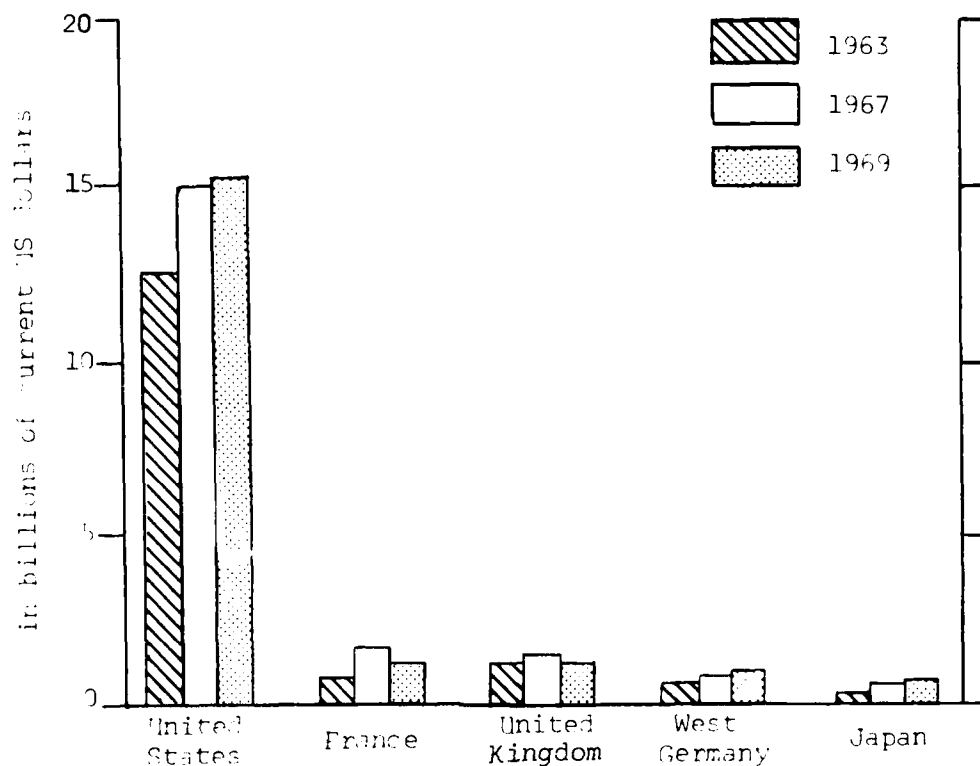
1. Government

a. Expenditures in Absolute Amounts. The level of Government support for research and development in the five Major States during the 1960s is shown in Figure 4 in terms of billions of current US dollars. Here, as in almost all comparisons of expenditures, the United States appears to tower over all other countries. The US government in 1969 spent from nine to twenty-two times as much as the government of any one of the Big Four. As for developments over time, Government spending on R&D rose in all five states between 1963 and 1967 and then, between 1967 and 1969, leveled off in the United States and declined in France and the United Kingdom, the two countries that ranked second and third after the United States in terms of state support for research and development. Only in the two low-ranking states, West Germany and Japan, did the flow of money tend to increase.

The situation in 1969 is revealed in greater detail in Table 5.¹⁵ The United States, with government expenditures of \$15.3 billion, was in a class by itself. France led the Big Four with almost \$1.7 billion. Following some distance behind were the United Kingdom and West Germany, with \$1.2 and \$1.0 billion, respectively. Japan did not even reach the \$1 billion level.

Among the remaining OECD nations, Canada ranked first with governmental expenditures of about \$600 million, not much less than those of Japan. The gap was much greater between Canada and the three states that followed next: Italy, the Netherlands, and Sweden, with governmental expenditures of \$340, \$220, and \$150 million, respectively. The governments of the other nine responding countries all devoted less than \$75 million to research and development.

15. Data for earlier years will be found in Table B-2.



Source: Table B-2.

Figure 4. GOVERNMENT EXPENDITURES ON R&D IN THE 1960s

Table 5

GOVERNMENT EXPENDITURES ON R&D IN 1969^a
(in millions of current US dollars)

High 5,000	Significant 1,000-1,999	Moderate 100-999	Low 20-99	Very Low 0-19
UNITED STATES 1,400	FRANCE 1,690 UNITED KINGDOM 1,030 WEST GERMANY 1,040	JAPAN 630		
		Canada 610 Italy 540 Netherlands 500 Sweden 170	Denmark 70 Norway 50 Belgium 40 Austria 38 Spain 32 Finland 29	Ireland 10 Greece 11 Portugal 8

^a - No more than year available.

Source: Table B-2.

b. Government Expenditures on R&D as a Percentage of GERD.

Several points emerge clearly from the information presented in Figure 5 on the share of Government R&D funding in GERD in the Major States during the 1960s. First, in every case, Government was an important source of support for research and development. Even in Japan, which ranked last among the five, the state provided more than one-fourth of national expenditures in 1969. In the other countries, the share was much larger: one-half in the United Kingdom, almost three-fifths in the United States, and almost two-thirds in France.

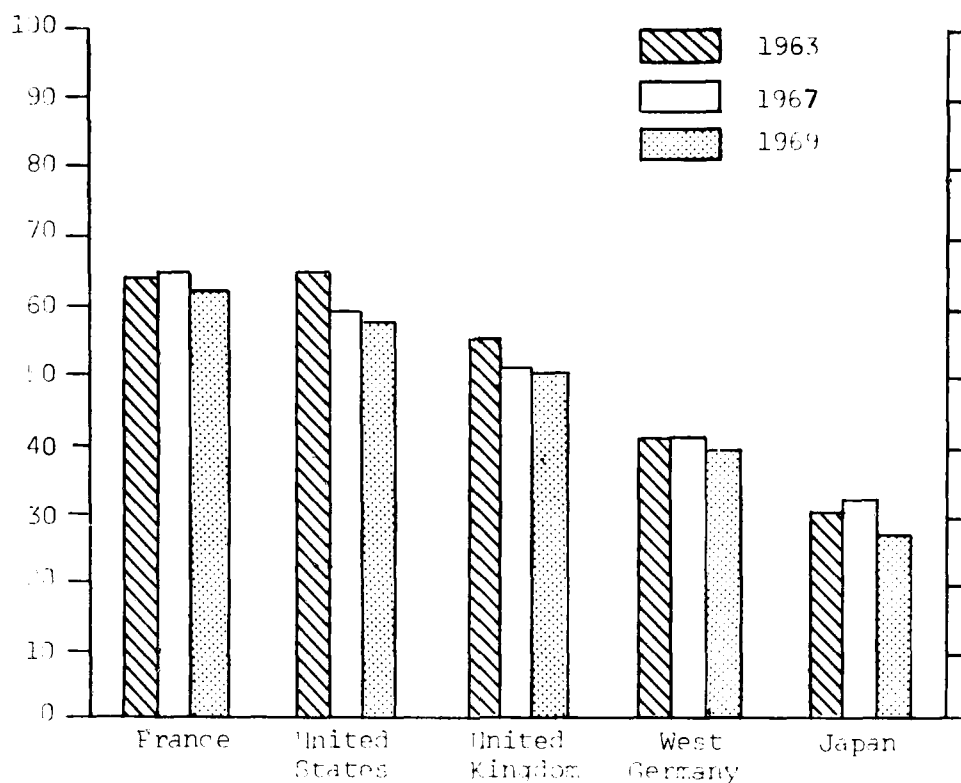
Second, the basic orientation of these states did not change during the 1960s. In 1963, 1967, and 1969, France, the United States, and the United Kingdom relied most heavily on Government backing for R&D, while West Germany and Japan looked to non-Government sources of support.

Third, by way of qualifying the above generalizations, it should be noted that the role of Government as a source of funds seems to be declining in all five of the Major States.

The OECD divides its member nations into two groups according to whether their governments supply more or less than one-half of the nation's financial support for R&D. The former are referred to as "government-funded" countries; the latter, as "private-funded" countries. This distinction is made in Table 6, which displays the ratio of government spending to GERD in 1969.¹⁶ The nineteen responding states are divided into two equal groups: ten government-funded and nine private-funded. The gap between France, the United States, and the United Kingdom on the one hand and West Germany and Japan on the other is more apparent than real. The twelve percentage points that separate West Germany from the United Kingdom also separate the United Kingdom from France and Japan from West Germany. The distribution among the five is, therefore, more in the nature of a continuum than a set of two clusters of states. This is even more true when

16. Data for earlier years will be found in Table B-1.

Percent



Source: Table B-1.

Figure 5. GOVERNMENT SPENDING ON R&D IN THE 1960s
AS A PERCENTAGE OF GERD

Table 6

GOVERNMENT SPENDING ON R&D AS A PERCENTAGE OF GERD IN 1969^a

"Government-funded" countries				"Private-funded" countries			
> 60		50-59		40-49		< 40	
FRANCE	63	UNITED STATES	58			WEST GERMANY	39
		UNITED KINGDOM	51			JAPAN	27
Portugal	72	Norway	58	Italy	48	Netherlands	38
Greece	71	Ireland	55	Finland	46	Belgium	31
Canada	62	Spain	51	Austria	45	Switzerland	21
		Denmark	50	Sweden	40		

a. Or nearest year available.

Source: Table B-1.

the other countries are examined. The range is wider--from 70 percent for Portugal and Greece to 20 percent for Switzerland--and most of the countries do tend to cluster in the mid-range between 40 and 60 percent, but there are no great gaps between the states in terms of government support for R&D as a percentage of GERD.

c. Government Expenditures on R&D as a Percentage of GNP. As the OECD observes, "the simple percentages of GERD reveal the balance between the sources of funds but do not relate government R&D funds to national resources."¹⁷ This requires that GERD as a percentage of GNP by source of funds be calculated. This has been done. The results for the Government sector in 1969 are displayed in Table 7.¹⁸ Unfortunately, data were available for only twelve countries.

Table 7

GOVERNMENT EXPENDITURES ON R&D AS A PERCENTAGE OF GNP IN 1969^a

High	Significant	Moderate	Low	Very Low
>1	0.75-1	0.5-0.75	0.2-0.5	<0.2
UNITED STATES 1.9 UNITED KINGDOM 1.2 FRANCE 1.2		WEST GERMANY 0.7	JAPAN 0.4	
	Canada 0.9 Netherlands 0.8	Norway 0.6 Sweden 0.5	Denmark 0.4 Italy 0.3 Ireland 0.23 Finland 0.22 Austria 0.21	Belgium 0.28 Portugal 0.17 Greece 0.14 Spain 0.10

a. Or nearest year available.

Source: Table B-4.

17. OECD, R&D Trends and Objectives, p. 7.

18. Data for earlier years for the Government and Business Enterprise sectors and a residual "Other" category will be found in Table B-4.

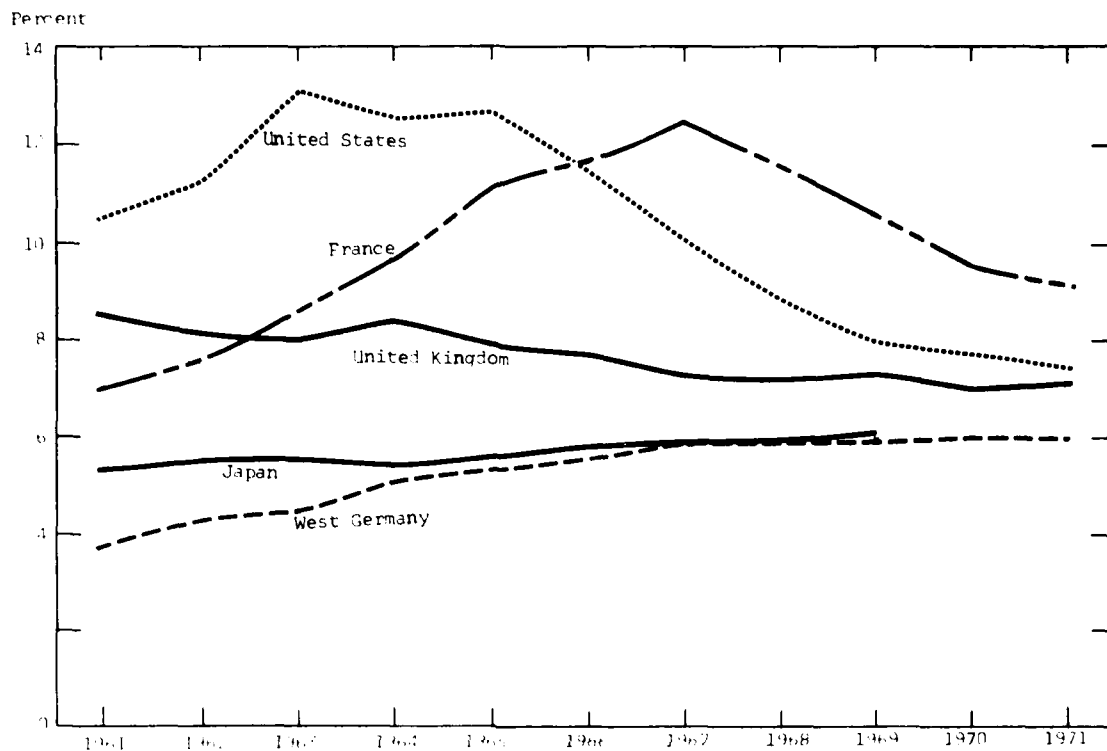
The only states for which the ratio of Government expenditures to GNP was "high" (that is, more than 1 percent) were the United States, the United Kingdom, and France. The other two Major States allocated much less of their current resources to research and development. West Germany fell into the "moderate" category with a ratio of 0.7 percent, while Japan with 0.4 percent devoted a "low" proportion of its gross national product to government-sponsored R&D. The governments of Canada and the Netherlands, with respective ratios of 0.9 and 0.8 percent, placed greater emphasis on R&D than did those of the latter two Major States. One of the more interesting facts to emerge from Table 7, however, is that the ratios for ten out of the eighteen responding countries indicated that R&D consumed a "low" or "very low" share of national resources.

d. Government Expenditures on R&D as a Percentage of Total Government Spending. State support for research and development may be compared not only with a nation's total resources but also with the total resources at the disposal of the government. In this case, the data are unusually rich, and it was possible to construct for twelve OECD member nations a consistent time series from the early 1960s to the early 1970s. The results for the five Major States are displayed in Figure 6.¹⁹

The weight of R&D in total government current expenditures has always been relatively small in Japan and West Germany. It is, however, slowly increasing: from 5.3 percent in 1961 to 6.1 percent in 1969 in Japan, and from 3.7 percent in 1961 to 6.0 percent in 1971 in West Germany.

Of greater interest is the changing relative position of the three countries whose governments have traditionally assigned the highest priority in their allocation of state funds to research and development. In 1961 the United Kingdom ranked second with a ratio of 8.5 percent. By 1971, however, the ratio had declined to 7.1

19. Data for the remaining seven countries will be found in Table B-3.



Source: Table B-3.

Figure 6. GOVERNMENT EXPENDITURES ON R&D IN THE 1960s
AS A PERCENTAGE OF TOTAL GOVERNMENT CURRENT EXPENDITURES

percent, and the United Kingdom had dropped to third place. The United States began the decade with the highest ratio of all: 10.5 percent. This peaked at 13.1 percent in 1963 and then began to contract until by 1971 it had fallen to 7.5 percent, only slightly higher than that of the United Kingdom. The French government, in contrast, assigned an increasing priority to R&D. Starting from 7.0 percent in 1961, it passed the United Kingdom in 1963 with a ratio of 8.3 percent. Three years later, in 1966, it moved past the United States into first place with a ratio of 11.8 percent. It peaked in 1967 with 12.5 percent and then, like the United States, began a steady decline and fell to 9.1 percent in 1971.

One after another, therefore, the three governments that have placed the greatest emphasis on research and development have decided

to assign a decreasing share of their resources on this activity. Only the two governments that have placed least emphasis on R&D have shown evidence of a willingness to devote a larger proportion of their resources to research and development. As a result, the ratios of government funding for R&D to total government expenditures have tended to converge.

The relative positions of the governments of all twelve responding states in 1969 are shown in Table 8. The ratios of the Major

Table 8

GOVERNMENT EXPENDITURES ON R&D AS A PERCENTAGE OF
TOTAL GOVERNMENT CURRENT EXPENDITURES^a

High	Significant	Moderate	Low
> 7	5-7	2-5	< 2
FRANCE 9.1 UNITED STATES 7.5 UNITED KINGDOM 7.1	JAPAN 6.1 WEST GERMANY 6.0		
	Belgium 5.9 Netherlands 5.4	Sweden 4.2 Norway 3.5 Canada 3.4 Italy 3.3	Spain 1.9

a. Figures represent last year for which data are available: 1969, 1970, or 1971.
Source: Table B-3.

States are higher than those of any other countries. Those for France, the United States, and the United Kingdom indicate that a comparatively high priority (that is, more than 7 percent) was assigned to R&D, and those for Japan and West Germany reflect a significant priority (5 to 7 percent) for this activity. Belgium and the Netherlands also fell into the latter category. As for the remaining five countries, their governments all assigned a "moderate" or "low" priority to R&D.

e. Degree of Government Orientation. In Table 9, the four indicators used by the OECD to compare the relative position of the countries responding to its surveys are brought together to show the

Table 9

DEGREE OF GOVERNMENT ORIENTATION IN R&D IN 1969^a

Country ^b	R A N K I N G ^c				
	High	Significant	Moderate	Low	Very Low
Government funded:					
Portugal					\$P
Greece					\$P
FRANCE	P E	\$			
Canada		P	\$E		
UNITED STATES	\$ P E				
Norway			P E	\$	
Ireland				P	\$
UNITED KINGDOM	P E	\$			
Spain				\$E	P
Denmark				\$P	
Private funded:					
Italy			\$E	P	
Finland				\$P	
Austria				\$P	
Sweden			\$P E		
WEST GERMANY		\$E	P		
Netherlands		P E	\$		
Belgium		E		\$	P
JAPAN		E	\$	P	
Switzerland					

a. Or nearest year available.

b. Countries are ranked within categories according to the size of the share of their government's R&D expenditures in GERD in 1969.

c. Symbols used are as follows:

For Government R&D expenditures in dollars: \$

For Government R&D expenditures as a percentage of GNP: P

For Government R&D expenditures as a percentage of total Government expenditures: E

Source: Tables 5 through 8.

"degree of government orientation."²⁰ The countries are listed in the order of the size of the share of GERD supplied by the Government sector as shown in Table 6.

The analysis by the OECD in 1967 of the relative positions of the government-funded countries may be quoted virtually unchanged as an accurate description of the situation in 1969.

The "government funded" Member countries fall into three sub-groups. The first contains the United States, the United Kingdom, and France where governments have large-scale national R&D programmes (notably in the defence, space and nuclear fields) which absorb a relatively "high" percentage of GNP and of all government resources. Governments in the second sub-group of Member countries, namely Canada and Norway, pursued less ambitious R&D policies during the 1960s, absorbing "significant" or "moderate" percentages of GNP and total government resources, but they still spent relatively more on R&D than the third sub-group, Greece, Portugal, and Ireland.²¹

The data show that Spain and Denmark should now be added to this last group.

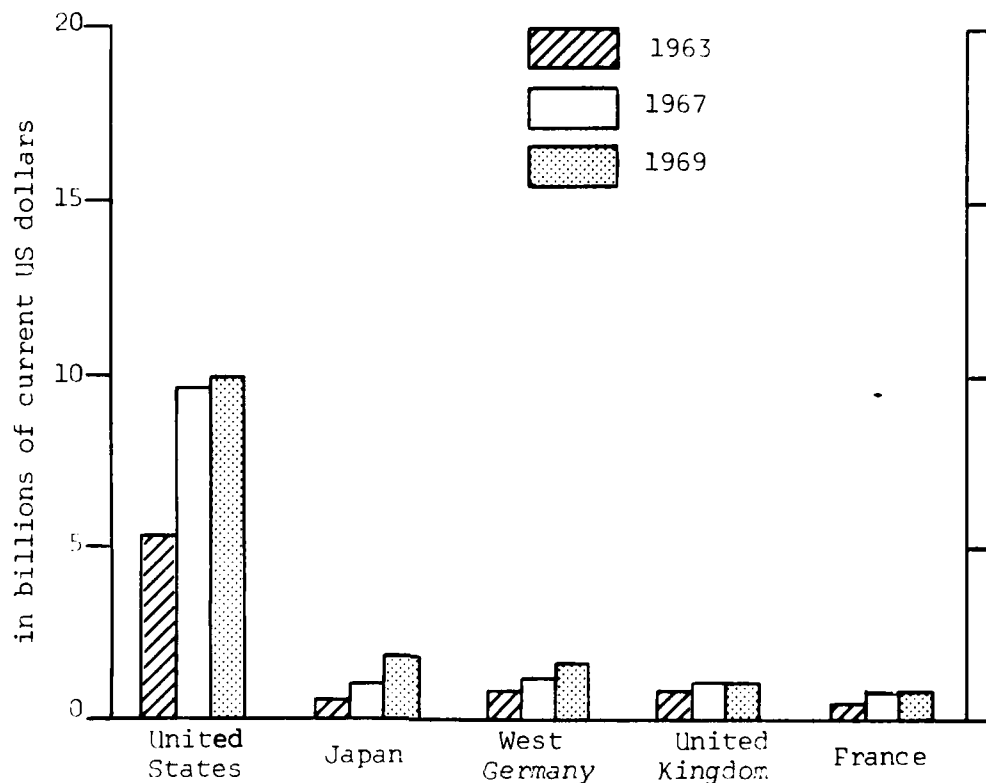
Among the private-funded countries, none ranks high by any criteria. In terms of both absolute sums and percentages of GNP and government spending, West Germany and the Netherlands allocate significant or moderate amounts to research and development. Italy and Sweden follow next in the "moderate"-to-"low" levels of support for R&D by all three criteria. Finland and Austria fall into the "low" category. More difficult to classify are Belgium and Japan, which devote "significant" percentages of government expenditures to R&D, but "moderate" or "low" amounts of money and "low" or "very low" shares of their GNP.

2. Business Enterprise

a. Expenditures in Absolute Amounts. It is useful to compare the image of Business Enterprise support for R&D presented in Figure 7

20. Table 9 and the analysis associated with it were suggested by OECD, R&D Trends and Objectives, p. 8.

21. Ibid.



Source: Table B-2.

Figure 7. BUSINESS ENTERPRISE EXPENDITURES
ON R&D IN THE 1960s

with that for Government presented in Figure 4. In the United States, Business spending on research and development was much higher than in any other country, but the gap was much narrower than in the case of Government spending. Business Enterprise expenditures were six to eleven times as large in the United States as in any one of the Big Four, compared with levels nine to twenty-two times higher for Government expenditures.

The rank order among the Big Four was reversed. Japan came second after the United States and was followed by West Germany, the United Kingdom, and France.

During the 1960s, spending by the Business Enterprise sector rose in the first two states, as did Government expenditures, but

stabilized in the last two, where Government spending declined. Business spending in the United States, like Government spending, leveled off.

The situation in 1969 for all eighteen responding OECD nations is shown in Table 10. By itself, US Business spent \$10 billion, a sum almost 50 percent larger than the combined expenditures of the Business Enterprise sectors of the other seventeen countries. The Japanese and West German Business sectors devoted \$1.8 and \$1.6 billion, respectively, to R&D, substantially more than the \$1.1 billion allocated by Business in the United Kingdom and almost twice as much as the \$880 million spent by Business Enterprise in France.

Some distance below France in the moderate category came the first of the smaller OECD nations, Italy and the Netherlands, with \$350 million each. The only other countries in which the Business Enterprise sector provided more than \$100 million for research and development were Canada, Sweden, and Belgium.

b. Business Enterprise Expenditures on R&D as a Percentage of GERD. The relative standing of the Major States in terms of the share of total national R&D resources originating in the Business Enterprise sector during the 1960s may be seen in Figure 8. As one would expect, the states are ranked in the reverse of the order they were in Figure 5, which showed Government spending as a percentage of GERD. Throughout the 1960s, West Germany and Japan were states in which Business supplied a large share of gross R&D expenditures. The Business Enterprise sectors of the United Kingdom and, particularly, the United States and France played a much less important role in supporting their respective national research and development efforts. The range of shares was wide: from a high of two-thirds of GERD for Japan to a low of one-third for France. If there is any trend to be discerned in Figure 8, it is that the importance of this sector is tending to increase--since 1963 in West Germany and the United States, since 1967 in Japan and France. Only in the United Kingdom has this sector's share remained constant.

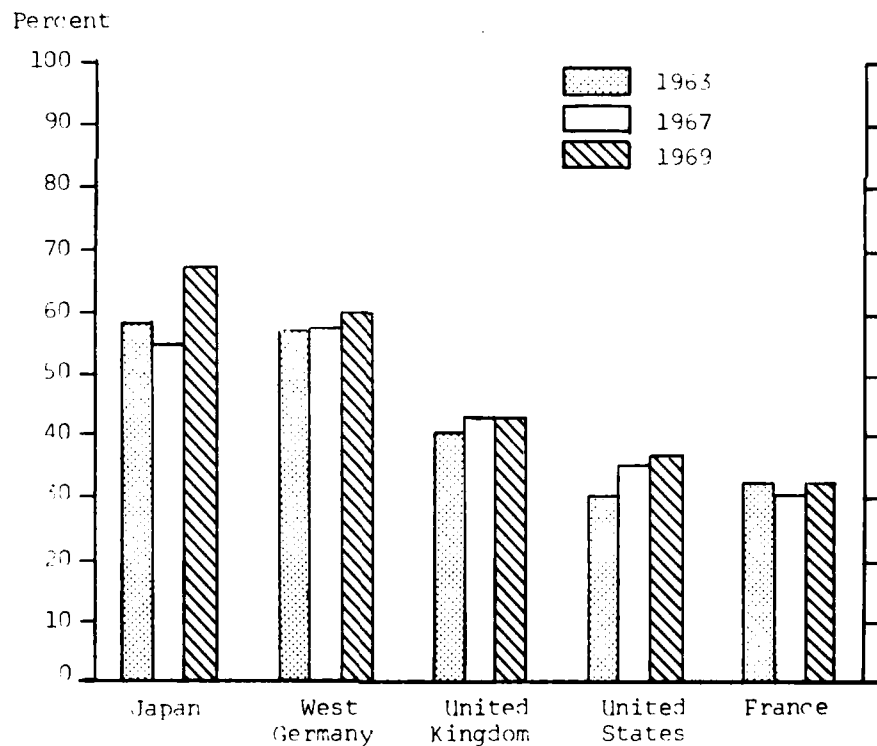
Table 10

BUSINESS ENTERPRISE EXPENDITURES ON R&D IN 1969^a
(in millions of current US dollars)

High	Significant	Moderate	Low	Very Low
> 2000	1000-1999	100-199	20-99	< 20
US 10,000	JAPAN 1,750 W. GERMANY 1,590 UK 1,060	FRANCE 880		
		Italy 350 Netherlands 350 Canada 290 Sweden 210 Belgium 110	Denmark 68 Austria 45 Norway 38 Finland 31 Spain 29	Ireland 9 Greece 4 Portugal 2

a. Or nearest year available.

Source: Table B-2.



Source: Table B-1.

Figure 8. BUSINESS ENTERPRISE SPENDING ON R&D IN THE 1960s AS A PERCENTAGE OF GERD

As it did in its analysis of the Government sector as a source of funds, the OECD has divided its eighteen responding countries into two groups, private funded and government funded, depending on whether Business supplied more or less than one-half of GERD. This distinction has been drawn in Table 11 for the year 1969.²² One would expect it to be a mirror image of Table 6; and, although a close comparison reveals that some countries have shifted in category and rank order, in general this is true. In this instance there does appear to be a genuine gap among the Major States. The two private-funded countries, Japan and West Germany, are at the far end of the spectrum with shares of 68 and 60 percent, respectively, and are separated by sixteen percentage points from the first government-funded Major State, the United Kingdom, with 44 percent. The range of values is, however, continuous for the thirteen other OECD countries. What is notable is that in only five of these does the Business Enterprise sector fund more than 50 percent of research and development. One state, Belgium, derives more than 60 percent of its R&D expenditures from Business. Thus, in contrast to Table 6, in which the nineteen responding member nations were divided about evenly between government-funded and private-funded countries, Table 11 has the eighteen respondents distributed unevenly, with seven in the former category and eleven in the latter. The reason for this incongruity is, of course, that private funding in Table 6 actually refers to all non-governmental funding, that is, funding by Higher Education, PNP, and Abroad as well as by Business Enterprise, while private funding in Table 11 reflects only Business expenditures.

c. Business Enterprise Expenditures on R&D as a Percentage of GNP. The most significant point to be made about Table 12, which shows the ratio of Business R&D spending to GNP in eighteen countries in 1969,²³ is that for four out of the five Major States the ratios

22. Data for earlier years will be found in Table B-1.

23. Data for earlier years will be found in Table B-4.

Table 11

BUSINESS ENTERPRISE SPENDING ON R&D AS A PERCENTAGE OF
GERD IN 1969^a

"Private-funded" countries		"Government-funded" countries	
> 60	50-59	40-49	< 40
JAPAN 68		UNITED KINGDOM 44	UNITED STATES 38
WEST GERMANY 60			FRANCE 33
Belgium 61	Netherlands 59	Finland 49	Norway 39
	Sweden 57	Denmark 47	Ireland 39
	Austria 53	Spain 45	Canada 30
	Italy 50		Greece 27
			Portugal 16

a. Or nearest year available.

Source: Table B-1.

Table 12

BUSINESS ENTERPRISE SPENDING ON R&D AS A PERCENTAGE OF
GNP IN 1969^a

High	Significant	Moderate	Low	Very Low
> 1	0.75-1	0.5-0.75	0.3-0.5	< 0.3
UNITED STATES 1.1		FRANCE 0.6		
UNITED KINGDOM 1.0				
WEST GERMANY 1.0				
JAPAN 1.0				
Netherlands 1.2		Sweden 0.7	Denmark 0.42	Ireland 0.23
		Belgium 0.6	Italy 0.40	Spain 0.09
		Canada 0.5	Norway 0.40	Greece 0.05
			Austria 0.37	Portugal 0.04
			Finland 0.35	

a. Or nearest year available.

Source: Table B-4.

were both "high" and essentially identical. The United States, the United Kingdom, West Germany, and Japan all devoted 1 percent of their gross national product to Business Enterprise R&D. France was two categories further down, with Business spending at 0.6 percent representing a moderate proportion of GNP. The contrast with Table 7 is striking. There the shares of Government expenditures in GNP are spread over a much wider range (from 0.4 to 1.5 percent) and are, in general, substantially higher.

Turning finally to the remaining OECD nations, we find that the similarities between the two tables are more striking than the differences. In the case of both the Business Enterprise and the Government sectors, the ratio of R&D spending to GNP is "low" or "very low" for nine states (compare Tables 7 and 12). In both tables, only four states have ratios that fall into a higher category. In both tables, three of these four states are identical: the Netherlands, Sweden, and Canada.

3. The Balance Between Government and Business Enterprise Funding²⁴

Among the ten countries identified as government funded in Table 6, the United States and the United Kingdom have Business Enterprise sectors that spend large sums on research and development, both in absolute amounts and as a percentage of GNP, but their Government sectors have ambitious R&D programs and spend even more. In France, the Government is also heavily involved in R&D, but Business Enterprise provides comparatively little support for this activity. In Canada and Norway, where Business expenditures on R&D are also relatively low, Government finances more R&D, largely in order to make up for this deficiency. Finally, in Portugal, Greece, Ireland, and Spain, Government spends comparatively little on R&D, but Business Enterprise spends even less.

24. This section attempts to summarize and update the commentary on the 1967 data that appears in OECD, R&D Trends and Objectives, p. 11.

Among the seven countries identified as private funded in Table 11, West Germany, Japan, and the Netherlands have Business Enterprise sectors that spend "high" sums on R&D compared with gross national product. In West Germany and Japan, absolute Business expenditures are significant. In the Netherlands, the ratio of Government spending on R&D to GNP is also "significant," but that for West Germany and Japan is "moderate" or "low." In all the remaining private-funded countries--Sweden, Belgium, Italy, and Austria--the Business Enterprise sector spends "moderate" or "low" amounts on R&D, both in absolute and relative terms, but the Government sector spends even less.

Both Finland, which falls into neither of the above two categories, and Denmark, the tenth among the government-funded countries, move back and forth across the boundary lines separating the various analytical categories and so elude analysis and escape most generalizations.

C. SECTORS OF PERFORMANCE

At the beginning of Section B, it was noted that nine-tenths of the financial support for research and development in OECD member countries characteristically came from the Government and Business Enterprise sectors. In this section, the analysis focuses again on Government and Business, for it is in these sectors that most research and development is conducted. The performance of R&D is, however, much less concentrated than is funding. For only one state (Spain) did the combined shares of Business Enterprise and Government exceed nine-tenths of GERD in 1969.²⁵ One-half of the remaining eighteen responding countries fell within a range of from 80 to 89 percent, another seven had combined shares of between 70 and 79 percent, and two reported that less than 70 percent of their R&D was conducted in the two dominant sectors.

Of the three remaining sectors (Higher Education, Private Non-profit, and Abroad), the OECD has not collected any data on "Abroad."

25. The following discussion is based on Table C-1.

R&D funded by a member nation but performed outside its territory evidently escapes the statistical net cast by the Organization--unless the research is conducted in another member nation, in which case it appears in the information on sources of funds under "Abroad."

Private Non-profit (PNP) institutions are not important loci of research and development activities in most countries. In fourteen states the portion of GERD performed in the PNP sector in 1969 was less than 3 percent. In two countries, the United States and Denmark, its share was slightly larger--3.7 and 4.9 percent, respectively; but only in Portugal, the Netherlands, and West Germany can PNP institutions be described as significant performers of R&D. The shares of GERD consumed in the PNP sectors of these countries were, respectively, 7.1, 8.7, and 9.7 percent, which still left Private Non-profit institutions as the least important sector of performance. In West Germany and the Netherlands, moreover, the relative position of this sector appears to be steadily deteriorating.

Higher Education is clearly the most important non-dominant sector of performance. In two states (Belgium and Norway), more than 30 percent of all research and development was performed in universities and colleges in 1969. The shares in most of the other sixteen responding countries were smaller but still substantial. Four states (Italy, Finland, Canada, and Denmark) reported that 20 to 30 percent of GERD was being conducted in the Higher Education sector. In nine countries, including four of the five Major States, the sector's share was between 10 and 20 percent. Only three countries, including the United Kingdom, channeled relatively little R&D funding (i.e., less than 10 percent) in this direction.

That Higher Education is a comparatively important sector of performance in some countries can be judged from the fact that it ranks second in seven out of eighteen states. Furthermore, there is reason to suspect that the OECD statistics on sectors of performance for at least six states, among them France and Japan, misrepresent reality

by overestimating the amount of R&D conducted in Government and underestimating the amount conducted in Higher Education.²⁶

Having taken note of the more important role of the Private Non-profit and Higher Education sectors in some countries in the performance, as opposed to the funding, of research and development, it is well to restate the point made at the beginning of this section: in most member states of the OECD most R&D is conducted in the Government and Business Enterprise sectors. It is to these two that we now turn.

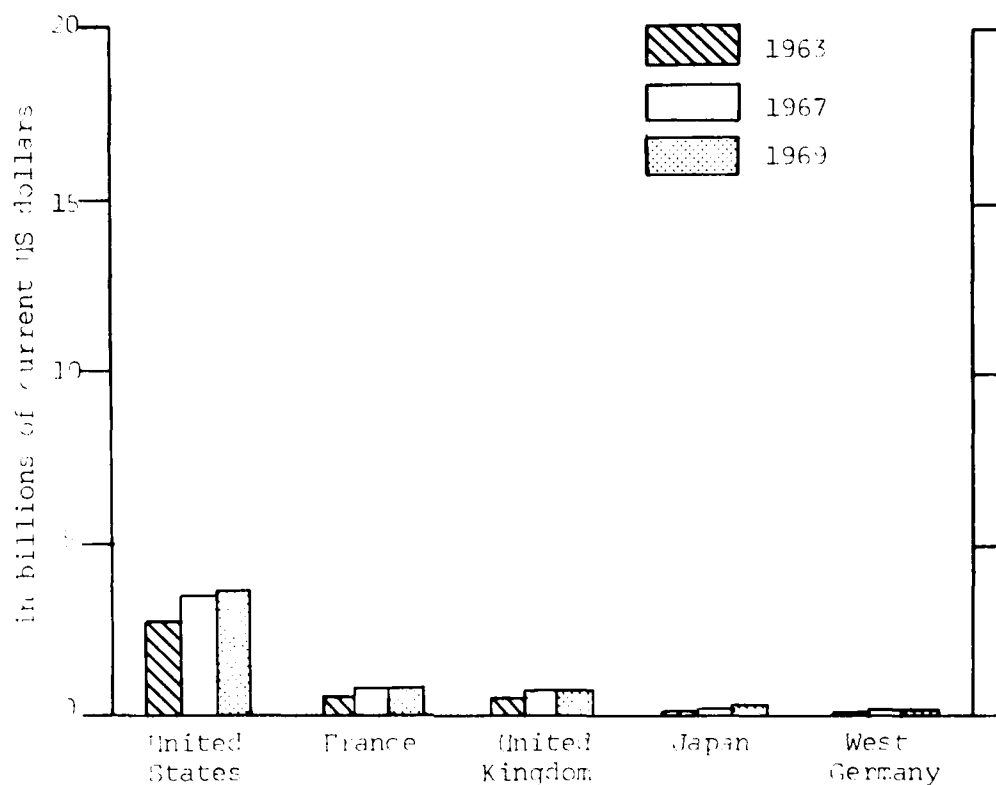
1. Government

a. Absolute Amounts of Expenditures Absorbed. In light of the levels of Government R&D spending indicated in Figure 4 (particularly for the United States) and the high degree of government orientation shown for the United Kingdom, France, and the United States in Table 9, it is interesting that relatively little R&D was performed in the Government sectors of any of the five Major States during the 1960s (see Figure 9). The US government naturally absorbed larger sums of money than did the governments of the Big Four, and it is not surprising that more R&D was conducted in the Government sectors of France and the United Kingdom than in those of Japan and West Germany. It is also worth noting that funding for R&D performed in this sector apparently tended to increase during the 1960s. But these distinctions are less important than the simple fact that the Government sector consumed far less of GERD than it generated.

The relative standing of eighteen respondents to the OECD survey conducted in 1969 is shown in Table 13.²⁷ The amount of R&D performed in the US Government sector was \$3.7 billion, more than 40 percent more than was performed in the Government sectors of all seventeen other countries, and almost five times as much as in that of France, the nation which ranked second. The Big Four, together with Canada

²⁶ See Table D-4, note c. The other four states for which data are probably incorrect are Italy, Spain, Ireland, and Canada.

²⁷ Data for earlier years will be found in Table C-2.



Source: Table C-2.

Figure 9. R&D PERFORMED IN THE GOVERNMENT SECTOR IN THE 1960s

Table 13

R&D PERFORMED IN THE GOVERNMENT SECTOR IN 1969^a
(in millions of current US dollars)

> 1000	100-999	20-99	< 20
UNITED STATES 4,750	FRANCE 780 UNITED KINGDOM 600 JAPAN 310 WEST GERMANY 120		
	Canada 340 Italy 170	Netherlands 67 Sweden 55 Denmark 38 Spain 36 Belgium 27	Norway 19 Switzerland 16 Finland 15 Ireland 11 Greece 8 Portugal 8

a. Or nearest year available.

Source: Table C-2.

and Italy, conducted from \$100 to \$800 million worth of R&D in their Government sectors. Expenditures in the remaining eleven states were much lower: between \$20 and \$70 million for five, less than \$20 million for six.

b. R&D Performed in the Government Sector as a Percentage of GERD.

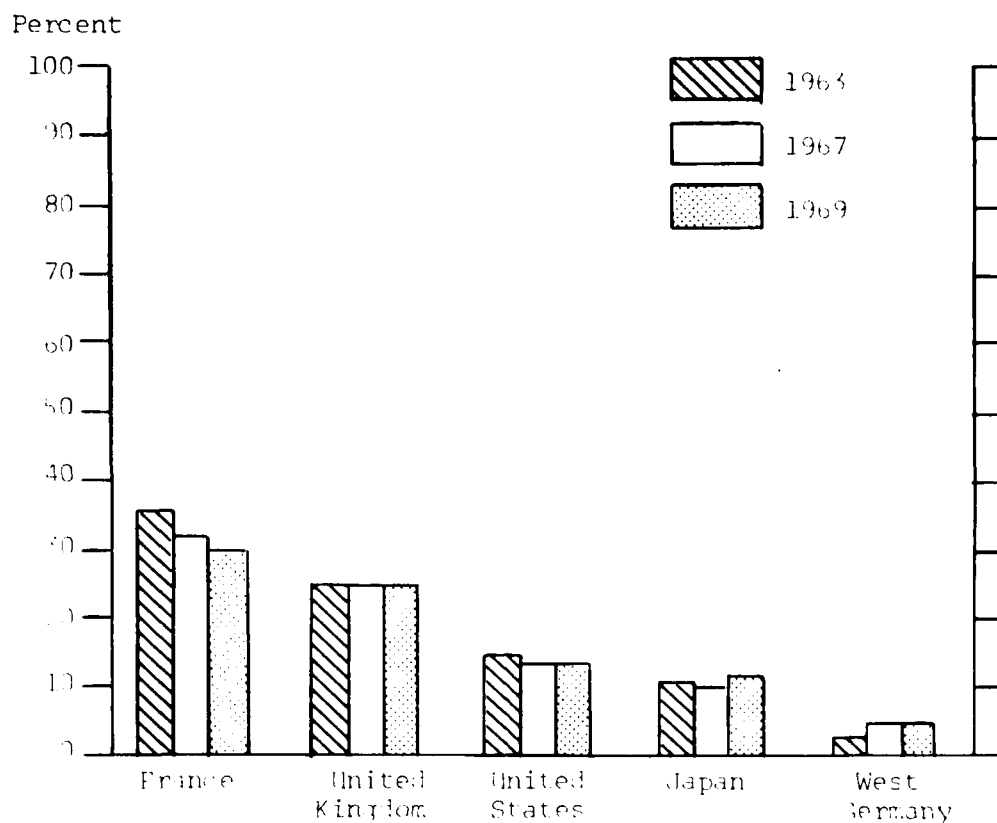
Among the Major States, the United Kingdom and France chose to have one-fourth or more of their research and development conducted in the Government sector (see Figure 10). Government accounted for substantially less in the other three countries: about one-eighth of the total in the United States and Japan, one-twentieth in West Germany. The range is, therefore, fairly wide. The share held by Government has declined in France, but has remained more or less stable in the other four Major States.

As can be seen from Table 14, the Government sector is a much more important performer of R&D in five of the thirteen remaining countries than it is in the Major States.²⁸ Its share of GERD is 35 percent in Canada, almost 50 percent in Ireland, about 55 percent in Spain and Greece, and almost 70 percent in Portugal. It is noteworthy that all but Canada are small, relatively underdeveloped countries with weak private enterprise sectors. The other eight states are divided into two equal groups. Four join France and the United Kingdom in the 20 to 29 percent range; four fall below the 20 percent level.

2. Business Enterprise

a. Absolute Amounts of Expenditures Absorbed. First, comparing Figures 9 and 11, we see that the level of R&D expenditures is higher in the Business Enterprise sector than in the Government sector in all five of the Major States and that it is much higher in the United States. Second, the vitality of the US Business Enterprise sector as a performer of R&D is apparent from its position relative to that of Business in the Big Four: it towers above the others,

28. Data for earlier years will be found in Table C-1.



Source: Table C-1.

Figure 10. R&D PERFORMED IN THE GOVERNMENT SECTOR IN THE 1960s AS A PERCENTAGE OF GERD

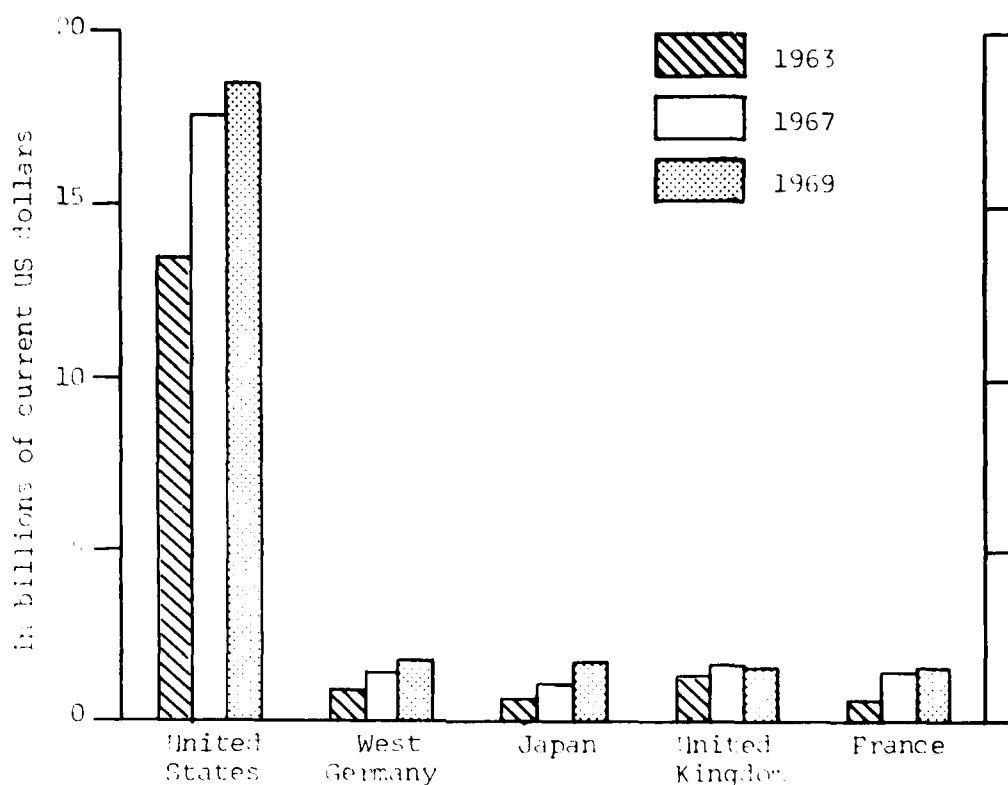
Table 14

R&D PERFORMED IN THE GOVERNMENT SECTOR AS A PERCENTAGE OF GERD IN 1969^a

> 50		30-49		20-29		• 20	
				FRANCE	26	UNITED STATES	14
				UNITED KINGDOM	25	JAPAN	12
						WEST GERMANY	5
Portugal	69	Ireland	48	Denmark	26	Sweden	15
Greece	56	Canada	35	Italy	25	Netherlands	11
Spain	55			Finland	24	Belgium	11
				Norway	20	Switzerland	4

a. Or nearest year available.

Source: Table C-1.



Source: Table C-2.

Figure 11. R&D PERFORMED IN THE BUSINESS ENTERPRISE SECTOR IN THE 1960s

consuming more than ten times the expenditures of any one of them. The Big Four all cluster fairly close together. Third, during the 1960s, allocations to the Business Enterprise sector have increased steadily in all of the Major States except the United Kingdom, where they have leveled off.

The situation in 1969 is shown for all nineteen responding countries in Table 15.²⁹ In terms of absolute amounts of funding, the Business Enterprise sector in the five Major States performs much more R&D than it does in the fourteen other OECD countries.

29. Data for earlier years will be found in Table C-2.

Table 15

R&D PERFORMED IN THE BUSINESS ENTERPRISE
SECTOR IN 1969^a
(in millions of current US dollars)

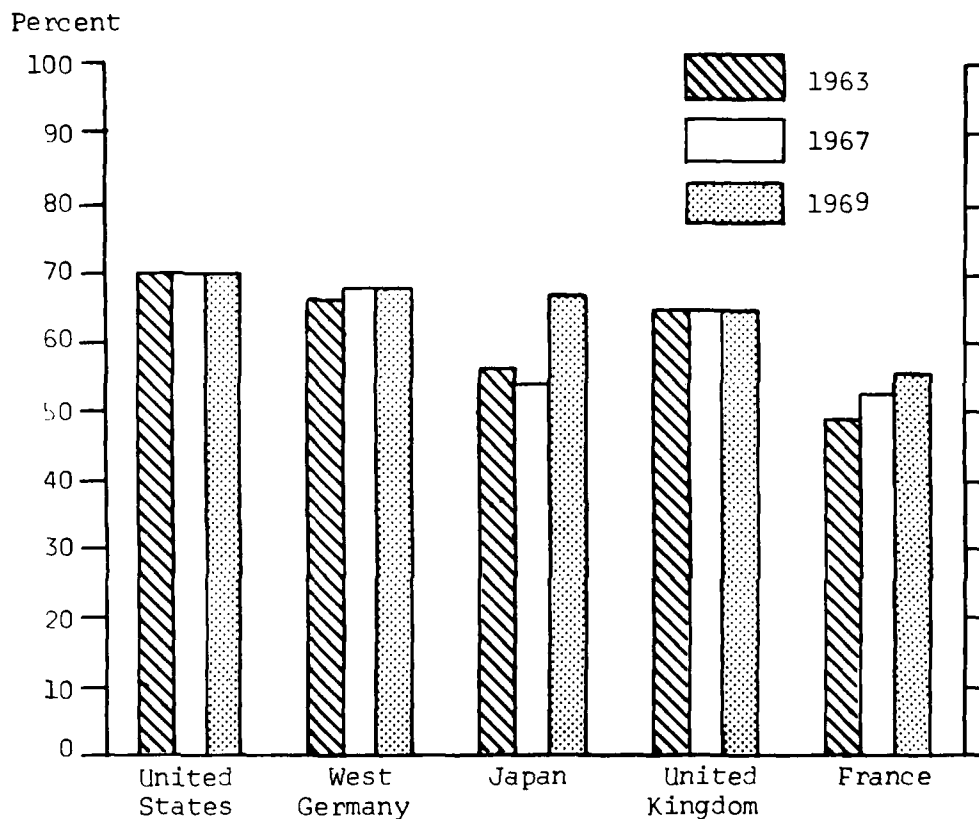
>2000	1000-1999	100-999	20-99	<20
UNITED STATES 18,480	WEST GERMANY 1,810 JAPAN 1,740 UNITED KINGDOM 1,580 FRANCE 1,490			
		Italy 380 Netherlands 360 Canada 360 Switzerland 330 Sweden 240 Belgium 150	Denmark 68 Austria 51 Norway 47 Finland 43 Spain 27	Ireland 8 Greece 4 Portugal 2

a. Or nearest year available.

Source: Table C-3.

About \$18.5 billion of R&D is conducted by US Business. The comparable figures for the Big Four range between \$1.5 and \$1.8 billion. All of the remaining states fall below the \$400 million line; and of these, eight allocate less than \$70 million to Business for R&D.

b. R&D Performed in the Business Enterprise Sector as a Percentage of GERD. Throughout the 1960s, most of the research and development supported by the Major States was conducted in the Business Enterprise sector (see Figure 12). The portion of GERD consumed by Business began the decade at a high level of 65 to 70 percent in the United States, West Germany, and the United Kingdom and remained there through 1969. In France and Japan, Business began with shares of 50 and 55 percent, respectively, which expanded to 55 and 65 percent by the end of the 1960s. The shares of GERD absorbed by this sector are, therefore, tending to converge. Just how important the role of Business as a performer of R&D has been in the Major States may be seen by comparing Figures 10 and 12. Business Enterprise far surpasses Government in terms of the portion of the national R&D effort it carries out.



Source: Table C-1.

Figure 12. R&D PERFORMED IN THE BUSINESS ENTERPRISE
SECTOR IN THE 1960s AS A PERCENTAGE OF GERD

Seven of the fourteen remaining countries for which data are available conformed to the same pattern (see Table 16). In 1969, their respective Business Enterprise sectors accounted for more than one-half of the R&D performed within the country.³⁰ In three other states, the sector's share was between 40 and 50 percent. In only four did it fall below the 40 percent mark.

Table 16

R&D PERFORMED IN THE BUSINESS ENTERPRISE
SECTOR IN 1969^a AS A PERCENTAGE OF GERD

> 60		50-59		40-49		< 40	
UNITED STATES	70	FRANCE	56				
WEST GERMANY	68						
JAPAN	67						
UNITED KINGDOM	65						
Switzerland	85	Belgium	56	Norway	48	Canada	37
Sweden	66	Italy	55	Denmark	47	Ireland	37
Netherlands	62	Finland	53	Spain	41	Greece	27
Austria	60					Portugal	16

a. Or nearest year available.

Source: Table C-1.

D. INTER-SECTORAL TRANSFERS

Thus far in this discussion we have seen that nine-tenths of all financial support for R&D originated in the Government and Business Enterprise sectors and that Higher Education, Private Non-profit institutions, and Abroad collectively supplied about one-tenth or less of total R&D expenditures. We have also seen that, although most R&D was conducted in the Government and Business Enterprise sectors, Government generated a larger share of GERD than it consumed, while the other three sectors--most particularly Higher Education and PNP institutions--tended to consume larger shares of GERD than they generated.

30. Data for earlier years will be found in Table C-1.

Even in the absence of statistics on transfers of funds between sectors, the foregoing would be enough to lead one to suspect that significant sums of money are flowing from Government to the other three sectors. As the following discussion will show, although reality is somewhat more complicated than the above would suggest, this hypothesis is corroborated by the OECD data. Moreover, the fact that it is Government and not some other sector that is the source of the great bulk of the funds moving between sectors is perhaps the single most important conclusion that one can draw from this section.

The following analysis focuses on the situation in 1969. With the exception of Business Enterprise, the detailed information required to trace changes over time in the pattern of inter-sectoral transfers was not readily available.

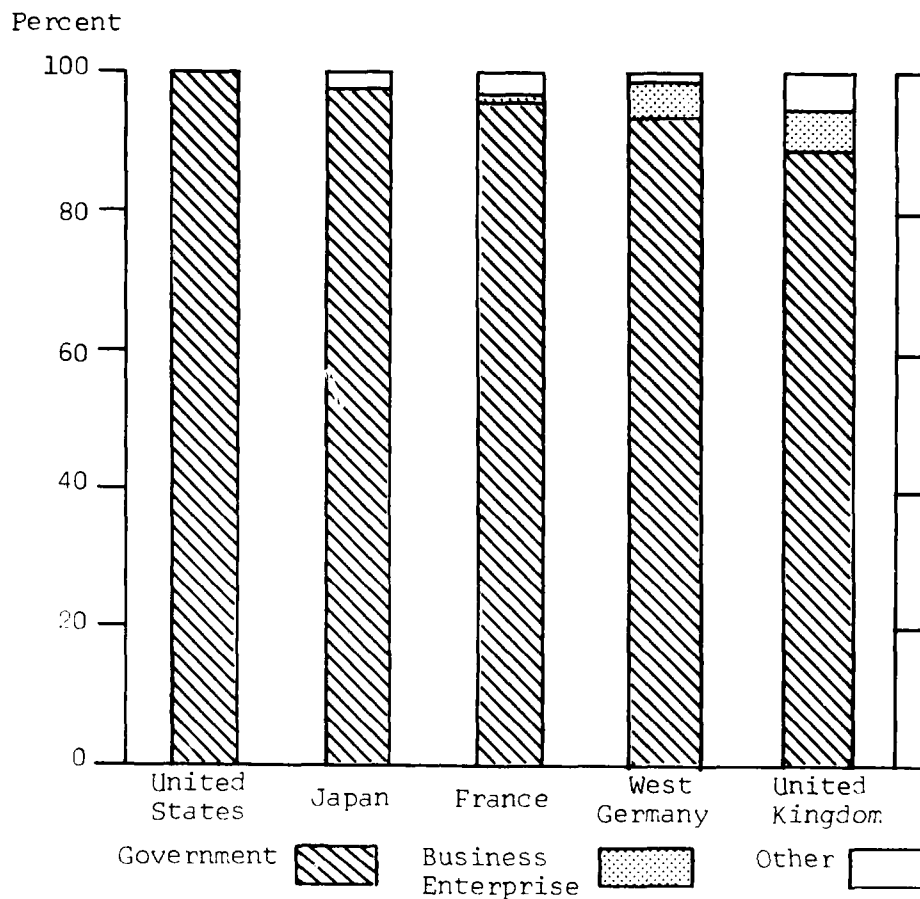
The OECD has compiled its statistics on the basis of where the funds for R&D performed in each sector come from, and it is in accordance with this approach that this analysis of inter-sectoral transfers has been organized. The data for the four main sectors of performance (excluding "Abroad") are discussed in the four sub-sections that follow. In the fifth, the OECD statistics have been rearranged to permit an analysis of the destination of R&D funds originating in the Government sector.

1. Sources of Funds for R&D Performed in the Government Sector

In every one of the five Major States, Government finances by itself all or almost all of the R&D it performs (see Figure 13). The Business Enterprise sector finances 5 to 6 percent of Government R&D in West Germany and the United Kingdom, but the fact remains that very little money flows from other sectors into Government.

This pattern is repeated in the eleven remaining member nations that responded to this part of the 1969 survey.³¹ In ten, more than 90 percent of the research and development conducted in this sector was supported by the sector's own funds. The exception was Spain,

31. See Table D-2.



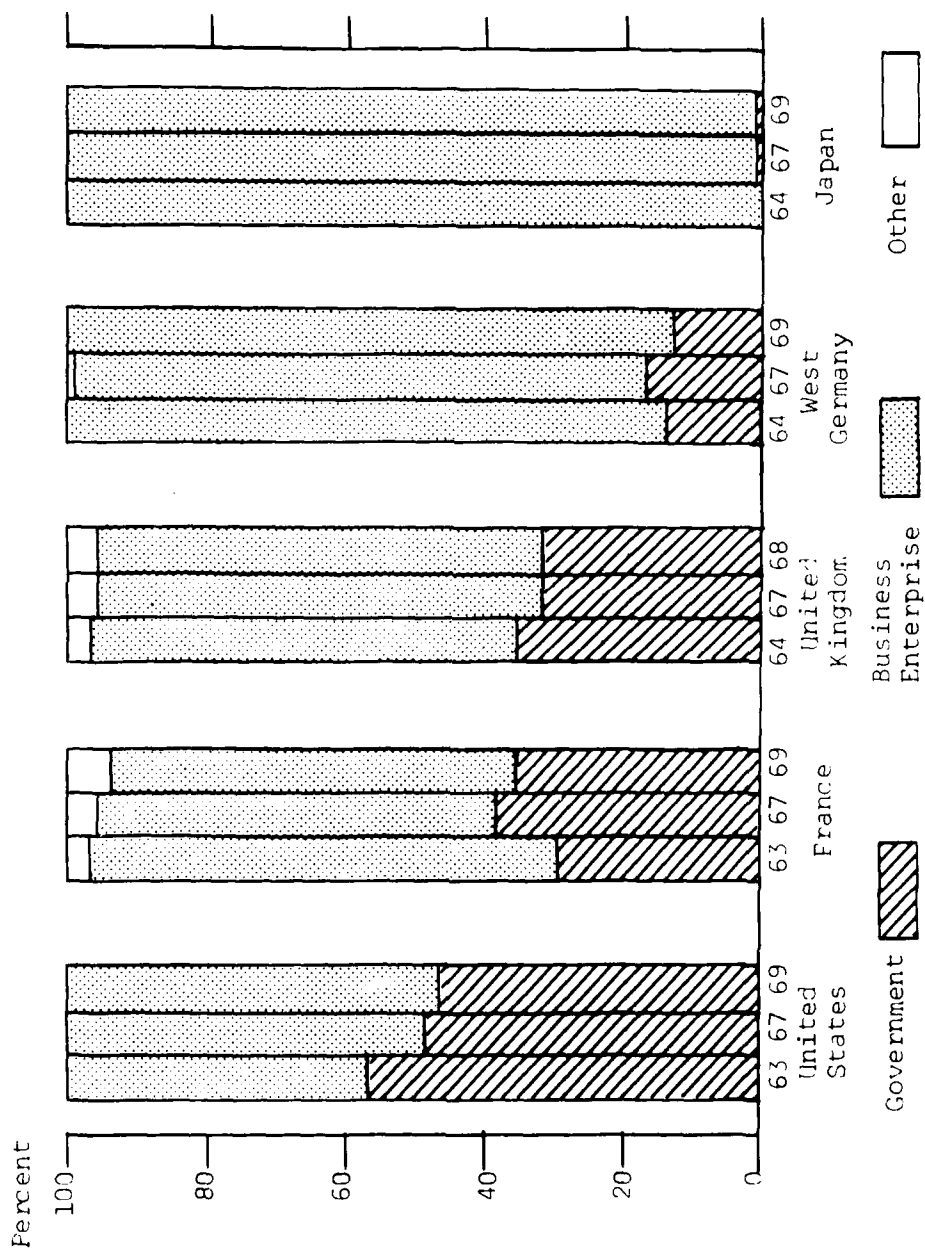
Source: Table D-2.

Figure 13. SOURCES OF FUNDS FOR R&D PERFORMED
IN THE GOVERNMENT SECTOR IN 1969

where its share fell to 84 percent and Business and PNP contributed 9 and 5 percent, respectively.

2. Sources of Funds for R&D Performed in the Business Enterprise Sector

Here the situation is more complicated. As can be seen in Figure 14, the Business Enterprise sectors of the Major States generated internally most of the funds they spent for research and development during the 1960s. Business supplied virtually all of its own requirements in Japan and from 82 to 86 percent in West Germany. In the other three Major States, the sector functioned in a much less



Source: Table D-1.

Figure 14. SOURCES OF FUNDS FOR R&D PERFORMED IN THE BUSINESS ENTERPRISE SECTOR IN THE 1960s

autonomous fashion. Business Enterprise in France began the decade supplying two-thirds of its own R&D expenditures, but ended by providing less than three-fifths. Although trends in the United Kingdom and the United States ran in the opposite direction, by 1968/69 intra-sectoral sources were still only meeting 64 and 54 percent, respectively, of the sector's demands.³²

Figure 14 shows that the needs that were not being met by the Business Enterprise sector itself were being fulfilled by Government: 13 to 17 percent of the total amount of R&D expenditures consumed within the Business sector in the case of West Germany, from 30 to 39 percent in the case of France,³³ and shares declining from 36 to 32 percent and from 57 to 47 percent in the United Kingdom and the United States, respectively.

The Business Enterprise sectors of the thirteen other responding nations are less dependent on Government support. In nine of these states, intra-sectoral financing is available for more than 90 percent of Business R&D. In none of the remaining four does the share of Business' "own funds" fall below 80 percent. As for changes over time, the share of internally generated funding is stable or increasing in most of the countries surveyed.

The role of Government as a source of funds for Business Enterprise R&D in 1969 is shown in Table 17. Clearly, Business tends to be far more dependent on Government in the Major States than it does in other OECD member nations. The shares of Government in the United Kingdom, France, and most particularly in the United States are very high--32, 36, and 47 percent, respectively. In Norway, the state which ranks fourth, Government supplies only 18 percent of Business needs. Of the eleven countries in which Government provides less than 10 percent, only one, Japan is a Major State.

32. Comprehensive data for the Business Enterprise sector will be found in Table D-1. In Business Enterprise, as in other sectors, intra-sectoral transfers are substantial.

33. PNP supplied 6 percent of Business requirements in 1969.

Table 17

PERCENTAGE OF BUSINESS ENTERPRISE R&D
FUNDED BY GOVERNMENT IN 1969^a

>40-50	30-40	15-20	10-15	5-10	<5
US 46.7	FRANCE 35.8 UK 31.8		W. GERMANY 13.2		JAPAN 1.2
		Norway 18.2	Canada 14.5 Sweden 14.4	Italy 7.2 Belgium 6.6	Portugal 4.3 Netherlands 3.9 Finland 3.5 Spain 1.7 Denmark 1.3 Austria 1.2 Ireland 0.7 Greece --

a. Or nearest year available.

Source: Table D-1.

3. Sources of Funds for R&D Performed in the Private Non-profit Sector

The PNP sector is much more dependent on extra-sectoral sources of support for financing its R&D activities than is Business Enterprise. Among the Major States, the share of intra-sectoral funds was highest in 1969 in Japan and France: about two-fifths of the total (see Figure 15). In the United Kingdom and the United States, in contrast, the share was much lower: one-sixth and one-fifth, respectively. In West Germany it was as low as one-twentieth. The share of intra-sectoral funds tended to be larger in the eight smaller states: above 40 percent for three, between 20 and 30 percent for another three, and below 15 for two.³⁴

Which sectors made up the deficiency? In France and Belgium, Higher Education provided one-eighth and one-sixth, respectively. In the United Kingdom, Sweden, and Japan, Business Enterprise supplied a more substantial proportion of PNP requirements: 28, 29, and 46 percent, respectively. Once again, however, it was Government that provided most of the financial backing coming from outside the sector (see Figure 15 and Table 18).

34. See Table D-3.

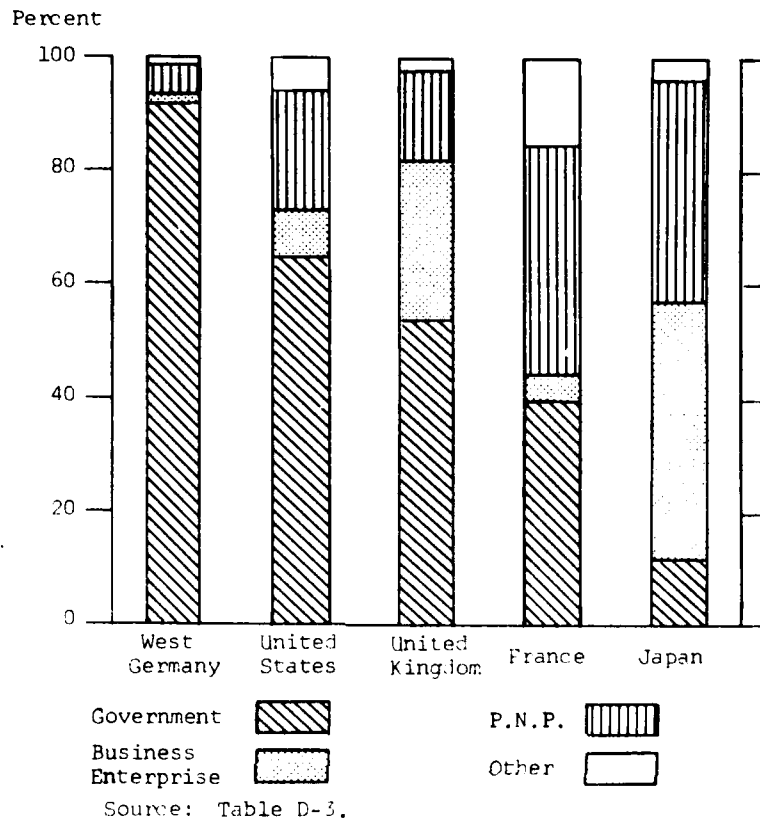


Figure 15. SOURCES OF FUNDS FOR R&D PERFORMED IN THE PRIVATE NON-PROFIT SECTOR IN 1969

Table 18

PERCENTAGE OF R&D IN THE PRIVATE NON-PROFIT SECTOR FUNDED BY GOVERNMENT IN 1969^a

> 90	70-80	60-70	50-60	40-50	< 40
W. GERMANY 92.2		US 65.1	UK 54.2	FRANCE 40.1	JAPAN 12.2
	Netherlands 77.6 Greece 72.6	Norway 68.0	Belgium 53.6	Finland 49.5 Ireland 42.5 Denmark 41.5	Sweden 14.3

a. Or nearest year available.

Source: Table D-3.

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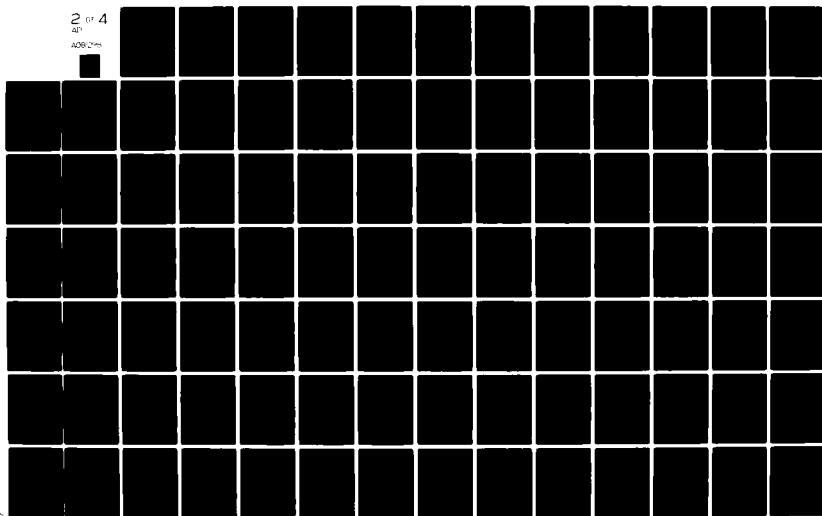
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Among the Major States, the Government sector provided least support for research and development in Private Non-profit institutions in Japan (12 percent). In the remaining Major States, it provided 40 percent in France, 55 percent in the United Kingdom, 65 percent in the United States, and 92 percent in West Germany. In four of the remaining eight countries, its share was between 54 and 78 percent, and in another three it was between 40 and 50 percent.

4. Sources of Funds for R&D Performed in the Higher Education Sector

In most countries, research and development conducted in colleges and universities is financed almost entirely by Government. In 1969, only Japan and the United States among the Major States had Higher Education sectors that funded appreciable amounts of their own R&D--16 and 27 percent, respectively. (See Figure 16.) The share in the United Kingdom was much lower and in the other two countries virtually zero.³⁵ The Government in 1969 supported 68 percent of the R&D conducted in the Higher Education sector in the United States, about 82 percent in the United Kingdom and Japan, and more than 95 percent in West Germany and France. In ten out of the twelve smaller states, the share of Government as a source of funds was larger than 90 percent; in the remaining two, larger than 80 percent.

5. Government Expenditures on R&D Distributed by Sectors of Performance

By this point, it should be possible to see why a special effort has been made to determine the allocation of R&D expenditures originating in the Government sector. No other sector funds an appreciable share of research and development performed by Government (see Figure 13). Government, on the other hand, is the only important outside contributor to Business Enterprise R&D (see Figure 14), is usually the principal source of support for PNP research and development

35. See Table D-4. In only three of the twelve smaller states--Ireland, Finland, and Canada--did the size of the share of "own funds" reach or exceed 5 percent. In Switzerland, Business covered 7 percent of the cost of R&D performed in the Higher Education sector. In Sweden, PNP institutions provided 6 percent.

(see Figure 15), and finances all or almost all Higher Education R&D (see Figure 16). Thus, when we speak of inter-sectoral transfers of funds, we are in effect talking about transfers from the Government sector to the other three sectors of performance.

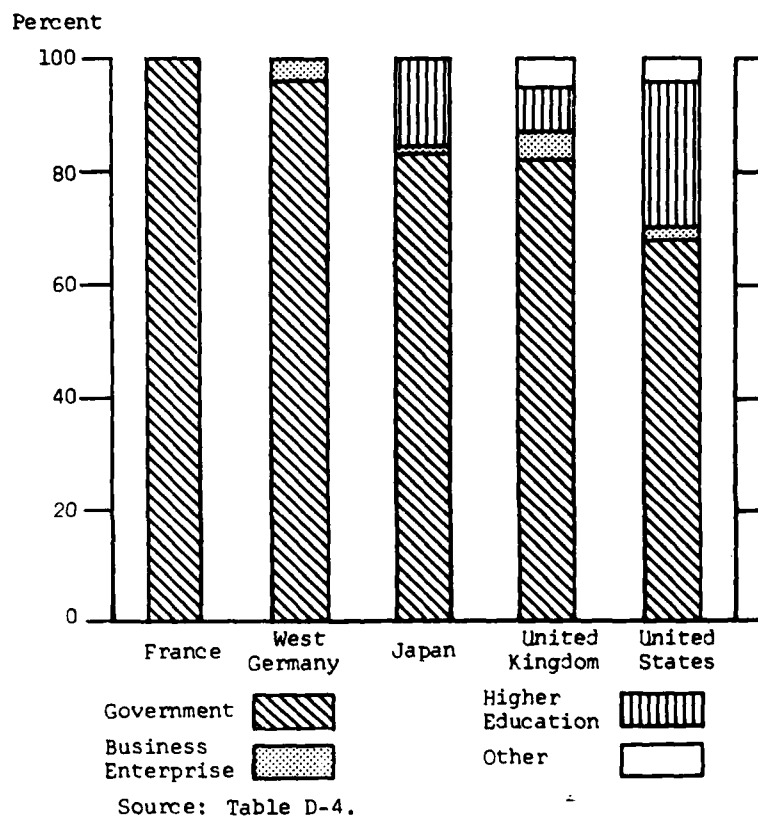


Figure 16. SOURCES OF FUNDS FOR R&D PERFORMED IN THE HIGHER EDUCATION SECTOR IN 1969

There is one important deficiency in the statistics for 1969 that must be mentioned. The national authorities of six states--France, Japan, Canada, Italy, Spain, and Ireland--provided the OECD with data that categorized certain funds supplied to the Higher Education sector by the Ministry of Education as that sector's own funds. This distorted reality in a number of ways. What is relevant in this context is that in these six states it reduced both the total amount of Government R&D expenditures and the flow of funds from Government

to Higher Education. The effect on the figures for the percentage distribution of Government R&D spending is perhaps best illustrated by the information on Japan presented in Figure 17. Between 1967 and 1969, the data report an abrupt contraction in the share of state R&D funds allocated to Higher Education and an equally abrupt expansion in the share of state expenditures consumed within the Government sector. It is highly unlikely that so violent a swing in government allocations of funds could have occurred, and the official Japanese statistics show that in fact such a change in priorities did not occur. It proved to be impracticable to make the necessary adjustments in the data for these six countries for 1969 in this sub-section, so the following generalizations should be regarded with some caution.³⁶

The analysis can be simplified at the outset by noting that state R&D expenditures were allocated almost exclusively to three sectors: Government, Business Enterprise, and Higher Education. In all the years for which data were available and in all but two of the eighteen states surveyed, Private Non-profit institutions received less than 5 percent of state funds (see Figure 17 and Table D-5). The two exceptions were West Germany and the Netherlands, where the PNP sector received 23 and 18 percent, respectively.³⁷

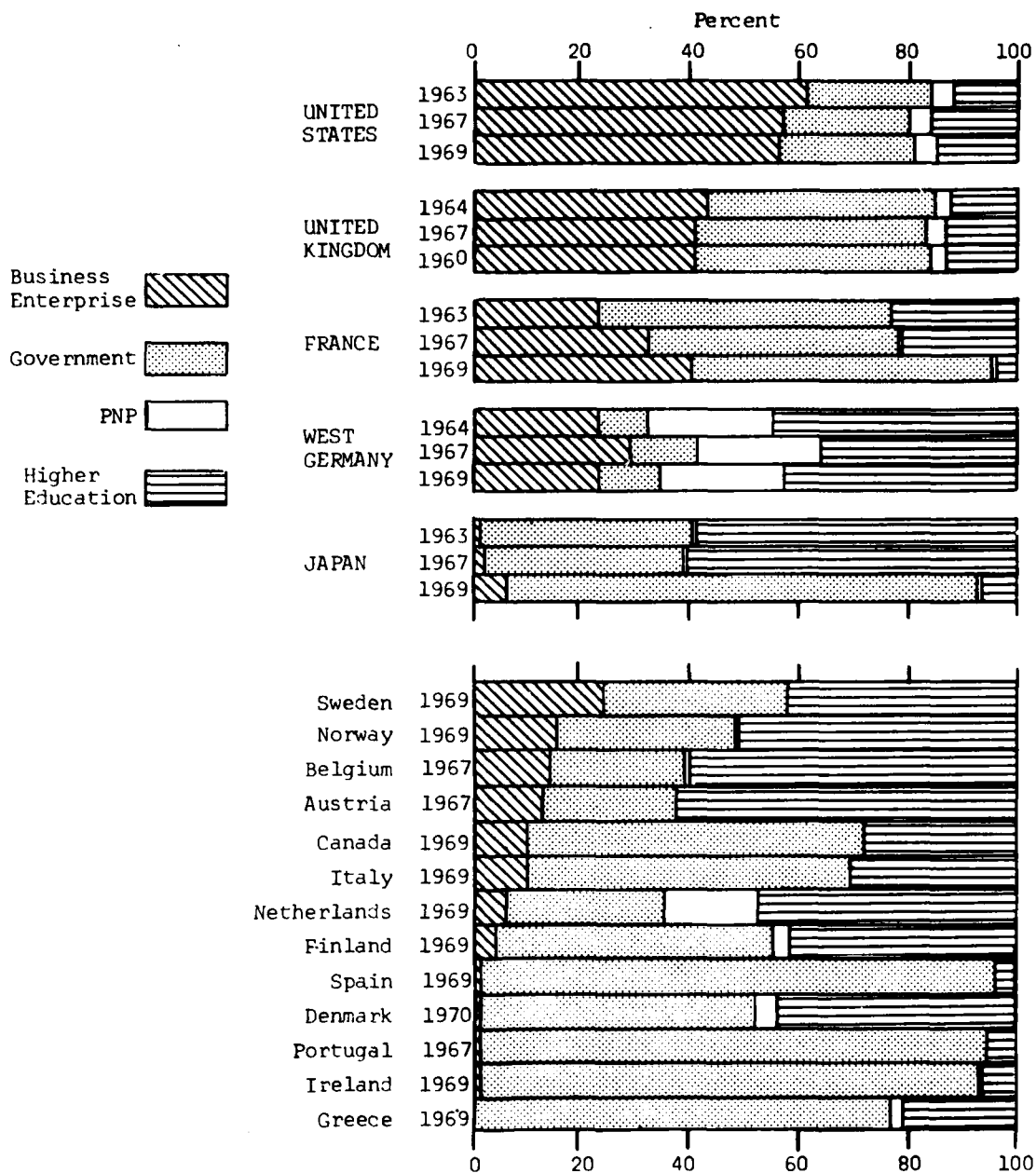
In five states the Government sector appears to absorb most of the funds it generates. The governments of Japan, Spain, Portugal, Ireland, and Greece all informed the OECD that the state consumed more than 75 percent of its own R&D expenditures in 1969.³⁸

In six countries the share of the Government's R&D funds absorbed by one sector in 1969 was larger than 55 percent but smaller than 75 percent. Government placed the highest priority on Business

36. This problem is noted in Table D-5, note g, and is discussed at length in Table D-4, note c.

37. The share of PNP institutions in West Germany has remained stable. In the Netherlands, however, their share has contracted sharply, from 41 percent in 1964 to 18 percent in 1969.

38. The share of intra-sectoral expenditures was more than 90 percent in Spain, Portugal, and Ireland. These figures are, of course, highly suspect for Japan, Spain, and Ireland.



Source: Table D-5.

Figure 17. GOVERNMENT EXPENDITURES ON R&D BY SECTOR OF PERFORMANCE IN THE 1960s

Enterprise in the United States,³⁹ on Higher Education in Belgium and Austria,⁴⁰ and on Government in France, Canada, and Italy.⁴¹

In a third group of three states, most Government spending on research and development in 1969 was divided more or less evenly between two sectors: Business Enterprise and Government in the United Kingdom, Government and Higher Education in Finland and Denmark.

In the remaining four states--Sweden, Norway, the Netherlands, and West Germany--that responded to this part of the OECD's questionnaire, three sectors received significant shares of the Government's R&D expenditures. Higher Education and Government ranked as the first and second most important sectors, respectively, in three of the four remaining countries. In those same three, Business Enterprise ranked third in Sweden and Norway, while the PNP sector ranked third in the Netherlands. In West Germany, perhaps the most atypical state of all, the rank order was Higher Education, Business Enterprise, and Private Non-profit.

This review of the sectoral distribution of Government funding for R&D indicates that spending tends to be concentrated in one or two sectors and that the sector that appears to be most frequently favored by Government is Government. It ranks first in eleven out of eighteen states and second in six out of the remaining seven. Among the Major States, the United Kingdom, Japan, and France fall into the first category; the United States, into the second. In West Germany, Government ranks fourth.

Excluding that portion of Government expenditures that is consumed within the sector, and looking only at the portion transferred

39. The sector that ranked second in the United States was Government.

40. Government ranked second in both states.

41. It is likely that, in these last three states, the share of Government is smaller and that of Higher Education larger than the statistics indicate. In 1969, the sector that ranked second in Canada and Italy was Higher Education. In France, it was Business Enterprise.

to other sectors, we find that one fact stands out with great clarity: in fifteen out of the eighteen responding nations, Higher Education receives priority over Business Enterprise. These fifteen countries include two Major States, West Germany and Japan.⁴²

The governments of the remaining three Major States--the United States, the United Kingdom, and France--are the only ones among the governments of the OECD member nations to give priority to Business Enterprise over Higher Education.⁴³ If anything, this understates the importance attached to Higher Education. In seven out of the fifteen states whose governments allocate more of their R&D funds to this sector than to Business Enterprise, the ratio of support for Higher Education to that for Business is more than five-to-one. And the statistical problems noted earlier for France, Japan, Canada, Italy, Spain and Ireland point in the direction of a greatly enhanced role for the Higher Education sector in these countries--though at the expense of Government rather than Business Enterprise.

E. TYPES OF ACTIVITY

This section is divided into three parts. The first breaks down total R&D expenditures in the responding OECD member nations by the three types of R&D activity identified by the Organization: basic research, applied research, and experimental development. The second analyzes the various sectors in which each of the three activities is performed. The third examines the balance of activities pursued in each of the four sectors of performance.

Several prefatory remarks are in order. First, it would be well to bear in mind that the phenomena under investigation are of a

42. The figures for Japan in Table D-5 give Business Enterprise a slight edge over Higher Education. It is known, however, that the latter sector actually absorbs most of the Japanese government's R&D expenditures.

43. It may be that this is a consequence of the fact that these three countries all have very large government R&D programs, programs which generate a strong demand for kinds of applied research and experimental development best performed in the Business Enterprise sector.

particularly elusive nature. The intractable definitional problems examined at length by the OECD will not be recapitulated here.⁴⁴ Suffice it to say that the statistics assembled by the Organization and presented in this section, although certainly the best available for purposes of cross-national comparisons, should be viewed with some skepticism.

Second, while fragmentary information was obtained from Japan and West Germany, only three of the Major States--the United States, France, and the United Kingdom--responded adequately to this portion of the OECD questionnaire. This limitation in the data base considerably reduces the reliability of the generalizations made on the basis of the available statistics.

Third, it has been possible to examine only one year: 1969. No attempt has been made to estimate trends in the distribution of R&D expenditures by type of activity.

Fourth, the expenditures analyzed are of a particular kind: "total intramural expenditures." These are defined by the OECD as "funds used for the performance of R&D and within a particular organization or sector of the economy, whatever the source of finance."⁴⁵ Intuitively, it would seem obvious that the sum of the intramural expenditures of the four sectors of performance should be identical to GERD, but such is not evidently the case, perhaps because certain portions of GERD could not be identified by type of activity. Whatever the reasons, the discrepancies involved may be substantial. For example, the sum of US expenditures on the three types of activity reported in Table E-1 is about \$26.3 billion, \$300 million less than the figure for GERD given in Table A-1. The difference between the two figures for the United Kingdom is even larger: \$380 million. Among the Major States, only in France is GERD the same as "total intramural expenditures."

44. See OECD, Directorate for Scientific Affairs, The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Research and Experimental Development, "Frascati Manual" (September 1970), Chapter II, pp. 8-21. See also Chapter II of this study, especially pp. 19-22.

45. Ibid., p. 43.

1. R&D Expenditures by Type of Activity

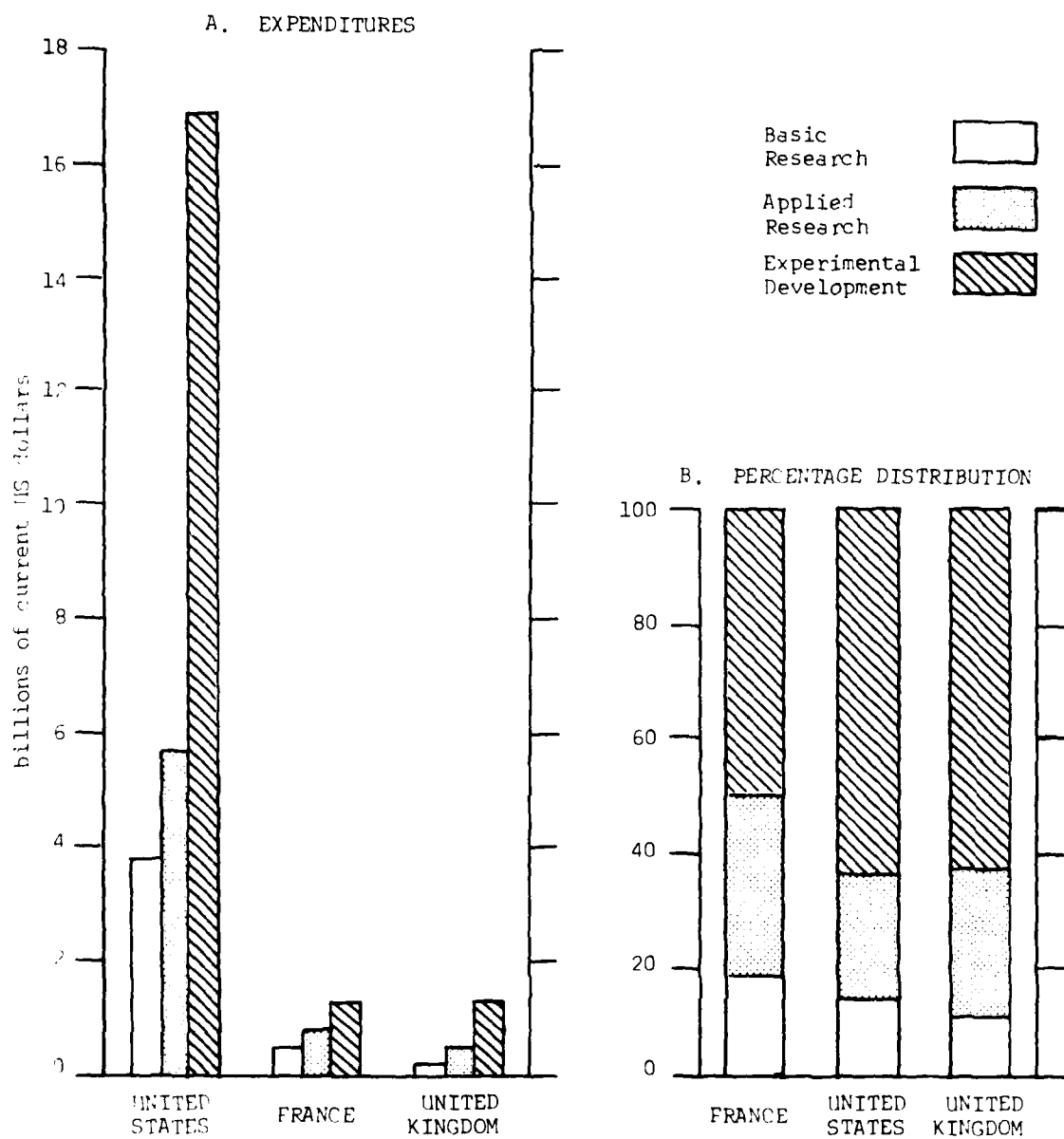
In terms of absolute amounts of money spent, the United States far surpassed every other state that responded to this part of the OECD survey (see Figure 18, Chart A, and Table 19). Expenditures on basic research in 1969 were almost \$3.8 billion in the United States, compared with \$490 million in France and \$220 million in the United Kingdom.⁴⁶ The comparable figures for applied research were \$5.7 billion and \$850 and \$530 billion. As for experimental development, the United Kingdom and France both spent \$1.3 billion as opposed to the \$16.9 billion provided in the United States. As Chart A of Figure 18 makes clear, the US lead was greatest in the area of experimental development. Whereas combined British and French expenditures on basic and applied research were 19 and 24 percent, respectively, of the US total, their combined expenditures on experimental development were only 16 percent of those in the United States.

In the three Major States, more money was spent on applied than on basic research and more on experimental development than on applied research. Table 19 has been constructed so as to facilitate a comparison of levels of spending by type of activity within each of the ten smaller countries that responded to the OECD's 1969 survey. Six out of the ten conformed to the pattern set by the Major States. In Italy, Belgium, Spain, and Greece, however, although more was still spent on applied than on basic research, less was spent on experimental development than on applied research.

Table 19 also reveals a striking degree of similarity in the order in which the countries are ranked within categories in terms of expenditures. In basic and applied research, the rank order is almost identical.⁴⁷ In all three types of activity, Canada, Italy, and the Netherlands are clustered together at the top, followed by Sweden and Belgium, Denmark and Norway, and Spain, Ireland, and Greece.

46. See Table E-1 for detailed information on absolute expenditures.

47. In this connection, it is pertinent to note the special problem of the Netherlands, for which there were available only figures reflecting aggregate expenditures on basic and applied research.



Source: Tables E-1 and E-2.

Figure 18. TOTAL INTRAMURAL R&D BY TYPE OF ACTIVITY IN 1969

Table 19

TOTAL INTRAMURAL EXPENDITURES ON R&D BY
TYPE OF ACTIVITY IN 1969^a
(in thousands of current US dollars)

Types of Activity	EXPENDITURES							
	>200	100-199	50-99	30-49	20-29	10-19	<10	
Experimental Development	Canada 315 Netherlands 254 Italy 257 Sweden 216		Belgium 69 Denmark 62	Norway 39			Ireland 9 Greece 4 Spain 4	
Applied Research	Canada 295 Italy 292	Belgium 108	Sweden 75	Denmark 32	Norway 26	Spain 19	Ireland 8 Greece 6	
Basic Research	Netherlands 232 ^b	Canada 167 Italy 145	Belgium 84	Sweden 47	Denmark 24	Norway 17	Spain 9 Greece 2 Ireland 2	

a. Or nearest year available.

b. Includes both Basic and Applied Research.

Source: Table E-1.

Turning to the percentage distribution of expenditures among the three types of activity in the Major States, Chart B in Figure 18 shows that, while in France basic and applied research consumed one-half of total spending, in the United States and the United Kingdom they were allocated only slightly more than one-third of the total.⁴⁸

In Table 20 a more basic distinction is drawn between countries that devote more than 50 percent of total intramural expenditures to experimental development and those that devote more than 50 percent to basic and applied research. The thirteen responding nations are divided almost equally between the two categories. All three of the Major States, including France, are to be found in the first, together with Sweden, the Netherlands, and Denmark.

48. See Table E-2 for detailed information on percentage distribution by type of activity.

Table 20

TOTAL INTRAMURAL EXPENDITURES ON R&D BY
TYPE OF ACTIVITY IN 1969^a
(percentage distribution)

Countries Emphasizing	Type of Activity		
	Experimental Development	Applied Research	Basic Research
Experimental Development:			
UNITED STATES	64.2	21.5	14.3
Sweden	63.9	22.2	13.9
UNITED KINGDOM	63.4	25.7	10.9
Netherlands	53.2	.	46.8 ^b
Denmark	52.5	27.0	20.4
FRANCE	50.2	31.6	18.2
Basic & Applied Research:			
Ireland	47.7	40.7	11.6
Norway	47.2	32.0	20.8
Canada	40.5	38.0	21.5
Italy	37.0	42.1	20.9
Greece	31.5	49.7	18.8
Belgium	26.3	41.5	32.2
Spain	3.0	55.1	41.9

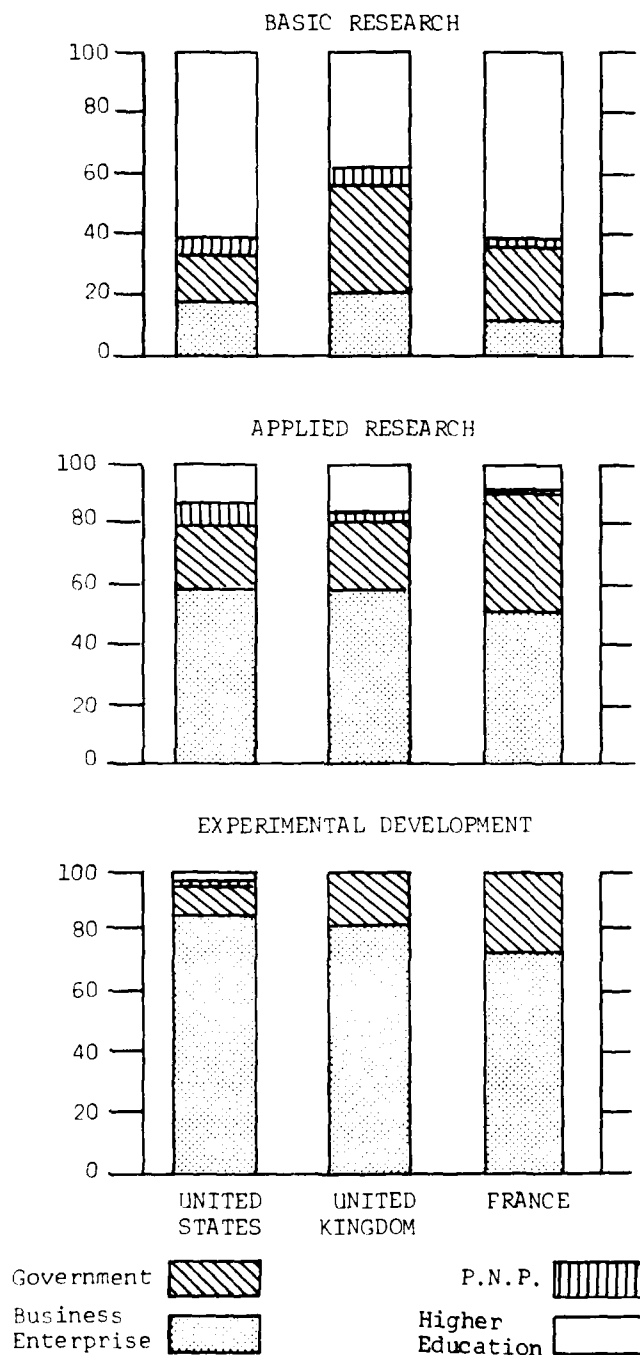
a. Or nearest year available.

b. Includes both Basic and Applied Research.

Source: Table E-2.

2. Sectors in Which the Three Types of Activity Are Performed

Figure 19 shows that, in general, in the three Major States that reported to the OECD, basic research tended to be performed in the Higher Education sector, while applied research and experimental development tended to be performed in the Business Enterprise sector. It also shows that the Government sector played an important supporting role in the performance of all three types of activity. In the very broadest terms, this pattern holds true for the thirteen responding member nations of the OECD.



Source: Tables E-3, E-4, and E-5.

Figure 19. TYPES OF ACTIVITY BY SECTORS OF PERFORMANCE IN 1969
(percentage distribution)

a. Basic Research. Sweden, Ireland, Norway, and Belgium are the extreme examples of the dominant position of Higher Education in the performance of basic research (see Table 21). In these four countries

Table 21

PERCENTAGE OF BASIC RESEARCH PERFORMED IN
HIGHER EDUCATION SECTOR IN 1969^a

80-90	70-79	60-69	30-59	20-29	< 20
		FRANCE 62 US 62	UK 38		
Sweden 87 Ireland 85	Norway 77 Belgium 73	Denmark 69 Canada 63	Italy 41	Greece 29 Netherlands 28	Spain 11

a. Or nearest year available.

Source: Table E-3

in 1969, the share of this sector ranged from 73 to 87 percent of the total. In another four countries, including France and the United States, it consumed between 60 and 69 percent of all basic research expenditures. In the United Kingdom, Government and Higher Education absorbed roughly equal amounts of money. In the remaining four smaller states, Higher Education ranked second.

b. Applied Research. Of the three types of activity, applied research is the one least concentrated in a single sector of performance. In Table 22, the twelve responding states are divided into two somewhat artificial categories, one made up of countries emphasizing the Business Enterprise sector in the performance of their applied research, the other consisting of countries emphasizing the Government sector. The latter includes five states; the former, seven, including the three Major States. Thus, it is true, broadly speaking, that applied research tends to be conducted in the Business Enterprise sector. It is worth noting, moreover, that in the five states in which Government ranks first, Business Enterprise ranks second. Yet even in the seven states in which Business plays the dominant role, significant amounts of applied research are performed in other sectors.

Table 22

APPLIED RESEARCH BY SECTOR OF PERFORMANCE IN 1969^a
(percentage distribution)

Countries Emphasizing	C a t e g o r y			
	Business Enterprise	Government	PNP	Higher Education
Business Enterprise:				
Belgium	65.6	15.2	0.3	18.9
UNITED STATES	58.6	21.1	7.6	12.6
UNITED KINGDOM	57.7	23.0	3.3	16.0
Italy	51.4	22.3	...	26.3
FRANCE	50.9	38.8	1.2	9.0
Norway	44.7	27.8	0.6	26.9
Sweden	43.3	41.0	0.1	15.5
Government:				
Ireland	11.6	75.9	1.2	11.3
Greece	23.7	64.0	2.3	10.1
Spain	37.0	60.5	--	2.5
Canada	29.8	53.2	.	16.9 ^b
Denmark	32.9	43.8	7.6	15.7

a. Or nearest year available.

b. Includes both PNP and Higher Education.

Source: Table E-4.

In two states, Higher Education conducts more than 25 percent of all applied research. As for the Government sector, its share is about 40 percent in two states and more than 20 percent in another four.

c. Experimental Development. This type of activity is usually performed almost entirely within the Business Enterprise sector. In no state did the share which this sector accounted for in 1969 fall below 50 percent (see Table 23). In the United States, the United Kingdom, and four smaller states, it absorbed more than 80 percent of total intramural expenditures on experimental development. In another three states, including France, its share was 75 percent or more of the total.

Table 23

PERCENTAGE OF EXPERIMENTAL DEVELOPMENT PERFORMED
IN BUSINESS ENTERPRISE SECTOR IN 1969^a

> 80		70-79		60-69		50-59	
US	86	FRANCE	75				
UK	83						
Belgium	91	Denmark	79	Canada	68	Spain	59
Sweden	89	Norway	78			Greece	57
Italy	86					Ireland	52
Netherlands	86						

a. Or nearest year available

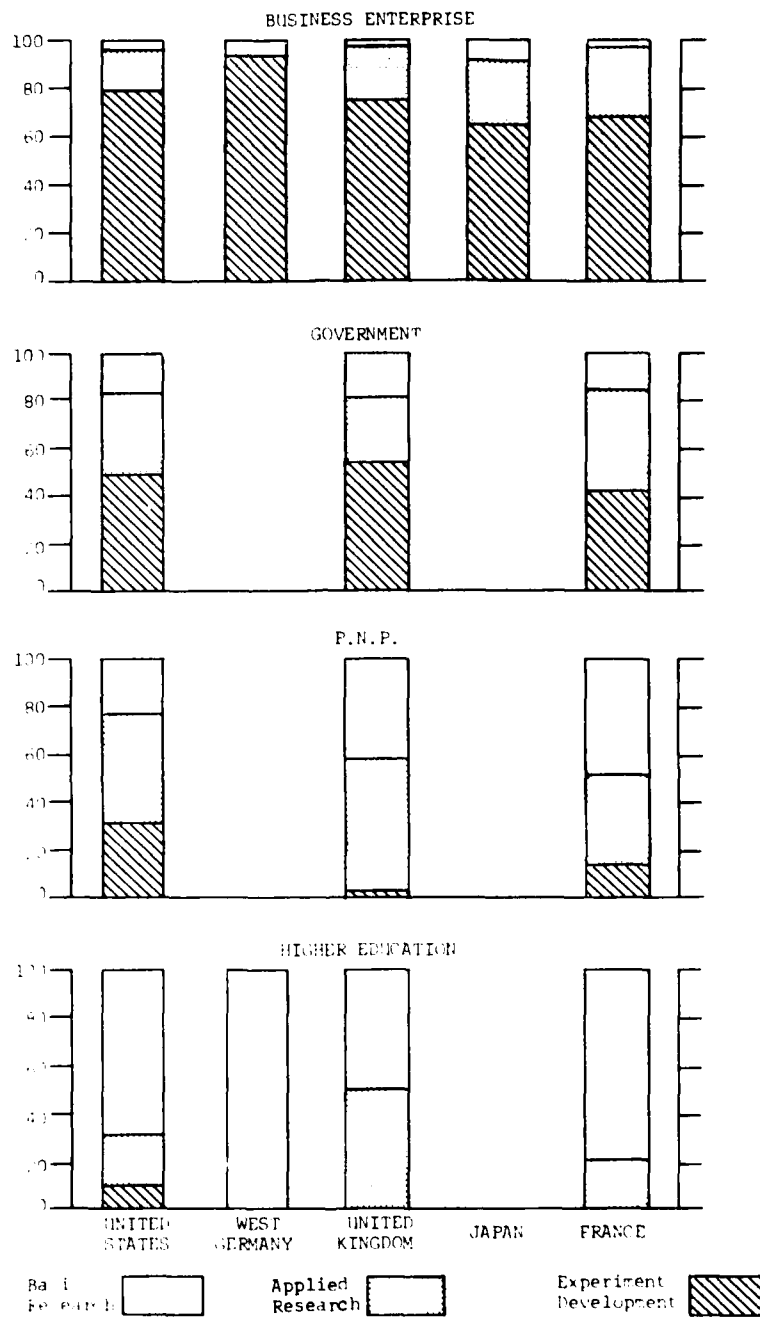
Source: Table E-5.

The only other sector in which a significant proportion of this type of activity was conducted was Government, which performed 25 percent of all experimental development in France and Canada, about 40 percent in Greece and Spain, and slightly less than 50 percent in Ireland (see Table E-5).

3. Types of Activity Carried Out in each Sector of Performance

The OECD has assembled at least some data on this subject for all five of the Major States. As displayed in Figure 20, in 1969 the Business Enterprise sector tended to concentrate on experimental development, Government pursued a mix of experimental development and applied research, while Private Non-profit institutions and Higher Education focused on basic and applied research.

a. Business Enterprise. As Table 24 demonstrates, experimental development accounts for a very large proportion of the R&D conducted in the Business Enterprise sector. In fifteen out of the eighteen responding nations, its share in 1969 was 60 percent or more of the total for the sector. All five of the Major States fell into this category, with the degree of concentration being highest in West Germany (more than 90 percent) and the United States and the United Kingdom (more than 75 percent).



NOTE: Experimental Development in the West German Business Enterprise sector includes Applied Research.

Source: Tables E-6 through E-9.

Figure 20. TYPES OF ACTIVITY CARRIED OUT IN EACH SECTOR OF PERFORMANCE IN 1969 (percentage distribution)

Table 24

PERCENTAGE OF BUSINESS ENTERPRISE R&D EXPENDITURES
DEVOTED TO EXPERIMENTAL DEVELOPMENT IN 1969^a

>80	70-79		60-69		40-59	<40
WEST GERMANY 93	US	79	FRANCE	68		
	UK	76	JAPAN	64		
Switzerland 86	Austria	74	Canada	68	Italy 58	Spain 11
Sweden 84	Norway	71	Finland	65	Belgium 43	
Ireland 82	Netherlands	70	Greece	60		
Denmark 82						

a. Or nearest year available

Source: Table E-6.

In some countries, however, sizable shares of Business R&D expenditures were devoted to other types of activity. Applied research absorbed more than 20 percent of the sector total in five states, including the United Kingdom, France, and Japan; more than 30 percent in three states; almost 50 percent in Belgium; and 80 percent in Spain. Even basic research accounted for more than 20 percent in two states. (See Table E-6.)

b. Government. In this sector, intramural expenditures tend to be spread more evenly among the three types of activity. Applied research ranked first in eight of the thirteen responding countries, basic research ranked first in one, and experimental development ranked first in four, including all three of the Major States represented (see Table 25). Yet in no country did the share of the principal type of activity exceed 61 percent; in every country one or both of the other two types of activity consumed very substantial shares of the sector total. Nevertheless, it is true that Government concentrated on applied research and experimental development.

c. Private Non-profit Institutions. In the PNP sector, as in the Government, R&D expenditures are rarely concentrated heavily on one type of activity. Table 26 shows that, among the eleven

Table 25

GOVERNMENT R&D BY TYPE OF ACTIVITY IN 1969^a
(percentage distribution)

Countries Emphasizing	Type of Activity		
	Basic Research	Applied Research	Experimental Development
Basic Research: Italy	43	37	19
Applied Research:			
Spain	37	61	3
Sweden	4	60	36
Belgium	29	60	11
Ireland	1	58	42
Greece	22	56	22
Canada	17	55	28
Denmark	20	50	30
Norway	18	44	38
Experimental Development:			
UNITED KINGDOM	19	28	53
UNITED STATES	17	34	49
FRANCE	15	42	43
Finland	19	39	43

a. Or nearest year available.

Source: Table E-7.

responding member nations, basic research ranked first in five, including France; applied research ranked first in four, including the United Kingdom and the United States; and experimental development ranked first in two. Once again, one or both of the two non-dominant types of activity absorbed large shares of total intramural expenditures. In most countries, however, basic and applied research constituted the basic foci of interest for PNP institutions.

d. Higher Education. With this sector we encounter once again the pattern of distribution encountered in the Business Enterprise sector: most intramural expenditures are concentrated on one type of activity, in this case, basic research. In all but two of the

Table 26

PRIVATE NON-PROFIT R&D BY TYPE OF ACTIVITY IN 1969^a
(percentage distribution)

Countries Emphasizing	Type of Activity		
	Basic Research	Applied Research	Experimental Development
Basic Research:			
Netherlands ^b	75.1	.	24.9
Belgium	73.2	26.8	--
Sweden	61.9	19.0	19.0
Norway	55.6	34.9	9.5
FRANCE	49.2	38.3	12.5
Applied Research:			
UNITED KINGDOM	41.7	56.6	1.7
Greece	34.6	50.1	15.3
Ireland	41.1	48.5	10.4
UNITED STATES	22.9	46.1	31.0
Experimental Development:			
Finland	17.1	32.3	50.6
Denmark	19.0	38.6	42.3

a. Or nearest year available.

b. Includes both Basic and Applied Research.

Source: Table E-8.

fourteen responding countries, this type of activity consumed 50 percent or more of the sector totals for 1969 (see Table 27). All four of the Major States represented conformed to this pattern. The degree of concentration was greatest in West Germany and the Netherlands and only slightly less in France, Belgium, Denmark, and Sweden.

It must be noted, however, that in some countries applied research played an important secondary role in the R&D activities of the Higher Education sector. This type of activity accounted for 20 percent or more of the sector total in six states, more than 30 percent in two states, and more than 40 percent in three states. In Greece, it accounted for more than one-half.

Table 27

PERCENTAGE OF HIGHER EDUCATION R&D EXPENDITURES
DEVOTED TO BASIC RESEARCH IN 1969^a

> 80	70-79	60-69	50-59	40-49
WEST GERMANY 100	FRANCE 79	US 69	UK 50	
Netherlands 86 ^b	Belgium 73	Ireland 66	Canada 59	Greece 48
	Denmark 71		Spain 59	Italy 43
	Sweden 70		Norway 59	

a. Or nearest year available.

b. Includes both Basic and Applied Research.

Source: Table E-9.

F. SUMMARY

Before proceeding to Chapter IV and an analysis of the objectives governmental R&D expenditures are intended to serve, the principal findings of the foregoing discussion will be briefly recapitulated.

1. Gross Expenditures on Research and Development (GERD)

GERD in the OECD area totaled \$41 billion in 1969, almost all of which originated in the five Major States. The twenty countries responding to the OECD's 1969 survey fell into three categories:

(a) In the United States, expenditures on R&D came to \$26.6 billion, a sum equivalent to 65 percent of all research and development conducted in the OECD area.

(b) Among the Big Four (France, West Germany, Japan, and the United Kingdom), GERD ranged from \$2.4 to \$2.7 billion. The collective R&D expenditures of these four states (\$10.4 billion) accounted for 25 percent of the financial support for research and development in the OECD area.

(c) The Smaller States generated less than 10 percent of area GERD. In none of these fifteen countries did spending rise above \$1 billion.

In all of the Major States, GERD ranged between 1.5 and 2.8 percent of gross national product. In thirteen out of the fifteen smaller states, the percentage was 1.4 percent or less.

Between 1961 and 1969, total spending on R&D in the OECD doubled. National R&D expenditures by the Major States expanded at different rates of growth over these eight years: relatively slowly in the United States and the United Kingdom, and fairly rapidly in France, Japan, and West Germany. As a result of these trends, the US share of OECD GERD contracted from three-quarters to two-thirds of the total, while the share of the Big Four expanded from one-fifth to one-quarter. The relative positions of the Big Four also changed. In 1961, the United Kingdom was clearly far in the lead with a GERD at least twice as large as that of France, West Germany, or Japan. By 1969, all four countries were clustered close together--with the United Kingdom in last rather than first place and Japan on the verge of moving past France and West Germany.

2. Sources of Funds

In almost all of the nations surveyed in 1969, the Business Enterprise and Government sectors together supplied more than 90 percent of the funds allocated to R&D. The remaining ten percent was supplied by the Higher Education, Private Non-profit, and Abroad sectors.

The responding member nations of the OECD may be divided into two groups, depending on whether it was the Government or Business Enterprise sector that supplied more than half of GERD. The group of "government-funded" countries was composed of nine states, including France, the United States, and the United Kingdom. The last two countries had Business Enterprise sectors that spent large sums on R&D, but the Government sector had ambitious R&D programs and spent even more, both in absolute terms and as a percentage of GNP and total Government resources. In France, Canada, and Norway, the Government was also heavily involved in R&D, but Business provided relatively little support. Finally, in Portugal, Greece, Ireland, and Spain, Government spent comparatively little on R&D, but Business Enterprise spent even less.

There were seven "private-funded" countries, including West Germany and Japan. In those two states and the Netherlands, Business

Enterprise expenditures were relatively high, both in absolute terms and as a percentage of GNP. Government spending was comparatively low in the first two but high in the Netherlands. In Sweden, Belgium, Italy, and Austria, Business spending on R&D was moderate in absolute and relative terms, but Government spending was even lower.

3. Sectors of Performance

The performance of R&D is much less concentrated than is the funding. In almost half of the responding countries, the combined shares of GERD consumed in the Business Enterprise and Government sectors were less than 80 percent in 1969. The next most important sector of performance was Higher Education.

In all of the five Major States, the Government sector performed far less, both absolutely and as a percentage of GERD, than it generated. Only in the United Kingdom and France was as much as one-quarter of R&D conducted in this sector. The four countries that allocated one-half or more of their national R&D effort to Government were all small, relatively underdeveloped countries with weak private enterprise sectors. Out of nineteen responding nations, twelve, including all of the Major States, had most of their research and development conducted in the Business Enterprise sector.

4. Inter-sectoral Transfers

Government finances from its own funds all or almost all of the R&D it performs and is the only important outside contributor to Business Enterprise R&D. In addition, it is usually the principal source of support for research and development conducted in Private Non-profit institutions and finances the great bulk of Higher Education R&D. Thus, Government is the source of most of the funds moving between sectors. In most countries, Government R&D expenditures are usually concentrated in one or two sectors of performance, of which the primary one tends to be itself and the other tends to be Higher Education.

5. Types of Activity

The thirteen responding OECD member nations may be divided into two roughly equal groups: one emphasizing basic and applied research and the other, experimental development. In general, however, most of the countries surveyed in 1969 devoted the largest portion of their R&D resources to experimental development, a smaller share to applied research, and the smallest share to basic research.

While most basic research is performed in the Higher Education sector and most experimental development is performed in the Business Enterprise sector, significant portions of applied research are conducted in the Business Enterprise, Higher Education, and Government sectors. The latter, in fact, plays an important supporting role in the performance of all three types of activity.

As for the type of activity carried out in each sector of performance, Business Enterprise tends to concentrate on experimental development; Government pursues a mix of experimental development and applied research; while Private Non-profit institutions and Higher Education focus on basic and applied research.

IV

GOVERNMENT R&D OBJECTIVES IN OECD MEMBER NATIONS

Section A of the previous chapter was devoted to an examination of the overall level of funding of research and development in the member nations of the OECD. Sections B, C, and D examined the four sets of institutions involved in supporting or conducting R&D, first in terms of the distribution of gross expenditures by sources of funds and sectors of performance, and second in terms of the flow of funds between the sectors. In Section E, expenditures were analyzed by type of activity. With this chapter we begin to address an entirely different issue: that of the purposes which R&D expenditures are intended to serve.

Ideally, it would be desirable to have total national expenditures on research and development broken down by objective. Unfortunately, the OECD has been unable to obtain this information.¹ What it has assembled is a large body of statistics on governmental R&D objectives. This means that all R&D funded by Business Enterprise, Private Non-profit institutions, Higher Education, and Abroad had to be excluded from the analysis. Nevertheless, Government is one of the two most important sources of funds; it supports much of the R&D conducted in the other sectors; and it allocates large sums to such important objectives as defense, space, and nuclear R&D. The distribution of governmental R&D expenditures is also an important indication of what the policy concerns of the central government may be.

1. The OECD is, however, attempting to move in this direction. Survey of R&D in 1969, Vol. 5, pp. 91-103, contains experimental tables in which GERD is analyzed by objective for eight member countries, including Japan and France. Because of their very serious deficiencies (noted in the above source, on pp. 20-21), the data have not been used in this study.

The OECD collected data on governmental R&D objectives for twelve countries. These include all five Major States, five of the six smaller countries that ranked highest in terms of GERD (Canada, Italy, the Netherlands, Sweden, and Belgium), and two countries with relatively low levels of spending on R&D (Norway and Spain). For most of these states, a continuous time series was constructed running from 1961 to the early 1970s.² Trends, therefore, can be traced with much more confidence than was possible in Chapter III, where data usually were available only for the three years in which the large-scale OECD surveys were taken.

All the OECD data on expenditures by objectives were expressed in terms of 1961 US dollars. This has the disadvantage of making comparisons with Chapter III difficult, but it yields one major benefit: the effects of inflation are neutralized. The statistics on trends in R&D expenditures by governmental objective consequently reflect "real" changes over time much more accurately than do the statistics expressed in current US dollars on, say, trends in R&D expenditures by sectors of performance.

A few cautionary words remain to be said before the analysis proper begins. Discussions of how state funds are distributed among R&D objectives sometimes give the impression, perhaps inadvertently, that the priority given the objectives is a product of a conscious decision by some organ of government charged with determining and executing a "science policy" for the state or the entire nation. To some extent--and perhaps in some countries to a considerable extent--this is undoubtedly the case; but it is also true that the actual pattern in the distribution of governmental financial support for research and development often becomes apparent only in retrospect, after the expenditures have been made, recorded, and assembled by government statisticians. At the time that decisions are being made

2. For nine states, the series begins in 1961; for two, in 1962; and for one in 1965. It ends in 1969 for three, in 1970 for two, in 1971 for three, and in 1972 for four.

to spend certain amounts of money on certain R&D projects, higher officials may not be aware of what is being decided within the heterogeneous collection of agencies, bureaus, laboratories, research councils, or ministries over which they preside, in part because research and development expenditures are often not identified as such in budgets and, if they are identified, often are not described in terms of the functions they are intended to fulfill. The OECD observes, with respect to this problem, that

in virtually none of the countries studied does there exist either a single R&D budget laid out by function or a pluri-annual plan for science in which R&D is viewed in relation to overall economic objectives.³

Thus, R&D statistics can be a useful tool for decisionmakers by revealing the actual priority given to various national objectives as reflected in data on past expenditures. This information can then be compared with the government's stated science policy to see whether the goals assigned the highest priority are actually receiving the most support and whether other objectives, which the government may have intended to deemphasize, are receiving more support than they should. Corrective action can then be taken. In the absence of such statistics, the actual scope of the government's R&D effort may not be apparent to decisionmakers.⁴

The OECD has formulated a set of fourteen objectives under which all Government R&D expenditures have been subsumed. These objectives, in turn, have been organized into five groups.⁵ The overall scheme of classification is reproduced below.

3. OECD, Changing Priorities for Government R&D, p. 111.

4. This subject is discussed at greater length in *ibid*, pp. 1-7 and pp. 109-12.

5. *Ibid*, p. 120. For a definition of each objective and a discussion of the classification, see pp. 118-29.

<u>Groups</u>	<u>Objectives</u>
I National Security and Big Science	Defense Civil Space Civil Nuclear
II Economic Development	Agriculture Mining and Manufacturing Economic Services
III Community Services	Health Pollution Public Welfare Other Community Services
IV Advancement of Science	Advancement of Research Advancement of Science via General University Funds
V Other Activities	Developing Countries Miscellaneous

The organization of this chapter parallels the organization of groups and objectives. The analysis begins with a broad overview of Government R&D priorities as reflected in the allocation of state funds among the five groups and fourteen objectives. Each group and its constituent objectives are then considered in turn. In the analysis, a great deal of emphasis has been placed on the first group, National Security and Big Science, and particularly on the single objective of Defense.

A. THE DISTRIBUTION OF GOVERNMENT R&D EXPENDITURES AMONG THE FIVE GROUPS OF OBJECTIVES

1. Total Government Spending on R&D

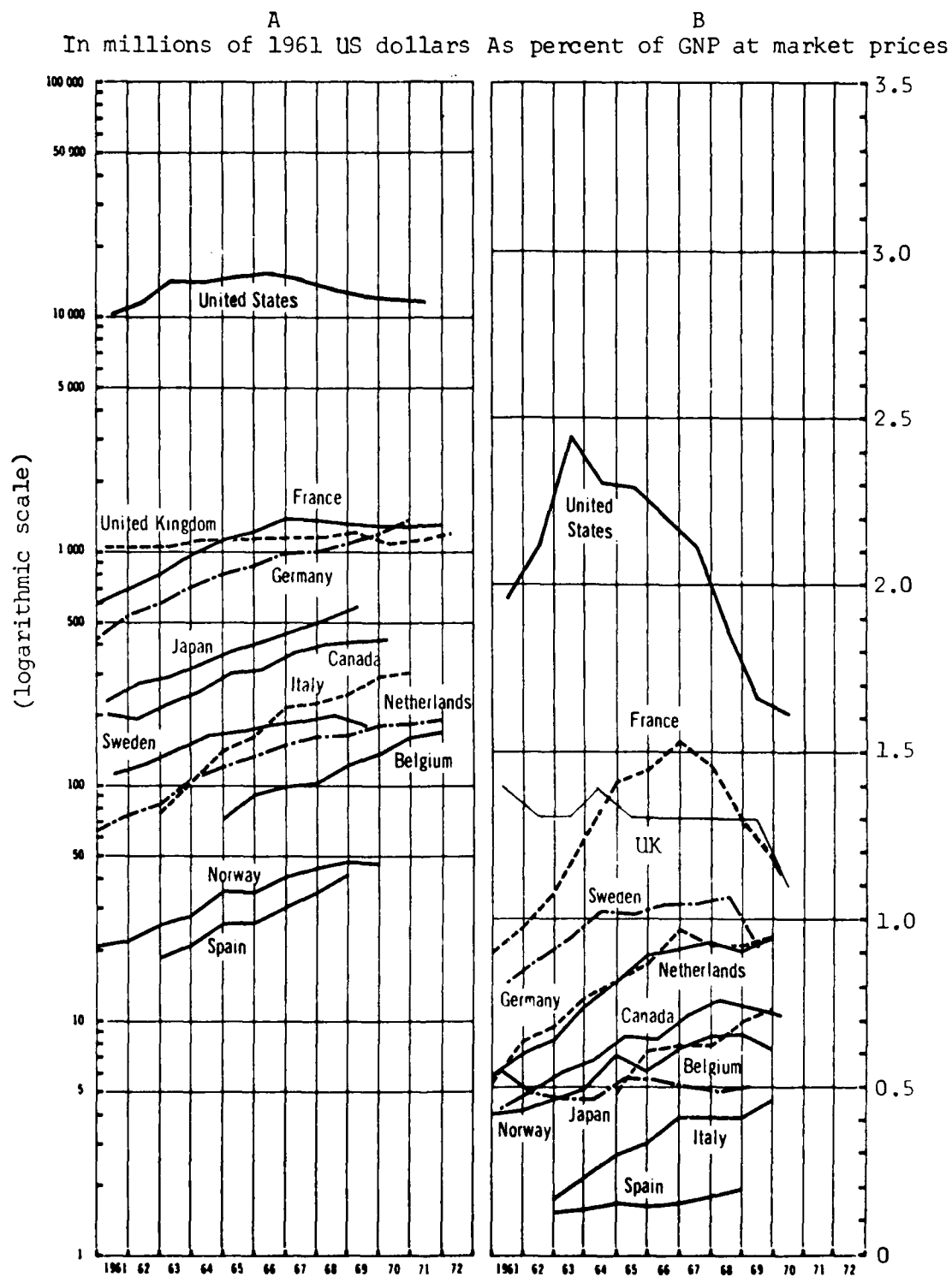
This chapter is based on statistics on Government R&D expenditures that are different from those used in the preparation of Chapter III.B, which dealt with sources of R&D funds. Although in both sections the data were drawn from OECD publications, Chapter III.B was based on materials published between 1971 and 1973, whereas the source material

for this section was published in mid-1973.⁶ It is not simply a matter of the earlier data being presented in terms of current US dollars and the latter being presented in terms of 1961 US dollars. A comparison of Tables B-2 and F-1 reveals that there are discrepancies in the figures on total Government R&D expenditures for 1961. Moreover, data on the individual objectives are available in 1961 US dollars from both sets of sources. A comparison of these figures reveals very substantial differences in the expenditures attributed to each state. In light of these facts, it seems clear that the most recent OECD publication on governmental objectives has refined and improved the data presented in earlier publications.

An OECD graph depicting total Government R&D funding in 1961 US dollars and as a percentage of gross national product is reproduced as Figure 21.⁷ With the appropriate adjustments having been made in Chart A of Figure 21 to remove the effects of inflation, the tendency toward a leveling off of Government expenditures in France and the United Kingdom and toward a decline in the United States emerges clearly. Expenditures in West Germany and Japan, in contrast, continued to climb throughout the 1960s. Comparing the situation in 1970, as shown in Table 28, with that portrayed earlier in Table 5 (Chapter III) for 1969, we find that the United States and Japan retain their positions as first and last among the five Major States, but that West Germany moves from fourth to second place, ahead of France and the United Kingdom. Within the group of smaller OECD member nations, the rank order changes very little.

6. The data for the Government sector in Chapter III.B were drawn from OECD, R&D Trends and Objectives; R&D Trends and Objectives, Appendix; and Survey of R&D in 1969, Vols. 2 and 5 (1971-73). The data on government spending used in this section were drawn from Changing Priorities for Government R&D (July 1973).

7. It is important to note that the scale used in Chart A of Figure 24 and a number of similar charts in this chapter is logarithmic. Supporting data will be found in Tables F-1 and F-2.



Source: OECD, Changing Priorities for Government R&D, Graph A, p. 171. See also Tables F-1 and F-2.

Figure 21. TOTAL GOVERNMENT R&D FUNDING

Table 28

GOVERNMENT EXPENDITURES ON R&D IN 1971^a
(in millions of 1961 US dollars)

>2000	1000-1999	100-999	<100
UNITED STATES 11,680	WEST GERMANY 1,420 FRANCE 1,350 UNITED KINGDOM 1,270	JAPAN 590	
		Canada 440 Italy 300 Netherlands 190 Sweden 180 Belgium 170	Norway 47 Spain 42

a. Or nearest year available.

Source: Table F-1.

Chart B of Figure 21 shows that Government spending on R&D as a percentage of GNP is falling in the United States, the United Kingdom, and France, is leveling off in West Germany, but is still climbing in Japan. A comparison of Tables 7 and 29 reveals some changes in the

Table 29

GOVERNMENT EXPENDITURES ON R&D AS A
PERCENTAGE OF GNP IN 1970^a

High >1	Significant 0.8-1	Moderate 0.5-0.7	Low 0.3-0.5	Very Low <0.3
UNITED STATES 1.6 FRANCE 1.2 UNITED KINGDOM 1.1	WEST GERMANY 0.9		JAPAN 0.5	
	Netherlands 0.9 Sweden 0.9	Canada 0.7 Belgium 0.7 Norway 0.6	Italy 0.5	Spain 0.2

a. Or nearest year available.

Source: Table F-2.

categories into which the responding countries fall. The United States, the United Kingdom, and France still rank as countries devoting a "high" proportion of their national wealth to government-funded research and development. Japan, too, remains in its former "low" position. West Germany, however, moves from the "moderate" to the "significant" category. Among the smaller states, Canada moves down one level, Sweden moves up one, and Belgium moves up two.

2. Summary Comparison of Government Allocations to R&D Objectives and Groups

A "composite ranking" of all fourteen R&D objectives has been constructed by the OECD for the twelve nations represented in this study. The composite yields a picture of the general order of importance assigned to the fourteen objectives in the OECD area. The results are displayed in Figure 22, which also lists each objective under the appropriate group. The objectives that rank first, second, and third are, respectively, Civil Nuclear, Mining and Manufacturing, and Defense. The next three are, in decreasing order of importance, Advancement of Science via General University Funds; Agriculture, Forestry, and Fisheries; and Advancement of Research.

Figure 23 ranks the groups in the order of their importance in Government R&D spending. Each country appears in five cells of the matrix, its position indicating the rank of a given group in that country's governmental R&D effort in 1961. The arrows show shifts in priority over the succeeding decade.⁸

In general, it appears that in the twelve states investigated the rank order of groups in 1971 tended to be as follows:

1. Advancement of Science (Group IV)
2. National Security and Big Science (Group I)
3. Economic Development (Group II)
4. Community Services (Group III)
5. Other Activities (Group V)

8. Figure 23 is derived from Table F-4. This table and Table F-3 were specially prepared for this study from the statistics on objectives assembled by the OECD.

I National Security and Big Science	II Economic Development	III Community Services	IV Advancement of Science	V Other Activities
1. Civil Nuclear	2. Mining and Manufacturing		4. Advancement of Science via General Univer- sity Funds	
3. Defense	5. Agriculture, Fisheries, and Forestry	7. Health	6. Advancement of Research	
8. Civil Space	9. Economic Services	10. Public Welfare		
		11. Other Community Services		
		12. Pollution		
				13. Miscellaneous
				14. Developing Countries

NOTE: The "composite ranking" was constructed by the OECD by ranking the amounts spent on the objectives within each country in 1969 from 1 to 14, adding the rank attributed to each objective in all twelve countries, and then ranking these "sums of the ranks."

Source: OECD, Changing Priorities for Government R&D, p. 164.

Figure 22. COMPOSITE RANKING OF FOURTEEN OECD OBJECTIVES
IN 1969: DISTRIBUTION BY MAJOR GROUP

Group	P R I O R I T Y				
	First	Second	Third	Fourth	Fifth
I. National Security and Big Science	UNITED STATES UNITED KINGDOM FRANCE Sweden WEST GERMANY Italy Canada	Spain Belgium Netherlands Japan Canada	Netherlands Norway JAPAN		
II. Economic Development	Spain Norway JAPAN Netherlands Canada	Belgium UNITED KINGDOM FRANCE Italy Sweden WEST GERMANY UNITED STATES			
III. Community Services	UNITED STATES		Netherlands Sweden Norway JAPAN Italy Spain Belgium Canada	WEST GERMANY FRANCE UNITED KINGDOM	
IV. Advancement of Science	JAPAN Netherlands Norway Belgium	Sweden UNITED KINGDOM FRANCE Italy WEST GERMANY	Spain Canada	UNITED STATES	
V. Other Activities			WEST GERMANY Netherlands JAPAN Belgium Italy UNITED STATES Sweden Spain Norway FRANCE UNITED KINGDOM Canada		

3. Or nearest year available. Note that countries are ranked within categories according to the size of the share of their Government's expenditures on a given Group in total Government R&D expenditures in the last year for which data are available.

Source: Table F-4 and OECD, Changing Priorities for Government R&D, p. 176.

Figure 23. RANK OF MAJOR GROUPS IN GOVERNMENT R&D FUNDING: SHIFTS BETWEEN 1961 and 1971^a

Between 1961 and 1971, the position of National Security and Big Science weakened. In 1961, it ranked first in seven countries, including all of the Major States except Japan, and second in another two. By 1971, however, it ranked first in only four. In West Germany and two smaller states, it slipped from first to second; and in Belgium it dropped from second to fourth.

Advancement of Science, on the other hand, improved its position, so that by the early 1970s it had probably supplanted National Security and Big Science as the most important group. Between 1961 and 1971, West Germany and Italy joined Japan and three smaller states in according this group the highest priority. In three other states, including France and the United Kingdom, it ranked second.

Whatever the relative position of Groups I and IV, there is no doubt about the order in which the remaining three groups were ranked. In 1971 as in 1961, seven out of twelve countries, including four of the Major States, ranked Economic Development third. Seven countries in 1961 and eight in 1971, including in that year three Major States, ranked Community Services fourth. As for Other Activities, its position, already low in 1961, was even lower by 1971, when it ranked last in eleven out of twelve countries.

The Major States appeared to fall into two categories in 1971. In the first, which contained the United States, the United Kingdom, and France, the greatest emphasis was placed on National Security and Big Science, followed by Advancement of Science (for France and the United Kingdom) or Community Services (for the United States). In the second category, which contained Japan and West Germany, primary emphasis was placed on Advancement of Science and secondary emphasis on National Security and Big Science (in West Germany) or Economic Development (in Japan). Thus, in four out of the five Major States, Groups I and IV ranked first or second.

This may be the place to discuss certain data problems that bear on the reliability of the preceding generalizations, particularly with respect to the seemingly high priority placed on Advancement of Science (Group IV) in Japan, the Netherlands, Italy, and West Germany. The statistics used in the preparation of Figure 23, in the discussions

of the individual objectives which follow later in this chapter, and in Series A of Table 30 are derived from reports forwarded to the OECD by national authorities who included in Group IV certain research in the agricultural and medical sciences financed by the Ministry of Education. In Table 30, Series B reflects adjustments in the national data made by the OECD with the purpose of reassigning to the appropriate objective expenditures for this kind of research. It will be seen that the share of Group III, which includes the objective "Health," expands, while that of Group IV contracts, often quite sharply. (Note that the effect on Group II, which includes the objective "Agriculture," is not shown.) In Japan, to take the most dramatic example, the share of Advancement of Science in 1971 falls by 17 percentage points from 61 to 44 percent of total Government R&D expenditures, while that of Community Services expands by 13 percentage points from 4 to 17 percent. Similar, although less dramatic, shifts occur in each of the eight states for which the OECD has recomputed the data. Thus, it would seem only prudent to retain a certain degree of skepticism when confronted with "hard" data on priorities among governmental objectives.

Figure 23 was derived from data on the share of each group in total Government R&D expenditures. Figure 24 presents these data in a more precise form, thereby making it possible to refine further judgments on relative priorities. The most striking trend visible in Figure 24 is the precipitous decline in the share of state R&D funds devoted to National Security and Big Science, a decline that was particularly sharp in those states that assign the highest priority to this group of objectives: the United States, the United Kingdom, France, and Sweden. Between 1961 and 1971, each of these four countries increased the shares allocated to Groups II, III, and IV. Even so, in 1971, each of the four still gave Group I a very large proportion of all Government expenditures on research and development: 76 percent in the United States, 54 percent in the United Kingdom, 49 percent in France, and 42 percent in Sweden. Japan and West Germany, in contrast, gave first priority to Advancement of Science but allocated smaller shares of the state R&D budget to this group: 61 and 41 percent, respectively.

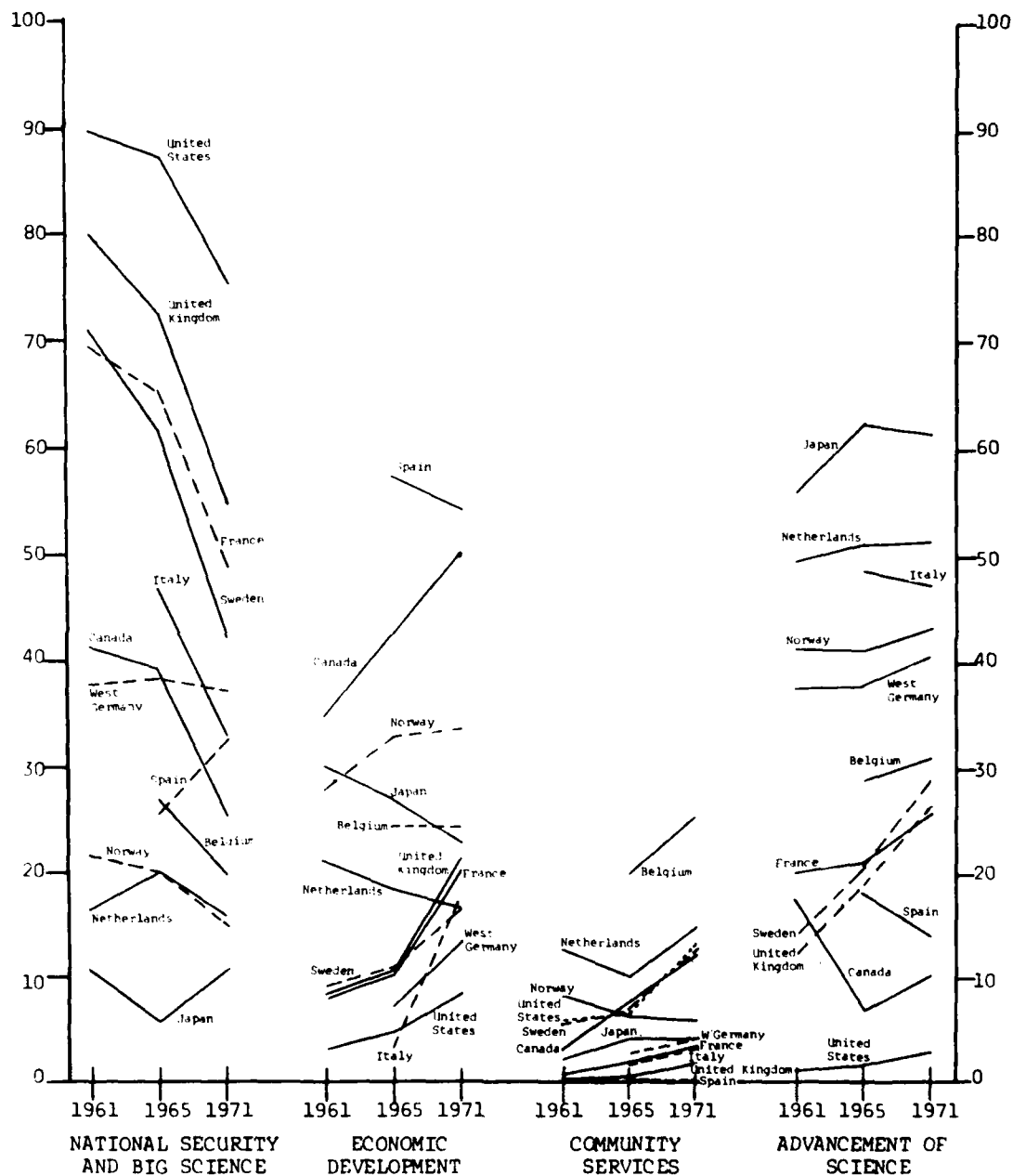
PERCENTAGE OF TOTAL GOVERNMENT R&D FUNDS DEVOTED TO GROUPS III AND IV IN SELECTED OECD MEMBER NATIONS

a. In Series A, research financed by the Ministry of Education in the agricultural and medical sciences is included in Group IV under the objective "Advancement of Research." In Series B, these expenditures are redistributed; R&D in the medical sciences is now included in Group III under the objective "Health." The impact on the objective "Agriculture" in Group II is not shown.

b. For 1971, read 1969.

c. For 1971, read 1972.

d. For 1971, read 1970.



Source: Table F-4.

Figure 24. GOVERNMENT FUNDING OF MAJOR GROUPS OF OBJECTIVES AS A PERCENTAGE OF TOTAL GOVERNMENT R&D EXPENDITURES

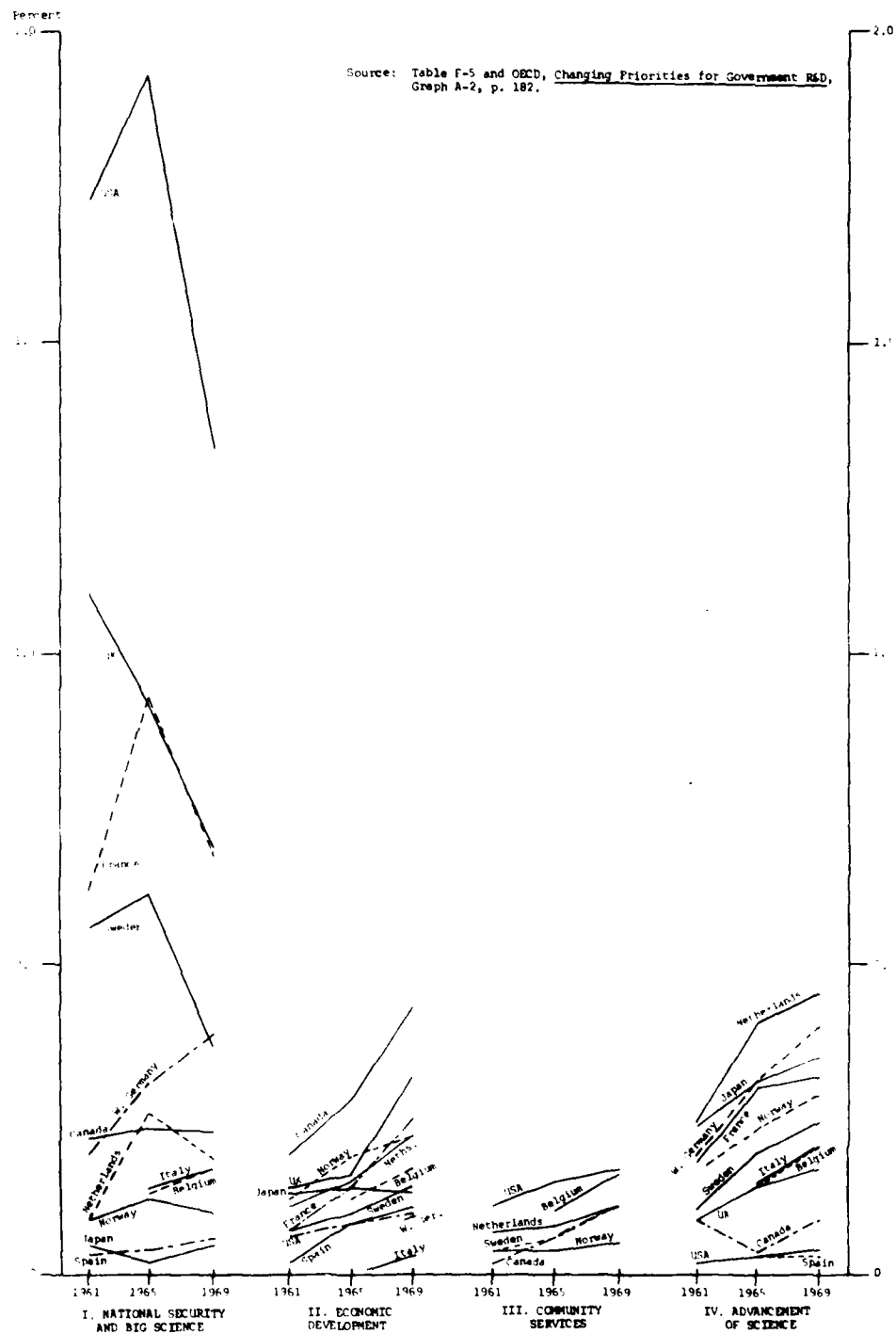


Figure 25. GOVERNMENT R&D FUNDING OF MAJOR GROUPS OF OBJECTIVES AS A PERCENTAGE OF GNP IN 1961, 1965, AND 1969

The OECD has used one other index of the relative priority assigned by its member states to the groups of objectives: the ratio of expenditures on each group to gross national product. This ratio is shown in Figure 25 for 1961, 1965, and 1969. Several conclusions can be drawn from this chart. First, the rank order of the Groups appears to be I, IV, II, III, and V.⁹ Second, there is a much greater range between countries in the degree of support given National Security and Big Science (Group I) than there is for the other three groups, where the nations surveyed tend to cluster closer together. This suggests that there is a greater degree of consensus regarding the share of the national wealth that should be devoted to research and development in Groups II, III, and IV than there is concerning the share to go to Group I. Third, in Figure 25, as in Figure 24, the relative position of National Security and Big Science in the countries that funded it most heavily is seen to be eroding rapidly.

B. GROUP I: NATIONAL SECURITY AND BIG SCIENCE

1. Overview

The share of total Government expenditures on research and development devoted to each of the three constituent objectives of Group I--Defense, Civil Nuclear, and Civil Space--is shown in Table 31 for 1961 and 1971.¹⁰ This permits an assessment both of the relative importance assigned to these three objectives and of changes in priorities that occurred in the ten years after 1961.

At the highest and least precise level of generalization, it appears that the Major States tended to emphasize Defense over Civil Nuclear R&D, that the smaller countries tended to give a higher priority to Civil Nuclear than to Defense, and that both sets of states

9. Group V, Other Activities, does not appear on either Figure 24 or Figure 25 because it absorbs such a small share of both total Government R&D expenditures and gross national product. It receives so little support from any country that it may be safely neglected.

10. For complete data on Group I, see Tables F-6 and F-7.

Table 31

CONSTITUENT OBJECTIVES OF GROUP I AS A PERCENTAGE OF TOTAL
GOVERNMENT R&D FUNDING, 1961 AND 1971

Country	O B J E C T I V E S					
	Defense		Civil Nuclear		Civil Space	
	1961	1971 ^a	1961	1971 ^a	1961	1971 ^a
Major States:						
UNITED STATES	71	53	7	5	12	18
UNITED KINGDOM	65	44	15	9	1	2
FRANCE	44	28	25	15	1	7
WEST GERMANY	22	15	16	17	--	7
JAPAN	4	2	7	8	...	1
Other OECD Nations:						
Sweden	47	31	24	10	--	1
Italy ^b	7	4	43	23	3	6
Spain ^b	4	8	18	17	4	7
Canada	22	11	19	13	...	1
Belgium ^c	2	1	20	16	5	3
Netherlands	4	4	12	8	--	3
Norway	7	6	15	8	--	1

a. Or nearest year available.

b. For 1961, read 1963.

c. For 1961, read 1965.

Source: Tables F-9, F-11, and F-13.

tended to assign a much lower priority to Civil Space. More specifically, in 1971 the governments of the United States, the United Kingdom, France, and Sweden allocated to Defense from one-quarter to one-half of all state R&D expenditures, a proportion much larger than that devoted to Civil Nuclear. West Germany and Canada in 1971 assigned a moderate and roughly equal priority to Defense and Civil Nuclear. Japan and five smaller states gave clear priority to Civil Nuclear over Defense, while Italy allocated almost one-quarter of all state R&D spending toward the former objective. With the exception of the United States, every one of the countries surveyed channeled more government funds into Civil Nuclear than into Civil Space R&D.

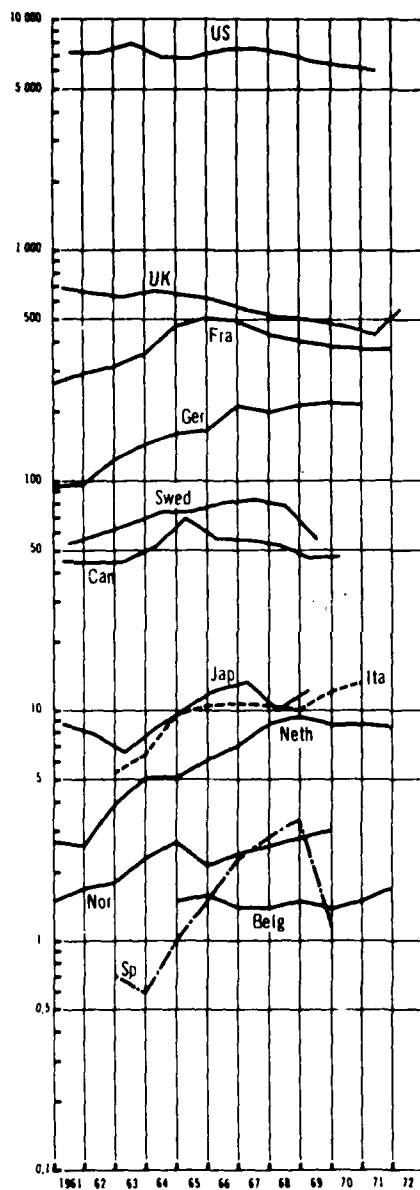
Over the decade under investigation, the share of both Defense and Civil Nuclear tended to contract, while that of Civil Space tended to expand. In ten out of the twelve states, the relative importance of both Defense and Civil Nuclear decreased between 1961 and 1971, with the difference that the share of the latter in 1961 tended to be much lower and the decrease tended to be much less dramatic. As for Civil Space, it began the 1960s with a very small share of Government R&D funds (little or nothing in half the states surveyed) and by 1971, even after years of steady growth, still accounted for only 7 percent or less of the total in eleven out of the twelve countries. The exception was the United States, where it absorbed almost one-fifth of Government spending on research and development.

2. Defense

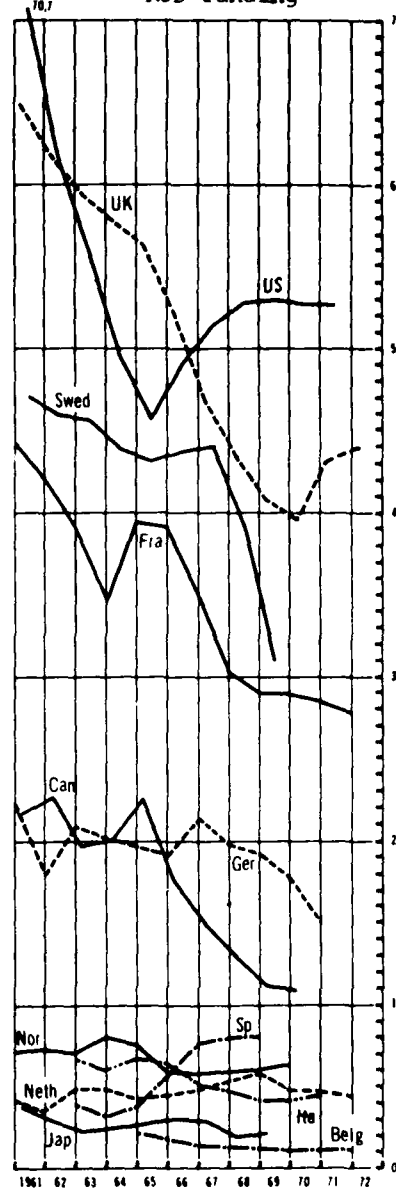
Figure 26 consists of two chart, which together convey the most essential information about trends in governmental expenditures on Defense. In Chart A, US spending is seen to be very high relative to the other states, but tending to decline.¹¹ It peaked at \$7.9 billion in 1963, declined, peaked again in 1967 at \$7.7 billion, and

11. A continuous time-series for spending on this objective in all twelve states will be found in Table F-8.

A
In millions of 1961 US dollars



B
As percent of total government R&D funding



Source: OECD, Changing Priorities for Government R&D, Graph B, p. 186. See also Tables F-8 and F-9.

Figure 26. GOVERNMENT FUNDING OF DEFENSE R&D

then declined again, falling steadily to \$6.2 billion in 1971. The United Kingdom and France ranked second and third in terms of spending. Expenditures in the former decreased during the 1960s, reached a low of \$390 million in 1971, and then rebounded to \$560 million in the following year. Expenditures in France, in contrast, rose during the early 1960s, reached a high of \$500 million in 1966, and then gradually declined to \$370 million in 1972. West Germany's expenditures rose to more than \$200 million in 1967 and remained more or less at that level through 1971. No other state devoted as much as \$90 million to Defense R&D. In most countries, expenditures on this objective increased in the first half of the decade and stabilized or decreased in the second half.

In those states that allocated the largest percentage of Government R&D funds to Defense, the share devoted to this objective tended to contract; in those states in which the percentage was smallest, the share tended to remain comparatively stable (see Chart B, Figure 26).¹² Although there were fluctuations in the trend lines for the six states that placed the greatest emphasis on Defense R&D, the downward tendency is unmistakable. Between 1961 and 1971, the share of Defense in the United Kingdom fell by 21 percentage points; in France and Sweden, by 16 percentage points; and in Canada and West Germany, by 11 and 7 points, respectively. In the United States, after a drastic decline from 71 percent of Government R&D spending in 1961 to a low of 46 percent in 1965, the share of Defense R&D expanded to 53 percent in 1968, at which level it remained for the following three years.

a. Degree of "Defense Orientation." For this one objective, the OECD expended an unusual amount of effort in analyzing the priority accorded it by the twelve nations surveyed. The OECD divided the twelve states into three groups--"defense R&D oriented" states, "moderate defense oriented" states, and "civil R&D oriented"

12. See Table F-9 for complete data.

states--on the basis of the priority they attached to the objective of Defense R&D. The results are shown in Table 32.

Table 32

RANK OF DEFENSE R&D AMONG ALL GOVERNMENT
R&D OBJECTIVES IN 1971^a

Rank	Defense R&D Oriented	Moderate Defense R&D	Civil R&D Oriented
1	UNITED STATES UNITED KINGDOM FRANCE Sweden		
3		WEST GERMANY	
4		Canada	
5			Spain JAPAN
6			Norway Italy
7			Netherlands
11			Belgium

a. Or nearest year available.

Source: OECD, Changing Priorities for Government R&D, pp. 206-207.

When countries are ranked according to the absolute amounts expended on Defense research and development in 1971, the three main clusters remain basically the same, although there are some changes in the rank order (see Figure 26 and Table 32). But given the wide range in the levels of GERD and of total government R&D expenditures, the absolute value of Defense R&D spending is an imprecise guide to what the OECD refers to as the "degree of defense orientation" in a given state. In an attempt to measure this quality, the Organization has developed four indicators.

The first of these has already been introduced in connection with the discussion of Chart B of Figure 26. This indicator--the share of Defense R&D expenditures in total Government R&D spending--is perhaps the most important of the four as an index of state R&D priorities.

As one might expect, the way in which the states are clustered in Table 33 is the same as that shown in Table 32. The four Defense R&D oriented countries fall into the "high" or "significant" percentage ranges, the moderate into the "moderate," the civil R&D oriented into the "low" or "very low." The only change in the rank order that needs to be mentioned is that Sweden replaces France in third place.

The distribution of states according to the second and third indicators--Defense R&D as a percentage of GERD and of GNP, respectively--is shown in Tables 34 and 35. Once again, the states cluster together in much the same fashion as they did in Table 32, the only deviation from the pattern being the relatively high share of GERD devoted to Defense in Spain.

As for the fourth and last indicator--Defense R&D as a percentage of total defense spending--the clusters remain the same, but the rank order among the defense R&D oriented countries is changed: France moves from third to first place, the United States drops from first to fourth, and Sweden moves up from fourth to third (compare Tables 32 and 36). More important than shifts in the rank order, however, is the fact that the defense R&D oriented states all allocated large and roughly equal proportions of their defense budgets--between 10 and 11 percent--to research and development. In West Germany and Canada, the shares were much smaller: 5.6 and 3.5 percent, respectively. No other state channeled as much as 2 percent of its defense expenditures into Defense R&D.

The remarkable consistency in the impressions conveyed by each of the four OECD indicators emerges with great clarity when the principal findings are brought together as they are in Table 37. The defense R&D oriented countries rank "high" or "significant" according to all four criteria, the moderate defense R&D countries tend to fall in the "moderate" category, while the civil R&D oriented countries generally rank "low" or "very low." At least in this one instance, therefore, there appears to be little need for caution in identifying a state in terms of its position relative to other states in the importance it attaches to research and development in the Defense area.

Table 33

INDICATOR 1: DEFENSE R&D AS A PERCENTAGE OF ALL
GOVERNMENT R&D FUNDS IN 1971^a

Percentage Range	Defense R&D Oriented	Moderate Defense R&D	Civil R&D Oriented
High: >40	UNITED STATES 53 UNITED KINGDOM 44		
Significant: 20-39	Sweden 31 FRANCE 28		
Moderate 10-19		WEST GERMANY 15 Canada 11	
Low: 5-9			Spain 8 Norway 6
Very Low: <5			Netherlands 4 Italy 4 JAPAN 2 Belgium 1

a. Or nearest year available.

Source: Table F-9.

Table 34

INDICATOR 2: DEFENSE R&D AS A PERCENTAGE OF GERD IN 1969^a

Percentage Range	Defense R&D Oriented	Moderate Defense R&D	Civil R&D Oriented
High: >30	UNITED STATES 30.6		
Significant: 20-29	UNITED KINGDOM 27.0 FRANCE 22.5 Sweden 20.9		
Moderate: 8-19		WEST GERMANY 10.0	Spain 8.6
Low: 5-7		Canada 6.0	
Very Low: <5			Norway 3.9 Netherlands 2.4 Italy 2.0 Belgium 0.8 JAPAN 0.7

a. Or nearest year available.

Source: Derived from Tables A-2 and F-8.

Table 35

INDICATOR 3: DEFENSE R&D AS A PERCENTAGE OF GNP IN 1968^a

Percentage Range	Defense R&D Oriented	Moderate Defense R&D	Civil R&D Oriented
High: > 0.5	UNITED STATES 0.89 UNITED KINGDOM 0.54		
Significant: 0.4-0.5	FRANCE 0.44 Sweden 0.40		
Moderate: 0.09-0.20		WEST GERMANY 0.20 Canada 0.09	
Low: 0.04			Netherlands 0.04 Norway 0.04
Very Low: < 0.04			Belgium 0.01 JAPAN 0.02

a. GNP at market prices (OECD National Accounts) adjusted to R&D fiscal years.

b. Data for Spain and Italy not available.

Source: OECD, R&D Trends and Objectives, Appendix, p. 55.

Table 36

INDICATOR 4: DEFENSE R&D AS A PERCENTAGE OF TOTAL DEFENSE SPENDING IN 1969^a

Percentage Range	Defense R&D Oriented	Moderate Defense R&D	Civil R&D Oriented
High: > 10	FRANCE 10.8 UNITED KINGDOM 10.7 Sweden 10.7 ^b UNITED STATES 10.1		
Significant: 5-10		WEST GERMANY 5.6	
Moderate: 3-5		Canada 3.5 ^b	
Low: 1-3			Netherlands 1.6 JAPAN 1.3 Norway 1.1
Very Low: < 1			Italy 0.5 Belgium 0.3

a. Data for Spain not available.

b. Data are for 1966.

Source: OECD, Changing Priorities for Government R&D, p. 205.

Table 37

INDICATORS OF DEFENSE ORIENTATION IN 1968-1971

Classes	Country	Government Funding of Defense R&D as a Percent of			
		1. All govt. R&D funds	2. GERD	3. GNP	4. All defense expenditures
Defense R&D Oriented	UNITED STATES	high	high	high	high
	UNITED KINGDOM	high	significant	significant	high
	FRANCE	significant	significant	significant	high
	Sweden	significant	significant	significant	high
Moderate Defense R&D	WEST GERMANY	moderate	moderate	moderate	significant
	Canada	moderate	low	moderate	moderate
Civil R&D Oriented	Spain	low	moderate	...	...
	Norway	low	very low	low	low
	Netherlands	very low	very low	low	low
	Italy	very low	very low	...	very low
	JAPAN	very low	very low	very low	low
	Belgium	very low	very low	very low	very low

Source: Tables 33 through 36.

b. The Place of Defense R&D in the National Defense Effort.

It might be supposed that a country's relative degree of defense R&D orientation is simply a reflection of the priority that it assigns to security matters in general. Table 36, which revealed the existence of a wide range in the shares of total defense spending devoted to Defense R&D, has already shown that there is reason to doubt this hypothesis. Table 38, on the other hand, which records the percentage of total government current expenditures absorbed by national defense in ten countries in 1969, suggests that defense R&D oriented countries do tend to devote a larger share of the national budget to security than do moderate defense R&D countries and that the latter tend to devote more to security than do the civil R&D oriented countries. There are,

Table 38

DEFENSE AS A PERCENTAGE OF TOTAL GOVERNMENT
CURRENT EXPENDITURES IN 1969

Percentage Range	Defense R&D Oriented	Moderate Defense R&D	Civil R&D Oriented
> 40	UNITED STATES 41.4		
25-30	FRANCE 28.5 UNITED KINGDOM 27.7		Italy 27.7
20-24	Sweden 21.4	Canada 21.7 WEST GERMANY 20.4	Netherlands 20.6
<20			Belgium 19.6 Norway 19.2

a. Data for Spain and Japan are not available.

b. Data are for 1966.

Source: OECD, Changing Priorities for Government R&D, p. 205.

however, two important differences that need to be noted and that, taken together, considerably reduce the plausibility of the notion that the degree of defense R&D orientation can be explained simply in terms of the degree of defense orientation. First, the boundaries between categories are not clear. In Table 38, the two moderate defense R&D countries are joined by one defense R&D oriented country (Sweden) and one civil R&D oriented country (the Netherlands) in a set of states spending between 20 and 22 percent of total Government expenditures on defense. Italy and the United Kingdom, civil and defense R&D oriented countries, respectively, allocate identical shares of the state budget to defense. Second, the range in the shares of defense spending in total Government spending is much more narrow (between 19 and 42 percent or a ratio of about 1:2) than is the case when one compares Defense R&D with the quantities used in constructing the various indicators described above (compare Table 38 with Tables 33 to 36).

c. The Place of Defense R&D in the National R&D Effort. Before concluding this discussion of Defense R&D, a few observations should be made concerning some experimental efforts by the OECD to trace the

impact of Defense R&D on the research and development efforts of its member nations.

Table 39 shows the estimated distribution of Government expenditures on Defense R&D by sector of performance in the late 1960s. The basic distinction to be noted is that between governments that conduct most of their Defense R&D themselves and those that assign to the Business Enterprise sector a major role in the performance of this objective. The five countries that fell into the former category--Canada, the Netherlands, Norway, Japan and Belgium¹³--were, with one exception, civil R&D oriented countries. The five that fell into the latter category--the United States, the United Kingdom, France, Sweden, and West Germany¹⁴--were, with one exception, defense R&D oriented countries.¹⁵ Thus, those governments that emphasize Defense R&D the least tend to have what little research and development they fund in this area performed within the Government sector, and those governments that assign the highest priority to this objective tend to rely most heavily on Business Enterprise.

In Table 40, there are presented some tentative figures bearing on the role of Government-funded Defense R&D in the research and development activities of the Business Enterprise sector. In the United States, the United Kingdom, and France, this one objective accounts for 50 or 60 percent of all Government R&D payments to industry. In Sweden and West Germany, its share is even larger: 85 to 90 percent. As for the share of Defense R&D in the total amount of R&D carried out in the Business Enterprise sector, it ranges from 12 percent or less in Canada and West Germany, to about 20 percent in

13. In the last three states, more than 90 percent of Defense R&D was performed in the Government sector.

14. In the last two states, three-quarters of Defense R&D was conducted in the Business Enterprise sector; in the United States two-thirds of the total was conducted in that sector.

15. In the United Kingdom and France, it should be noted, the share of Business Enterprise is only slightly larger than that of Government.

Table 39

ESTIMATED SECTOR OF PERFORMANCE OF DEFENSE R&D IN THE LATE 1960s

Country	Total	Intramural	EXTRAMURAL			
			Business Enterprise	Higher Education	Other National	Abroad
UNITED STATES	100 ^a	28	63	6	4	--
	100 ^b	25	66	5	3	--
UNITED KINGDOM	100 ^c	42	51	1	--	6
	100 ^d	44	48	1	--	7
FRANCE	100 ^e	39	59	2	--	--
	100 ^f	49	50	1	--	--
Sweden	100 ^g	24	74	1	--	1
WEST GERMANY ^h	100	.	75	.	25	.
Canada ⁱ	100	64	26	.	5	3
Netherlands	100	42	10	.	48	--
Norway ^g	100	95	5	--	--	--
JAPAN ^g	100	97	3	--	--	--
Belgium ^g	100	100	--	--	--	--

a. International Statistical Year (ISY) 1966: including capital expenditure, excluding military nuclear.

b. DoD current obligations excluding military nuclear.

c. Gross defense expenditures: 1967/68.

d. Gross defense expenditures: 1968/69.

e. The 1967 national report; excluding military nuclear.

f. OECD estimate including military nuclear.

g. ISY 1967 results.

Source: OECD, R&D Trends and Objectives, Table D-2, p. 66.

h. OECD estimate 1968/69 based on R&D Trends and Objectives. Intramural probably includes a small element of extramural.

i. OECD estimate Canada (1964 ISY).

j. OECD estimate based on preliminary data in R&D Trends and Objectives.

Intramural probably includes an undefined amount of extramural.

Table 40

IMPACT OF GOVERNMENT-FUNDED DEFENSE R&D ON R&D PERFORMED
IN THE BUSINESS ENTERPRISE SECTOR

Country	Year	Defense R&D as a Percentage of All Government R&D Payments to Industry	Estimated Defense R&D as a Percentage of All R&D Per- formed in BE Sector
UNITED STATES	1962	80 ^a	
	1968	51 ^b 63 ^a	26 ^b 31 ^a
UNITED KINGDOM	1964	90	32
	1968	59	19
FRANCE	1963	64	19
	1967	53	21
Sweden ^c	1967	90	15-20
WEST GERMANY	1964	85	12
Canada ^c	1963	25	8
	1965	35	9
	1967	31	4
	1969	16	...

Note: All of the percentages in this table, and particularly those in the second column, should be treated with great caution.

- a. Based on government extramural expenditures.
- b. Based on industry's receipts.
- c. The figures quoted in the table probably slightly overestimate the share of all Business Enterprise R&D financed out of defense funds in Canada and underestimate the percentage in Sweden. For those two countries, there is a significant difference between what government reports having given and what industry reports having received. In addition, in Sweden there is a difference between the budget data used here and the ISY results.

Source: OECD, R&D Trends and Objectives, Appendix, p. 68.

Sweden, France, and the United Kingdom, to 25 percent or more in the United States. The conclusions to be drawn seem to be, first, that in all four defense R&D oriented countries and in one moderate defense R&D country (West Germany), Defense R&D accounts for most--and in at least two states almost all--Government transfers of funds to Business for purposes of research and development. Second, in the defense R&D oriented countries, Government-funded R&D focused on Defense accounts for a substantial share--more than 20 percent--of all R&D carried out in the Business Enterprise sector.

3. Civil Nuclear

Among the seven states in which expenditures on this second constituent objective of Group I have been largest, spending in terms of 1961 US dollars has tended to decline in three (the United States, the United Kingdom, and France), to remain more or less stable in two (Canada and Italy), and to increase in two (Japan and West Germany) (see Chart A, Figure 27).¹⁶ The United States, as usual, was in first place, with expenditures in 1971 of \$600 million, a sum larger than the combined expenditures of the Big Four. West Germany and France each devoted about \$200 million to Civil Nuclear R&D; the United Kingdom, about half as much. Japanese expenditures on this objective were still only \$44 million, less than those of either Italy or Canada.

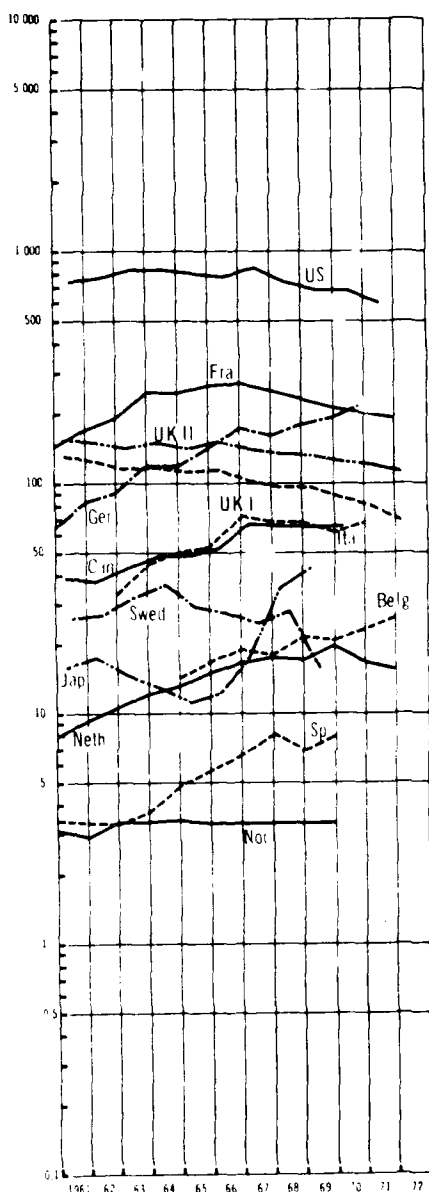
Turning next to expenditures on Civil Nuclear R&D as a percentage of total Government R&D funding, we see that the relative importance of this objective is definitely tending to decrease (see Chart B, Figure 27).¹⁷ Among the Major States, its share in the United States is low and stable; in West Germany, France, and the United Kingdom, higher but contracting; and in Japan, low but expanding.

In 1971 there was, in general, little to differentiate the Major States from the smaller countries, except that it was one of the latter (Italy with a share of 23 percent) that accorded this objective

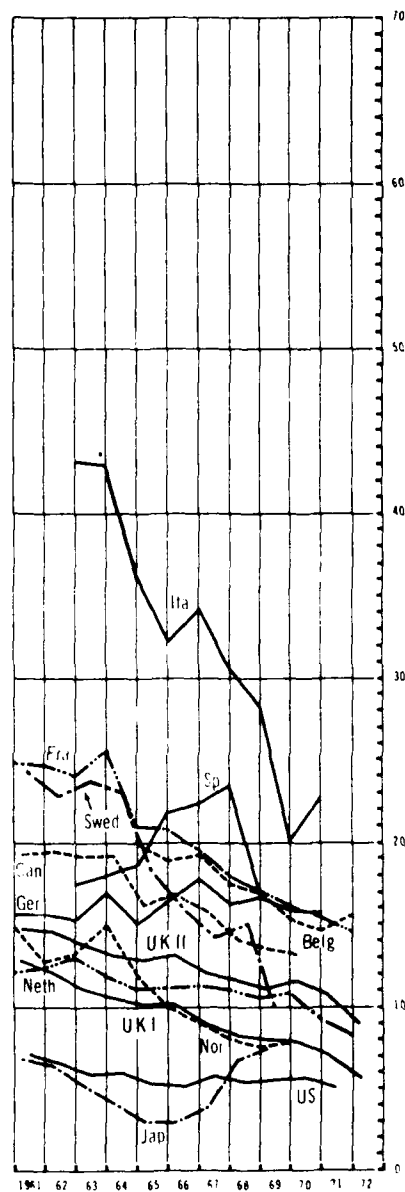
16. Complete data will be found in Table F-10.

17. See Table F-11 for complete data.

A
In millions of 1961 US dollars



B
As percent of total government
R&D funding



Source: OECD, Changing Priorities for Government R&D, Graph C, p. 208. See also Table F-10 and F-11.

Note: UK I includes the activities of the UK Atomic Energy Authority (AEA). UK II includes AEA and the activities of the nuclear science committee of the Science Research Council.

Figure 27. GOVERNMENT FUNDING OF CIVIL NUCLEAR R&D

the highest priority. Six states, including West Germany and France, devoted from 10 to 16 percent of state R&D expenditures to Civil Nuclear R&D. The remaining five states allocated 10 percent or less to this objective.

4. Civil Space

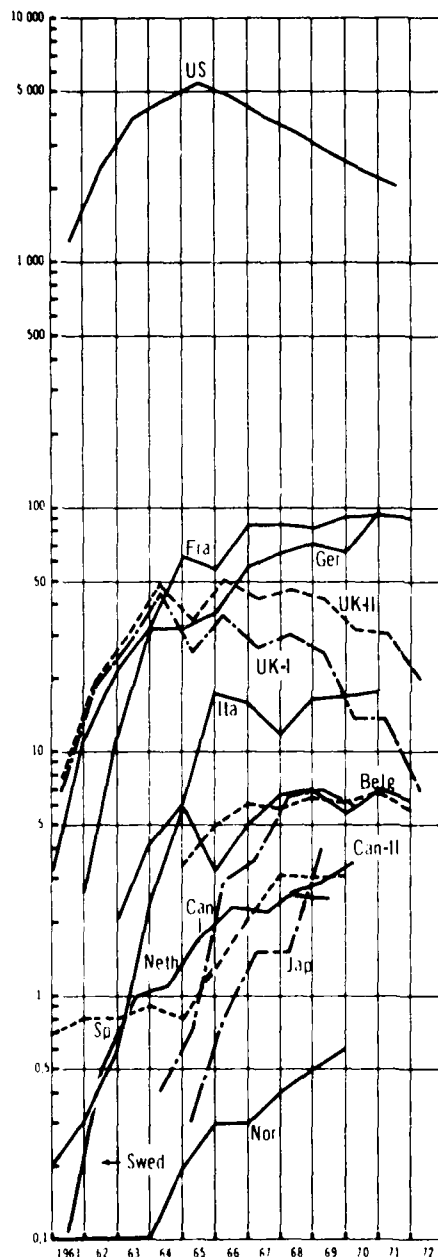
Chart A of Figure 28 shows that, in ten out of the twelve responding countries, spending on this objective rose very rapidly in the early 1960s, after which growth tended to be more moderate (as in West Germany), to stabilize (as in France), or to decline (as in the United States and the United Kingdom). The major exception was Japan, where spending, although low, was still growing at a rapid rate in the late 1960s.¹⁸

The countries surveyed fall into four distinct categories in terms of the funds that their governments allocated to Civil Space R&D in 1971. In the first category was the United States, with expenditures of \$2.1 billion, a level of funding more than twenty-two times higher than that in the second-ranking state. In the second category were West Germany and France, with expenditures of about \$90 million each. Still further down were the United Kingdom and Italy, each of which devoted roughly \$20 million to Civil Space R&D. In the last category were the seven remaining states. These gave very little support to this objective: in no case more than \$7 million.

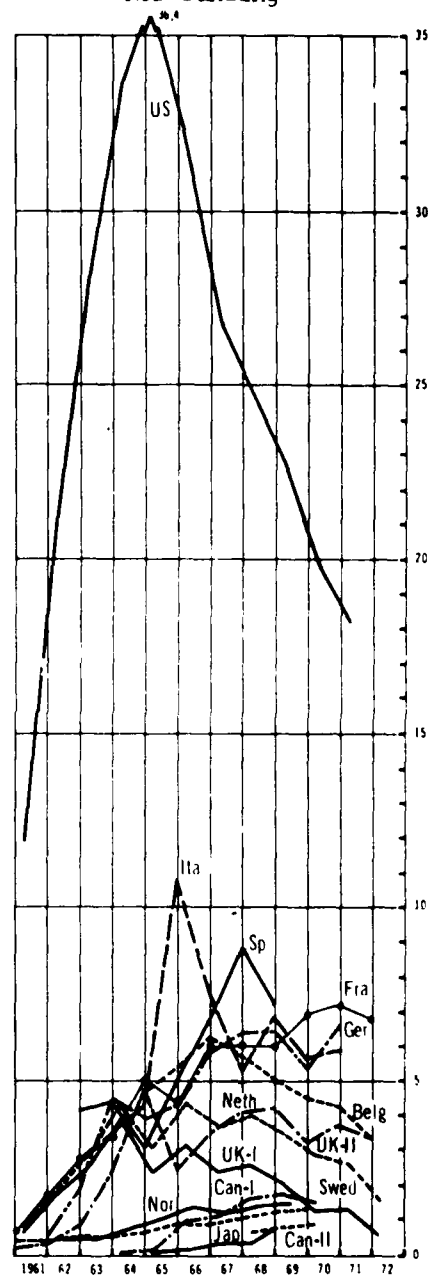
In terms of the share of total Government R&D spending consumed by research and development focused on Civil Space, the trends that can be traced in Chart B of Figure 28 are less important than the distinction to be drawn between the very high priority given to this objective in the United States and the relatively low priority assigned it in the eleven other countries. Even in 1971, after the share of Civil Space had been expanding for years in many of the latter and contracting dramatically in the United States, the US government still devoted a relatively large share of its total R&D effort to this

18. Complete data on expenditures will be found in Table F-12.

A
In millions of 1961 US dollars



B
As percent of total government
R&D funding



Source: OECD, Changing Priorities for Government R&D, Graph D, p. 228. See also Tables F-12 and F-13.

Note: See note for Figure 27, p. 131.

Figure 28. GOVERNMENT FUNDING OF CIVIL SPACE R&D

objective: 18 percent, compared with 6 or 7 percent in France, West Germany, Spain, and Italy, and 3 percent or less in the remaining seven states.¹⁹

C. GROUP II: ECONOMIC DEVELOPMENT

1. Overview

It is clear from Table 41 that, in general, the governments of the twelve member nations of the OECD represented in the survey gave the highest priority among the three constituent objectives of Economic Development to Mining and Manufacturing, a lower priority to Agriculture

Table 41

CONSTITUENT OBJECTIVES OF GROUP II AS A PERCENTAGE
OF TOTAL GOVERNMENT R&D FUNDING, 1961 AND 1971

Country	O b j e c t i v e s					
	Agriculture		Mining & Manufacturing		Economic Services	
	1961	1971 ^a	1961	1971 ^a	1961	1971 ^a
Major States:						
JAPAN	16	14	11	7	4	2
UNITED KINGDOM	1	2	6	16	1	3
FRANCE	2	4	3	13	3	3
WEST GERMANY ^b	2	2	4	11	--	1
UNITED STATES	2	2	1	4	1	2
Other OECD Nations:						
Spain ^c	17	20	36	30	5	4
Canada	25	21	9	22	1	8
Norway	20	16	7	14	2	3
Belgium ^c	8	6	12	15	4	3
Italy ^c	1	1	--	14	2	1
Netherlands	11	7	9	7	1	2
Sweden	5	8	3	4	1	4

a. Or nearest year available.

b. For 1961, read 1967.

c. For 1961, read 1965.

Source: Table F-15.

19. See Table F-13 for detailed data.

Forestry, Hunting, and Fishing, and lowest priority to Economic Services. This last objective, in fact, received so little support--4 percent or less in eleven out of the twelve responding countries in 1971--that it will not be examined in this section. The analysis instead will focus on the first two objectives.

In 1961, in seven out of the twelve states, Agriculture absorbed a larger fraction of total Government R&D expenditures than did Mining and Manufacturing. By 1971, however, because the share of Agriculture had tended to contract or remain stable during the 1960s while the share of Mining and Manufacturing had tended to expand, two-thirds of the countries represented were giving greater emphasis to Mining and Manufacturing than to Agriculture. Of the five Major States, four conformed to this pattern; three--the United Kingdom, France, and West Germany--weighted their Economic Development activities heavily in favor of Mining and Manufacturing R&D. Japan was the principal exception: the share of the latter objective was only half as large as that of agriculture.²⁰

2. Agriculture, Forestry, Hunting, and Fishing

Earlier in this chapter, in the discussion of Table 30, it was observed that the figures for Group IV (Advancement of Science) might be inflated due to the inclusion in that group of expenditures on objectives such as Health or Agriculture. The OECD statement of the problem as it applies to the latter is worth repeating:

The main problem of comparison in this objective is not to define "Agriculture" itself but to decide what constitutes R & D funds "voted in support of agriculture." The relevant funds of ministries of agriculture should clearly be included but the position is less clear for research councils and university research. Some agricultural research councils are funded by ministries of education or science and could, therefore, also quite reasonably be included in "Advancement of Research." In addition, universities perform significant amounts

20. For more detailed information on the constituent objectives of Group II, see Tables F-14 and F-15.

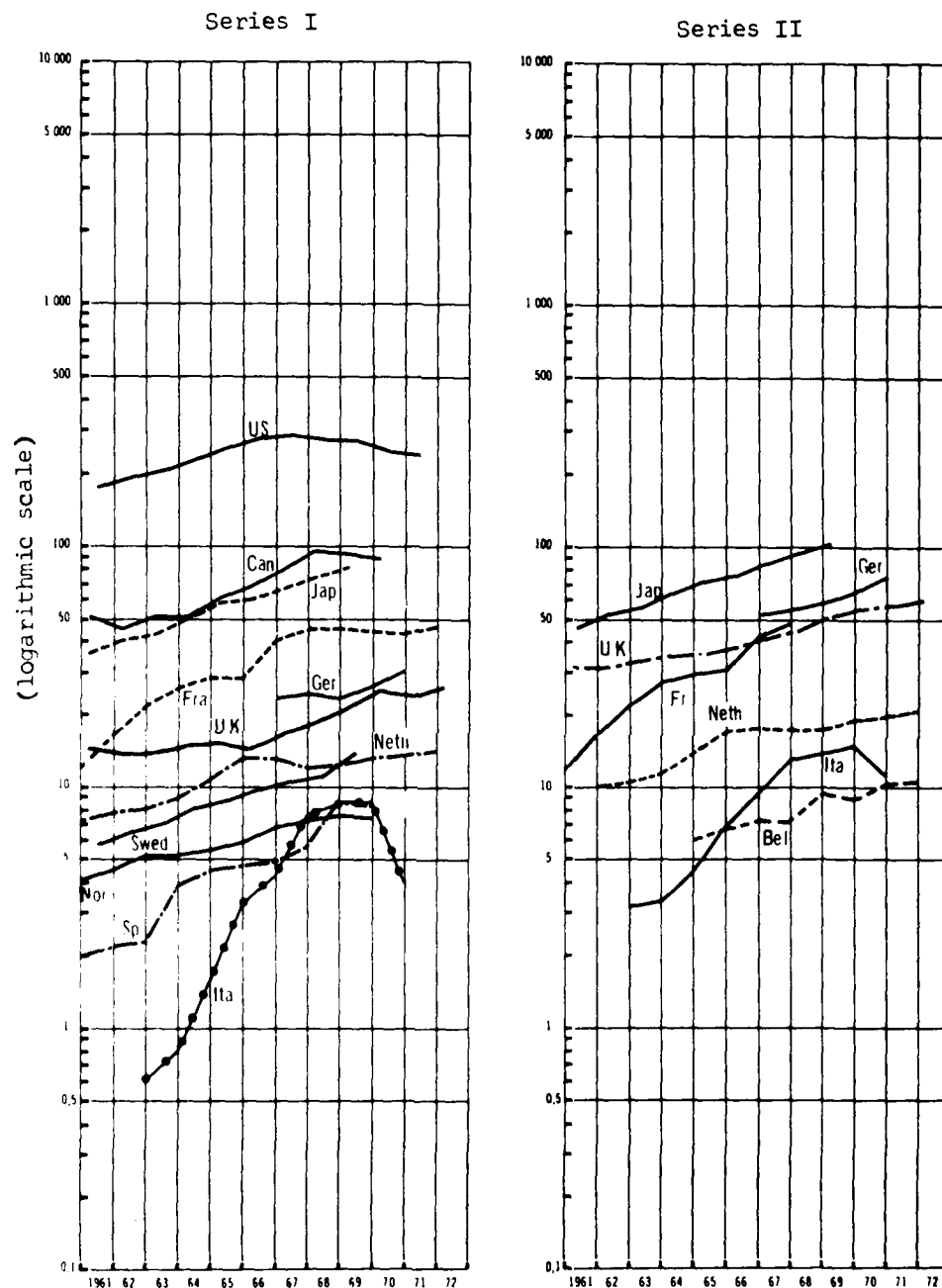
of agricultural research using the funds voted to them in support of their general mission of education and research. These latter sums are generally included in advancement of science via general university funds. However, though the governments have no control over the amount and area of agricultural research performed at universities, in many countries the sums concerned are known and governments may take them into consideration when planning their specific support of R & D for agriculture.²¹

These considerations led the OECD to prepare two series of statistics on this objective: Series I, the so-called "lower estimate," reflects primarily direct Government funding through the various ministries concerned and is the basis for the preceding estimate of the relative importance of Agriculture R&D within Group II. Series II, the "upper estimate," includes programs previously subsumed under Advancement of Science and is a product of a special effort by the Organization to recalculate the data. As can be seen in Figures 29 and 30 and Tables 42 and 43, the effect of this recomputation on the absolute and relative positions of the states is often substantial.

In both Series I and Series II of Figure 29, expenditures on Agriculture R&D in 1961 US dollars are shown to be rising. The difference is that in Series II, the trend lines for Japan, West Germany, the United Kingdom, France, and two smaller countries are all displaced upward. The impact on the relative standing of the countries may be judged from Table 42. The United States remains in first place with expenditures of \$240 million. Japan remains in second place, but the reported level of support increases from \$82 to \$106 million. West Germany and the United Kingdom each more than double their expenditures and move ahead of France in the rank order.

Trends in expenditures on Agriculture R&D as a percentage of total Government R&D funding were mixed: in one-half of the states the share of this objective contracted, in the other half it expanded (see Figure 30). Once again, the most significant point to emerge

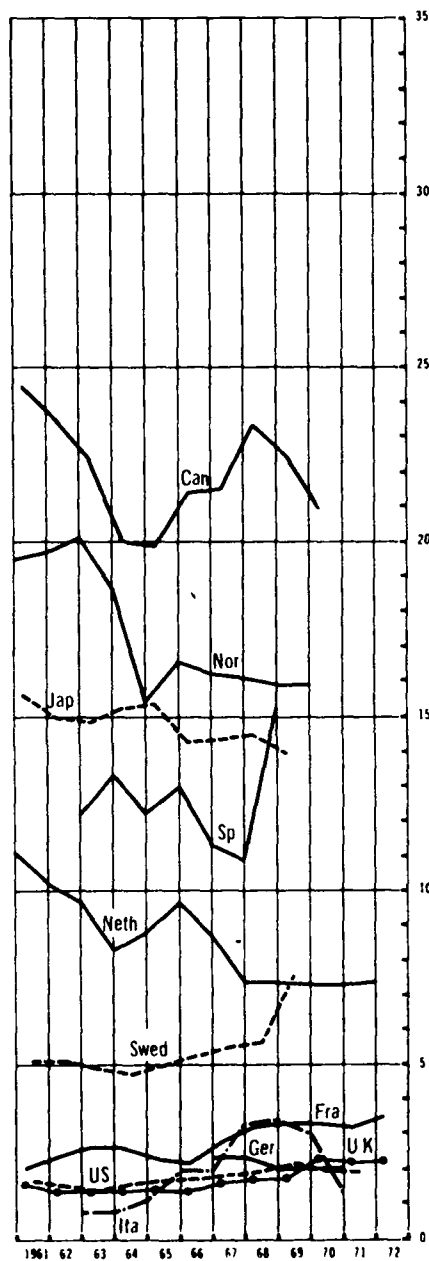
21. OECD, Changing Priorities for Government R&D, pp. 253-54.



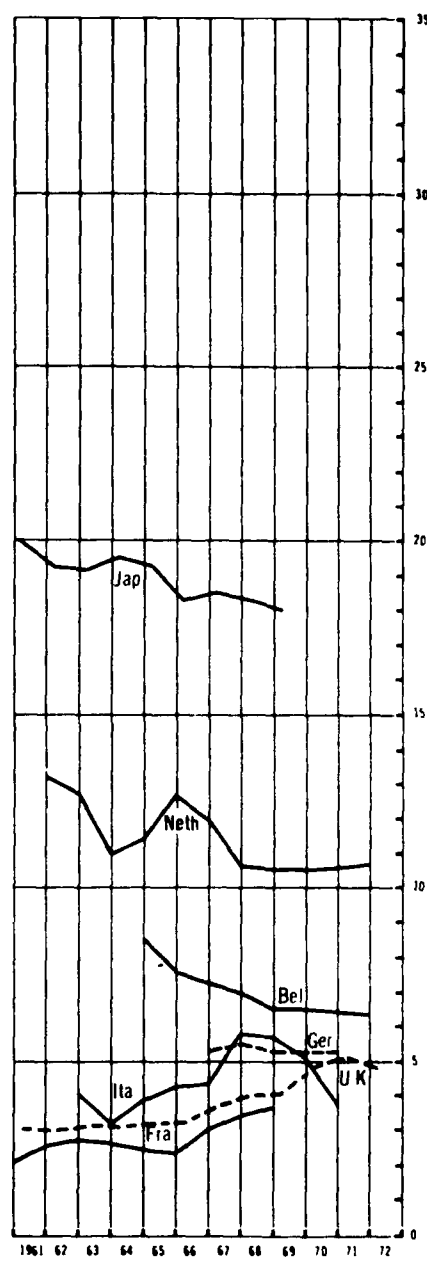
Source: OECD, Changing Priorities for Government R&D, Graphs E.I and E.II, pp. 250 and 265. See also Tables F-14 and F-15.

Figure 29. AGRICULTURE, FORESTRY, HUNTING, AND FISHING
Government Funding of R&D
(in millions of 1961 US dollars)

Series I



Series II



Source: OECD, *Changing Priorities for Government R&D*, Graphs E.I and E.II, pp. 250 and 265. See also Tables F-14 and F-15.

Figure 30. AGRICULTURE, FORESTRY, HUNTING, AND FISHING
Government Funding of R&D
(as percent of total government R&D funding)

Table 42
GOVERNMENT EXPENDITURES ON AGRICULTURE, FORESTRY, AND FISHING
R&D IN 1971^a
(in millions of 1961 US dollars)

>100	50-100	25-50	10-25	<10
Lower Estimate ^b				
UNITED STATES 240	Canada 89 JAPAN 82	FRANCE 47 WEST GERMANY 30 UNITED KINGDOM 27	Netherlands 14 Sweden 14	Spain 9 Norway 8 Italy 4
Upper Estimate ^c				
JAPAN 106	WEST GERMANY 76 UNITED KINGDOM 62	FRANCE 48	Netherlands 20 Italy 11 Belgium 11	

a. Or nearest year available.

b. Data not available for Belgium.

c. Data not available for Canada, Norway, Spain, Sweden, and the United States.

Source: For lower estimate, Table F-14; for upper estimate, OECD, Changing Priorities for Government R&D, pp. 268-69.

Table 43
PERCENTAGE OF TOTAL GOVERNMENT R&D EXPENDITURES DEVOTED
TO AGRICULTURE, FORESTRY, AND FISHING R&D IN 1971^a

> 20	15-20	10-15	5-10	<5
Lower Estimate ^b				
Canada 21 Spain 20	Norway 16	JAPAN 14	Sweden 8 Netherlands 7	FRANCE 4 UNITED KINGDOM 2 WEST GERMANY 2 UNITED STATES 2 Italy 1
Upper Estimate ^c				
	JAPAN 18	Netherlands 11	Belgium 6 WEST GERMANY 5	UNITED KINGDOM 5 Italy 4 FRANCE 3

a. Or nearest year available.

b. Data not available for Belgium.

c. Data not available for Canada, Norway, Spain, Sweden, and the United States.

Source: For lower estimate, Table F-15; for upper estimate, OECD, Changing Priorities for Government R&D, pp. 268-69.

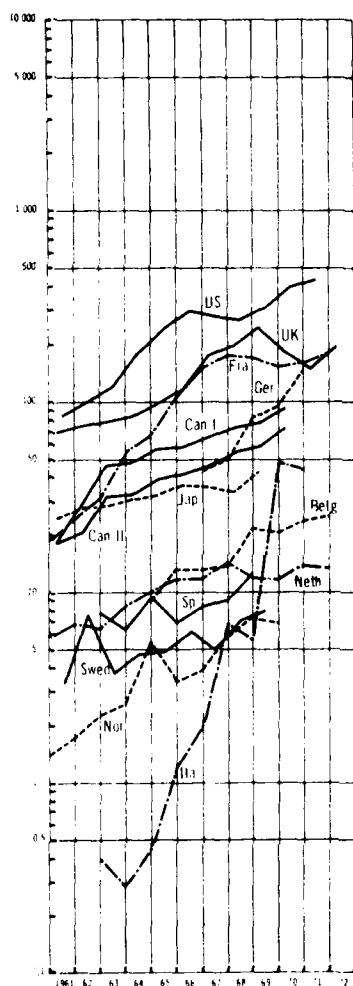
from a comparison of Series I and II in this figure is that, for five of the six states for which the data were recomputed, the trend lines are displaced upward. Table 43 charts the change in the share which this objective accounted for in each country in 1971. Canada and Spain still devoted the largest share of their governmental R&D resources to Agriculture--about 20 percent. Japan was still the only one of the Major States to attach much importance to Agriculture R&D; its share grew from 14 to 18 percent. These three and Norway, with 16 percent, were the only ones to devote more than 15 percent of their R&D effort to Agriculture. The share in the four other Major States was in each case 5 percent or less even after the data revisions outlined above had been made.

3. Mining and Manufacturing

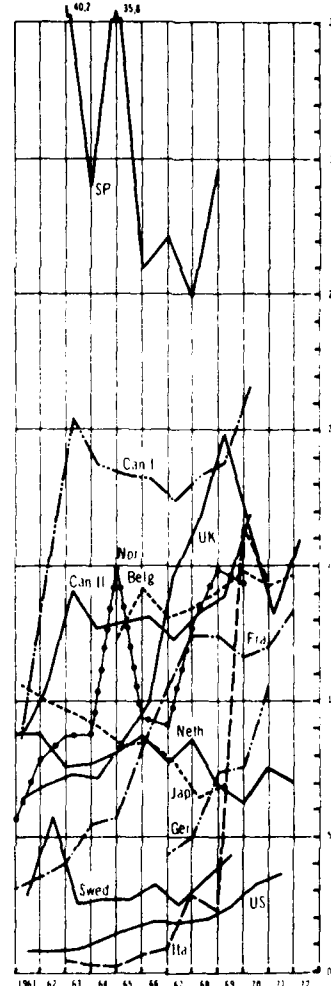
During the period under review, expenditures on this objective increased in every one of the twelve countries represented, often very substantially (see Figure 31, Chart A). The four countries that ranked highest in 1971 were grouped fairly close together and were all Major States: the United States with \$440 million, the United Kingdom with \$200 million, France with \$180 million, and West Germany with \$150 million. Of the remaining eight states, none allocated more than \$100 million to Mining and Manufacturing.

As a result of fluctuations in the shares of state R&D spending devoted to this objective, the pattern in Chart B of Figure 31 is a complicated one that all but conceals the fact that the relative importance of Mining and Manufacturing increased between 1961 and 1971 in three-quarters of the responding countries, including all of the Major States except Japan. As late as 1971, however, this objective was still assigned a relatively modest priority in most states, albeit a priority higher than that of Agriculture. Spain and Canada, with shares of 30 and 22 percent, respectively, were the only countries whose governments can be said to have placed much emphasis on Mining and Manufacturing R&D. The share in the United Kingdom, the state which ranked third, was only 16 percent. Another five states,

A
In millions of 1961 US dollars



B
As percent of total government
R&D funding



Source: OECD, Changing Priorities for Government R&D, Graph F, p. 270. See also Tables F-14 and F-15.

Figure 31. GOVERNMENT FUNDING OF MINING AND MANUFACTURING R&D

including West Germany and France, registered modest shares of between 10 and 15 percent. The remaining four devoted 7 percent or less to this objective.

D. GROUP III: COMMUNITY SERVICES

1. Overview

This group is composed of four objectives: Health, Pollution, Public Welfare, and Other Community Services. Of these, only the first absorbs a significant share of total government R&D expenditures (see Table 44). In no country did the share devoted to Pollution or

Table 44

CONSTITUENT OBJECTIVES OF GROUP III AS A PERCENTAGE OF
TOTAL GOVERNMENT R&D FUNDING, 1961 AND 1971^a

Country	O B J E C T I V E S							
	Health		Pollution		Public Welfare		Other Community Services	
	1961	1971	1961	1971	1961	1971	1961	1971
Major States:								
UNITED STATES	5	9	--	1	--	2	--	1
JAPAN	1	2	...	...	1	2	1	1
WEST GERMANY ^b	2	3	--	--	1	1	...	...
FRANCE	--	2	...	...	--	1	--	1
UNITED KINGDOM	--	1	...	...	...	...	--	1
Other OECD Nations:								
Belgium ^c	14	16	1	1	3	5	3	4
Netherlands	5	5	3	2	4	6	1	1
Sweden	4	8	...	1	1	3	1	1
Canada	3	10	...	--	--	--	--	1
Norway	5	5	...	...	2	2	1	1
Italy ^c	1	2	...	...	--	--	--	1
Spain ^c	...	...	...	...	--	--	--	--

a. Or nearest year available.

b. For 1961, read 1967.

c. For 1961, read 1965.

Source: Table F-17.

Other Community Services rise above 4 percent, and only in Belgium and the Netherlands in 1971 did the share allocated to Public Welfare rise as high as 5 or 6 percent. These last three objectives, consequently, will be excluded from the analysis.²²

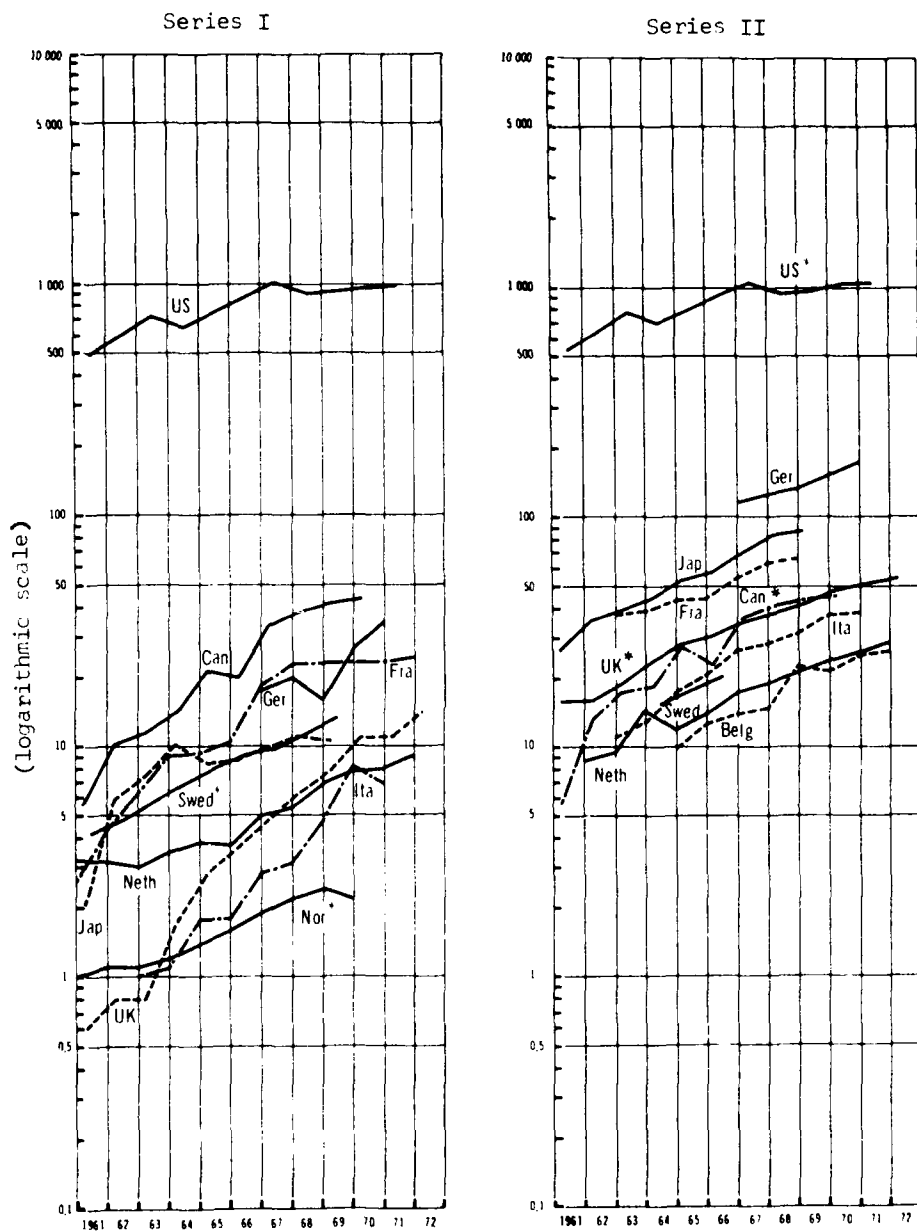
2. Health

For this objective, as for Agriculture, the OECD has reallocated part of the R&D expenditures formerly assigned to Advancement of Science. The effects on the statistics on research and development in the area of Health are, if anything, even more dramatic than they were for Agriculture.

Several conclusions can be drawn from Figure 32, which shows Government spending on Health R&D (in 1961 dollars) during the 1960s and early 1970s. First, expenditures on this objective increased in virtually every state according to both of the statistical series developed by the OECD. Second, for every one of the nine states for which the data were recomputed, the result was an upward displacement in the trend line (compare Series I and II). Third, in contrast to what happened in the case of Agriculture, there is apparent a definite flattening of the curve for at least four states: Japan, France, the United Kingdom, and Italy. This suggests that Health R&D performed in universities and colleges and formerly concealed within Advancement of Science accounted for a much larger share of all Health R&D in the early 1960s than it did toward the end of the decade. Fourth, while Series II still shows the United States spending far more on this objective than any other state, the adjustments in the data result in a definite closing of the gap between the United States and the remaining nine countries represented.

Table 45 shows how dramatic the impact of the OECD effort is on our image of the situation in 1971. French government spending on Health R&D more than doubles from \$25 to \$67 million, while expenditures in the United Kingdom increase fourfold from \$14 to \$55 million,

22. For more detailed information on Group III objectives, see Tables F-16 and F-17.



Source: OECD, Changing Priorities for Government R&D, Graphs H.I and H.II, pp. 306 and 323. See also Tables F-16 and F-17.

* = Slightly underestimated.

Figure 32. GOVERNMENT FUNDING OF HEALTH R&D
(in millions of 1961 US dollars)

Table 45

GOVERNMENT EXPENDITURES ON HEALTH R&D IN 1971^a
(in millions of 1961 US dollars)

>900	50-200	25-50	10-25	<10
Lower Estimate ^b				
UNITED STATES 990		Canada 44 WEST GERMANY 35	FRANCE 25 UNITED KINGDOM 14 Sweden 14 JAPAN 11	Netherlands 9 Italy 7 Norway 2
Upper Estimate ^c				
UNITED STATES 1,061	WEST GERMANY 171 JAPAN 88 FRANCE 67 UNITED KINGDOM 55	Canada 46 Italy 38 Netherlands 29 Belgium 27		

a. Or nearest available year.

b. Data not available for Belgium and Spain.

c. Data not available for Norway, Spain, and Sweden.

Source: For lower estimate, Table F-16; for upper estimate, OECD, Changing Priorities for Government R&D, pp. 216-27.

Table 46

PERCENTAGE OF TOTAL GOVERNMENT R&D EXPENDITURES DEVOTED
TO HEALTH R&D IN 1971^a

15-20	10-15	5-10	<5
Lower Estimate ^b			
	Canada 10	UNITED STATES 9 Sweden 8	Netherlands 5 Norway 5 Italy 3 WEST GERMANY 3 JAPAN 2 FRANCE 2 UNITED KINGDOM 1
Upper Estimate ^c			
Belgium 16 JAPAN 15	Netherlands 15 Italy 13 WEST GERMANY 12 Canada 11	UNITED STATES 9	FRANCE 5 UNITED KINGDOM 4

a. Or nearest year available.

b. Data not available for Belgium and Spain.

c. Data not available for Norway, Spain, and Sweden.

Source: For lower estimate, Table F-17; for upper estimate, OECD, Changing Priorities for Government R&D, pp. 326-27.

in West Germany by fivefold from \$35 to \$171 million, and in Japan by eightfold from \$11 to \$88 million. The magnitude of the Japanese increase results in its moving from last to second place among the Big Four.

Expenditures on Health R&D as a percentage of total Government spending on research and development are displayed in Figure 33. A comparison of Series I and II reveals that, not only does the OECD's recalculation result in an upward displacement in the trend lines for the respective countries, it also changes the shape of those curves, in most cases almost beyond recognition. The impact on the relative standing of the countries surveyed emerges with greater clarity in Table 46. Whereas according to the lower estimate the United States ranked first among the Major States in 1971 with a share of 9 percent and the Big Four clustered close together further down with shares of from 1 to 3 percent, according to the upper estimate the United States ranked third (with its share unchanged at 9 percent) behind Japan with 15 percent and West Germany with 12 percent. The Netherlands and Italy also registered large increases.

The net effect of these changes is to raise Health from a comparatively unimportant objective to one of considerable significance in a number of countries. If Series I is relied upon, the rank of Health among the fourteen OECD objectives ranges from second to fifth in 3 states and from sixth to ninth in 7 states. If Series II is substituted, the number of states in the first set increases from 3 to 7, while that in the second set decreases from 7 to 2.

E. GROUP IV: ADVANCEMENT OF SCIENCE

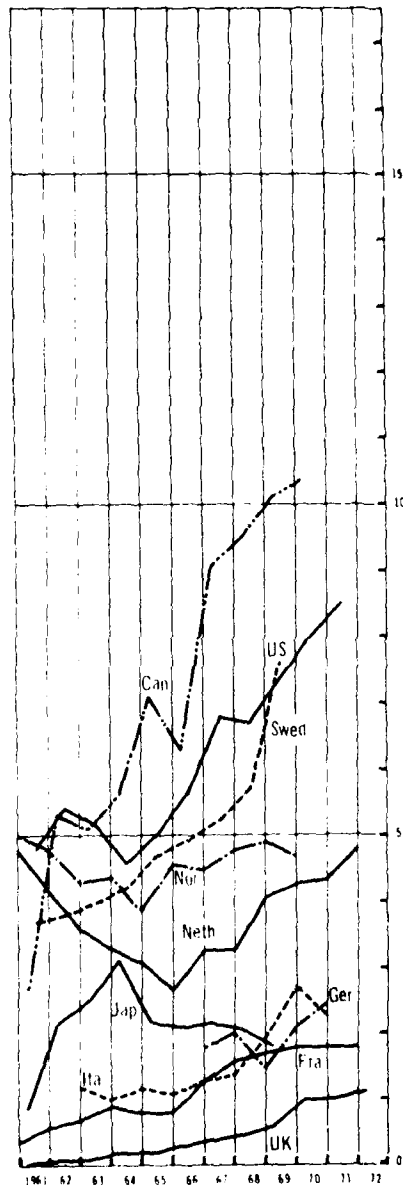
1. Overview

The two constituent objectives of this group require definition. Expenditures on "Advancement of Research" R&D include:

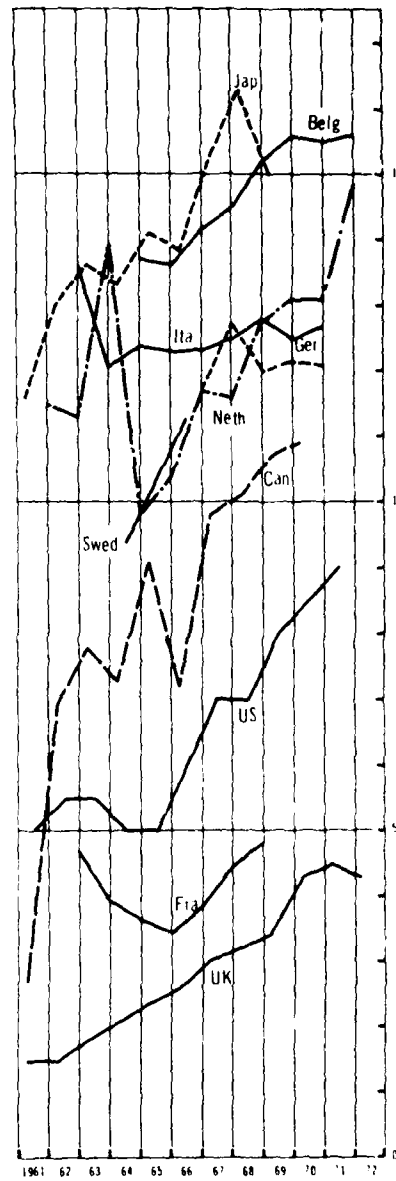
funds voted to foundations, programmes and institutions devoted to research of a general nature or research on various broad fields, whose projects are usually chosen using scientific criteria.²³

23. OECD, Changing Priorities for Government R&D, p. 379.

Series I



Series II



Source: OECD, Changing Priorities for Government R&D, Graphs H.I and H.II, pp. 306 and 323. See also Tables F-16 and F-17.

Figure 33. GOVERNMENT FUNDING OF HEALTH R&D
(as percent of total government R&D funding)

"Advancement of Science via General University Funds," on the other hand, comprises:

research financed out of the funds that government allocates to universities usually through the Ministry of Education, to accomplish their mission of teaching and training. Each university then determines the share of general funds to be devoted to R&D.²⁴

Among the nine countries for which it is possible to make comparisons,²⁵ six, including Japan and West Germany, place greater emphasis on the latter objective, while the other three, including France and the United Kingdom, assign a higher priority to the former (see Table 47). The six states that allocate a higher share of their research and development expenditures to Advancement of Science via General University Funds tend to assign a greater importance to this objective than the three states that allocate a larger share to Advancement of Research do to that objective, probably because, as has been explained several times earlier in this chapter, the first of the two includes a great deal of research that properly should be subsumed under other objectives.

Over the ten years from 1961 to 1971, the share of all Government support for R&D consumed by each of these two objectives has gradually increased in about two-thirds of the responding states.²⁶

2. Advancement of Research

Figure 34, Chart A, shows that spending on this objective tended to increase gradually and in most cases steadily in the twelve responding countries.²⁷ At the end of the period for which data were

24. Ibid, p. 397.

25. There are no data for the United States, Canada, or Belgium on Advancement of Science via General University funds.

26. For more complete data on Group IV objectives, see Tables F-18 and F-19.

27. For an explanation of the two series used for the United Kingdom and the discontinuity in the West German data, see OECD, Changing Priorities for Government R&D, p. 381.

Table 47

CONSTITUENT OBJECTIVES OF GROUP IV AS A PERCENTAGE OF
TOTAL GOVERNMENT R&D FUNDING, 1961 AND 1971^a

Country	O b j e c t i v e s			
	Advancement of Research		Advancement of Science via General University Funds	
	1961	1971	1961	1971
Major States:				
JAPAN	--	--	56	61
WEST GERMANY	3	8	34	33
UNITED KINGDOM	6	16	6	10
FRANCE	13	15	7	11
UNITED STATES	1	3	...	...
Other OECD Nations:				
Netherlands	4	7	45	45
Italy ^b	20	18	29	29
Norway	11	8	31	35
Belgium ^b	29	31	...	...
Sweden	2	6	12	23
Spain ^b	18	13	--	1
Canada	17	10	...	...

a. Or nearest year available

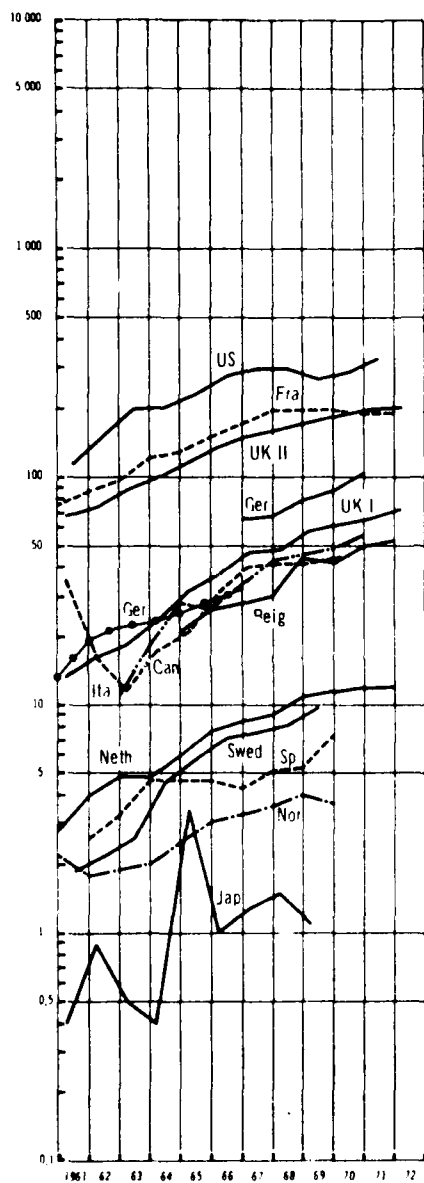
b. For 1961, read 1965.

Source: Table F-19.

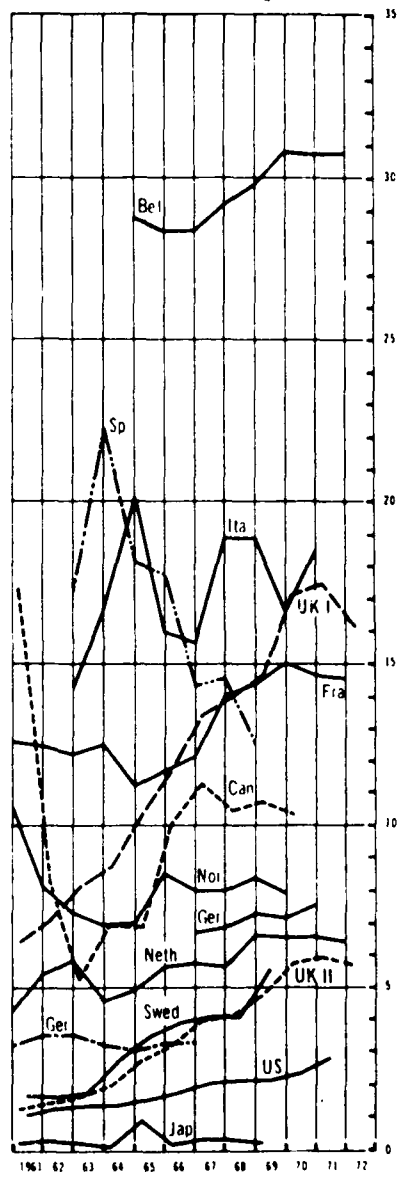
available, four of the Major States were clustered comparatively close together, with expenditures on this objective ranging from about \$110 million in West Germany to roughly \$200 million in France and the United Kingdom, to \$330 million in the United States. Expenditures in the fifth Major State, Japan, were negligible. Italy, Belgium, and Canada constituted a middle-ranking grouping of countries devoting from \$44 to \$56 million to Advancement of Research. The remaining four states allocated \$12 million or less to this objective.

Trend lines showing the percentage of Government R&D spending on Advancement of Research fluctuate and do not conform to any common pattern. In nine out of the twelve states, however, the share was

A
In millions of 1961 US dollars



B
As percent of total government R&D funding



Source: OECD, *Changing Priorities for Government R&D*, Graph L, p. 378. See also Tables F-18 and F-19.

Figure 34. GOVERNMENT FUNDING OF ADVANCEMENT OF RESEARCH R&D

larger in 1971 than in 1961 (see Figure 34, Chart B). Belgium was the only state to assign a high priority to this objective. Its share (31 percent) was about twice as large as that of the United Kingdom or France and two-thirds again as large as that of Italy. In the remaining eight states, the share was 13 percent or less

3. Advancement of Science via General University Funds

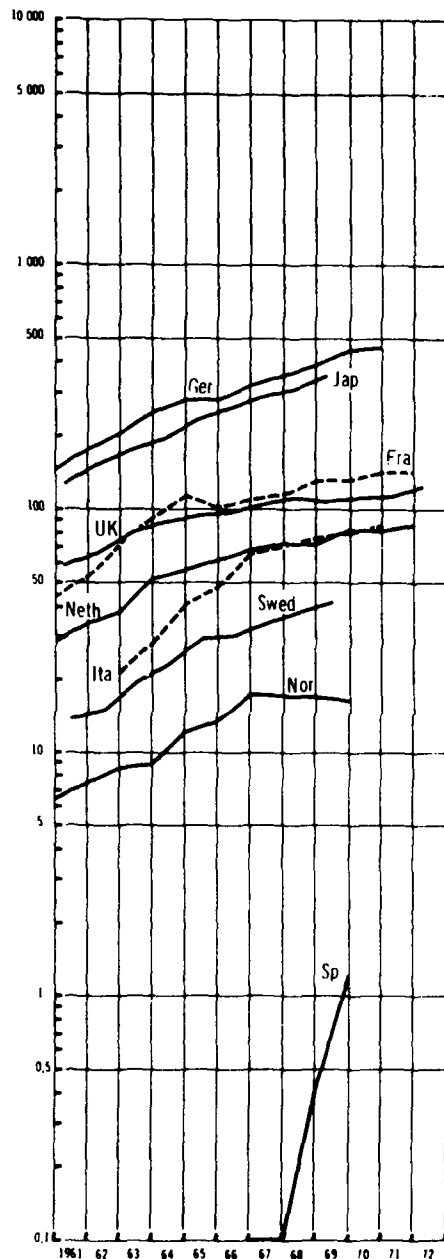
Expenditures in this objective tended to follow a steady upward course (see Chart A, Figure 35). The nine states for which data are available for 1971 appear to fall into four distinct groups. First are West Germany and Japan, with expenditures of \$470 and \$360 million, respectively. Some distance further down are France and the United Kingdom, with about \$140 million each. Still further down are Italy and the Netherlands, with about \$87 million each, and, below them, the other three states.

The shares of total Government R&D expenditures allocated to Advancement of Science via General University Funds are spread over a wide range, as is shown on Chart B of Figure 35. In five states the share in 1971 was larger than it had been in 1961, in three states it remained about the same, and in one it declined. In general, the rank order among the states remained much the same. Among the four Major States for which statistics have been gathered by the OECD, Japan ranked first, with 61 percent of the state's allocations to research and development ostensibly being consumed by this one objective. West Germany's share was much smaller--only 33 percent, while those of France and the United Kingdom were smaller still--about 10 percent each.

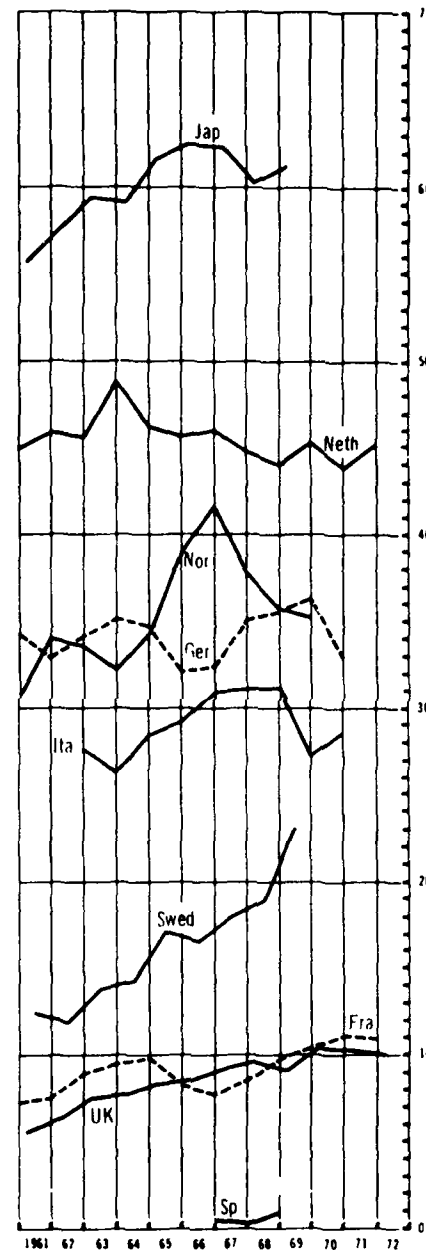
F. GROUP V: OTHER ACTIVITIES

As can be seen in Table 48, the share of Government R&D funds channeled into the two constituent objectives of this group--Developing Countries and Miscellaneous--have been infinitesimal or, at best,

A
In millions of 1961 US dollars



B
As percent of total government R&D funding



Source: OECD, Changing Priorities for Government R&D, Graph M, p. 396. See Tables F-18 and F-19.

Figure 35. GOVERNMENT FUNDING OF ADVANCEMENT OF SCIENCE
VIA GENERAL UNIVERSITY FUNDS R&D

Table 48

CONSTITUENT OBJECTIVES OF GROUP V AS A PERCENTAGE OF
TOTAL GOVERNMENT R&D FUNDING, 1961 AND 1971^a

Country	O b j e c t i v e s			
	Developing Countries		Miscellaneous	
	1961	1971	1961	1971
Major States:				
WEST GERMANY ^b	...	...	6	5
FRANCE	2	2	--	--
UNITED KINGDOM	--	1	1	1
JAPAN	...	...	1	1
UNITED STATES	--	--	--	--
Other OECD Nations:				
Netherlands	--	1	--	1
Canada	...	--	4	1
Belgium ^c	--	--	...	...
Italy ^c	...	--	1	--
Sweden	...	...	...	...
Norway	...	...	...	...
Spain	...	...	...	...

- a. Or nearest year available.
b. For 1961, read 1967.
c. For 1961, read 1965.

Source: Table F-21.

very small.²⁸ Group V is essentially a residual statistical category, plays no significant role in the R&D policies of any state, and therefore will not be investigated here.

28. See Tables F-20 and F-21 for more complete data on Group V objectives.

ALLOCATION OF FINANCIAL RESOURCES TO R&D
BY SELECTED NON-OECD COUNTRIES

A. INTRODUCTION

In Chapter II it was suggested that when one leaves the R&D statistics of the OECD countries and moves to those of the non-OECD countries, he enters a quite different world--both literally and figuratively. Literally, because the OECD countries, by and large, constitute most of the advanced nations of the world, while the non-OECD countries, with the exception chiefly of the Soviet Union and several East European states, basically constitute the less developed countries, or LDCs. One enters a different world figuratively because the non-OECD (i.e., UNESCO) statistics differ considerably in consistency, comprehensiveness, and reliability from those developed in the OECD's special surveys of its members.

Consequently, it was neither possible nor desirable in this portion of the paper to present or analyze the R&D statistics for the non-OECD countries in the same detail as for the OECD members. Moreover, the reader will note that not only are there fewer tables and detailed statistical breakouts for the non-OECD countries, but that the countries displayed in the various breakouts are not always identical. In other words, the data available for some countries were simply not available for others. The major countries are usually fairly well represented, however, and for the others we have tried to select, from those for whom data were available, countries that were illustrative of their geographic regions.

The reader will also note that the UNESCO terminology is different from that of the OECD in some of the statistical areas. This is especially noticeable in the portions dealing with "sectors of performance" and "sources of funds," and is due to the greater complexity

of political and economic systems in the UNESCO's worldwide membership, as opposed to the more homogeneous membership of the OECD. The chief problem here is one of separating "Government" and "Productive" sectors from each other in countries where private enterprise as such does not exist--for example, in the Communist countries. For reference purposes, there are quoted below the UNESCO definitions for the categories in both sectors of performance and sources of funds:

1. Sectors of Performance

The sectors of performance identify those areas of the economy in which R&D work is performed. The term "sector of performance" distinguishes the execution or performance of R&D activities from their financing. Three sectors of performance have been established for the purpose of the survey and defined, to the fullest extent possible, in accordance with the definitions of the United Nations System of National Accounts (SNA) and the System of Material Product Balances (MPS) as used by socialist countries.

Productive sector:

In general this sector includes:

- (a) both domestic and foreign-owned industrial and trading establishments located in the country, which produce and distribute goods and services for sale, and organizations directly serving them, whatever their form of ownership, private, non-profit, or government. It also includes government monopolies and nationalized industries, particularly public utilities, transport undertakings, post offices, communications and broadcasting, and all other government establishments which function as productive units;
- (b) also included are governmental or non-governmental organizations and private non-profit institutions mainly or exclusively serving industrial and trading establishments, except those institutes, experimental stations, etc., operating under the direct control of or being associated with institutions of higher education (see below). In socialist countries R&D institutes of branch ministries are to be classified in this sector.

Integrated and non-integrated R&D. Due to the different structure of the productive sector in countries with different socio-economic systems and in order to facilitate comparisons, the R&D effort should be measured on the following two "levels":

- (a) Integrated R&D. This includes all R&D activities integrated or directly associated with other economic activities of industrial and trading establishments, or groups of such establishments belonging to the same enterprise as defined in (a) above.

(b) Non-integrated R&D. This includes all R&D activities not integrated or directly associated with other economic activities, executed by such governmental or non-governmental organizations or institutes defined in (b) above which are serving a specific two- or three-digit group of the economy, even if they are partly or wholly financed by the State budget or, in the case of East European countries, by the Technical and Economic Progress Fund.

Higher education sector. This sector comprises all institutions of higher education at the third level which require, as a minimum condition of admission, the successful completion of education at the second level, or evidence of the attainment of an equivalent level of knowledge, i.e., all universities, colleges of technology, etc., whatever their source of finance, or their legal or economic status. It also includes experimental stations, clinics, and research institutes operating under the direct control of institutions of higher education administered by or associated with them. It excludes national research councils which are classified in the general service sector.

General service sector. The general service sector comprises all R&D activities not covered above. In general, it includes all bodies, departments and establishments of government--central, state or provincial, district or county, municipal, town or village--which serve the community as a whole, and engage in a wide range of usual government services such as administration, defence and regulation of public order, health, cultural, recreational and other social services and promotion of economic growth and welfare and technological development. It includes laboratories of national research councils as well as academies of science, professional scientific organizations, State museums, scientific societies and other non-profit organizations which primarily serve government, even though they are not formally part of the government. It excludes institutions of higher education, as well as government monopolies and nationalized industries which function as productive enterprises and government services and organizations which serve enterprises of a specific two- or three-digit group of the economy. These belong to the productive sector or the higher education sector, as defined above.

2. Sources of Funds

The sources of funds for expenditure on R&D are defined as follows:

Government funds. This includes all funds originating from the ordinary or extraordinary budget or from extra-budgetary sources of both the central government and the state and local governments such as provincial, district or county, municipal town or village. It also includes the funds originating from those intermediary public and private organizations which are set up by government and whose financial means are exclusively provided by government.

Productive enterprise funds. This includes all those funds allocated to R&D by establishments of the productive sector, as defined under "Sectors of performance," which originate from the economic activities of these establishments. That is, the R&D funds made available from the production of goods and services for sale on the market.

Special funds. This category of source of funds primarily provides for the structure of finance of R&D in East European countries. As far as these countries are concerned special funds include, above all, the financial means originating from the Technical and Economic Progress Fund and from similar funds.

Foreign funds. This category includes all funds received from abroad for R&D performed inside the reporting country by establishments, departments and institutions which are defined under "Sectors of performance." It covers funds received from international organizations (whether located inside or outside the country), foreign governments and private funds from abroad, including funds from parent or affiliated organizations or companies abroad.

Other funds. Includes all funds which cannot be classified in one of the preceding categories, such as endowments or gifts. This category also includes own funds of institutions of higher education.¹

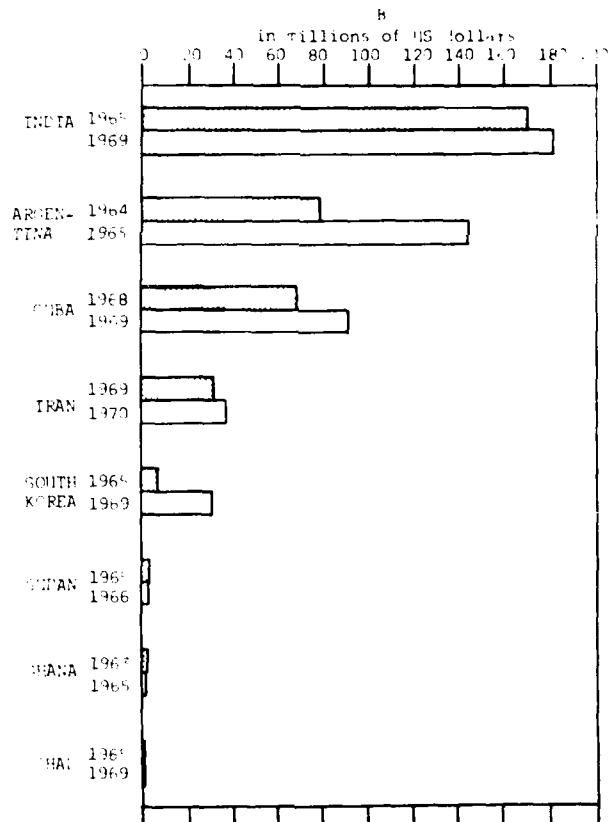
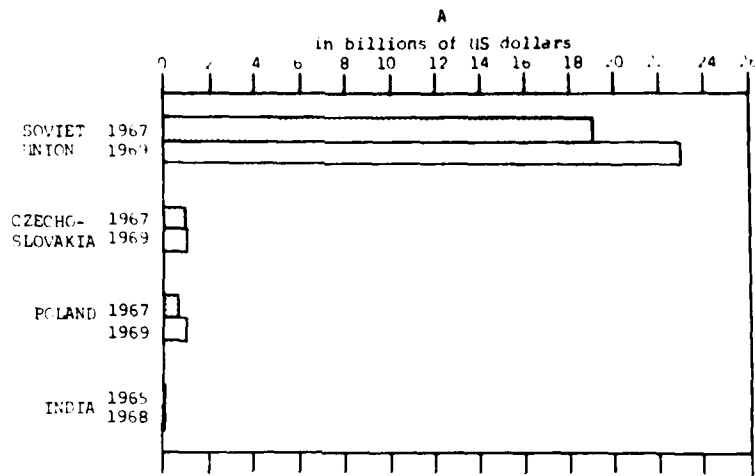
The differences between OECD and UNESCO terminology are not so great, however, as to render impossible at least general comparisons. Occasionally we shall suggest such comparisons where they appear justified. Let us now look at some very broad indications of the gross expenditures on R&D (GERD) for some selected non-OECD countries.

B. MAJOR TRENDS IN GERD

We have already called attention to the wide disparity between the developed countries and the underdeveloped countries in their expenditures on research and development. Figure 36 makes this point even more starkly.² It will be noted that India appears in both

1. UNESCO, Statistical Abstract 1971, pp. 579-80 and p. 582.

2. The following discussion should be read in conjunction with Table G-1, "Historical Trends in GERD, Selected Non-OECD Countries," and Table A-1, "Gross Expenditures on Research and Development During the 1960s: National and Regional Totals," in Part II. Any references to specific numbers or countries that do not appear on Figures 36-A or 36-B are derived from these referenced tables in Part II.



Source: Table G-1.

Figure 36. HISTORICAL TRENDS IN GERD, SELECTED NON-OECD COUNTRIES
(in current US dollars)

Figures 36-A and 36-B--barely registering on the billion-dollar scale of the former, where it is grouped with the Soviet Union, Czechoslovakia, and Poland, and yet dominating other "Third World" countries on the million-dollar scale of the latter, where this time, for example, Chad and Ghana barely register. To make the point more specifically, while India's \$180 million R&D expenditure in 1969 was very large by Third World standards, especially compared with the two or three millions of some of the African countries, and even with the \$39 million of Iran (1970) or the \$70 million of Israel (see Table G-2), it was well below the \$1 billion of Poland, it was less than a third of the \$585 million expenditure of the Netherlands, and was infinitesimal compared with the nearly \$24 billion R&D expenditure of the Soviet Union.³

This disproportion between the R&D expenditures of the Soviet Union and those of the other countries shown in Figure 36 is the second major point highlighted by this chart. To some extent the position of the Soviet Union among the non-OECD countries is analogous to that of the United States within the OECD. There is, of course, apparently little parallel between Soviet and US civilian R&D expenditures, and, as noted earlier, there is great uncertainty regarding the actual size of Soviet military R&D outlays. (Some estimates place Soviet military R&D expenditures alone at a level equal to or even higher than the total national Soviet R&D expenditures shown here.) But whatever the estimate used, the Soviet Union clearly far surpasses all other non-OECD nations--and also all OECD nations except the United States--in the scale of its national R&D efforts.

A third inference to be drawn from this figure (and from Table G-1 on which it is based) is that R&D expenditures in the non-OECD countries have been generally increasing. Because of the incompleteness of the data, however, and other factors, such as changing valuations of national currencies, this trend must be left only as a general inference.

3. See Note 12, Chapter II, regarding the controversial nature of estimates of Soviet R&D expenditures.

C. GERD AS A PERCENTAGE OF GNP⁴

While the figures for GERD in the preceding section give some idea of the relative gross efforts of various non-OECD countries in their R&D expenditures, they do not convey much sense of the actual priority accorded R&D--that is, the intensiveness of the R&D effort of those countries. Assessing GERD as a percentage of GNP offers an approximation of this degree of intensiveness.

Admittedly, comparing percentages of GNP devoted to R&D by various countries acquired something of a bad name several years ago when such percentages appeared sometimes to be treated almost as national targets, with insufficient concern for the purposes and anticipated effectiveness of the expenditures. Moreover, there are special problems in making accurate measurements of GNP for the non-OECD countries because of the generally poorer systems of economic statistics that are encountered in most of them.⁵ It should be clear that the following figures for GERD as a percentage of GNP in the non-OECD countries should be treated only as general indicators.

Having said so much, let us look at the standing of some of the major non-OECD countries in terms of their gross expenditures on R&D expressed as a percentage of GNP (Figure 37). One is struck immediately by the very high figures for the Soviet Union and Czechoslovakia--5.11 percent and 4.97 percent, respectively, in 1969. Even if we take

4. This section should be read in conjunction with Tables G-2 and A-4.

5. Table G-2 shows the basis for the percentages used in this section. For the Soviet bloc countries, and for several others, it seemed desirable to use the International Institute for Strategic Studies' The Military Balance as the source for GNP figures, rather than the Net Material Product figures of UNESCO. This occasioned slightly different final percentages for GERD/GNP than those computed from the UNESCO figures, but these differences were not significant except for the Soviet Union and Czechoslovakia. For these latter, the UNESCO percentages were lower and may well be more reasonable than the ones derived from The Military Balance. The respective UNESCO figures for GERD as a percentage of GNP in 1969 are: USSR, 3.8 percent; Poland, 2.3 percent; Czechoslovakia, 4.1 percent.

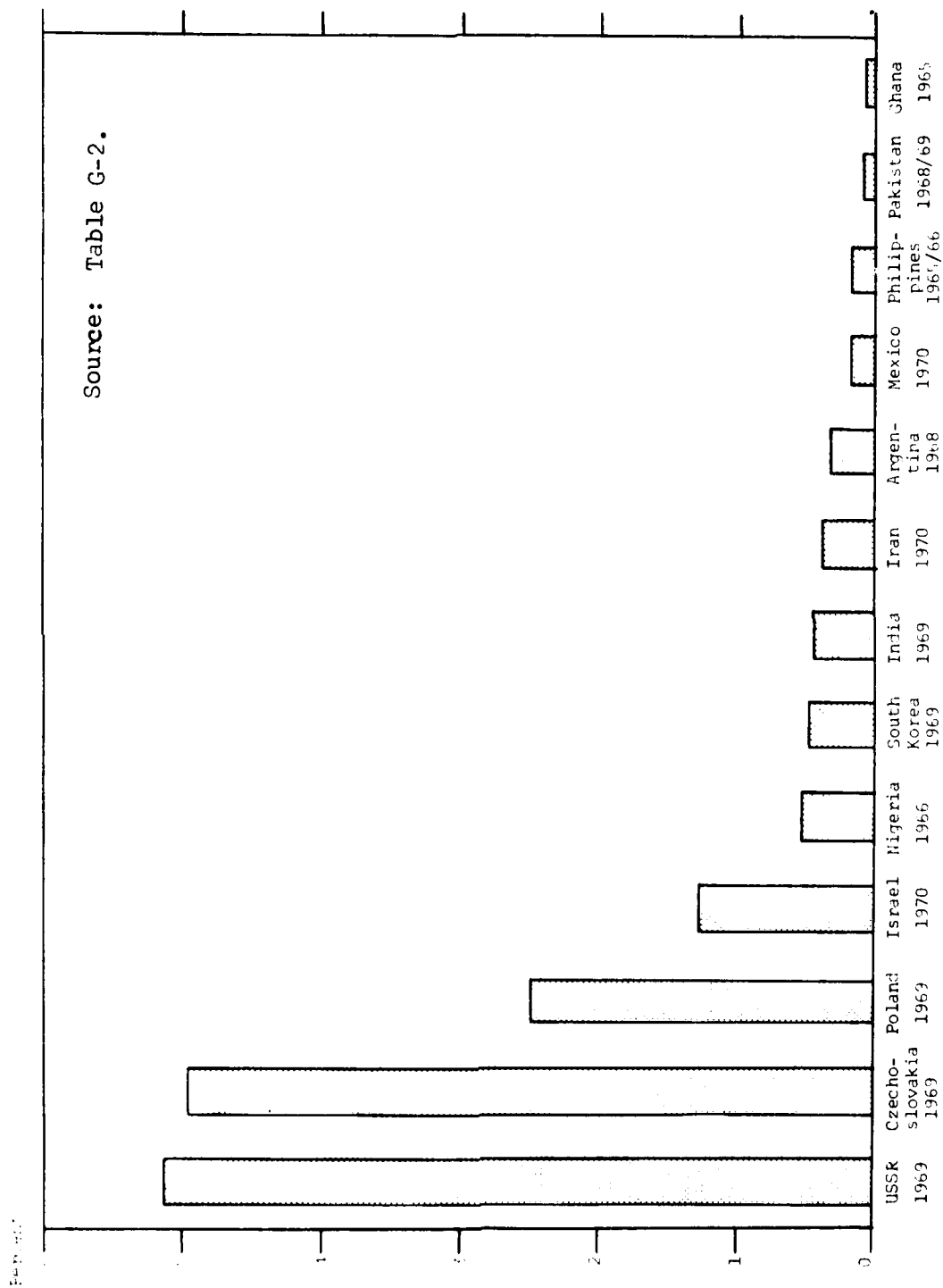


Figure 37. GERD AS A PERCENTAGE OF GNP AT MARKET PRICES, SELECTED NON-OECD COUNTRIES

the lower figures computed by UNESCO--3.8 percent and 4.1 percent, respectively (see footnote 5)--these are still very imposing indices of national R&D effort, especially if we recall that the United States at the peak of its huge space and defense programs in 1964 reached a high point of 3 percent of GNP expended for R&D, which has been declining ever since. (By 1972 the US figure was down to approximately 2.4 percent. In 1969, the figure for US GERD as a percentage of GNP was 2.8; the United Kingdom stood at 2.4 percent; France at 1.9 percent; Germany at 1.7 percent; and Japan at 1.5 percent.) The Soviet bloc figures then are remarkably high. To what extent they represent reality we are unable to say. At the least, one can deduce that the Soviet bloc countries listed here almost certainly conduct a sizable and relatively intensive R&D effort. This conclusion is strengthened when one also considers the large manpower resources devoted to R&D that are reported by all these countries (see Figure 43, Chapter VI, and Table H-1).

Leaving the Soviet bloc and moving to the Third World countries depicted in Figure 37, we notice a radically different situation. If we take the frequently cited figure of one percent of GNP expended for R&D as a sort of rule-of-thumb dividing line between the more-developed and less-developed countries--at least insofar as their approach to R&D is concerned--we note once again the relatively low priority accorded R&D by almost all Third World countries. Israel, which in 1970 spent 1.29 percent of GNP on R&D, is the only included country over the one percent mark. All others are well below; except for Nigeria, in fact, all are below one-half of one percent. India, which as we noted earlier led the Third World countries in absolute gross expenditures for R&D, spent only .43 percent of its GNP for this purpose in 1969; Mexico and Argentina, which were also among the leaders in absolute gross expenditures for R&D, spent only .14 and .31 percent of GNP, respectively; and countries such as Ghana and Kenya spent less than .1 percent. (The GERD figures for Pakistan and Iraq are only partial and, therefore, the computed percentages of GNP are also lower than they should be.) Of course, when we couple these

very low percentages of GERD in relation to GNP with the fact that most of these countries have relatively low GNPs also (compared with the OECD and advanced Soviet bloc countries), we have simply reinforced our earlier statement that almost all the research and development in the world is performed in a few advanced countries.

D. GERD BY SOURCE OF FUNDS⁶

Our data for GERD by source of funds for non-OECD countries are not very satisfactory. We have only the one year's data for each country (usually 1969), and as a glance at Table G-3 will show, there are quite a few blank spots in the breakout of the various sectors. There is also no information at all on sources of R&D funds within the Soviet Union. Still, Figure 38 and Table G-3 do offer a modicum of enlightenment regarding the sources of R&D funds in several representative non-OECD countries.

Perhaps the chief point to strike the reader is the generally high percentage of R&D funds supplied by Government in most of the included countries, as compared with the OECD. In none of the countries displayed in Figure 38 did Government supply less than 32 percent of GERD (Poland), whereas in three (India, Iran, and Mexico) the Government share was over 90 percent, and in two it was over 70 percent (South Korea and Nigeria). This can be compared with the OECD where, among the advanced countries, France had the highest Government share of GERD with some 63 percent in 1969; the comparable figure in West Germany was 39 percent and in Japan approximately 26 percent.⁷ The pattern of very high Government funding of R&D does appear, especially in earlier years, in such OECD countries as Greece (82 percent),

6. This section should be read in conjunction with Table G-3.

7. In the United States the government share of GERD was 57 percent, and in the United Kingdom 50 percent. In all these countries except Japan, Government has funded very large defense and big science R&D programs, which by their nature are not conducive to private enterprise assumption of prime responsibility. See the discussion of OECD countries in Chapter IV.

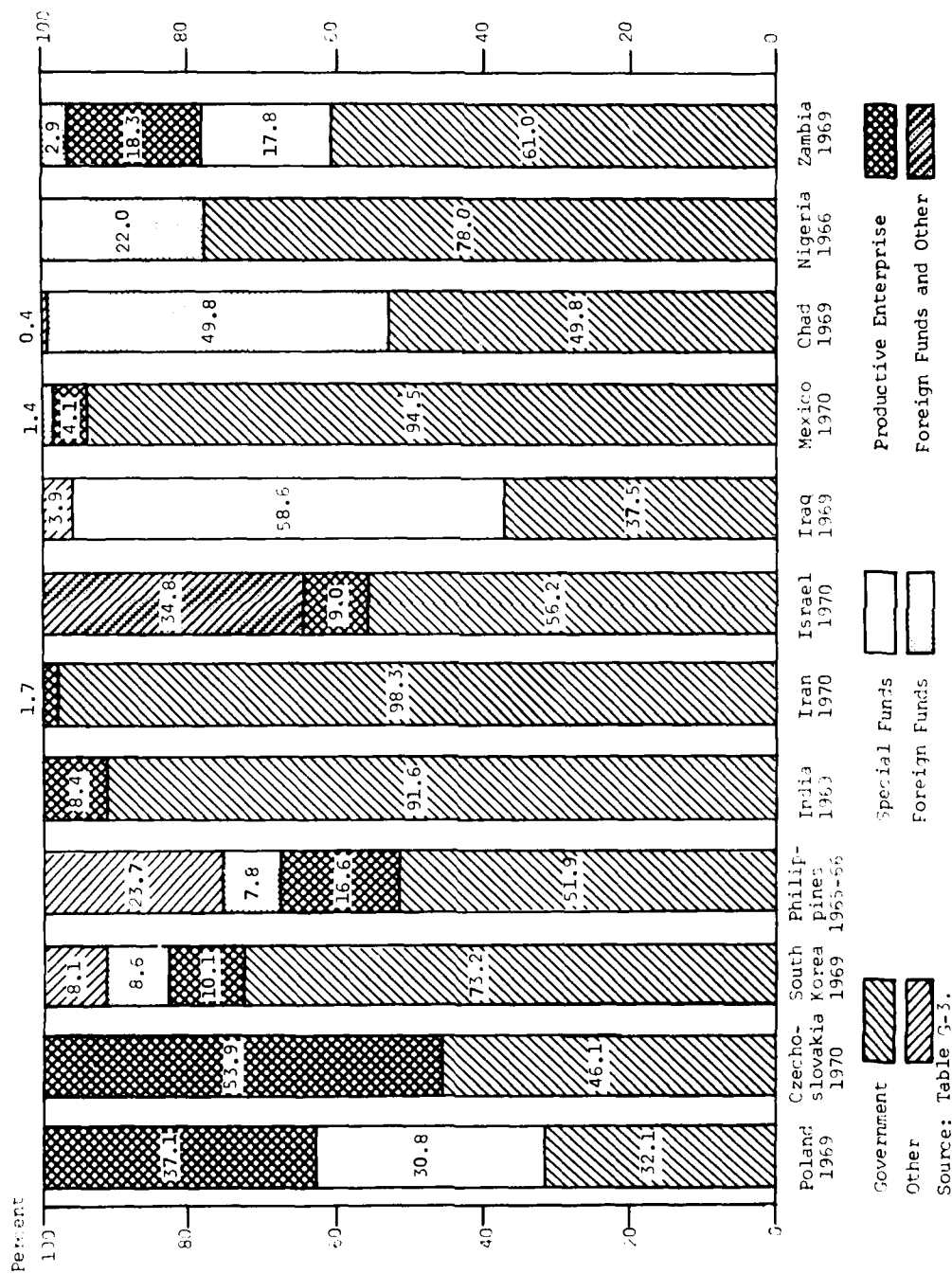


Figure 38. GIRD BY SOURCE OF FUNDS FOR SELECTED NON-OECD COUNTRIES
(percentage distribution)

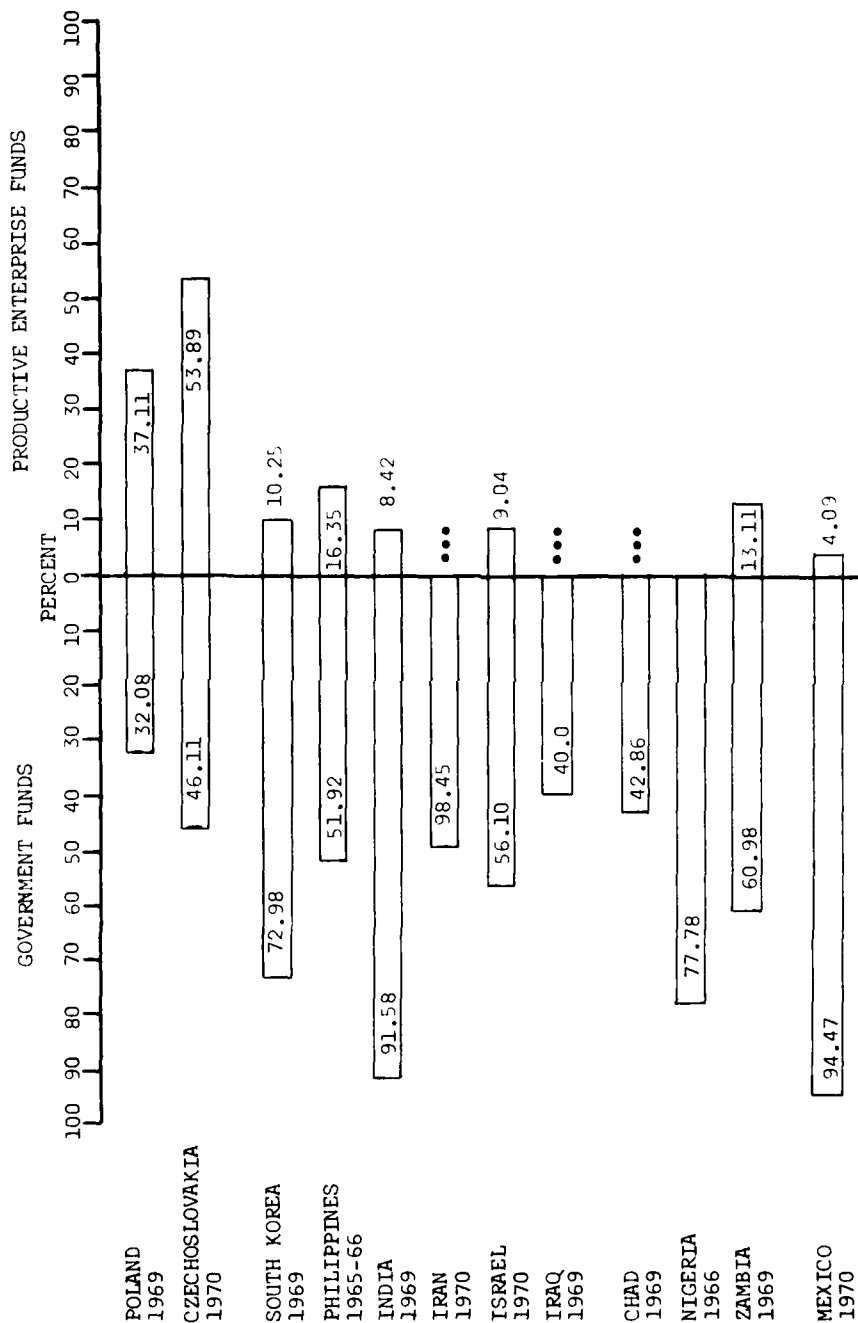
Spain (nearly 74 percent), and Portugal (71 percent)--all in 1964. In none of these, however, was it even then as high as in the highest non-OECD countries, and most of the remaining OECD countries have been consistently much lower. The conclusion would appear evident that in those countries with a relatively weak Productive Enterprise sector,⁸ the Government sector has usually tended to assume the major responsibility for funding R&D. Of course, in most such countries (including those OECD members, such as Greece, Spain, and Portugal, with high Government support of R&D), both GERD itself and GERD as a percentage of GNP are themselves quite low in comparison with the major industrialized countries--meaning simply that Government funds the greatest part of what little R&D is accomplished.

In only two of the included countries in Figure 38 (Poland and Czechoslovakia) does Productive Enterprise assume a major role as a source of R&D funds. GERD in both these countries is also relatively large, which suggests that whatever their form of government these countries have more in common with the industrialized OECD countries, from the standpoint of R&D accomplishment and division of responsibility, than they do with the remainder of the world. In Israel, a relatively industrialized country also, there is nevertheless only weak support of R&D by Productive Enterprise (9 percent), with Government supplying 56 percent of funds, and Foreign sources (plus Other--the two are not broken out) funding a very high 35 percent of R&D. This is presumably accounted for by the large external sources of support available from the world Jewish community and also the United States.

Figure 39 displays in a different manner some of the same information contained in Figure 38, but highlights the comparison between the Government and Productive Enterprise sectors.⁹ Here once again

8. In non-Communist countries, the Productive Enterprise sector is essentially synonymous with private enterprise.

9. The discussion attending this figure, and Figure 40 referred to immediately below, should be read in conjunction with Tables G-6 and G-5, respectively. It should be noted that in treating different countries in these figures we are not always dealing with identical reference years; in gross terms, however, the comparisons still appear valid.

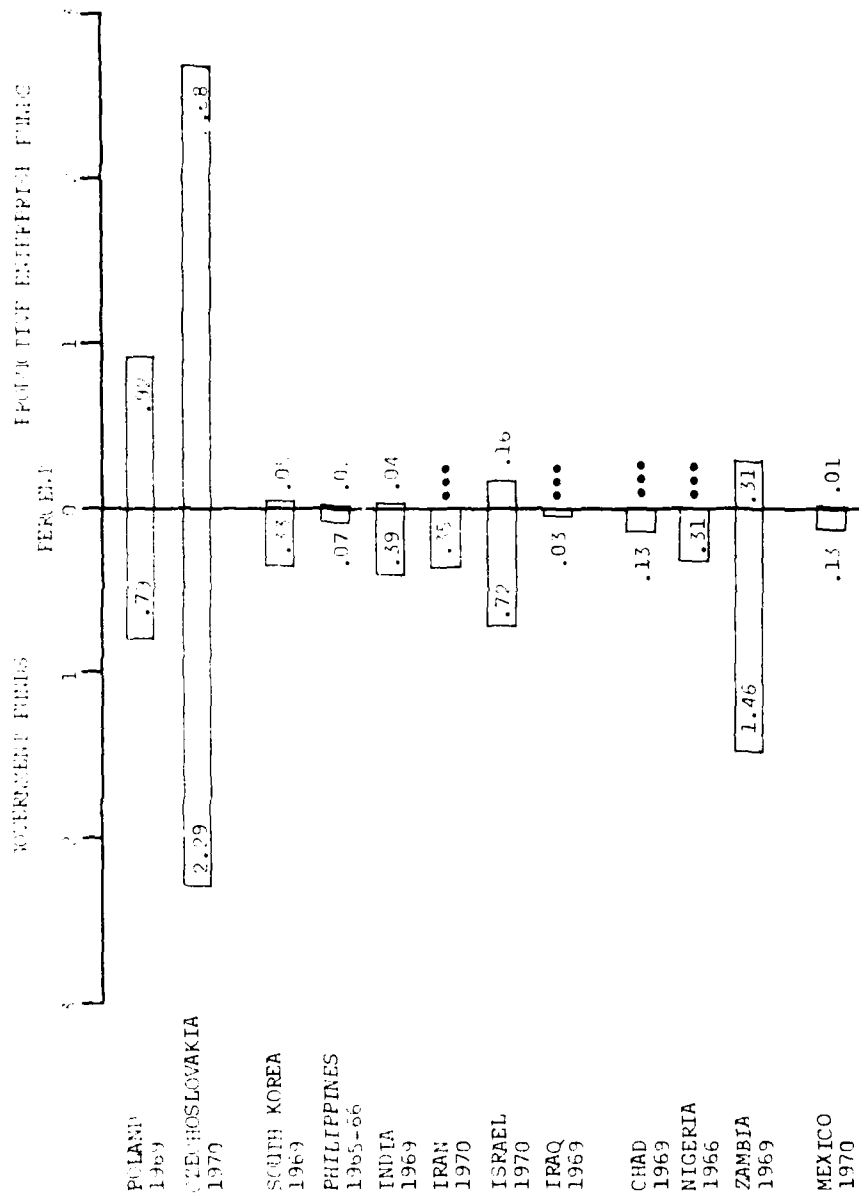


Source: Table G-6.

... = Not applicable

Note: The percentages on this chart were computed on a slightly different basis from those accomplished by UNESCO and referenced in Figure 38 and Table G-3; in a few instances this resulted in minor variations from the UNESCO percentage figures.

Figure 39. GOVERNMENT AND PRODUCTIVE ENTERPRISE FUNDS EXPENDED FOR R&D AS A PERCENTAGE OF GED FOR SELECTED NON-OECD COUNTRIES



Source: Table G-5.

Note: The percentages on this chart were computed on a slightly different basis from those accomplished by UNESCO and referenced in Figure 38 and Table G-5; in a few instances this resulted in minor variations from the UNESCO percentage figures.

Figure 40. GOVERNMENT AND PRODUCTIVE ENTERPRISE FUNDS EXPENDED FOR R&D AS A PERCENTAGE OF GNP FOR SELECTED NON-OECD COUNTRIES

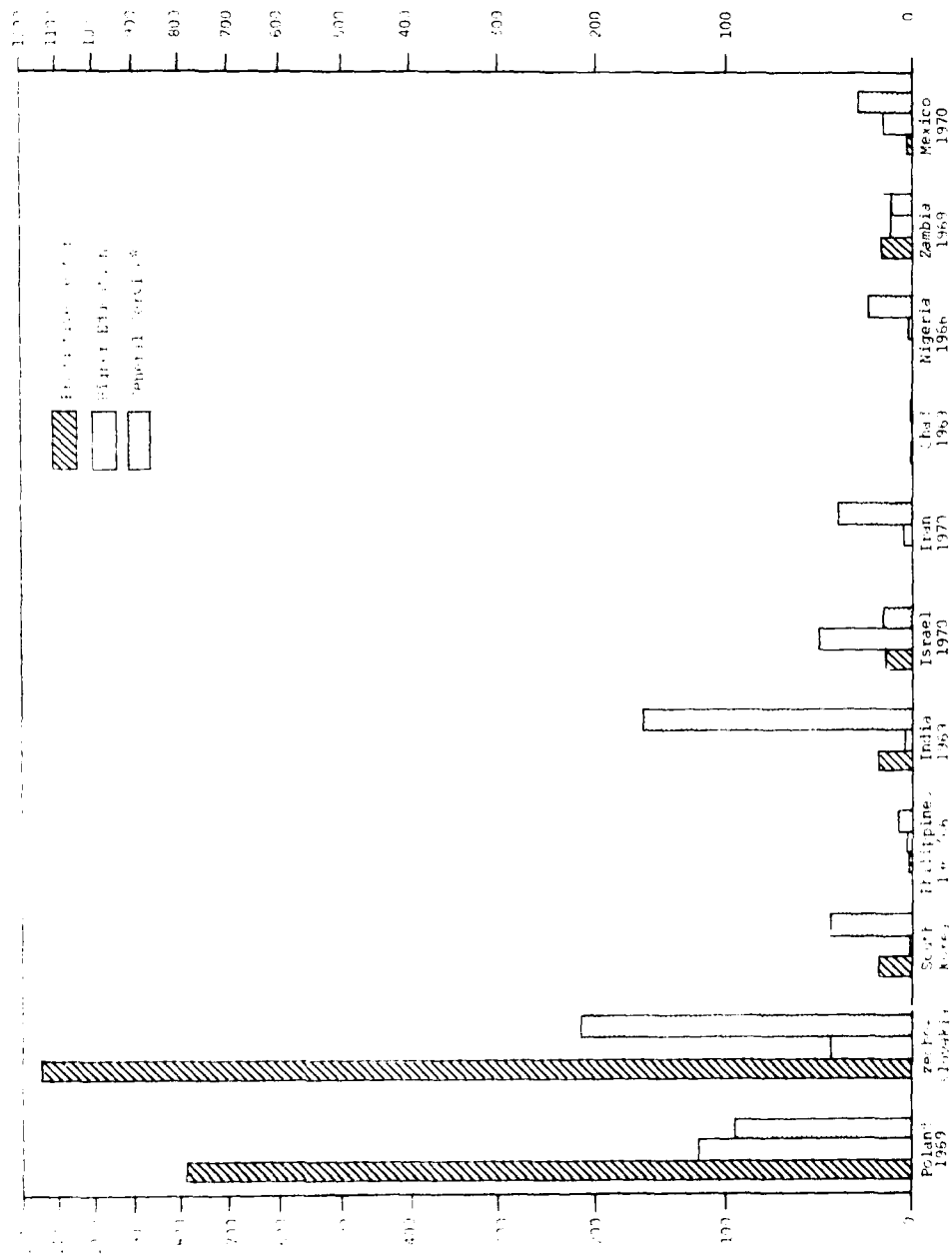
we note the greater relative balance between these two sectors in Poland and Czechoslovakia. In all other countries displayed, the dominance of the Government sector in funding R&D is clearly overwhelming.

One may also explore this question of sources of funds for R&D in somewhat greater depth by looking at the expenditures of Government and Productive Enterprise sectors as percentages of GNP. Figure 40 makes such a comparison. The same two points noted previously--the relative balance between the two sectors in the Communist countries and the dominance by Government in all others--are again apparent here. One may note here again the greater relative commitment of national resources to R&D by the Government of Israel, especially in comparison with much larger countries such as India and Mexico. Something of an anomaly appears in the striking percentage of GNP apparently committed to R&D, especially by the Government sector, in Zambia. In total these figures far exceed the percentage allocated even by Israel, and indeed exceed the percentage of GNP allocated to R&D by some of the most advanced of the OECD countries. If the figures are correct--and we display them here as they are reported by, and to, UNESCO--then it might be surmised that the large relative investment in R&D by the Zambian government is probably related to the country's huge copper industry.

E. GERD BY SECTOR OF PERFORMANCE

Let us now turn from sources of funds for R&D to the sectors of performance--that is, to the matter of where R&D is actually performed, without regard to how it is funded. Figure 41 shows the same countries with which we dealt in the previous section, this time with their respective expenditures for R&D broken out by sectors of performance. Some interesting comparisons are immediately apparent.¹⁰

10. The percentage figures cited in the following discussion are derived from Table G-4, which was the basis for Figure 41. For even wider comparisons, the reader's attention is called to Table C-1 in Part II, which shows GERD by sectors of performance for the OECD nations.



*The General Services sector of performance is roughly equivalent to the OECD's Government sector.
See the Introduction to this chapter for a more detailed definition.

Source: Table 3-4.

Figure 41. GERD BY SECTOR OF PERFORMANCE FOR SELECTED NON-OECD COUNTRIES
(in millions of current US dollars)

As before, Poland and Czechoslovakia are in a class by themselves, not only in the absolute scale of R&D performed in the various sectors, which one would expect, but in the overwhelming percentage of R&D performed in the Productive sector.¹¹ In Poland the pertinent figure is nearly 79 percent, and in Czechoslovakia it is over 82 percent.¹² No other country in this presentation even approximates this distribution: Zambia is closest, with some 43 percent performed in the Productive sector, and then South Korea, with 35 percent. In Israel, which is next, only 16 percent was performed in the Productive sector; in the Philippines 14 percent; in India 8 percent; and in Mexico less than 6 percent.¹³

Where, then, is R&D performed in these countries, if not in the Productive sector? In Israel, by far the greatest portion is in the Higher Education sector, almost 66 percent. In fact, Israel far exceeds all the other countries displayed here in the proportion of GERD performed in the Higher Education sector; Mexico is next, with nearly 32 percent; then Zambia with nearly 30 percent; the Philippines with 24 percent; and India with less than 2 percent. By contrast, the two Eastern European countries, Poland and Czechoslovakia, perform only 12 percent and 3 percent, respectively, of their R&D in the Higher Education sector. What, if anything, can be deduced from these disparities?

11. We can make no pretense of knowing specifically what these two Communist countries include in the Productive sector. For a general description of the category, the reader is referred again to the definitions in the Introduction to this chapter.

12. By way of comparison, some 70 percent of US GERD in 1969 was performed in the Business Enterprise sector; 68 percent in West Germany; 67 percent in Japan; 65 percent in the United Kingdom; and 56 percent in France. The pertinent figure for Switzerland was 85 percent. See Table C-1.

13. Again for comparison, of the smaller countries in the OECD, Sweden in 1969 performed 66 percent of GERD in the Business Enterprise sector; Austria 60 percent; Norway 48 percent; Spain 41 percent; and Greece 27 percent. Only Portugal, with 16 percent (lowest in this respect in the OECD), could compare with Israel. See Table C-1.

It will be remembered that in most countries it is fundamental research (as opposed to applied research or experimental development) that is usually performed in the universities. As a rule, such research tends to be more fragmented and individualized, and less oriented towards a practical product. One might assume, therefore, that Israel tends to emphasize fundamental research very heavily, and that it may well have major attendant problems (as do most countries in this respect) in developing effective links between university research and that done in the commercial sector.

The relatively high percentage of GERD in Mexico that is performed in the Higher Education sector also suggests a non-commercial orientation for a considerable portion of that nation's research. It may be noted that this tendency to have relatively large percentages of the national research effort performed in the universities appears to be part of a general pattern in most Latin American countries. One must also remember, of course, that much of this university research is in the social sciences, including in some countries the humanities, architecture, law, and other "soft" sciences. The conclusion is unavoidable, therefore, that even the relatively small resources allocated to R&D by most Latin American countries involve a disproportionate amount that is not "innovation oriented." In short, the "modern scientific revolution" referred to in Chapter I, wherein science and technology have increasingly blended in a mutually reinforcing system based on large research teams and a sophisticated institutional context, has only partially affected the Latin American countries. This same generalization, of course, is true for most of the Third World.

In addition to the Higher Education sector, the General Service (or Government) sector also appears to absorb rather high proportions of GERD in some of the countries displayed in Figure 41. India, Iran, and Nigeria, where the pertinent figure in each case is over 90 percent, are especially startling in this regard. Indeed, since India shows less than 2 percent of its R&D performed in the universities, one may wonder somewhat about the correctness of the figures; in any event, it would appear that these three countries have concentrated

extremely large portions of the nation's R&D performance in government laboratories. While one cannot generalize, it may be noted that this is a tendency that several of the OECD countries (notably Canada) have gone to some lengths to attempt to change, in the conviction that it represents an unhealthy situation for the nation generally. Other countries where R&D performance in the General Service sector is very high are Mexico, with some 63 percent; the Philippines, 62 percent; and South Korea, 61 percent. (We shall disregard Chad, where as we have noted previously the reported figures are only partial.)

In general, Figure 41 suggests that, with the exception of Poland, Czechoslovakia, and Zambia, most of the non-OECD countries displayed have tended to perform the greatest part of their R&D in either government laboratories or the universities, or in some combination of both, whereas most OECD nations (especially the major industrialized ones) rely to a much greater extent on the Business Enterprise (or, for UNESCO, Productive) sector for performance of research and development.

F. CURRENT R&D EXPENDITURES BY TYPE OF R&D ACTIVITY¹⁴

Since our data for this particular statistical breakout are neither very comprehensive nor precise, we shall not explore the subject in detail. Figure 42 shows a representative group of non-OECD countries, including most of those with which we dealt in the preceding section. As we should expect, applied research and experimental development appear to absorb considerably more funds in most of these countries than does fundamental research, and, as we would also expect, the two Eastern European countries, Poland and Czechoslovakia,

14. It will be noted that only "current" expenditures are available here, as opposed to "total" expenditures, which include also capital expenses. Current expenditures include all labor costs, expendable supplies, minor equipment, rent, maintenance and repair, utilities, administrative expenses, and the like, while capital expenditures include investment in land, buildings, and major equipment (excluding depreciation). See UNESCO, Statistical Yearbook 1971, pp. 581-82. Figure 42 and the attendant discussion should be read in conjunction with Table G-7.

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R AND D RESOURCE ALLOCATIONS BY SELECTED FOREIGN COUNTRIES, (U)
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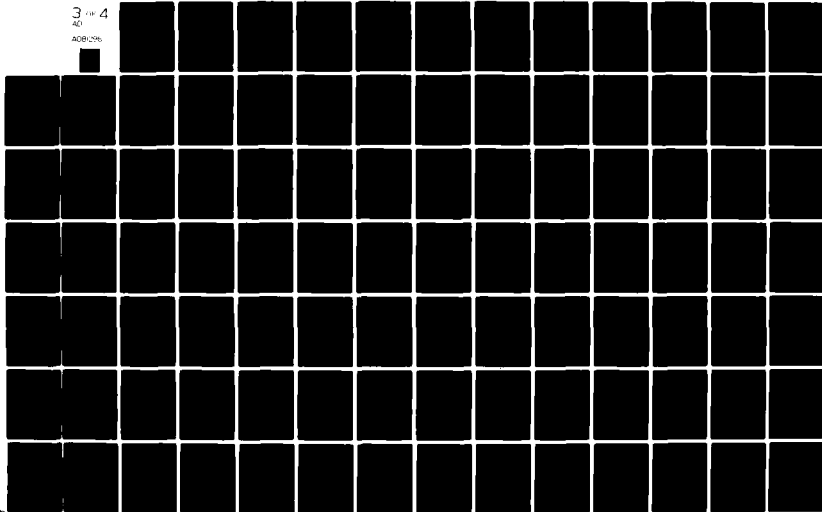
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dwarf the other countries displayed in all three categories of research. It might be noted that in Argentina, where some 30 percent of current R&D expenditures is for fundamental research, and in the Philippines where fundamental research absorbs 27 percent, we see further evidence of the trend to which we called attention in the preceding section--to wit, a disproportionate amount of the national R&D effort being expended in the universities.

VI

ALLOCATION OF MANPOWER RESOURCES TO R&D BY SELECTED COUNTRIES WORLDWIDE

In this chapter both OECD and non-OECD countries are included in the same graphic presentations, and a single data source was used for all--the UNESCO Statistical Yearbook 1971. These data, as we have noted previously, were obtained by UNESCO primarily from replies to the second in a series of annual surveys sent to member states during 1970; the replies were also supplemented by official national publications. The reader is reminded of the cautions set forth earlier about making precise comparisons between countries. At the least, he should be familiar with the footnotes accompanying the referenced tables in Part II if any comparisons are made. Moreover, there is no intention to suggest that "scientists and engineers" in different countries have received comparable training or that there is necessarily any correlation between the numbers of R&D personnel and national competence in research and development.

The following UNESCO definitions apply to the terms used in the ensuing charts and the attendant discussion:

Scientist and engineer. Includes any person who has received scientific or technical training in the natural sciences, engineering, agricultural, medical and social sciences as follows: completed education at the third level¹ leading to an academic degree; or completed third-level non-university education (or training) which does not

1. "Third level" institutions are defined as "degree-granting and non-degree-granting institutions of higher education of all types (such as universities, teacher-training colleges, technical colleges, etc.), both public and private. As far as possible, the figures include part-time ... students, but those for correspondence courses are generally excluded." UNESCO, Statistical Yearbook 1971, p. 331. Once again, the reader is reminded that these figures include personnel not only in the social sciences but, for many countries, such fields as architecture, law, fine arts, and humanities.

lead to an academic degree but is nationally recognized as qualifying for a professional career; or training and professional experience which is nationally recognized (e.g. membership in professional societies, professional certificate or licence) as being equivalent to the formal education indicated.

Technician. Includes any person who has received specialized vocational or technical training in any branch of knowledge or technology as specified below: one to two years' training beyond completed education at the second level or three to four years' training beyond the first cycle of secondary education, whether or not leading to a degree or diploma; on-the-job training and professional experience which is nationally recognized as being equivalent to the level of education indicated. Laboratory assistants who meet these requirements are also classed as technicians.

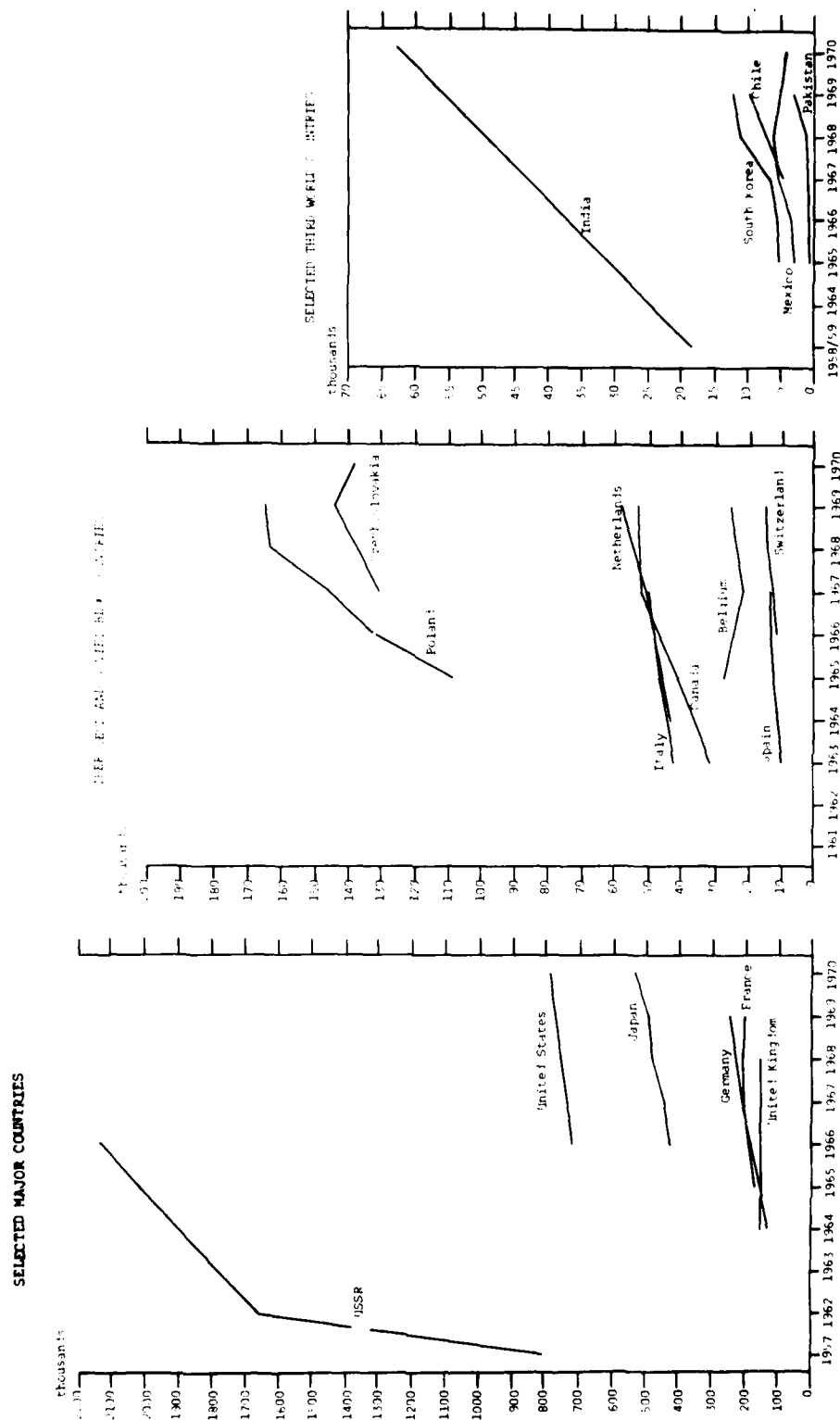
Auxiliary personnel.² The residual group includes skilled workers, such as machinists, sheet-metal workers and other trade workers, operatives, etc., as well as unskilled workers; all clerical, administrative and other supporting personnel such as secretariat personnel. Security, janitorial and maintenance personnel engaged in general "housekeeping" activities are excluded. However, scientists and engineers engaged in any of these activities are included in the category "Scientist and engineer."³

A. HISTORICAL TREND OF TOTAL PERSONNEL ENGAGED IN R&D

Figure 43 shows three sets of representative countries of the world grouped roughly according to the size of their R&D work force. It will be noted that each of the three graphs uses a different scale. It should also be remembered that, as the preceding definitions make clear, we are speaking here of total personnel engaged in the R&D function--that is, not only technically trained persons but unskilled, clerical, and administrative personnel also (excluding only janitorial and other housekeeping personnel). Among the world's major countries

2. Even though none of the included tables or charts specifically breaks out the categories of "technicians" and "auxiliary personnel," the definitions are included here to show the other categories that go to make up the total personnel group, other than scientists and engineers. The definitions also serve to clarify the distinctions between scientists and engineers and other R&D personnel.

3. UNESCO, Statistical Abstract 1971, p. 578.



Source: Table H-1.

Figure 43. HISTORICAL TREND OF TOTAL PERSONNEL ENGAGED IN R&D FOR SELECTED COUNTRIES WORLDWIDE

shown in the left-hand presentation of Figure 43, the Soviet Union appears to have by far the largest number of personnel involved in its R&D effort, with a total in 1966 of over two million and with the trend steadily upward. In the United States, the total number of personnel appears to be less than half that in the USSR, with the upward trend much more gradual. In Japan, while the number of persons engaged in R&D is substantially below that in the United States, it is not nearly as much so as one would expect considering the great difference in R&D expenditures between the two countries (approximately 1:10). Moreover, it is also not clear why Japan should loom so much larger in total R&D personnel than the major countries of Western Europe, considering the general similarities in total R&D expenditures of all these countries. Different definitions and reporting systems may well play a part; on the other hand, we are very likely also dealing with a genuine major difference in numbers of R&D personnel, due in varying degrees to a lower wage structure, undervalued currency, and different overall approaches to the performance of R&D in Japan. Among the three West European countries displayed, it will be noted that Germany has rather steadily increased its total personnel allocated to R&D, France turned slightly down beginning in about 1968, and the United Kingdom has remained at almost a constant level for some four years.⁴

Among the intermediate countries shown on the center graph, Poland and Czechoslovakia appear to considerably outstrip the OECD countries in this category in the total number of personnel allocated to R&D. (We make no attempt here to compare R&D expenditures between the Communist and OECD countries, as these figures are derived from two different data sources.) Once again, different definitions and reporting systems between the Communist and OECD countries may possibly account

4. The lower total number of R&D personnel for the United Kingdom, compared with France and Germany, is probably partially or wholly accounted for by the fact that the UK data do not include the Higher Education sector, nor do they include social sciences. See pertinent notes to Table H-1 in Part II.

for some of the disparity. For the OECD countries shown, we may say that their positions relative to each other accord in general with what we know of their R&D expenditures--except for Spain, whose standing appears to be higher than one might otherwise expect.

As for the Third World countries displayed, India clearly dwarfs all the others. Indeed, if one should take all these figures at face value, it would appear that India in 1970 had more total personnel engaged in R&D than either Canada, Italy, or the Netherlands. While this might in truth be so, because of wage and price differentials between India and the more developed countries, the differences in educational and economic systems are such that comparisons are probably pointless. For the other countries shown, we see an apparent general upward trend (except for Mexico) in allocation of personnel resources to R&D; the most we can say, however, is that the totals for these countries of only a few thousands of R&D personnel generally accord with what we know of their R&D expenditures.

B. NUMBER OF SCIENTISTS AND ENGINEERS ENGAGED IN R&D

Figure 44 shows numbers of scientists and engineers engaged in R&D for the same three sets of countries displayed in the previous figure, with the addition this time of Israel to the third grouping.⁵ Among the world's major countries shown in the graph on the left, approximately the same rank order as on the previous figure is maintained--that is, the Soviet Union is far above all the others and the trend is sharply upward; the United States is next with approximately half the total of the Soviet Union and the upward trend is more gradual; Japan follows, with a total a little more than half that of the United States; and the three major West European countries are grouped roughly together at the bottom. The disparity between Japan and the West European countries here is even more pronounced than in the previous presentation; once again, we cannot account for the differences, except as suggested earlier.

5. Data for total R&D personnel were not available for Israel.

Source: Table H-1.

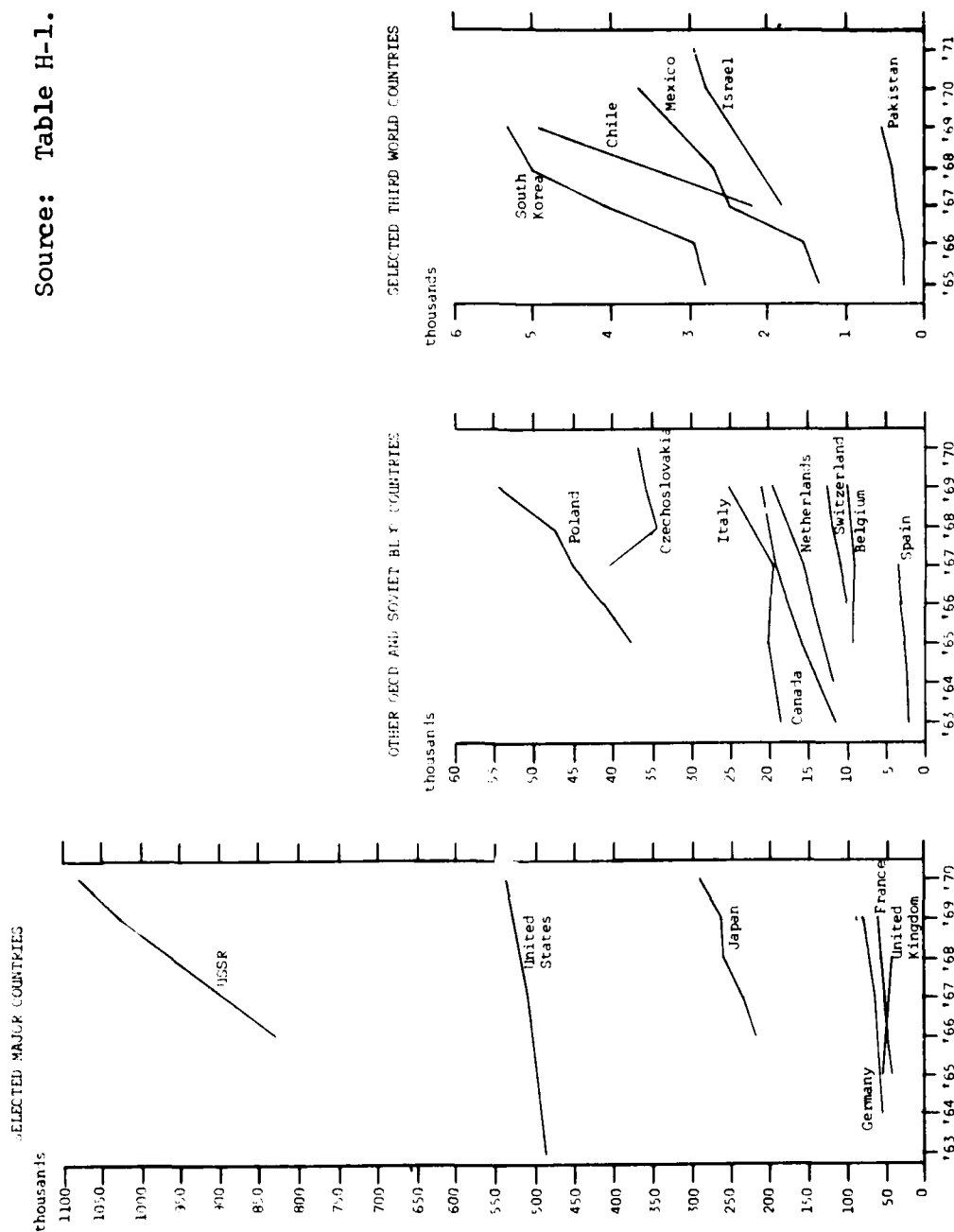


Figure 44. NUMBER OF SCIENTISTS AND ENGINEERS ENGAGED IN R&D FOR SELECTED COUNTRIES WORLDWIDE

For the intermediate countries displayed in the center graph, again the same pattern as before generally exists, except that Spain appears in a position more nearly according with the level of its R&D expenditures. The trend for all these countries in number of scientists and engineers engaged in R&D is generally upward--as it also appears to be for the Third World countries shown on the right. The differences in the absolute scales for the three graphs, however, should always be kept in mind; thus, there are approximately 3,000 scientists and engineers engaged in R&D in Israel, 10,000 to 20,000 in Belgium and the Netherlands, respectively, some 75,000 in Germany, and well over 500,000 in the United States.

It should also be of interest to see in what sectors of performance the scientists and engineers engaged in R&D in the various countries are employed. Figure 45 presents this information for a representative group of countries worldwide. (The required information is not available for the Soviet Union, however.) The reader's attention should be called to the fact that the information is presented this time on a logarithmic scale that considerably distorts some of the relative standings, especially, for example, of the leaders, such as the United States. Special attention should be given, therefore, to the actual numbers on the scale, rather than merely to the apparent relative positions of the different countries.

As one would expect, in almost all the more advanced countries the greatest number of scientists and engineers engaged in R&D are employed in the Productive sector (for capitalist countries this may be read as the Business Enterprise sector). In the United States, Germany, and Poland, especially, it will be noted that those employed in the Productive sector amount to several times the total for the next highest sector. In Japan, however, apparently a remarkably large number of scientists and engineers are employed in the Higher Education sector; since the relative Japanese expenditures among the various sectors do not parallel this disproportion, one would assume that

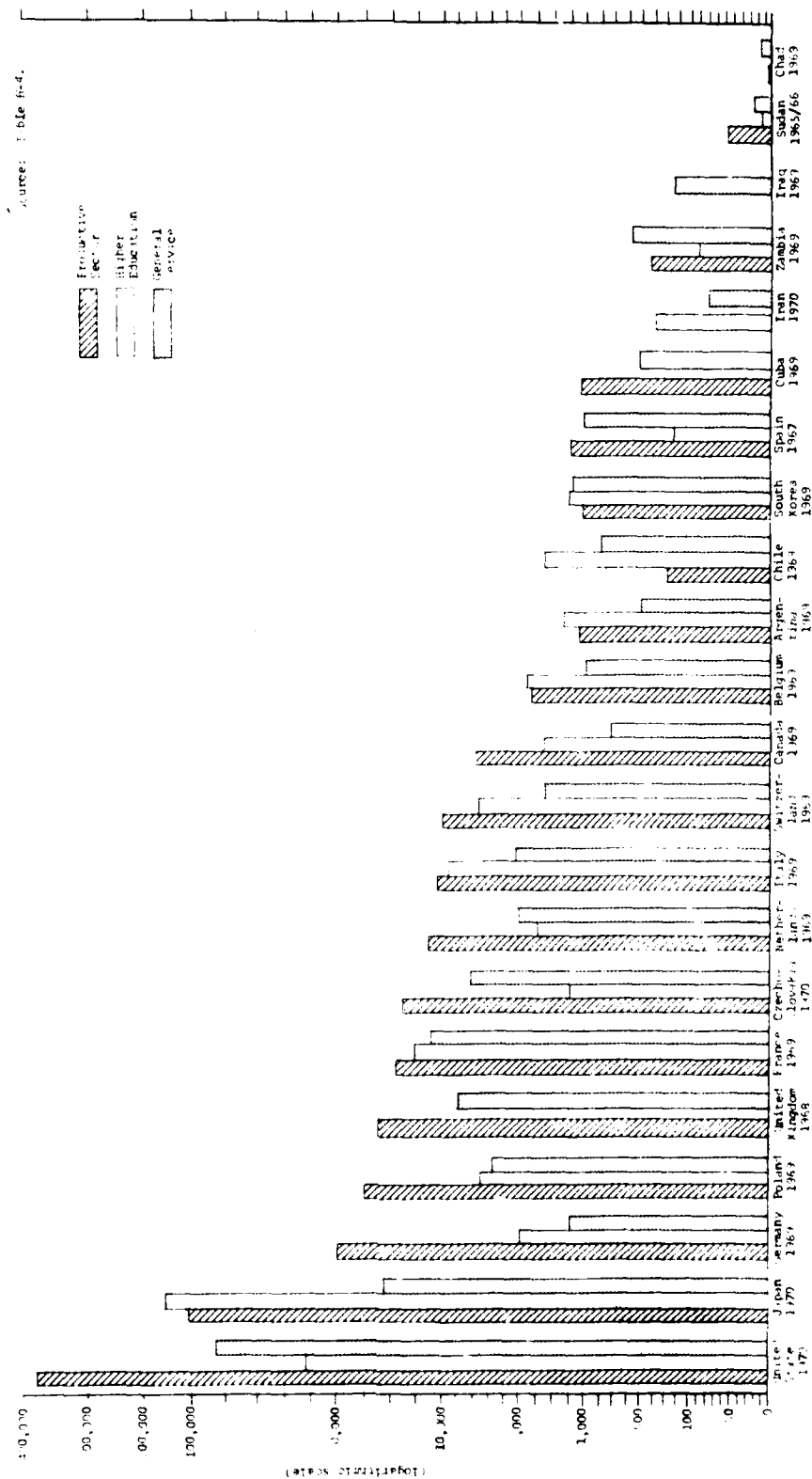


Figure 45. SCIENTISTS AND ENGINEERS ENGAGED IN R&D BY SECTOR OF PERFORMANCE FOR SELECTED COUNTRIES WORLDWIDE

Japan has a great many professors of science working in the universities but supported by comparatively small amounts of funds--and indeed, this appears to be the case.

As we move toward the less advanced countries on the lower end of the scale, we note again the pattern we have grown to expect from these countries' allocations of financial resources to the various sectors of performance--that is, proportionately larger numbers of scientists and engineers working in the Higher Education or General Service (Government) sectors, as compared with the Productive sector.

VII

PROJECTIONS OF CURRENT AND FUTURE R&D EXPENDITURES BY SELECTED MAJOR NATIONS

In Chapters III, IV, and V, past expenditures on R&D by OECD and non-OECD nations were analyzed. For all but a few of those countries, data were available only through the late 1960s. In this chapter, an attempt is made to estimate present and future levels of support for R&D by extrapolating from the data base established in the preceding chapters.

Three restrictions should be noted at the outset. First, projections have not been made past 1975. Considerable uncertainty is involved in extending the data series even that far, and the problem worsens, of course, the further into the future ones goes. Second, because of time and resource constraints, the number of countries for which projections have been attempted has been limited to five: the United States, France, West Germany, Japan, and the United Kingdom. These five countries were responsible for nearly 90 percent of the R&D accomplished in the non-Communist world in 1969 and thus are clearly the ones upon which any attempt to estimate future trends in expenditures should focus. As for projections of the future scale of Soviet R&D--a subject which is obviously of great interest to US policymakers--we must once again note the specialized and controversial nature of such estimates and the several large research efforts already directed solely to that end. A deliberate decision was therefore made not to expend the limited resources of this project on further probing into the area of Soviet R&D.

The third restriction concerns the level of analysis. Projections have been made only for gross expenditures on R&D (GERD). Estimates for sources of funds, sectors of performance, and other analytical categories have not been attempted, largely because the methods used to obtain the projections are necessarily crude, so crude that any

effort to refine the estimates into the constituent elements of GERD would be pointless.

A. METHODOLOGY

The projections are primarily based on the statistical foundation provided by the three OECD surveys conducted in the 1960s. The results of these surveys have already been discussed in Section A of Chapter III and are displayed in Figure 2 and Table A-1. Information for each country is available in current US dollars for three points in time: 1963 or 1964, 1967 or 1968, and 1968 or 1969. The data pertaining to the five countries for which projections have been made here have been extracted and are listed in Line A of Tables 49 through 53 of this chapter.

Two methods were used to derive the projections. The first involved computing past average annual rates of growth in GERD and then projecting those rates of growth into the 1969-1975 time period. The second method involved estimating future GNP and future ratios of GERD to GNP for each country, from which were derived projections of future national expenditures on research and development. Neither of these approaches is a reliable guide to future developments. Nevertheless, they appear to be the best available and in fact are the ones used by the National Science Foundation (NSF) to project future US spending on R&D.¹

1. Projections Based on Average Annual Rates of Growth in GERD

The dangers inherent in this method are obvious. There is no guarantee that the trends in R&D expenditures evident during the 1960s have continued into the early 1970s or that they will still be in evidence in 1975. Moreover, there is the question of selecting the time period from which the average annual rate of growth is to

1. National Science Foundation, National Patterns of R&D Resources: Funds and Manpower in the United States, 1953-1973, NSF 73-303 (Washington, D.C.: 1973), p. 5.

be derived. Although in principle a longer period of time would seem preferable to a shorter one, so that the effects of short-term changes in the growth rate can be minimized, averages based on the entire 1963/64 to 1968/69 period usually yield unrealistically high projections of future growth, simply because the rapid upsurge in GERD registered in many nations in the early and mid-1960s was already tapering off by the end of the decade. If, in an effort to avoid this pitfall, the average is derived simply from the late 1960s--that is, from the data available for 1967/68 and 1968/69--it is clear that the one or two years surveyed can provide only a very imperfect base from which to project a trend for the next six years. Because no other alternatives were available, however, both of these methods have been used. The projections generated appear in Tables 49 through 53 on Lines A' and A", respectively.

2. Projections Based on GERD as a Percentage of Estimated Future GNP

Deriving future GERD from its estimated share of future GNP offers even more opportunities for error.² The first problem is to project future gross national product. This has been done by computing the annual growth rates in GNP in national currencies from 1969 to 1972/73 and then applying those rates to GNP figures expressed in current US dollars for the last year available (1972 or 1973). This yields GNP projections in dollars for 1973/74 through 1975. The accuracy of these GNP projections is dependent on three critical (and to some extent unrealistic) assumptions: (a) the future rates of growth of real GNP will continue to be what they have been in the past, (b) past rates of inflation will continue unchanged in the future, and (c) exchange rates will not change between 1972/73 and 1975. While it was not practicable in this study to attempt to compensate for all the possible variables that could affect these assumptions, one that could not be ignored was the energy crisis, which will undoubtedly

2. The procedure discussed in the following paragraphs also describes the process by which Table I-1 in Part II was constructed.

have a large negative effect--but of unpredictable dimensions--on growth rates in GNP in 1974 and 1975. In an effort to compensate for the effects of this factor, the GNP growth rate was arbitrarily reduced by fifty percent.

After projecting each country's future GNP for the years in question, the next step was to estimate the future share of GERD in the gross national product. Two methods were employed. The first was to make a straight-line projection of the ratio of GERD to GNP for the last year for which OECD data were available (that is, 1968 or 1969). This approach has the advantage of being simple but is unlikely to yield an accurate forecast. The second approach was more complicated and attempted to take account of the trends that could be discerned from the available data. Two sources for such trends were used: (a) Table A-4, which shows GERD as a percentage of GNP for 1961, 1963, 1967, and 1969; and (b) NSF estimates for GERD in the countries in question, in national currencies for 1970 and 1971,³ divided by GNP figures for those years compiled by national authorities. Whatever trends emerged from the two sources were then projected into the period from 1972 to 1975. This projection is likely to be somewhat closer to reality than the preceding "straight-line" one.

In both cases, once the series of GERD/GNP ratios based on past experience were prepared, they were applied to the future GNP projections in order to generate forecasts of future GERD. The projections based on these two methods will be found in Lines B and B', respectively, of the tables following.

The limited reliability of estimates made in the manner described is clearly apparent. It would be desirable to check them against national statistics on GERD, at least through 1972, but it was not possible in most cases to gather more than fragmentary data from national sources. The major exception in this regard--and therefore the major test of the reliability of the methodology--was the United

3. National Science Foundation, National Science Board, Science and Indicators, 1972 (Washington, D.C.: 1973), p. 102.

States, for which NSF estimates of US GERD were available through 1973. These NSF estimates have been listed in Table 49. Lastly, any additional (usually fragmentary) information that could be secured on R&D trends in the other countries has been added to the appropriate tables as a further check.

3. Summary of Methodology

To recapitulate, then, this chapter contains projections of gross national expenditures on R&D for the years 1970 through 1975 for the following five non-Communist major countries: United States (Table 49), France (Table 50), West Germany (Table 51), Japan (Table 52), and the United Kingdom (Table 53). These projections are of two basic sorts, each of which in turn contains two variants:

(1) For each of the five countries, projections have first been made based on average annual rates of growth in GERD. These projections are based on OECD data for past expenditures (the figures for past expenditures appear as Line A on the tables), first using rates of growth during the greater part of the decade of the 1960s (these projections appear as Line A'), and then a rate of growth during only the last two or three years of the decade (Line A").

(2) A second set of projections has been made based on estimates of GERD as a percentage of GNP, first using a straight-line projection of the ratio of GERD to GNP that obtained in the last year for which OECD data were available (that is, 1968 or 1969), and then using varying ratios of GERD to GNP derived from apparent trends in the early 1970s. These projections appear in Lines B and B', respectively.

Lastly, we have added as additional lines on each table any further data or projections from other sources for the years 1970-1975.

B. VALIDITY OF THE PROJECTIONS

The caveats expressed in the preceding section should have made it clear that the projections that follow are very approximate in nature. At the same time, these estimates do have some basic validity. They are constructed on the basis of trends that are matters of current fact. If major and unforeseen changes occur in the trends, that of course will have an impact on the projections. For the

moment, however, the methods described above are the best available for estimating what the R&D expenditures of the several nations may be now and in the near future. Moreover, since a number of projections have been made, the reader has the opportunity to choose among a range of alternatives. Should he have greater expertise than the authors of this paper pretend to have, or should he be more intimately acquainted with actual conditions and future national science policies in these countries, the alternative statistical series may be of some assistance in making projections of his own.

In a few instances, based on our own familiarity with the data and with existing trends, we have suggested that some of the projections appear to be either too high or too low, and we have proposed figures that seem to us to be more likely to conform to future reality. These suggestions have no special authority, however, and the reader may wish to make his own adjustments. What is needed, of course, is a special study devoted to precisely this question of projections, so that a wider search might be made for corroborating data and for more specific indicators of the various nations' future policies on research and development. Even so, our projections, as they stand, yield some rather surprising results.

C. THE UNITED STATES

The OECD and NSF data on GERD are identical for 1964 and fairly close for 1968 and 1969 (see Table 49). Thereafter, projections based on average annual growth rates derived from the OECD statistics (Lines A' and A'') begin to diverge from the NSF data and estimates (Line C). The average growth rates of both 6.7 and 5.0 percent per year proved to be too high when compared with the NSF current estimate. The former yielded a GERD of \$34.5 billion for 1973; the latter, a GERD of \$32.3 billion. The NSF estimate was considerably lower: \$30.1 billion. If this estimate is correct, the US average annual rate of growth of GERD is continuing to decline: over the three years between 1970 and 1973, it was 4.27 percent. If this rate continues unchanged, US GERD in 1975 will amount to \$32.7 billion (see Line C').

Table 49

PAST AND PROJECTED FUTURE GERD IN THE UNITED STATES
(in millions of current US dollars)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
GERD derived from OECD data:													
A' Past expenditures		19,215				25,330	26,595	28,400	30,300	32,300	34,500	36,800	39,300
A' 5.7% growth rate ^a								28,000	29,300	30,800	32,300	33,900	35,600
A" 5.0% growth rate													
GERD derived from share of GNP:													
B' Constant ratio of 2.8% ^c								27,400	29,600	32,300	36,100	37,500	39,200
B' Ratio declining from 2.8 to 2.1% ^c								26,560	27,315	29,150	30,100	29,580	29,400
GERD derived from NSF data:													
C' Past expenditures	17,371	19,214	20,439	22,264	23,613	25,119	26,179	26,560	27,315 ^d	29,150 ^e	30,100 ^e	31,400	32,700
C' 4.3% growth rate ^f													
GERD derived from Battelle data:													
D' Battelle forecast												32,400	34,100
D' 5.1% growth rate ^g													

a. Projection based on 1964-1969 average annual growth rate of 6.7 percent.

b. Projection based on 1968-1969 growth rate of 5.0 percent.

c. For details, see Table I-1.

d. Preliminary.

e. Estimated.

f. Projection based on 1970-1973 average annual growth rate of 4.27 percent.

g. Projection based on 1970-1974 average annual growth rate of 5.11 percent. (NSF and Battelle data combined.)

Source: For A: Table A-1. For B: Table I-1. For C: National Science Foundation, National Patterns of R&D Resources: Funds and Manpower in the United States, 1953-1973, NSF 73-303 (Washington, D.C., 1973), Table B-1, pp. 26-27. For D: W. Halder Fisher, Probable Levels of R&D Expenditures in 1974: Forecast and Analysis (Columbus, Ohio: Battelle Memorial Institute, December 1973), p. 1.

A comparison of the NSF figures with those derived from the projected share of GERD in GNP shows that the constant share of 2.8 percent projected in Line B is much too high. Line B' is, of course, derived from Line C and therefore yields an identical figure for 1973: \$30.1 billion. It should be noted, however, that the \$29.5 billion predicted by this method for the following year, on the assumption that the ratio of GERD to GNP will gradually decline from 2.8 percent in 1969 to 2.1 percent in 1975, is almost \$3 billion less than the \$32.4 billion forecast by the Battelle Memorial Institute for 1974 (see Line D). This suggests that the share of GERD in GNP may have stabilized for the moment at about 2.3 percent and that the \$29.4 billion projected for 1975 by Line B' is too low.

The Battelle estimate for 1974 is probably the best available for that year. It assumes, however, that GERD will grow at the usually high rate of 7.64 percent between 1973 and 1974. Should this prove to be true and if we assume that GERD grows between 1974 and 1975 at 5.11 percent (the average annual growth rate between 1970 and 1974 obtained by combining the figures used by the NSF and Battelle), then US GERD in 1975 would total \$34.1 billion (see Line D').

The best estimate for "present" GERD is clearly that prepared by the National Science Foundation: \$30.1 billion.⁴ US GERD for 1975 will probably fall within the range created by projecting from the NSF and combined NSF-Battelle data, that is, from the \$32.7 to \$34.1 billion indicated in Lines C' and D'.

It is worth noting before concluding this section that the above figures for 1975 are well below those generated by the relatively crude methods used in Lines A' and B but fall within the range of figures generated by the somewhat more realistic approach used in Lines A'' and B'. At least for the United States, therefore, these two series do provide a rough indication of present and future levels of R&D spending.

4. Here, and for the remainder of this chapter, "the present" is defined as 1973.

D. FRANCE

At the outset, it would be well to discard Lines A' and B (see Table 50), which are based on the clearly unrealistic assumptions that French GERD will continue to grow at the high average rate of 15.6 percent a year that prevailed between 1963 and 1968, or that it will continue to account for 1.9 percent of GNP, the share existing in 1968. These estimates are belied by the sharp downturn in the rate of growth in French GERD at the end of the decade and by fragmentary information on subsequent French expenditures (see below).

The figure projected in Line C' for 1975 is also likely to be too high.⁵ It is derived from an official French estimate that was probably made in early 1971 and that assumed an average annual rate of growth, in francs, of 8.5 percent. The level of expenditures projected, 22.5 billion francs, may have been more in the nature of a target than a realistic estimate. One year later the source for Line D remarked that actual expenditures were likely to be much less:

Everything points to the inability of the sixth plan to attain its objective so that expenditure by the end of 1975 will be, at best, the minimum expected (19,500 million francs).⁶

The forecast made in Line D, \$4.2 billion, will therefore be taken as the maximum estimate for gross expenditures on R&D in 1975. As for the maximum estimate for 1973, the figure derived from the B' projection, that is, \$3.9 billion, would appear reasonable, the higher figures in Lines A' and B having been ruled out as clearly unlikely.

The figures at the lower end of the range in 1973 and 1975 may be estimated by taking a look at the remaining series. Line A" assumes that GERD will continue to increase at the 1967-68 rate of 4.5 percent.

5. In this instance, the year 1975 will be dealt with before 1973 because additional data projecting GERD for that year are available. The 1973 projection will be obtained by working back from these estimates.

6. Emphasis added. La Recherche, as quoted in Nature, May 26, 1972, p. 210.

Table 50

PAST AND PROJECTED FUTURE GERD OF FRANCE
(in millions of current US dollars)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
GERD derived from OECD data:													
A Past expenditures	1,300												
A' 15.6% growth rate ^a					2,562	2,678	3,100	3,600	4,100	4,900	5,500	6,400	7,400
A'' 4.5% growth rate ^b							2,800	2,900	3,100	3,200	3,300	3,500	3,600
GERD derived from share of GNP													
B Constant ratio of 1.9% ^c							2,700	2,800	3,100	3,700	4,800	5,100	5,300
B' Ratio declining from 1.9 to 1.4% ^c							2,600	2,700	2,800	3,200	3,900	4,000	3,900
GERD derived from French data:													
C Past expenditures	1,282	1,663	1,990	2,191	2,522	2,641	2,456 ^d	2,590	2,870				4,900
C' 8.5% growth rate ^e													4,200
D French data ^f													
E GERD derived from NSF data ^g								2,736	3,025				

a. Projection based on 1963-1968 average annual growth rate of 15.6 percent.

b. Projection based on 1967-1968 growth rate of 4.5 percent.

c. For details, see Table I-1.

d. Provisional data. The apparent decline in R&D spending is a result of the August 1969 change in exchange rates.

e. Expenditures in terms of francs increased.

f. Projection made by source which supplied data for Series C. Figure for 1975 converted at the September 1973 rate of 4,604 francs to one US dollar. (See Statistical Office of the European Communities, General Statistics: Monthly Statistics, Issue No. 10, 1973.) Growth rate calculated on the basis of projections in francs.

g. NSF estimates.

f. For conversion rate used, see preceding note.

g. NSF estimates.

Source: For A: Table A-1. For B: Table I-1. For C: Based on table prepared by Service Inventaire of the DGRST (Délégation Générale à la Recherche Scientifique et Technique) as cited in Science Policy News, September 1971, pp. 24-25. The data extracted from this table refer to GERD compiled according to OECD standards. Figures in this source are expressed in francs and have been converted into US dollars at the rates listed in United Nations, Statistical Office, Statistical Yearbook, 1970, p. 606 (for 1963 through 1968) and 1972, p. 630 (for 1969 through 1971). For D: Nature, Vol. 237, May 26, 1972, p. 210 (from La Recherche). For E: National Science Foundation, National Science Board, Science Indicators, 1972 (Washington, D.C., 1973), Appendix Table 1, p. 102. Figures in this source are expressed in francs and have been converted into US dollars at the rates listed in the United Nations, Statistical Office, Statistical Yearbook, 1972, p. 630.

This estimate may be somewhat too conservative, at least in the light of what is known of French plans. Line B' assumes that GERD will account for a share of GNP that contracts by about .08 percentage points a year from 1.9 percent in 1969 to 1.4 percent in 1975. Combined with the GNP projections, this yields a level of expenditures that jumps from \$3.2 billion in 1972 to \$3.9 billion in 1973 and then remains relatively constant for the next two years. This series may perhaps give too high a figure for 1973 but may be closer to the truth for 1975. For 1973, therefore, the lower end of the range has been arbitrarily estimated as the average of the figures given in Lines A" and B', that is, \$3.6 billion; for 1975, the figure given in Series B' has been reduced by \$100 million to \$3.8 billion.

Thus, the best estimate for French GERD in 1973 would range between \$3.6 billion and \$3.9 billion and for 1975 between \$3.8 billion and \$4.2 billion.

E. WEST GERMANY

With the Federal Republic of Germany, we come to a state for which there is little factual information against which to check our projections. What little there is--the NSF estimates for 1970 and 1971--would indicate that the figures generated according to the standard methodology used in this chapter may be too low.

In Lines A' and A", it is assumed that GERD continues to grow at rapid rates of between 12.7 and 13.1 percent per year (see Table 51). The numbers yielded by these two growth rates have been averaged for both 1973 and 1975 and the product used to supply the figure at the lower end of the range for those years: \$4.3 and \$5.5 billion, respectively.

In Lines B and B', it is assumed that the ratio of GERD to GNP remains constant at either the 1969 figure of 1.7 percent or the 1970-71 figure of 2.0 percent. The numbers yielded by these two percentages have also been averaged for both 1973 and 1975 and the product used to supply the figure at the upper end of the range for those years: \$6.3 and \$7.0 billion, respectively. Thus, the West German GERD projected for 1973 would range between \$4.3 billion and \$6.3 billion and for 1975 between \$5.5 and \$7.0 billion.

Table 51
PAST AND PROJECTED FUTURE GERD IN WEST GERMANY
(in millions of current US dollars)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
GERD derived from OECD data:													
A' Past expenditures													
A' 13.1% growth rate ^a		1,485			2,084		2,552	2,000	3,400	3,800	4,300	4,900	5,600
A' 12.7% growth rate ^b								3,000	3,400	3,800	4,300	4,800	5,400
GERD derived from share of GNP:													
B' Constant ratio of 1.7 ^c								3,200	3,500	4,400	5,800	6,100	6,400
B' Constant ratio of 2.0 ^c								4,400	4,100	5,100	6,900	7,200	7,600
C GERD derived from NSF data ^d								3,810	4,621				

a. Projection based on 1964-1969 average annual growth rate of 13.1 percent.
b. Projection based on 1967-1969 average annual growth rate of 12.7 percent.
c. For details, see Table I-1.
d. NSF estimates.

Source: For A: Table A-1. For B: Table I-1. For C: National Science Foundation, National Science Board, Science Indicators, 1972 (Washington, D.C., 1973), Appendix Table 1, p. 102. Figures in this source are expressed in marks and have been converted into US dollars at the rates listed in the United Nations, Statistical Office, Statistical Yearbook, 1972, p. 640.

It will be noted that the estimates are both very high and very vague for West Germany. Unfortunately, at this point there is no way to determine whether the range should be adjusted to a lower set of values or how the estimate could be made more precise. The most that can be said is that the estimates do not appear unreasonable, since everything we know about the growth rate of German R&D suggests that it is high, and we are not yet aware of any turndown.

F. JAPAN

After the United States, Japan is the country with the longest available time series of official government statistics on R&D expenditures. These statistics therefore provide an opportunity to check the reliability of our projections (see Table 52). What is perhaps most striking is that the Japanese statistical data for 1970 and 1971 and the projections through 1975 contain figures that are much higher than those projected in Lines A' and A" on the basis of past OECD data. This is a result not only of the assumed higher average annual rate of growth in GERD (21.6 percent compared with about 16 percent), but also of the radical shifts in exchange rates--shifts that are reflected in Line C' but not in Lines A' and A". If we are interested in comparisons based on current prices and prevailing exchange rates, Line C' should be preferred over the other two.

As for the two series based on projections of gross national product and the share of GERD in GNP, the one that assumes a constant ratio of 1.5 percent (see Line B) seems unduly conservative, while the one that assumes a share gradually rising from 1.7 percent in 1969 to 2.3 percent in 1975 (see Line B') yields figures very close to those derived from the Japanese data. Given the fact that GERD has tended to account for a gradually expanding share of GNP, this estimate cannot be dismissed as completely unrealistic.

Nevertheless, the figures for present and future Japanese GERD that appear in Lines B' and C' are very high, so high that it seems only prudent to question whether the ratio of GERD to GNP will continue to expand in the future as fast as it has in the past and

Table 52

PAST AND PROJECTED FUTURE GERD IN JAPAN
(in millions of current US dollars)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
GERD derived from OECD data:													
A Past expenditures,													
A' 16.7% growth rate ^a	1,023				1,951		2,592	3,000	3,500	4,100	4,800	5,600	6,500
A" 15.3% growth rate ^b								3,000	3,400	4,000	4,600	5,300	6,100
GERD derived from share of GNP:													
B Constant ratio of 1.3% ^c													
B' Ratio increasing from 1.7 to 2.3% ^c													
GERD derived from Japanese data:													
C Past expenditures,													
C' 21.6% growth rate ^d	1,023	1,217	1,413	1,507	1,951	2,438	2,958	3,765	4,534	6,100	8,100	9,200	11,200
D GERD derived from NSF data ^e													
								3,356	4,765				

a. Projection based on 1963-1969 average annual growth rate of 16.7 percent.

b. Projection based on 1967-1969 average annual growth rate of 15.3 percent.

c. For details, see Table I-1.

d. Calculated on the basis of data in yen.

e. NSF estimates.

Source: For A: Table A-1. For B: Table I-1. For C: Office of the Prime Minister, Bureau of Statistics, Report on the Survey of Research and Development in Japan, 1967, Summary table 1, pp. 36-37 (for years 1963 through 1966), 1970, Summary table 2, pp. 44-45 (for years 1967 through 1969), and 1972, p. 18 (for years 1970 and 1971), as cited in Nathan M. White, Research and Development in Japan (Volume II in Status of R&D Programs for Selected Foreign Countries), IDA Paper P-326 (Arlington, Virginia, 1973), Table 1, p. 16 (updated). Figures in original source are expressed in yen and have been converted into dollars at the rate of 360 yen to one US dollar through 1970, and 338 yen to one US dollar for 1971. Rates used in projection are, for one US dollar, 308 yen in 1972, 280 yen in 1973, and 300 yen in 1974-75. For D: National Science Foundation, National Science Board, Science Indicators, 1972 (Washington, D.C., 1973), Appendix Table 1, p. 102. Figures in this source are expressed in yen and have been converted into US dollars at the rates listed in United Nations, Statistical Office, Statistical Yearbook, 1972, p. 630.

whether GERD will continue to expand at the very rapid average rate of almost 22 percent a year.⁷ The average of these two projections, therefore, has been taken as the upper limit of the range for each year. The lower limit has been set arbitrarily 15 percent lower.

The best estimates for Japanese GERD thereby generated are: for 1973, between \$7.1 and \$8.4 billion; for 1975, between \$9.5 and \$11.2 billion.

G. THE UNITED KINGDOM

As was the case for West Germany, factual data for the United Kingdom was almost entirely lacking, and we were forced to rely on the projections made in accordance with the standard methodology (see Table 53).

Two of the projections can be discarded at the outset. There is little likelihood that the -7.9 percent growth rate extrapolated for GERD in Line A" from the short 1967-68 base period will prove to be correct. At the other end of the spectrum, it also seems improbable that the trend toward a declining ratio of GERD to GNP has stopped, as is predicted in Line B.

As for the two remaining projections, Line A' is certainly more plausible than Line A"; but in light of the NSF estimate for 1971, showing expenditures of \$2.9 billion compared with our projection of \$2.7 billion (see Line C), the 3.1 percent growth rate projected for GERD may be somewhat too low. The figures for 1973 and 1975 have, therefore, been increased slightly (but not enough to make up the entire difference between the NSF estimate and our projection) to provide the figures at the lower limits of the ranges for those years: \$3.0 and \$3.2 billion.

7. The impact of the present energy crisis on the Japanese economy will almost certainly be severe. This factor has been taken into consideration in the GNP projections, but at present there is no way of knowing what repercussion it will eventually have in the R&D area.

Table 53

PAST AND PROJECTED GERD IN THE UNITED KINGDOM
(in millions of current US dollars)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
GERD derived from OECD data:													
A. Past expenditures													
A' 3.1% growth rate ^a		2,150			2,649	2,440	2,000	2,600	2,700	2,800	2,800	2,900	3,000
A'' -7.3% growth rate ^b							2,200	2,100	1,900	1,800	1,600	1,500	1,400
GERD derived from share of GNP:													
B. Constant ratio of 2.4% ^c							2,700	2,900	3,300	3,800	4,300	4,600	4,800
B' Ratio declining from 2.6% to 1.1% ^c							2,900	3,000	3,200	3,500	3,800	3,800	3,800
C. GERD derived from NCF data ^d								2,585	2,910				

a. Projection based on 1964-1968 average annual growth rate of 3.1 percent.

b. Projection based on 1967-1968 growth rate of -7.9 percent.

c. For details, see Table I-1.

d. NCF estimates.

Source: For A: Table A-1. For B: Table I-1. For C: National Science Foundation, National Science Board, Science Indicators, 1972 (Washington, D.C., 1973), Appendix Table 1, p. 102. Figures in this source are expressed in pounds and have been converted into US dollars at the rates listed in the United Nations, Statistical Office, Statistical Yearbook, 1972, p. 631.

Line B' assumes that the share of GNP devoted to GERD will continue to contract by about one-tenth of a percentage point a year, as it did during the two years from 1969 to 1971. This seems perhaps a little too conservative and so the figures projected in this series for 1973 and 1975 have been arbitrarily increased by \$200 and \$300 million, respectively, to provide the figures at the upper limits of the ranges for those years: \$4.0 and \$4.1 billion.

The best estimates for the United Kingdom, therefore, range from \$3.0 billion to \$4.0 billion for 1973, and from \$3.2 billion to \$4.1 billion for 1975.

H. SUMMARY COMPARISON

1. The Present Situation

As a consequence of differing rates of growth in GERD and drastic shifts in exchange rates, there have probably taken place important changes in the relative levels of support for R&D in the five Major States since the last OECD survey was conducted in 1969. In that year, the combined expenditures of the Big Four were less than 40 percent of those of the United States. As Table 54 shows, by the present time their collective GERD may be between 60 and 75 percent of that of the United States. Again, whereas in 1969 US expenditures were ten times larger than those of the second-ranking state, at the present time they may be only four times larger. Thus, although the projections for the individual countries may well be, and indeed probably are, incorrect in detail, one major conclusion cannot be avoided: The formerly predominant US position in R&D expenditures, compared with that of other major non-Communist industrialized states, is steadily eroding.

The suddenness of the change in relative position is more apparent than real. The dollar was overvalued at the time the OECD surveys were taken and so the position of the United States was never in reality as overwhelmingly dominant as the statistics indicated. The revaluations and devaluations that have been carried out since 1969

Table 54

PROJECTIONS OF PRESENT AND FUTURE GERD
IN FIVE SELECTED OECD MEMBER NATIONS
(in billions of current US dollars)

Country ^a	Actual	Projected	
	1969	1973	1975
UNITED STATES	26.6	30.1	32.7-34.1
JAPAN	2.6	7.1-8.4	9.5-11.2
WEST GERMANY	2.7	4.3-6.3	5.5-7.0
FRANCE	2.7	3.6-3.9	3.8-4.2
UNITED KINGDOM	2.4	3.0-4.0	3.2-4.1

a. Countries are ranked in the order of the size of their projected GERD in 1975.

Source: Table A-1 and Sections C through G of Chapter VII.

have resulted in figures that represent a much closer approximation to the actual "balance of power" in research and development than was available earlier.

There may also have occurred a change in the relative positions of the Big Four. The year 1969 saw them clustered close together with GERDs of between \$2.4 and \$2.7 billion. By the present time, Japan has probably established a definitive lead over the other three. Its expenditures of from \$7.1 to \$8.4 billion are probably twice as large as those of either France or the United Kingdom (or larger than their combined expenditures) and about one-quarter those of the United States. West Germany probably occupies a position midway between Japan and the other two states. It would appear, therefore, that while the distance between the United States and the Big Four is narrowing, the spread among those states is increasing.

2. The Situation in 1975

The relative position among the Major States in 1975 is more difficult to estimate. In this instance, the projection for the United States, like that for the other countries, is expressed in terms of a range of values. The ranges of the others have expanded or contracted from what they were in 1973.

Comparing the United States with the Big Four, we find that Japanese GERD may have increased from about one-quarter to almost one-third that of the United States and that the collective GERD of the Big Four may amount to approximately 70 to 80 percent of US GERD, depending on whether one compares the lower or higher ends of the ranges of the respective states. This suggests that the trend discerned in the analysis of the present situation will continue. Between 1973 and 1975, the United States will probably lose more ground to the Big Four.

As for the Big Four themselves, France and the United Kingdom should stay close together at the bottom, West Germany should increase the distance between them and itself, and Japan should pull still further into the lead. Its GERD by 1975 may be two-and-one-half times as large as the GERD of either France or the United Kingdom.

VIII

ISSUES OF INTEREST FOR US POLICY

A. SIGNIFICANCE OF R&D INPUTS IN RELATION TO OUTPUTS

A major reason for the increasing international interest in research and development has been the assumed causal connection between R&D and economic growth. Thus the relative immensity of US investments in R&D and US economic preeminence since World War II were clearly seen as closely if not directly related to each other when the OECD began its R&D surveys in the 1960s as part of its overall program of studies on technological innovation and economic growth.

Although there undoubtedly is a connection between a country's ability to mount a substantial R&D effort and its ability to sustain economic growth, the linkages are by no means obvious. It is only necessary to note that, among the advanced states of the non-Communist world, the United Kingdom for years allocated resources to R&D second in magnitude only to those of the United States while maintaining a very low rate of economic growth and that Japan, while enjoying the world's highest rate of economic growth, channeled comparatively small sums into R&D. Yet if the causal connection between research and development and economic growth is obscure, and if much depends on such factors as timing, the industrial structure, the human capabilities, and the resource endowment of a particular country, or the pool of readily assimilable knowledge available outside the country, it nevertheless remains true that economic growth is propelled by technological change, which itself is made possible by the "outputs" of R&D activity.

Several of the "Issues of Interest for US Policy" referred to later in this chapter bear on this general issue of presumed linkages between strength in R&D, economic growth, and political-military power. These presumptions, or hypotheses, relate basically to two "gaps," one

between the advanced countries of the OECD and the underdeveloped nations of the so-called Third World, the other between the United States and its four most powerful allies: the United Kingdom, France, West Germany, and Japan. The data indicate the existence of an enormous gap between the underdeveloped countries, which collectively account for only an insignificant share of the research and development carried out in the world, and a small number of advanced states, which collectively all but monopolize R&D. The data also suggest that the once enormous gap between the United States and its major allies in the area of R&D is fast closing. These two changes raise troublesome questions for future US policy. It should be emphasized, however, that the present state of research into these policy questions is such that both students and policymakers have only just begun to close with them.

The first "Issue of Interest for US Policy," therefore, is the necessity for securing a better grasp on the precise significance of various levels of inputs--both by the United States and other nations--to the R&D process, as they relate to outputs in terms of political, economic, and military power.

B. TECHNOLOGY GAP BETWEEN RICH AND POOR NATIONS

Perhaps the most far-reaching and at the same time most elusive issue of interest for US policy arising from the analysis in this study lies in the fact that by far the greatest part of the world's research and development is performed in a relatively few advanced countries. A different but related aspect of this issue concerns the fact that in the less advanced countries a considerably larger portion of the national R&D effort is funded by the Government, and performed in the Government and Higher Education sectors (as opposed to the Business Enterprise, or Productive, sector), than is true for the advanced countries. In other words, the less advanced countries accomplish relatively little research and development, and a large proportion of what they do perform tends to be in sectors of the economy that are not oriented towards technological innovation and commercial profit.

In a sense, of course, the above differences between the R&D efforts of the more advanced and less advanced countries stem precisely from the definitional distinction between the two sets of countries. Extensive R&D expenditures by a nation require, at the least, a fairly sophisticated science and technology base in personnel and facilities, plus sufficient available capital for risk-taking ventures--not to mention the intangible factor of the will to utilize the two in combination. Since these attributes are exactly those of the advanced countries, as opposed to the less developed countries, what is new, one may ask, about this particular problem?

The problem does appear to have at least two new dimensions, however, one of which is substantive and the other more a matter of mind and attitude. The substantive aspect concerns the future economic development of the poor nations as compared with the rich. If there is in truth significant correlation between financial inputs and successful outputs in industrially financed R&D activity in the advanced countries, as appears to be accepted by most students of the research process,¹ and if it is proper to extend this relationship to the less advanced countries, then it would appear likely that the advanced countries may continue to develop technologically in a manner and at a rate disproportionate to those of the LDCs. On the other hand, the question might well be raised as to what extent the LDCs need to perform R&D (in the Western sense) at all, if improved means can be found to adapt the world's store of technology to their requirements. Of course, "adapt," as used here, cannot mean simply "transfer" of Western technology.

The second, or attitudinal, aspect of the problem concerns the political and economic reactions of the less developed nations if

1. See particularly, Keith Pavitt and Solomon Wald, The Conditions for Success in Technological Innovation (Paris: Organisation for Economic Co-operation and Development, 1971), Paragraph 93, and Annex A, "National Performance in Technological Innovation in Ten Countries: Its Relationship to Other National Characteristics Often Advanced as Being Important in the Innovation Process," pp. 143-48.

they become increasingly convinced that there is no reliable expectation of closing the gap with the advanced countries under present circumstances.² Individuals in some of these countries maintain that they can only reverse current trends by rejecting Western technological tutelage completely and re-doing all necessary R&D on their own. Leaders in other LDCs are energetically searching for new formulas for cooperation with the advanced nations, with the objective of ensuring that such cooperation stimulates genuine technological creativity in the less advanced partner. Among still others in the less advanced countries there appears to be an incipient reaction that they must make the advanced countries pay by whatever means are at hand (for example, by harassing the multi-national corporations or by withholding scarce natural resources) for their scientific and technological dominance.

The implications of the above state of affairs are so broad--extending through the entire spectrum of international relations from

2. See, for example, the following three articles in the March/April, 1973, issue of Ceres, a journal published by the United Nations Food and Agriculture Organization:

Surendra J. Patel, "The Cost of Technological Dependence," pp. 16-19. "The economic power and the technical competence of the multi-national corporations, which own most of modern technology, are matched against the weakness and ignorance of the small enterprises of poor countries. The latter do not have even the basic information needed for looking for a new production technology and the details of its operation...." (pp. 16-17)

Mohamed Lahbabi, "The User's Viewpoint," pp. 46-49. "The under-developed countries which, by definition, are trailing far behind the industrialized countries, are caught today in a situation where the rhythm of technological development is accelerating, propelling the most advanced countries even farther ahead. The result is that the less developed face the risk--at least for some time--of being increasingly outdistanced, not only materially in production and consumption but especially in the creation and assimilation of ideas and technologies." (p. 46)

Miguel S. Wionczek, "Mexico: Where Patents go Through Customs," pp. 22-26. "There is a definite connexion between the falling off and decline--in relative terms, at least--of local invention and innovation and the growing concentration of research and development in the hands of multi-national corporations with their headquarters outside the region." (p. 23)

strategic through political and economic to social and cultural factors--that no attempt will be made here to trace them. Indeed, the problem constitutes a complete study in itself, and an increasing number of scholars and organizations are giving urgent consideration to various of its aspects. Thus, the principles and processes for the "transfer of technology" between advanced and less advanced countries have been the subject of major international conferences and reports.³ The multi-national corporation is coming in for greatly increased attention, both as an alleged instrument of technological and economic exploitation and as a potential means for bridging the gap between the advanced and less advanced countries. Major US companies (e.g., in the aircraft industry) are increasingly moving toward commercial arrangements with other countries, including the LDCs, that provide for cooperative performance of both R&D and production in exchange for end-product sales to the foreign partner. Meanwhile, it would appear that a major concern of US policy for many years must be the devising of new means of scientific and technological cooperation, on a basis of mutual benefit and mutual contribution, between this nation and the less developed portions of the world.

C. CHANGING RELATIVE POSITION OF THE UNITED STATES IN WORLD R&D

As the decade of the 1970s progresses, the United States appears to be moving into an international scientific and technological environment that differs radically from that of the past. Prior to the 1960s, only the United States and to a much lesser extent the United Kingdom, among the technologically advanced nations, had carried on large research and development programs. (We shall leave aside the

3. See, for example, Edward P. Hawthorne, The Transfer of Technology (Paris: Organisation for Economic Co-operation and Development, 1971). This book was based on a seminar in Istanbul, October 5-9, 1970, which was a part of the OECD's program of technical assistance to its developing member and associate countries (Greece, Portugal, Spain, Turkey, and Yugoslavia). The United Nations is also deeply involved in the study of this problem.

Soviet Union, for the moment.) During the 1960s, however, and especially in the first half of the decade, all the advanced nations of the OECD increased substantially their expenditures for R&D. By the end of the decade, US expenditures for R&D were still approximately ten times those of the next highest OECD nation, but the US portion of the total R&D expenditures by OECD members had dropped considerably--from 75 percent in 1961 to 65 percent in 1969. Moreover, the trend in US R&D expenditures clearly showed a leveling off tendency that had begun well back in the 1960s, whereas the expenditures of several other major OECD nations (notably Germany and Japan) continued to grow vigorously throughout the decade. (The United Kingdom's R&D effort, meanwhile, leveled off even before that of the United States and by the end of the decade was steadily falling behind that of the other leading OECD nations.)

While we have no firm post-1969 data for any country other than the United States, tentative extrapolations from the 1969 data suggest that whereas US gross expenditures on research and development (GERD) in 1969 was more than two-and-one-half times that of Japan, West Germany, France, and the United Kingdom combined, by 1975 the collective GERD of the Big Four is likely to amount to approximately 70 to 80 percent of US R&D expenditures. Moreover, if in truth R&D performed in the United States costs appreciably more than equivalent R&D performed in Western Europe and Japan, as maintained by some analysts, and if this differential persists through 1975 to the continued disadvantage of the United States, then the collective GERD of the Big Four in 1975 might even be approximately equal to that of the United States in real terms.

All of this is not quite as sudden as it might seem, since the previous over-valuation of the US dollar tended to exaggerate US dominance in R&D expenditures during the 1960s. On the other hand, the extent of the change within approximately one decade is rather drastic. At the least it would appear to suggest that US technology in the future may face increasing competition from Western Europe and Japan.

It must be remembered, of course, that we have been speaking here only of GERD--gross national expenditures on all kinds of research and development--and that we are not addressing the question of what various nations may be getting in return for their R&D money and effort. Even less are we suggesting that in some absolute sense the more money spent for R&D the better, or that every bit of research and development undertaken somehow adds to a nation's greatness. To the extent, however, that there is a correlation between total national expenditures on research and development and international economic competitiveness, it would appear that the period when the United States "bestrode the world like a Colossus" may be steadily drawing to a close, technologically speaking. As noted earlier, many US-controlled corporations appear to have already recognized the growing importance of international cooperation and interdependence. US national policies--political and military as well as scientific and technological--may also need to accommodate increasingly to the trend.

D. PROPORTION OF NATIONAL R&D EXPENDITURES FUNDED BY THE US GOVERNMENT

Most governments, when they have become convinced of the necessity for increasing national R&D expenditures, for whatever purpose, have tended as a first move to increase the proportion of GERD funded by the Government sector. The basic reason is simple: the response is immediate and predictable, compared with an attempt to increase Business Enterprise R&D expenditures, and the objectives of the R&D can be made to conform to government policy. There are also secondary benefits, in that Government funding of R&D may encourage quicker diffusion of the results as compared with Business Enterprise's proprietary approach, and the Government-funded R&D effort is usually better insulated from the economy's cyclical behavior. On the other hand, there are potential difficulties involved in a top-heavy funding of R&D by the Government. These may range from an onerous taxation burden with no imminent payoff, to the eventual disadvantages in either performing unduly large proportions of national R&D in government laboratories or in having large segments of the private

enterprise sector dependent on the government instead of a competitive market for their risk-taking R&D funds. As a result, even though various of the OECD major nations in the past have for one reason or another funded large portions of the national R&D total through the Government sector, they have usually attempted after a time to reduce this proportion and have made strong efforts to stimulate the R&D initiatives of the Business Enterprise sector.

In the United States, as compared with most other advanced OECD countries, the proportion of total national R&D funding supplied by the Government has been unusually high for the past two decades, due to heavy US government support of Defense, Civil Nuclear, and Civil Space R&D programs. Thus, as late as 1969, 58 percent of US GERD was funded by the Government sector, compared with 51 percent in the United Kingdom, 40 percent in Sweden, 39 percent in Germany, 38 percent in the Netherlands, and 27 percent in Japan. (Only France, with 63 percent of GERD funded by the government, and Canada, with 62 percent, exceeded the US percentage--for reasons similar to those of the United States in the former case, and because of weaknesses in the Business Enterprise sector in the latter case.) Conversely, the percentage of total national R&D funding supplied by Business Enterprise in the United States was below that in most other industrially advanced OECD countries--in 1969, 38 percent in the United States compared with 68 percent in Japan, 60 percent in Germany, 59 percent in the Netherlands, 57 percent in Sweden, and 44 percent in the United Kingdom. As would be expected, France and Canada with 33 and 30 percent, respectively, of GERD funded by Business Enterprise, had lower percentages than the United States.

It must be remembered, of course, that in absolute dollar amounts US Business funding of R&D in 1969 was approximately six times that of either the German or Japanese Business Enterprise sector. Also, the trend in the United States (as in the other major OECD countries) has been for a gradual increase in Business Enterprise expenditures as a percentage of GERD and a concomitant reduction in the percentage supplied by Government funding. On the other hand, the relatively

high percentage of US GERD supplied by Government funding, compared with other major OECD nations (especially Germany and Japan), could be an occasion for concern by US policymakers in view of the increasingly competitive economic environment likely to be faced by US technology in future years.

E. DECLINE IN US AND ALLIED DEFENSE R&D

Since the mid-1960s there has been a gradual decline in the priority accorded Defense R&D expenditures by the governments of the United States and most of its major allies. While US Defense R&D expenditures measured in current dollars have remained relatively constant since 1966 (in the neighborhood of \$8.5 billion), the trend is steadily downward when the effects of inflation are removed--declining from a peak of \$7.9 billion (in 1961 dollars) in 1963 to \$6.2 billion in 1971.⁴ The declining priority of US Defense R&D is even more apparent when it is compared over time with total government expenditures for R&D: in 1961, US Defense R&D expenditures absorbed 71 percent of US government-funded R&D; by 1965 Defense R&D had dropped to 46 percent of the total. From this low point Defense R&D gradually recovered to approximately 53 percent in 1968, near which it has generally remained ever since--though with a very slight further declining trend.

Similarly for the major US allies, Defense R&D during the 1960s absorbed a declining percentage of total government R&D funding: for the United Kingdom, from 65 percent in 1961 to 44 percent in 1972; for France, from 44 percent in 1961 to 28 percent in 1971; for Germany, from 23 percent in 1961 to 15 percent in 1970; and for Canada, from 22 percent in 1961 to 11 percent in 1970. The absolute level of Defense R&D expenditures for these countries, even when measured in constant US dollars, actually remained fairly constant, or in the

4. See Figure 26, p. 119. The current dollar figures are not treated in the referenced section, but are matters of general knowledge.

case of Germany (and also Italy, the Netherlands, and Japan) even rose during the decade. But in terms of relative priority in total government R&D funding, Defense has steadily lost ground to other groups of objectives--and not to Big Science (Civil Nuclear and Civil Space), but to socially and economically oriented objectives such as Advancement of Science (i.e., government support of research in universities), Economic Development (especially Mining and Manufacturing), and Community Services (especially Health). Moreover, current trends suggest that these shifts in governmental priorities will become even more pronounced in the future.

To a large extent, the above situation reflects the decline in the cold war. It also represents, however, domestic demands in virtually all Western countries for changes in that intangible factor called "quality of life." These demands will not easily be stilled--or satisfied. The extent to which comparable demands are being made in the Soviet Union is not clear; or more precisely, it is not clear to what extent such demands are reflected in Soviet R&D priorities. In any event, the United States' major allies (and to a somewhat lesser extent, the United States itself) appear to be steadily shifting their priorities, as these are reflected in their R&D expenditure objectives, away from the area of national defense and toward the solution of domestic economic and social problems.

F. FOREIGN CIVIL NUCLEAR AND SPACE PROGRAMS

Big Science (Civil Nuclear and Civil Space) shared with Defense, during the 1960s, the status of a major R&D objective of the governments of leading OECD nations. The experience of different countries varied widely, however, between the two objectives, with the major distinction being that Civil Nuclear programs absorbed proportionally a much larger share of other OECD nations' R&D funds, in comparison with the United States, than did Civil Space.

For the United States, Civil Nuclear has been a relatively stable but gradually declining objective, both in constant dollar expenditures

and as a percentage of total government R&D expenditures.⁵ Spending on this objective has similarly declined steadily in the two other OECD nations that previously maintained the largest Civil Nuclear programs--France and the United Kingdom. The Swedish Civil Nuclear program also shows a rather sharp decline since about 1964, as measured both in constant US dollars and as a percentage of total government R&D expenditures. In Canada and Italy, Civil Nuclear expenditures have been relatively stable, though representing a declining percentage of total government R&D expenditures. Only in Germany and Japan does Civil Nuclear R&D constitute an objective of steady growth. In fact, German R&D expenditures on this objective surpassed those of France in 1970. Japanese Civil Nuclear expenditures, while still somewhat below those of Canada and Italy in 1969, were nevertheless growing rapidly. (If the upward trend in the Japanese program has continued, it could well have passed both these latter countries by the present time.)

In Civil Space, the United States has from the beginning been in a class by itself, among OECD nations.⁶ Thus, US Civil Space R&D expenditures peaked at nearly \$6 billion in 1965, and though they have been steadily declining ever since were still over \$2 billion in 1971--more than twenty-two times larger than those of the next highest spender, West Germany. Meanwhile, the French Civil Space R&D program appears to have leveled off at about \$90 million per year, and that of Great Britain (which consisted chiefly of efforts to secure a civil return from former military programs) has been declining sharply for the past several years, reaching a level of some \$20 million in 1972. Japanese Civil Space R&D expenditures, while still quite low in 1969 (below those of Belgium and the Netherlands), were tending sharply upwards.

In sum, the United States still appears to dominate Civil Nuclear and Civil Space R&D in the non-Communist world. While this is

5. See Figure 27, p. 131.

6. See Figure 28, p. 133.

completely so in the Civil Space field, it is much less so for Civil Nuclear R&D (to which the West European countries have made a major commitment of resources). Even in the latter, however, the US expenditures of \$600 million in 1971 were larger than the combined allocations of France, the United Kingdom, West Germany, and Japan. When this absolute US predominance for the past decade or more is perceived in the light of the discouraging experience of the West Europeans in both their national and (especially) their international cooperative nuclear programs, the US lead in the Civil Nuclear field would not appear seriously in danger--at least to the extent that R&D expenditures are a criterion. It should be noted, however, that German and Japanese R&D expenditures for both Civil Space and Civil Nuclear objectives have maintained a steady growth rate for several years, while those of all the other major OECD countries have been either stable or declining.

PART TWO

STATISTICAL DATA

NOTES TO READER:

The following symbols are used throughout the tables:

Data not available	...
Magnitude nil or negligible	-
Not available but included in other line or total	.

The exchange rates used in preparing the data for this study are discussed in the Series J appendix, which begins on page 317.

Series A

R&D FINANCIAL ALLOCATIONS

Table A-1

GROSS EXPENDITURES ON RESEARCH AND DEVELOPMENT DURING THE 1960s:
NATIONAL AND REGIONAL TOTALS
(in millions of current US dollars)

Country ^a	1961	1963	1967	1969
EEC Members of OECD:				
FRANCE ^{b,c}	915.1	1,299.8	2,562.3	2,678.2
WEST GERMANY ^d	788.6 ^e	1,436.3	2,084.3	2,652.0
UNITED KINGDOM ^{c,d}	1,841.6 ^f	2,159.9	2,648.7	2,439.8
Italy	213.7 ^f	293.1	447.0	694.3
Netherlands ^d	164.1 ^e	330.4	513.8	585.5
Belgium	100.0 ^e	136.8	176.0	261.1
Denmark ^g	...	...	...	145.3
Ireland	7.9 ^f	10.4	17.1	22.4
Sub-total ^h	4,031.0	5,666.7	8,449.2	9,478.6
Other OECD:				
UNITED STATES ⁱ	15,655.0	19,215.0	25,330.0	26,595.0
JAPAN ^j	765.3	1,022.8	1,951.4	2,592.3
Canada	363.3	429.6	828.3	979.2
Switzerland	...	...	...	391.4
Sweden ^{d,k}	208.2 ^e	243.8	336.1	368.1
Norway	35.6 ^e	42.4	80.7	97.0
Austria	17.0 ^f	23.2	62.2	84.6
Spain ^d	17.7 ^f	28.0	57.1	64.8
Finland	...	...	...	63.3
Turkey	...	...	...	48.3
Greece ^{e,k}	5.9 ^f	7.9	11.3	15.1
Portugal ^d	6.8 ^f	9.2	11.1	...
TOTAL OECD ^l	21,105.8	26,688.6	37,117.8	40,777.7
Total "Big Four" ^m	4,310.6	5,918.8	9,246.7	10,362.3
Warsaw Pact States:				
USSR ^{n,o}	...	...	19,548.0 ^p	23,846.8
Czechoslovakia ⁿ	...	633.5	991.2	1,368.8
Poland ⁿ	...	...	682.0	1,001.7
East Germany	...	...	438.0	775.0
Hungary ⁿ	...	134.8	286.5	359.6
Rumania ⁿ	...	...	176.6	215.5
Bulgaria ^{o,q}	...	...	91.7	...
TOTAL WARSAW PACT ^r	...	...	22,214.0	27,567.4

Notes for Table A-1:

- a. Countries are ranked within categories according to the size of their GERD in 1969.
- b. GERD, including the social sciences and humanities.
- c. For 1969, read 1968.
- d. For 1963, read 1964.
- e. OECD estimate based on budget data and 1963 ISY (International Statistical Year) survey.
- f. Gross OECD estimate based on percentage of GNP.
- g. For 1969, read 1970.
- h. This sub-total represents the sum of the national GERDs of the preceding eight countries which, together with Luxembourg, constitute the expanded EEC created in January 1973. It reflects, therefore, the sums committed to R&D by the incipient nine-nation EEC, not the six-nation EEC which existed at the time the OECD surveys were made.
- i. "National R&D Spending," including spending on social science R&D. 1963 is National Science Foundation (NSF) 1964; 1967 is NSF 1968.
- j. Including the social sciences and humanities.
- k. For 1967, read 1966 or 1966/67.
- l. OECD member nations not included are Australia, Iceland, Luxembourg (also a member of the EEC), and the two associate members, Yugoslavia and New Zealand.
- m. The "Big Four" (France, Germany, United Kingdom, and Japan) are the four OECD member nations who ranked just below after the United States in terms of the financial support given to research and development.
- n. Also including data for law, humanities, education, and art.
- o. "Expenditure on science," from the national budget and other sources.
- p. Does not include GERD for Byelorussia.
- q. Also including data for humanities.
- r. This total represents the sum of the national GERDs of the preceding seven countries, which constitute the membership of the Warsaw Pact.

Source: OECD data: For 1961, 1963, and 1967, OECD, R&D Trends and Objectives, Table 1, p. 31. For 1969, OECD, Survey of R&D in 1969, Vol. 5, Table 1, p. 27.

Warsaw Pact data: For East Germany, in national currency for 1967 and 1969, Statistisches Jahrbuch der Deutschen Demokratischen Republik [Statistical handbook of the GDR] (Berlin, 1970), p. 325. It is unclear whether the sums given in the handbook refer only to total outlays in the state budget or to total outlays from all sources. For Bulgaria, in national currency for 1967, UNESCO, National Science Policies in Europe, p. 48. For all other Warsaw Pact states, in national currencies for 1967 and 1969, UNESCO, Statistical Yearbook, 1971, pp. 644-46, and 1969, pp. 489-90. For exchange rates, The Institute for Strategic Studies, The Military Balance (London), 1967-1968, pp. 2-4 (for 1967) and 1969-1970, pp. 5, 12-14 (for 1969). In the case of the USSR, the 1969 exchange rate was used for 1967.

Table A-2
GROSS EXPENDITURES ON RESEARCH AND DEVELOPMENT DURING THE 1960s:
NATIONAL AND REGIONAL TOTALS
(in millions of 1961 US dollars)

Country ^a	1961	1963	1967	1969
EEC Members of OECD:				
WEST GERMANY	788.6	1,299.9	1,742.5	2,121.6
FRANCE	915.1	1,169.8	2,047.3	1,920.5
UNITED KINGDOM	1,841.6	1,980.6	2,153.4	1,907.9
Italy	213.7	255.0	335.3	491.7
Netherlands	164.1	282.2	377.1	385.8
Belgium	100.0	131.4	142.4	198.7
Denmark	...	...	...	90.5
Ireland	7.9	9.7	17.3	14.9
Sub-total ^b	4,031.0	5,128.6	6,811.3	7,131.4
Other OECD:				
UNITED STATES	15,655.0	18,427.2	21,631.8	21,674.9
JAPAN	765.3	941.0	1,500.6	1,832.8
Canada	363.3	415.8	699.9	764.8
Switzerland	...	...	...	77.0
Sweden	208.2	219.0	269.6	367.2
Norway	35.6	40.2	63.9	75.1
Austria	17.0	21.7	43.9	64.5
Finland	...	...	...	47.6
Spain	17.7	22.9	44.2	39.4
Greece	9.9	7.4	9.3	12.7
Portugal	6.8	8.9	9.3	...
TOTAL OECD	21,108.8	25,232.7	31,089.4	32,184.0
Total "Big Four"	4,310.6	5,391.3	6,647.1	7,782.6

Note: Fixed 1961 prices were derived from the figures for GERD in current prices used in Table A-1. These were converted into fixed 1961 prices according to the following procedure.

The OECD, in *R&D Trends and Objectives*, Appendix, pp. 414-15, provides deflators for the years 1961 through 1969 or 1970 based on GNP at market prices for both (a) financial years based on calendar years and (b) the financial years used in each country. The former have been used to generate data on the ten countries for which the OECD supplies deflators, that is, Belgium, Canada, France, West Germany, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and the United States. In most cases, these figures are identical to those presented in OECD, *R&D Trends and Objectives*, Table 1, p. 31, for 1963 and 1967. This source does, however, appear to contain some errors. The figures for West Germany (1963 and 1967), the United Kingdom (1967), the Netherlands, Sweden, and Norway (1963 and 1967) seem to be incorrect. It should be noted that care must be used in applying the OECD deflators to Table A-1. As the notes to that table explain, the OECD figures on GERD at current prices do not always reflect expenditures for the years indicated on the table proper.

For all countries other than the ten for which the OECD supplied deflators, the figures on Table A-1 were converted to fixed 1961 prices by using the price indices which appear in United Nations, *Yearbook of National Accounts Statistics*, 1970, Vol. I and 1972, Vols. I and II, in the first table for each country under the heading "Correlative Price Index Numbers." In most cases, since the base chosen was some year other than 1961, it was necessary to recompute the index. The 1970 Yearbook contains figures for 1961 as well as 1963, 1967, and 1969. The values for the latter year should be checked against the more recent, adjusted figures which appear in the *1971 Yearbook*.

- a. Countries are ranked within categories according to the size of their GERD in 1969. OECD member nations not included are Australia, Ireland, Turkey, Luxembourg (also a member of the EEC), and the two associate members, Yugoslavia and New Zealand.
- b. Total of "incipient EEC." See Table A-1, note h.

Source: Data derived from Table A-1.

Table A-3

NATIONAL GERD AS A PERCENTAGE OF REGIONAL
GERD DURING THE 1960s

Country	1961	1963	1967	1969
EEC Members of OECD:				
FRANCE	4.36	4.86	6.90	6.57
WEST GERMANY	3.75	5.37	5.62	6.50
UNITED KINGDOM	8.77	8.08	7.14	5.98
Italy	1.02	1.10	1.20	1.70
Netherlands	0.78	1.24	1.38	1.44
Belgium	0.48	0.51	0.47	0.64
Denmark	...	...	...	0.36
Ireland	0.04	0.04	0.05	0.05
Sub-total	19.19	21.19	22.75	23.24
Other OECD:				
UNITED STATES	74.53	71.86	68.24	65.22
JAPAN	3.64	3.83	3.26	6.36
Canada	1.73	1.61	2.23	2.40
Switzerland	...	...	...	0.96
Sweden	0.99	0.91	0.91	0.90
Norway	0.17	0.16	0.22	0.24
Austria	0.08	0.09	0.17	0.21
Spain	0.08	0.10	0.15	0.16
Finland	...	...	...	0.16
Turkey	...	...	...	0.12
Greece	0.03	0.03	0.03	0.04
Portugal	0.03	0.03	0.03	...
TOTAL OECD	100.0	100.0	100.0	100.0
Total "Big Four"	90.5	29.14	24.91	24.41
Warsaw Pact:				
USSR	...	...	88.00	6.10
Czechoslovakia	...	...	4.46	4.37
Poland	...	...	3.07	3.63
East Germany	...	...	1.97	2.81
Hungary	...	...	1.39	1.30
Romania	...	...	0.79	0.78
Bulgaria	...	...	0.41	...
TOTAL WARSAW PACT	...	...	100.0	100.0

Source: Table A-1.

Table A-4

GERD AS A PERCENTAGE OF GNP AT MARKET PRICES

Country ^a	1961	1963	1967	1969
Major OECD Members: ^b				
UNITED STATES ^{c,d,e}	2.75	2.99	2.87	2.8
UNITED KINGDOM ^{c,f,g}	2.27	2.15	2.24	2.4
FRANCE	1.38	1.56	2.21	1.9
WEST GERMANY ^h	...	1.38	1.72	1.7
JAPAN	...	1.50	1.64	1.5
Other OECD: ^b				
Netherlands ^h	...	1.92	2.24	2.1
Switzerland	...	...	...	2.1
Canada	...	1.07	1.44	1.4
Sweden ^h	...	1.31	1.39	1.3
Belgium	...	0.98	0.90	1.1
Norway	...	0.74	0.96	1.0
Denmark ⁱ	...	...	...	0.9
Italy	...	0.59	0.64	0.8
Austria	...	0.29	0.58	0.7
Finland	...	...	...	0.7
Ireland	...	0.45	0.55	0.6
Turkey	...	...	...	0.4
Spain ^h	...	0.15	0.21	0.2
Greece ^{h,j}	...	0.15	0.17	0.2
Portugal ^h	...	0.27	0.24	...
Warsaw Pact States: ^k				
USSR	...	...	5.46	5.12 (3.8)
Czechoslovakia	...	...	3.89	4.84 (4.1)
Hungary	...	...	2.37	2.67 (2.6)
Poland	...	...	2.01 (1.8)	2.47 (2.3)
East Germany	...	...	1.54	2.42
Rumania	...	...	1.04	1.08
Bulgaria	...	...	1.22 (1.4)	...

Notes for Table A-4:

- a. Countries are ranked within categories according to the size of the share of their GNP accounted for by their GERD in 1969.
- b. For details related to the definition of GERD in OECD member nations, see notes to Table A-1.
- c. For 1961, read 1961/62.
- d. For 1963, read 1963/64.
- e. For 1967, read 1967/68.
- f. For 1963, read 1964/65.
- g. For 1969, read 1968.
- h. For 1963, read 1964.
- i. For 1969, read 1970.
- j. For 1967, read 1966.
- k. For an explanation of the figures in parentheses, see the note on sources.

Source: OECD: OECD, R&D Trends and Objectives, Appendix, Table 6, p. 9 (for 1961-67); and OECD, Survey of R&D in 1969, Vol. 5, Table T, p. 27 (for 1969). Note that in another OECD source--R&D Trends and Objectives, Table 2, p. 32--different figures are given in the case of some countries for the ratio of GERD to GNP.

Warsaw Pact: Data on GERD derived from Table A-1. Data on GNP obtained from International Institute for Strategic Studies, The Military Balance (London), 1968-1969, pp. 2-4 (for 1967) and 1970-1971, pp. 6, 14-17 (for 1969). For an explanation of the procedure used in calculating the Soviet GNP, see pp. 10-11 of the latter source. GNP for the East European countries and the USSR have been estimated in terms of Western purchasing power equivalents. (See below for further information.)

With the Statistical Yearbooks for 1970 and 1971, UNESCO has begun to supply data on GERD as a percent of GNP or, in the case of the Soviet Union and the East European countries, as a percent of net material product (NMP). These figures appear in parentheses in the Warsaw Pact category for the countries and years for which they are available. On the assumption that UNESCO has derived its figures from data on GERD and GNP expressed in national currencies, these ratios may well represent a more accurate reflection of reality than ratios derived from a comparison of figures on GERD and GNP expressed in US dollars. The latter, of course, suffer from all of the problems associated with converting Communist currencies into US currency.

Table A-5
PER CAPITA GNP AT MARKET PRICES IN 1969
(in current US dollars)

>3000	2000-2999	1000-1999	<1000
UNITED STATES 4660	FRANCE 2790 WEST GERMANY 2520	UNITED KINGDOM 1980 JAPAN 1640	
Sweden 3490	Denmark 2870	Finland 1970	Greece 950
Canada 3250	Norway 2550	Austria 1730	Spain 863
Switzerland 3030	Belgium 2380 Netherlands 2190	Italy 1530 Ireland 1190	Turkey 370

Source: OECD, Survey of R&D in 1969, Vol. 5, Table T, p. 22.

Table A-6
PER CAPITA EXPENDITURES ON R&D IN 1969
(in current US dollars)

> 60	40-59	20-39	<20
UNITED STATES 131	FRANCE 53 WEST GERMANY 44 UNITED KINGDOM 44	JAPAN 25	
Switzerland 63	Canada 54 Netherlands 46 Sweden 46	Denmark 30 Belgium 27 Norway 25	Finland 14 Italy 13 Austria 12 Ireland 8 Greece 2 Spain 2 Turkey 1

Source: OECD, Survey of R&D in 1969, Vol. 5, Table T, p. 22.

Series B

SOURCES OF R&D FUNDS IN OECD MEMBER COUNTRIES

Table B-1

GROSS EXPENDITURES ON R&D BY SOURCES OF FUNDS
IN THE 1960s: PERCENTAGE DISTRIBUTION

Country ^a	Year	Government	Business Enterprise	C A T E G O R Y ^b		
				Higher Education	Private Non-profit	Abroad
Major OECD Members:						
FRANCE	1961	64.9	...	...	...	...
	1967	64.9	32.7	...	(7.4)	...
	1968	64.5	...	...	...	...
	1967	66.3	30.8	...	(7.9)	...
	1969 ^c	62.7 ^d	32.7	...	0.5	4.1
UNITED STATES	1961	63.4	...	...	...	...
	1967	61.7	30.6	...	(4.1)	...
	1968	60.8	...	...	...	...
	1967	59.2	36.0 ^{e,g}	...	(4.8)	...
	1969 ^c	47.6 ^e	37.6 ^{e,g}	3.4 ^{e,h}	1.3	.
UNITED KINGDOM	1961	47.5	...	...	...	...
	1964	44.6	41.4	...	(4.0)	...
	1967	41.1	43.4	...	(5.3)	...
	1968 ^c	50.6	42.6	0.6	1.7 ⁱ	3.6
WEST GERMANY	1964	41.0	7.2	...	(1.8)	...
	1967	41.7	17.5	...	(1.7)	...
	1968	39.1	60.0	.	0.1	0.3
JAPAN	1964	30.1	8.7	...	(11.2)	...
	1967	31.3	14.9	...	(10.1)	...
	1968	33.3	17.1	1.1 ^j	0.1	0.1
Other EEC:						
Portugal	1961	72.1	17.8	...	(11.7)	...
	1967	71.1	16.1	...	(11.4)	...
Greece	1964	44.0	15.9	...	(4.1)	...
	1967	41.0	33.1	...	(5.2)	...
	1968	71.4	30.1	0.1	0.6	1.8
Greece	1967	33.1	33.1	13.0	0.9	2.3
	1968	1.1	...	...	...	...
	1967	33.4	21.0	...	(10.6)	...
Norway	1967	60.0 ^k	30.0	4.3	0.3	0.3
	1967	4.1	37.8	...	(4.1)	...
	1967	37.3	37.1	...	(4.6)	...
Ireland	1968	17.3	30.4	0.4	0.8	1.4
	1965	64.0	26.7	...	(2.3)	...
	1967	50.6	36.7	...	(17.7)	...
Spain	1968	1.6	25.7	5.0	0.7	2.1
	1964	78.7	21.7	...	(0.0)	...
	1967	42.0	41.4	...	(6.7)	...
Denmark	1967	30.3 ^l	41.3	...	1.3	1.0 ^m
	1967	3.1	...	...	...	...
	1970 ⁿ	0.2	36.7	0.1 ^{o,k}	1.7	0.1
Italy	1964	33.1	61.4	...	(4.1)	...
	1968	26.4	...	...	...	...
	1967	36.3	7.7	...	(7.1)	...
Finland	1968	39.7	33.1	...	...	1.6
	1967	41.7	...	...	...	...
	1969	41.7	49.7	1.1	3.0	0.9
Austria	1967	40.3	31.1	...	(4.5)	...
	1967	38.4	58.0 ^p	...	(3.7)	...
	1969	44.9	37.0 ^q	...	(3.1)	...
Sweden	1964	45.8	31.7	...	(2.3)	...
	1966	40.1	1.1	...	(1.8)	...
	1969	40.7	16.8	0.1	1.1	1.6
Netherlands	1961	39.9	4.1	...	(1.6)	...
	1966	34.0	37.3	...	(2.7)	...
	1969	37.7	30.7	0.1	1.1	1.0
Belgium	1968	35.3	...	...	(3.3)	...
	1967	31.3	61.1	...	(7.3)	...
Switzerland	1967	31.1	...	...	...	...

Notes for Table B-1:

- a. Countries are ranked within categories according to the size of their government's share of GERD in 1969. OECD member nations not included are Turkey, Australia, Iceland, Luxembourg, and the two associate members, Yugoslavia and New Zealand.
- b. Figures within parentheses represent the sum of expenditures by the three funding sources subsumed under the "Other" category.
- c. Total intramural expenditure.
- d. Figures have been adjusted to reflect the OECD estimates which appear in Survey of R&D in 1969, Vol. 5, Table 1.1, note (d). Some idea of the extent of the changes that this entailed may be obtained by comparing the figures in this table with those provided in the original OECD table. These appear below:

Country	Category	
	Government	Higher Education
FRANCE	49.8	12.8
JAPAN	13.7	18.0
Canada	53.9	13.0
Ireland	49.8	8.7
Spain	49.1	1.8
Italy	41.0	7.3

For a more extensive discussion of this problem, see Table D-4, note c.

- e. Current expenditure.
- f. Current expenditure plus depreciation.
- g. Including the social sciences.
- h. Not Private Non-profit sector but funds from "other national sources."
- i. Including funds devoted to R&D in the social sciences and humanities in the Business Enterprise sector.
- j. National authorities assumed that certain small institutes for which sources of funds data were not available were financed entirely via funds from government.
- k. Including national estimate amounting to some 20 percent of the total.
- l. Including funds from "other enterprises."
- m. Government data have been adjusted.

Source: For 1963 and 1967: OECD, R&D Trends and Objectives, Table 3, p. 33. For 1969: OECD, Survey of R&D in 1969, Vol. 5, Table 1.1(B), p. 28. Additional data on the Government sector were drawn from the following publications: for Denmark (1967), Finland (1967), Austria (1969), and Switzerland (1967), OECD, Survey of R&D in 1969, Vol. 2, chart on p. 16; for Canada (1965), France (1961 and 1965), Italy (1965), and the United States (1961 and 1965): OECD, R&D Trends and Objectives, Appendix, Table 7, p. 10.

Table B-2

GROSS EXPENDITURES ON R&D BY SOURCES OF FUNDS
IN THE 1960s: ABSOLUTE AMOUNTS
(in millions of current US dollars)

Country ^a	Year	CATEGORY				
		Government	Business Enterprise	Higher Education	Private Non-profit	Other ^b
Major OECD Members:						
UNITED STATES	1961	9,921.5	...	...	...	...
	1962	12,547.4	5,879.8	...	(787.8)	...
	1967	14,991.4	9,118.8	...	1,511.4	...
	1969	16,318.7	9,999.7	904.1	1,411.7	...
FRANCE	1961	533.9	...	...	...	...
	1962	830.6	425.0	...	(341.1)	...
	1967	1,673.2	789.2	...	(243.4)	...
	1969	1,679.2	875.9	--	17.4	104.8
UNITED KINGDOM	1961	1,056.9	...	...	...	...
	1962	1,179.3	894.2	...	(285.1)	...
	1967	1,358.8	1,149.5	...	(143.4)	...
	1968	1,234.5	1,061.3	14.6	41.1	97.6
WEST GERMANY	1964	588.9	871.1	...	(11.4)	...
	1967	800.8	1,198.0	...	(201.7)	...
	1969	1,045.1	1,191.1	...	(11.1)	4.3
JAPAN	1962	408.9	400.3	...	(114.1)	...
	1967	801.1	1,071.7	...	(17.1)	...
	1969	881.6	1,711.4	14.1	(1.1)	...
Other EEC:						
Canada	1961	18.1	14.1	...	...	...
	1962	41.1	10.1	...	(1.1)	...
	1969	107.1	231.1	89.1	...	...
Italy	1961	...	161.1	...	...	...
	1962	17.1	17.1	...	(1.1)	...
	1969	...	447.1	--	...	11.1
Netherlands	1961	111.1	190.1	...	(1.1)	...
	1962	101.1	101.1	...	(1.1)	...
	1969	120.7	340.1	0.1	4.1	4.4
Sweden	1961	111.1	11.1	...	(7.1)	...
	1962	111.1	11.1	...	(1.1)	...
	1969	138.1	101.1	1.7	...	1.1
Austria	1961	...	...	...	...	...
	1962	11.1	...	...	...	...
	1969	11.1	...	0.1	...	0.7
Belgium	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	107.7	...	(1.1)	...
Denmark	1961	...	...	...	...	...
	1962	...	...	...	(1.1)	...
	1969	...	...	...	(1.1)	...
Finland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	--	...	...
Greece	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	0.7	...	0.6
Ireland	1961	...	...	...	...	...
	1962	...	...	...	(1.1)	...
	1969	...	...	0.7	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland	1961	...	...	...	...	...
	1962	...	...	...	...	...
	1969	...	...	...	...	...
Ireland						

Table B-3

GOVERNMENT EXPENDITURES ON R&D IN THE 1960s AS A PERCENTAGE OF
TOTAL GOVERNMENT CURRENT EXPENDITURES

Country	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Major OEEC Members:											
FRANCE	7.0	7.7	8.1	8.7	11.7	11.4	11.1	11.6	10.7	9.5	9.1
UNITED STATES	10.1	11.1	11.1	11.1	11.7	11.1	10.1	9.3	8.9	7.8	7.5
UNITED KINGDOM	8.1	8.1	8.1	8.1	8.1	7.7	7.3	7.1	7.0	7.0	7.1
GERMANY	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
NET MEMBER	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Other OEEC:											
Belgium	...	...	...	...	3.8	4.6	4.6	4.5	4.1	3.4	3.9
Netherlands	...	...	...	...	3.7	5.6	5.9	5.3	5.1	5.7	5.4
Sweden	...	...	...	...	3.6	5.3	5.1	4.9	4.1	...	...
Norway	...	...	...	...	3.6	3.7	3.5	3.7	3.7	3.7	...
Canada	...	...	...	...	4.1	3.8	4.0	4.0	3.3	3.3	3.4
Italy	...	...	...	...	3.2	2.4	3.1	3.0	3.1	2.7	3.3
Spain	...	...	...	...	1.8	1.7	1.6	1.3	1.3	...	...

a. Countries are ranked within categories according to the size of the share of their government's R&D expenditures in total government expenditures at the end of the period for which data were available. OEEC member nations not included are Iceland, Ireland, Switzerland, Austria, Finland, Turkey, Greece, Portugal, Australia, Iceland, Luxembourg, and the two associate members, Yugoslavia and New Zealand.

b. R&D data for fiscal 1961/62 have been taken as a percentage of total current expenditure for calendar 1961. The same procedure has been followed for each preceding year.

Source: OEEC, Changing Priorities for Government R&D, Table C, p. 428.

Table B-4

GERD AS A PERCENTAGE OF GNP BY SOURCES OF FUNDS IN THE 1960s

Country ^a	Year	As a % of GNP		
		Government	Business Enterprise	Other
Major EEC Member:				
UNITED KINGDOM	1961/62	1.75	0.40	0.11
	1962/63	1.65	0.4	0.12
	1963/64	1.45	0.35	0.14
	1964/65	1.70	1.04	0.14
	1965/66	1.4	1.11	0.14
WEST GERMANY	1961	1.1	0.4	0.05
	1962	1.12	0.38	0.05
	1963	1.1	0.37	0.1
	1964	1.1	1.03	0.14
	1965	1.1	1.03	0.14
FRANCE	1961	1.0	0.3	0.04
	1962	1.0	0.1	0.06
	1963	1.0	0.3	0.09
	1964	1.04	0.3	0.05
	1965	1.04	0.3	0.03
WEST GERMANY	1961	0.7	0.7	0.02
	1962	0.71	0.69	0.02
	1963	0.7	1.02	0.01
ITALY	1961	0.47	0.06	0.17
	1962	0.5	0.04	0.22
	1963	0.45	1.01	0.09
Other EEC Member:				
NETHERLANDS	1961	0.3	0.3	0.16
	1962	0.3	0.41	0.17
	1963	0.27	0.3	0.11
	1964	0.40	0.10	0.17
NETHERLANDS	1961	0.37	1.0	0.13
	1962	0.67	1.0	0.29
	1963	0.74	1.0	0.07
DENMARK	1961	0.33	0.3	0.3
	1962	0.3	0.3	0.34
	1963	0.36	0.39	0.34
LUXEMBOURG	1961	0.0	0.7	0.34
	1962	0.0	0.7	0.34
	1963	0.0	0.74	0.34
BELGIUM	1961	0.3	0.3	0.07
	1962	0.3	0.3	0.07
	1963	0.3	0.3	0.07
IRELAND	1961	0.0	0.3	0.07
	1962	0.0	0.3	0.07
	1963	0.0	0.3	0.07
FINLAND	1961	0.0	0.3	0.07
	1962	0.0	0.3	0.07
	1963	0.0	0.3	0.07
AUSTRIA	1961	0.0	0.3	0.07
	1962	0.0	0.3	0.07
	1963	0.0	0.3	0.07
BELGIUM	1961	0.3	0.3	0.07
	1962	0.3	0.3	0.07
	1963	0.3	0.3	0.07
PORTUGAL	1964	0.13	0.0	0.07
	1965	0.17	0.04	0.07
GREECE	1964	0.12	0.07	0.00
	1965	0.10	0.06	0.01
	1969	0.14	0.0	--
SPAIN	1964	0.11	0.04	0.00
	1967	0.09	0.11	0.01
	1969	0.10	0.09	0.01

a. Countries are ranked within categories according to the size of their government's expenditures in the GNP in the last year for which data were available. Non-member nations not included are Australia, Iceland, Luxembourg, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.

Source: ECU, 1961, 1962, and 1963, Appendix, Table B, p. 9. Data for Denmark and Finland for 1961 were derived from Tables A-4 and B-1.

Series C

SECTORS OF PERFORMANCE IN OECD MEMBER COUNTRIES

Table C-1

GROSS EXPENDITURES ON R&D BY SECTORS OF PERFORMANCE:
PERCENTAGE DISTRIBUTION

Country ^a	Year	C A T E G O R Y ^b			
		Business Enterprise	Government	Higher Education	Private Non-profit
Major OECD Members:					
UNITED STATES	1964	70.3	14.8	11.6	3.7
	1968	69.5	13.8	13.1	3.6
	1969	69.5 ^c	14.1 ^d	12.7 ^{d,e}	3.7 ^d
WEST GERMANY	1964	66.0	3.4	19.6	11.0
	1967	68.1	5.1	16.3	10.4
	1969	68.2	4.7	17.5	9.7
JAPAN	1963	56.3	11.0	29.1	3.6
	1967	54.0	10.3 ^f	32.7 ^f	3.1
	1969	67.3	12.1 ^f	19.0 ^f	1.5
UNITED KINGDOM	1964	65.3	24.9	7.3	2.5
	1967	64.9	24.8	7.8	2.5
	1968	64.7	24.5	8.3	2.5 ^g
FRANCE	1963	48.9	35.9	14.7	0.5
	1967	53.1	31.8 ^f	14.1 ^f	1.0
	1969	55.5	29.2 ^f	14.2 ^f	1.0
Other OECD:					
Switzerland	1969	84.7	4.2	11.0	...
Sweden	1964	69.2	16.1	14.3	0.4
	1966	69.9	14.2	15.5	0.4
	1969	66.0	14.8	19.1	0.1
Netherlands	1964	55.5	2.8	20.6	21.1
	1967	58.1	2.7	21.5	17.7
	1969	62.1	11.4	17.9	8.7
Austria	1963	63.5	9.5	26.0	1.0
	1967	63.4	9.0	27.5	0.1
	1969	60.0	...	...	...
Belgium	1963	63.0	9.8	19.9	1.3
	1967	66.8	10.4	21.4	1.3
	1969	56.4	10.5	32.5	0.5
Italy	1963	52.1	23.5	14.4	--
	1967	60.5	28.2 ^f	11.2 ^f	--
	1969	54.8	25.1 ^f	20.1 ^f	...
Finland	1969	52.6	24.1	20.8	2.5
Norway	1963	51.7	21.0	24.9	2.3
	1967	50.0	16.1	32.8	1.1
	1969	48.2	20.0	31.2	0.5
Denmark	1970	47.0	25.8	22.3	4.9
Spain	1964	25.2	68.4	6.4	--
	1967	44.6 ^d	52.8 ^f	2.7 ^f	...
	1969	41.4	55.3 ^f	3.2 ^f	--
Canada	1963	39.7	40.4	19.9	--
	1967	37.7	35.6 ^f	26.7 ^f	--
	1969	36.6	34.5 ^f	28.9 ^f	.
Ireland	1963	29.1	56.7	10.6	3.6
	1967	35.4	48.3 ^f	14.6 ^f	1.1
	1969	36.5	47.7 ^f	14.9 ^f	0.9
Greece	1964	15.8	74.1	9.4	0.9
	1966	33.5	44.4	20.7	1.3
	1969	26.5	56.0	15.4	2.1
Portugal	1964	22.1	66.3	6.3	5.3
	1967	16.1	69.4	7.4	7.1

Notes for Table C-1:

NOTE: The data for this table were obtained from OECD, R&D Trends and Objectives, Table 5, p. 35. It soon became evident that the sum of the shares of the four sectors of performance did not always equal national GERD. A check of the statistics revealed the following errors: The sum of the sectoral shares for West Germany in 1967 was 90 percent; for Japan in 1963, 93 percent; for the Netherlands in 1963, 104 percent; for Norway in 1963, 99.4 percent; and for Spain in 1963, 110 percent.

A survey of other sources of information indicated that the following changes should be made: For West Germany in 1967, the share of the Business Enterprise sector should be 68.1 instead of 58.2 percent (see OECD, R&D Trends and Objectives, Appendix, Table 8, p. 11); for Japan in 1963, the share of the Higher Education sector should be 29.1 instead of 22.1 percent (see Office of the Prime Minister, Bureau of Statistics, Report on the Survey of Research and Development in Japan [Tokyo, 1967], Summary Table 1, pp. 36-37); for the Netherlands in 1963, the share of the Business Enterprise sector should be 55.5 instead of 59.5 percent (see OECD, R&D Trends and Objectives, Appendix, Table 8, p. 11); for Norway in 1963, the share of the Business Enterprise sector should be 51.7 instead of 51.2 percent (ibid); and for Spain in 1963, the share of the Higher Education sector should be 6.4 instead of 16.4 percent (see OECD, The Overall Level and Structure of R&D Efforts in OECD Member Countries, Vol. 1, Table 1, p. 57).

- a. Countries are ranked within categories according to the amount of R&D performed in the Business Enterprise sector in 1969. OECD member nations not represented include Turkey, Australia, Iceland, and Luxembourg and the two associate members, Yugoslavia and New Zealand.
- b. Note that this table contains no information on that part of GERD that is performed abroad.
- c. Current intramural expenditure plus depreciation.
 - i. Including the social sciences.
- e. Current intramural expenditure.
- f. It is likely that the share of GERD expended within the Government sector is actually somewhat smaller than appears here and that the share expended within the Higher Education sector is somewhat larger. For an explanation of why this is so, see Table D-4, note c.
- g. Private Non-profit institutes proper plus enterprises' extramural expenditure to individuals and other non-survey performers.

Source: For 1963 and 1967: OECD, R&D Trends and Objectives, Table 5, p. 35.
For 1969: OECD, Survey of R&D in 1969, Vol. 5, Table 1.2(B), p. 30.

Table C-2

GROSS EXPENDITURES ON R&D BY SECTORS OF PERFORMANCE:
ABSOLUTE AMOUNTS
(in millions of current US dollars)

Country ^a	Year	C A T E G O R Y ^b			
		Business Enterprise	Government	Higher Education	Private Non-profit
Major OECD Members:					
UNITED STATES	1964	13,508.1	2,843.8	2,228.9	634.1
	1968	17,604.4	3,495.5	3,318.2	911.9
	1969	18,483.5	3,749.9	3,377.6	984.0
WEST GERMANY	1964	948.0	48.8	281.5	158.0
	1967	1,421.5	106.3	339.7	216.8
	1969	1,808.7	124.6	464.1	257.2
JAPAN	1963	575.8	112.5	297.6	36.8
	1967	1,053.8	201.0	638.1	60.5
	1969	1,744.6	313.7	492.5	38.9
UNITED KINGDOM	1964	1,410.4	537.8	157.7	54.0
	1967	1,719.0	656.9	206.6	66.2
	1968	1,578.6	597.8	202.5	61.0
FRANCE	1963	635.6	466.6	191.1	6.5
	1967	1,360.6	814.8	361.3	25.6
	1969	1,486.4	782.0	380.3	26.8
Other OECD:					
Italy	1963	162.0	68.9	42.2	--
	1967	270.9	126.1	50.1	--
	1969	380.5	174.8	139.6	...
Netherlands	1964	183.4	9.3	68.1	69.7
	1967	298.5	13.9	110.5	90.9
	1969	363.6	66.7	104.8	50.9
Canada	1967	170.6	173.6	85.5	--
	1967	312.3	294.9	221.2	--
	1969	358.4	337.8	283.0	.
Switzerland	1969	331.5	16.4	43.1	...
Sweden	1964	168.7	39.3	34.9	1.0
	1966	244.9	47.7	52.1	1.3
	1969	242.9	54.5	70.3	0.4
Belgium	1963	94.4	13.4	27.2	1.8
	1967	117.6	18.3	37.7	2.3
	1969	147.3	27.4	84.9	1.3
Denmark	1970	68.3	37.5	32.4	7.1
Austria	1963	14.7	2.2	6.0	0.2
	1967	39.4	5.6	17.1	0.1
	1969	50.8	...	...	...
Norway	1963	21.9	8.9	10.6	1.0
	1967	40.4	13.0	26.5	0.9
	1969	46.8	19.4	30.3	0.5
Finland	1969	33.3	15.3	13.2	1.6
Spain	1964	7.1	19.2	1.8	--
	1967	26.6	30.4	1.6	...
	1969	26.8	35.8	2.1	--
Ireland	1963	3.0	5.9	1.1	0.4
	1967	6.1	8.4	2.5	0.2
	1969	8.2	10.7	3.3	0.2
Greece	1964	1.2	5.9	0.7	0.1
	1966	3.8	5.0	2.3	0.1
	1969	4.0	8.4	2.3	0.3
Portugal	1964	2.0	6.1	0.6	0.5
	1967	1.8	7.7	0.8	0.8

- a. Countries are ranked within categories according to the amount of R&D performed in the Business Enterprise sector in 1969. OECD member nations not represented include Turkey, Australia, Iceland, and Luxembourg and the two associate members, Yugoslavia and New Zealand.
- b. Note that this table contains no information on that part of GERD which is performed abroad.

Source: Data were obtained by allocating national expenditures on R&D as shown in Table A-1 according to the percentage distribution indicated in Table C-1; see those tables for detailed notes.

Series D

INTER-SECTORAL TRANSFERS IN OECD MEMBER COUNTRIES

Table D-1

**SOURCES OF FUNDS FOR R&D PERFORMED IN THE BUSINESS
ENTERPRISE SECTOR IN THE 1960s
(percentage distribution)**

Country ^a	Year	C A T E G O R Y				
		Business Enterprise	Government	Private Non-profit	Higher Education	Abroad
Major OECD Members:						
UNITED STATES	1961	43.9	56.1	--	--	--
	1963	42.8	57.2	--	--	--
	1965	46.3	53.7	--	--	--
	1967	51.1	48.9	--	--	--
	1969 ^b	53.4	46.7	.	.	.
FRANCE	1961	66.2	32.8	--	--	1.1
	1963	66.7	30.3	--	--	3.1
	1965	58.6	36.5	--	--	4.9
	1967	56.9	38.8	--	--	4.3
	1969 ^c	58.1	35.8	--	--	6.1
UNITED KINGDOM	1961	59.4	40.5	--	--	0.2
	1964	61.3	35.8	--	--	2.9
	1967	64.1	32.2	--	--	3.7
	1968 ^c	63.4	31.8	0.4	--	4.4
WEST GERMANY	1964	85.7	14.0	--	--	0.3
	1967	81.9	17.3	0.3	3	0.4
	1969 ^c	86.4	13.2	0.1	.	0.3
JAPAN	1963	99.6	0.4	--	--	--
	1967	98.9	0.9	0.2	--	--
	1969 ^c	98.7	1.2	--	--	--
Other OECD:						
Norway	1963	71.6	23.6	1.9	0.4	2.5
	1967	73.2	24.6	--	--	2.2
	1969 ^c	80.6	18.2	--	--	1.2
Canada	1963	80.6	11.4	--	--	4.0
	1965	73.4	17.4	--	--	9.2
	1967	80.3	14.1	--	--	5.0
	1969 ^c	80.6	14.3	--	--	5.0
Sweden	1964	72.8	26.7	--	--	0.4
	1967	77.6	22.0	0.1	--	0.1
	1969 ^c	84.4	14.4	0.2	--	0.9
Italy	1963	98.3	1.0	--	--	0.8
	1965	94.6	4.4	--	--	2.5
	1967	94.1	5.1	--	--	4.6
	1969	90.4	7.2	...	--	2.4
Belgium	1963	97.1	3.8	--	--	2.3
	1967	98.6	0.1	0.1	--	2.5
Portugal	1964	80.6	7.7	--	14.9	1.8
	1967	66.6	4.7	--	--	--
Netherlands	1964	93.2	1.1	4.7	--	1.4
	1967	95.9	1.4	1.4	--	1.4
	1969 ^c	93.2	3.9	1.8	0.1	0.9
Finland	1969 ⁱ	92.1	3.8	0.5	--	1.5
Spain	1964	100.0	--	--	--	--
	1967	96.6	1.3	--	0.2	1.8
	1969 ^{c,e}	97.0	1.7	--	--	1.3
Denmark	1970 ^c	98.2	1.3 ^{f,g}	--	--	0.5
Austria	1963	84.7	13.4	--	--	1.9
	1967	90.9	8.2	0.2	--	0.8
	1969 ^h	98.6	1.7 ⁱ	0.1 ^j	.	.
Ireland	1963	89.7	9.6	--	--	0.7
	1967	96.6	2.0	--	--	1.4
	1969	98.1	0.7	--	--	1.1
Greece	1964	100.0	--	--	--	--
	1966	98.7	--	--	--	1.2
	1969 ^c	100.0	--	--	--	--

Notes for Table D-1:

- a. Countries are ranked within categories according to the size of their government's share of funding for R&D performed in the Business Enterprise sector in 1969. OECD member nations not included are Australia, Iceland, Luxembourg, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures plus depreciation.
- c. Total intramural expenditures.
- d. Included in another source of funds, which was not indicated.
- e. Including the social sciences and the humanities.
- f. Includes loan from government of 6,651 million Danish Kroner.
- g. Including national estimates of about 20 percent of the total.
- h. Total intramural and extramural expenditures.
- i. Funds from the Industrial Research Promotion Fund.
- j. Includes funds from the Higher Education sector and "Abroad."

Source: For Austria in 1969, OECD, Survey of R&D in 1969, Vol. 1, Table E.2(F), p. 38; other 1969 data, Vol. 5, Table 1.3(B), p. 32. For all other data: OECD, R&D Trends and Objectives, Appendix, Table 8, p. 11. (Note that the figures in this table are expressed in terms of percentages of GERD. These have been converted into percentages of that portion of GERD performed in the Business Enterprise sector.)

Table D-2

SOURCES OF FUNDS FOR R&D PERFORMED IN THE
GOVERNMENT SECTOR IN 1969
(percentage distribution)

Country ^a	C A T E G O R Y				
	Business Enterprise	Government	Private Non-profit	Higher Education	Abroad
Major OECD Members:					
UNITED STATES ^b	--	100.0	--	--	--
JAPAN	1.9	98.1	--	--	--
FRANCE	1.1	95.9	--	0.6	2.4
WEST GERMANY	5.3	93.6 ^c	1.0	--	--
UNITED KINGDOM ^{d,e}	5.8	89.2	2.8	--	2.2
Other OECD:					
Denmark ^f	0.4	99.2 ^j	0.2	--	0.3
Canada ^b	0.8	98.4	--	0.1	0.7
Greece	--	98.3	--	--	1.7
Italy	2.3	96.7	...	--	0.9
Finland	1.6	96.6	1.8	--	0.3
Ireland	3.8	96.1	--	--	--
Norway	0.7	96.1	0.6	--	2.6
Belgium	1.2	94.9	1.9	0.1	1.9
Netherlands	--	94.7	0.1	0.4	4.8
Sweden	4.5	92.9	0.6	0.2	1.7
Spain	9.0	84.1	5.1	1.1	0.6

- a. Countries are ranked within categories according to the size of their government's share of funding for R&D performed in the Government sector. The percentage shares reflect the funding sources of total intramural expenditures. OECD member nations not included are Australia, Austria, Iceland, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Including the social sciences.
- c. Of which 38.1 million DM (or 7.8 percent) is federal contributions to the Länder.
- d. For 1969, read 1968.
- e. Receipts from other sectors include receipts from the sale of licenses, patents, products, and so on.
- f. For 1969, read 1970.
- g. Includes loans and funds from other nonspecified sources.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 1.4(B), p. 34.

Table D-3

SOURCES OF FUNDS FOR R&D PERFORMED IN THE
PRIVATE NON-PROFIT SECTOR IN 1969
(percentage distribution)

Country ^a	C A T E G O R Y				
	Business Enterprise	Government	Private Non-profit	Higher Education	Abroad
Major OECD Members:					
WEST GERMANY	2.2	92.2	4.5	^b	1.1
UNITED STATES	8.2	65.1	21.3	--	--
UNITED KINGDOM ^{c,d}	28.2	54.2	15.6	.	2.0
FRANCE	4.8	40.1	39.1	12.7	3.2
JAPAN	45.5	12.2	39.2	--	3.1
Other OECD:					
Netherlands	13.9	77.6	4.5	--	4.1
Greece	--	72.6	13.3	--	14.1
Norway	7.8	68.0	25.1	--	9.4
Belgium	1.2	53.6	28.0	15.6	1.6
Finland	5.6	49.5	44.3	--	2.6
Ireland	14.2	42.5	29.2 ^f	--	13.4
Denmark ^e	5.3	41.5	51.9 ^f	--	1.3
Sweden	28.8	14.3	47.6	9.3	--

- a. Countries are ranked within categories according to the size of their government's share of funding for R&D performed in the Private Non-profit sector. The percentage shares reflect the funding sources of total intramural expenditures. OECD member nations not included are Australia, Austria, Canada, Iceland, Italy, Luxembourg, Portugal, Spain, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand. Canada is not represented because Private Non-profit cannot be distinguished from Higher Education as a sector of performance.
- b. Included in a nonspecified source of funds.
- c. For 1969, read 1968.
- d. Intramural spending in the Private Non-profit sector proper plus residual intramural expenditure in "Other" sectors.
- e. For 1969, read 1970.
- f. Loans and funds from nonspecified sources are included in "own funds."

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 1.5(B), p. 36.

Table D-4
SOURCES OF FUNDS FOR R&D PERFORMED IN THE
HIGHER EDUCATION SECTOR IN 1969
(percentage distribution)

Country ^a	C A T E G O R Y				
	Business Enterprise	Government	Private Non-profit	Higher Education	Abroad
Major OECD Members:					
FRANCE ^b	0.1	99.7	0.1	--	--
WEST GERMANY	3.7	96.3	--	--	--
JAPAN ^b	0.5	83.3	--	10.1	0.1
UNITED KINGDOM ^{c,d}	4.6	81.9	4.2	7.6	1.8
UNITED STATES ^e	1.8	67.8	4.0	26.5	.
Other OECD:					
Italy ^b	--	100.0	--	--	--
Spain ^b	0.1	99.8	0.1	--	0.1
Netherlands	0.5	98.9	--	--	0.5
Denmark ^f	--	98.8	0.4	0.4 ^g	0.3
Greece	--	95.9	1.7	0.9	1.5
Norway	1.7	94.5	1.7	1.2	0.9
Finland	0.7	93.1	1.0	5.2	--
Belgium	1.4	92.4	0.7	3.7	1.8
Canada ^{b,h}	0.3	90.9	1.2	7.2	0.3
Ireland ^b	1.4	90.3	0.7	5.0	2.7
Sweden	1.9	88.6	6.2	0.5	2.7
Switzerland ^c	7.0	83.0	4.3	1.4	4.2

Notes for Table D-4:

- a. Countries are ranked within categories according to the size of their government's share of funding for R&D performed in the Higher Education sector. The percentage shares reflect the funding sources of total intramural expenditures. OECD member nations not included are Australia, Austria, Iceland, Luxembourg, Portugal, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. The national authorities that supplied data to the OECD considered certain funds supplied by the Government sector (essentially from the Ministry of Education) as funds supplied by the Higher Education sector. The OECD accepted this definition in preparing its table on sources of funds for R&D performed in the Higher Education sector. In a note to its table, however, the OECD offered other figures that it considered more accurately reflected the true magnitude and distribution of R&D financial support for six member nations. Those figures have been used in preparing this table. The adjustments required resulted in each of the six cases in a reduction in funds supplied by the Higher Education

sector to itself, an increase in funds supplied by the Government sector, and, most significantly, in a very substantial increase in the total level of support for R&D performed in the Higher Education sector. This suggests that the distribution of GERD among the sources of funds and sectors of performance and the transfer of funds from the Government sector to the Higher Education sector is not that shown in the OECD tables. It is probable that, for each of these six countries in 1969, (1) the figures on government funding of R&D should be increased by the same amount the figures on Higher Education funding have been reduced in this table, (2) the figures on R&D performed in the Government sector should be reduced by the same amount the figures on R&D performed in the Higher Education sector have been increased, and (3) the data on the flow of funds from the Government to the Higher Education sector should be changed to reflect these adjustments. Unfortunately, it proved impracticable to recompute all of the OECD tables. Tables B-1 and B-2 on sources of funding do, however, reflect the adjustments suggested by the OECD.

Some idea of the extent of the changes entailed by this procedure may be obtained by comparing the figures in this table to those provided in the original OECD table. These appear below:

Country	C A T E G O R Y				
	Business Enterprise	Government	Private Non-profit	Higher Education	Abroad
FRANCE	0.6	10.8	0.5	88.0	0.1
JAPAN	0.8	4.4	--	94.7	0.1
Italy	--	63.4	...	36.6	--
Spain	1.4	58.7	0.8	37.4	1.7
Canada	0.7	51.0	2.9	44.8	0.7
Ireland	5.6	22.1	2.8	58.4	11.0

- c. For 1969, read 1968.
- d. Excludes payments in respect of post-graduates. Excluding Research Council units at universities.
- e. Including the social sciences.
- f. For 1969, read 1970.
- g. Loans and funds from nonspecified sources are included in "own funds."
- h. Including Private Non-profit institutes.
- i. National estimates.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 1.6(B), p. 38.

Table D-5

GOVERNMENT EXPENDITURES ON R&D BY SECTOR OF PERFORMANCE IN THE 1960s
(percentage distribution)

Country ^a	Year	CATEGORY			
		Business Enterprise	Government	Private Non-profit	Higher Education
Major OECD Members:					
UNITED STATES	1961	44.8	21.1	3.2	10.9
	1963	41.9	22.7	4.5	12.3
	1965	44.6	23.1	3.8	13.5
	1967	47.4	23.3	4.1	15.2
	1969	46.3 ^b	24.6 ^{c,d}	4.2 ^e	15.0 ^{e,c}
UNITED KINGDOM	1961	41.9	41.0	1.7	7.3
	1964	41.9	42.1	3.3	11.5
	1967	40.7	44.1	2.7	12.5
	1968	40.6	43.3	2.7	13.4
FRANCE	1961	23.9	56.9	--	19.3
	1963	23.7	53.8	0.3	22.7
	1965	23.1	48.4	0.5	22.0
	1967	31.5	46.6 ^f	0.6	21.2 ^f
	1969	39.9	46.2 ^f	0.8	3.1 ^f
WEST GERMANY	1964	22.6	8.1	23.4	45.9
	1967	28.6	11.9	23.4	35.7
	1969	27.0	11.2	21.8	40.0
ITALY	1963	0.6	34.4	0.2	59.0
	1967	1.6	35.8 ^g	0.6	61.0 ^g
	1969	6.1	36.7 ^g	1.4	55.0 ^g
Other OECD:					
Austria	1964	40.6	37.0	--	22.3
	1967	38.6	31.4	--	37.1
	1969	23.6	34.2	--	42.1
Belgium	1963	22.6	32.2	2.4	42.9
	1967	21.1	27.7	1.2	53.0
	1969	17.1	37.7	0.6	41.0
Canada	1963	10.8	27.5	1.7	60.3
	1967	14.0	26.5	1.0	58.6
Denmark	1963	11.1	27.7	0.2	66.3
	1967	14.5	27.9	0.3	63.9
Finland	1963	11.1	72.7	--	17.8
	1967	14.1	67.1	--	18.4
	1967	4.7	64.1 ^h	--	34.7 ^{h,i}
	1969	2.8	61.1 ^h	--	37.3 ^{h,i}
Greece	1963	1.1	67.7	--	31.3
	1967	4.7	68.4	--	26.9
	1967	3.4	73.0	--	32.7 ^h
	1969	4.7	74.3	--	31.0 ^{h,i}
Japan	1964	1.7	60.7	40.8	50.1
	1967	1.1	60.1	50.1 ^h	48.1 ^h
	1969	1.1	58.7 ⁱ	17.1 ^h	47.0 ^h
	1969	4.0	59.9	2.7	47.4
Netherlands	1964	--	32.8	--	7.2
	1967	1.4 ^j	33.8 ⁱ	--	4.8 ^j
	1969	1.4	34.8	--	4.8
Norway	1963	1.3 ^{j,k}	60.8 ^l	4.1	43.9
	1967	0.8	94.1	--	5.1
Portugal	1963	1.0	93.7	--	5.3
	1967	1.0	93.7	--	5.3
Sweden	1963	4.4	38.6	3.7	53.3
	1967	1.4	37.7	--	59.5
	1969	0.7	37.1 ⁱ	0.8	61.4 ⁱ
Switzerland	1964	--	60.1	3.7	39.2
	1967	--	71.1	3.7	28.2
	1969	--	77.2	1.1	21.7

Notes for Table D-5:

- a. Countries are ranked within categories according to the size of the share of their government's R&D expenditures absorbed by the Business Enterprise sector. OECD member nations not included are Australia, Iceland, Luxembourg, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditure plus depreciation.
- c. Including the social sciences.
- d. Total intramural expenditures.
- e. Current intramural expenditures.
- f. It is likely that the flow of funds from Government to the Higher Education sector is somewhat larger than is indicated here and that the Government sector itself is somewhat smaller. For an explanation of why this is so, see Table D-4, note c.
- g. Private Non-profit cannot be distinguished from Higher Education as a sector of performance.
- h. Data are not comparable with corresponding data for 1967.
- i. Including the social sciences and humanities.
- j. Includes loan from Government of 6,651 million D. Kr.
- k. Including national estimates of about 20 percent of the total.
- l. Includes loans and funds from other nonspecified sources.

Source: For all years prior to 1969: OECD, R&D Trends and Objectives, Appendix, Table 7, p. 10. (Note that the figures in this table are expressed in terms of percentages of GERD. These have been converted into percentages of total government expenditures on R&D performed in each sector.) For 1969: OECD, Survey of R&D in 1969, Vol. 5, Tables 1.3(A), 1.4(A), 1.5(A), and 1.6(A), pp. 32-39. (Note that these tables refer to sources of funds for the four sectors of performance. For each country the figures on government funding for each sector have been extracted, added together, and checked against the figures on total government funding in Table 1.1(A). The percentage distribution for 1969 was then derived.)

Series E

TYPES OF R&D ACTIVITY IN OECD MEMBER COUNTRIES

Table E-1

TOTAL INTRAMURAL EXPENDITURES ON R&D BY TYPE OF ACTIVITY IN 1969
(in millions of current US dollars)

Country ^a	Basic Research	Applied Research	Experimental Development
Major OECD Members:			
UNITED STATES ^b	3,761.0	5,654.0	16,868.0
FRANCE ^c	488.2	846.6	1,343.3
UNITED KINGDOM ^{b,d}	224.5	528.7	1,304.4
Other OECD:			
Netherlands ^b	232.0 ¹	.	263.5
Canada ^b	167.3	294.7	314.5
Italy ^d	145.0	292.4	256.9
Belgium ^c	84.1	108.3	68.7
Sweden ^b	46.9	75.0	215.6
Denmark ^{b,f}	24.2	32.0	62.3
Norway ^b	17.1	26.3	38.8
Spain ^b	9.4	18.8	3.3
Greece ^b	2.3	6.1	3.8
Ireland ^b	2.2	7.6	9.0

- a. Countries are ranked within categories according to the amount of financial support provided for basic research. OECD member nations not represented include Australia, Austria, Finland, West Germany, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Total intramural expenditure.
- d. For 1969, read 1968.
- e. Includes both basic and applied research.
- f. For 1969, read 1970.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.5, pp. 72-73.

Table E-2

TOTAL INTRAMURAL EXPENDITURES ON R&D BY TYPE OF ACTIVITY IN 1969
(percentage distribution)

Country ^a	Basic Research	Applied Research	Experimental Development
Major OECD Members:			
FRANCE	18.2	31.6	50.2
UNITED STATES	14.3	21.5	64.2
UNITED KINGDOM	10.9	25.7	63.4
Other OECD:			
Netherlands	46.8 ^b	.	53.2
Spain	41.9	55.1	3.0
Belgium	32.2	41.5	26.3
Canada	21.5	38.0	40.5
Italy	20.9	42.1	37.0
Norway	20.8	32.0	47.2
Denmark	20.4	27.0	52.5
Greece	18.8	49.7	31.5
Sweden	13.9	22.2	63.9
Ireland	11.6	40.7	47.7

a. Countries are ranked within categories according to the size of the share of GERD consumed by basic research. OECD member nations not included are Australia, Austria, Finland, West Germany, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.

b. Includes both basic and applied research.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.5, pp. 72-73.

Table E-3

BASIC RESEARCH BY SECTOR OF PERFORMANCE IN 1969
(percentage distribution)

Country ^a	C A T E G O R Y			
	Business Enterprise	Government	Private Non-profit	Higher Education
Major OECD Members:				
FRANCE ^b	10.6	24.2 ^f	2.7 ^f	63.3 ^c
UNITED STATES ^d	17.2 ^e	15.3 ^f	5.7 ^f	61.8 ^f
UNITED KINGDOM ^{d,g}	21.0	35.3 ^h	5.7 ⁱ	38.0
Other OECD:				
Sweden ^d	8.5	4.0	0.5	86.9 ^c
Ireland ^d	7.3	3.7	3.6	85.4
Norway ^d	4.5	16.9	1.5	77.0
Belgium ^b	16.1	9.5	1.2 ⁱ	73.2 ⁱ
Denmark ^{d,j}	2.7	22.9 ⁱ	5.0 ⁱ	69.5 ⁱ
Canada ^d	8.5	29.1	.	62.5 ^{c,k}
Italy ^b	6.6	52.1	...	41.3
Greece ^d	0.4	65.7	4.2	29.7
Netherlands ^{d,l}	41.1 ^f	18.6	12.1	28.2
Spain ^d	7.9 ^f	81.0	--	11.0

- a. Countries are ranked within categories according to the size of the share of basic research expenditures consumed within the Higher Education sector. OECD member nations not included are Australia, Austria, Finland, West Germany, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Total intramural expenditures.
- c. National estimates.
- d. Current intramural expenditures.
- e. Current expenditures plus depreciation.
- f. Including the social sciences.
- g. For 1969, read 1968.
- h. Excluding a share of £34,106th, which could not be broken down by activity.
- i. Partial data.
- j. Includes both Private Non-profit and Higher Education.
- k. For 1969, read 1970.
- l. Including applied research.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.1(B), p. 64.

Table E-4

APPLIED RESEARCH BY SECTOR OF PERFORMANCE IN 1969
(percentage distribution)

Country ^a	C A T E G O R Y			
	Business Enterprise	Government	Private Non-profit	Higher Education
Major OECD Members:				
UNITED STATES ^b	58.6 ^c	21.1 ^d	7.6 ^d	12.6 ^d
UNITED KINGDOM ^{b,e}	57.7	23.0 ^f	3.3 ^g	16.0.
FRANCE ^h	50.9	38.8	1.2	9.0 ⁱ
Other OECD:				
Belgium ^h	65.6	15.2	0.3	18.9
Italy ^h	51.4	22.3	...	26.3
Norway ^b	44.7	27.8	0.6	26.9
Sweden ^b	43.3	41.0	0.1	15.5 ⁱ
Spain ^b	37.0 ^d	60.5	--	2.5
Denmark ^{b,j}	32.9	43.8	7.6	15.7 ^g
Canada ^b	29.8	53.2	.	16.9 ^{i,k}
Greece ^b	23.7	64.0	2.3	10.1
Ireland ^b	11.6	75.9	1.2	11.3

- a. Countries are ranked within categories according to the size of the share of applied research expenditures consumed within the Business Enterprise sector. OECD member nations not included are Australia, Austria, Finland, West Germany, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Current expenditures plus depreciation.
- d. Including the social sciences.
- e. For 1969, read 1968.
- f. Excluding a share of £34,106th, which could not be broken down by activity.
- g. Partial data.
- h. Total intramural expenditures.
- i. National estimates.
- j. For 1969, read 1970.
- k. Includes both Private Non-profit and Higher Education.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.2(B), p. 66.

Table E-5

EXPERIMENTAL DEVELOPMENT BY SECTOR OF PERFORMANCE IN 1969
(percentage distribution)

Country ^a	C A T E G O R Y			
	Business Enterprise	Government	Private Non-profit	Higher Education
Major OECD Members:				
UNITED STATES ^b	86.0 ^c	10.2 ^d	1.7 ^d	2.0 ^d
UNITED KINGDOM ^{b,e}	82.5	17.4 ^f	-- ^h	-- ⁱ
FRANCE ⁱ	74.8	24.9	0.2	-- ⁱ
Other OECD:				
Belgium ^h	91.3	4.5	--	4.1 ⁱ
Sweden ^b	88.6	8.6	--	2.7 ⁱ
Italy ^h	85.9	13.1	...	1.0
Netherlands ^b	85.9	5.4	4.5	4.2
Denmark ^{b,j}	79.3	13.6 ^g	4.3 ^g	2.8 ^g
Norway ^b	78.3	16.1	0.1	5.4 ^{i,k}
Canada ^b	67.6 ^d	25.6	.	6.8 ^{i,k}
Spain ^b	59.4 ^d	40.4	--	0.2
Greece ^b	57.0	38.8	1.1	3.1
Ireland ^b	52.3	46.5	0.2	0.9

- a. Countries are ranked within categories according to the size of the share of experimental development expenditures consumed within the Business Enterprise sector. OECD member nations not included are Australia, Austria, Finland, West Germany, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Current expenditures plus depreciation.
- d. Including the social sciences.
- e. For 1969, read 1968.
- f. Excluding a share of £34,106th, which could not be broken down by activity.
- g. Partial data.
- h. Total intramural expenditures.
- i. National estimates.
- j. For 1969, read 1970.
- k. Includes both Private Non-profit and Higher Education.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.4(B), p. 70.

Table E-6

BUSINESS ENTERPRISE R&D BY TYPE OF ACTIVITY IN 1969
(percentage distribution)

Country ^a	TYPE OF ACTIVITY		
	Basic Research	Applied Research	Experimental Development
Major OECD Members:			
WEST GERMANY ^b	7.0	.	93.0 ^c
UNITED STATES ^d	3.5	17.9	78.6
UNITED KINGDOM ^b	3.3	21.4	75.3
FRANCE ^e	3.5	29.0	67.5
JAPAN ^e	9.1	27.0	63.9
Other OECD:			
Switzerland ^{e, f}	12.5	.	87.5 ^c
Sweden ^b	1.8	14.3	84.0
Ireland ^b	2.8	15.4	81.8
Denmark ^b	1.1	17.4	81.5
Austria ^g	26.1 ^h	.	73.9
Norway ^b	1.8	27.4	70.8
Netherlands ^b	29.7 ^h	.	70.3
Canada ^b	4.5	27.9	67.6
Finland ^b	2.9	32.1	65.0
Greece ^b	0.3	39.4	60.3
Italy ^e	2.5	39.5	58.0
Belgium ^e	9.2	48.2	42.6
Spain ^{b, i}	7.9	81.0	11.0

- a. Countries are ranked within categories according to the size of the share of Business Enterprise R&D expenditures devoted to Experimental Development. OECD member nations not included are Australia, Iceland, Luxembourg, Portugal, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Includes both Applied Research and Experimental Development.
- d. Current expenditures plus depreciation.
- e. Total intramural expenditures.
- f. Manufacturing only.
- g. Intramural and extramural expenditures.
- h. Includes both Basic and Applied Research.
- i. Includes the social sciences.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.5, pp. 72-73.

Table E-7

GOVERNMENT R&D BY TYPE OF ACTIVITY IN 1969
(percentage distribution)

Country ^a	T Y P E O F A C T I V I T Y		
	Basic Research	Applied Research	Experimental Development
Major OECD Members:			
UNITED KINGDOM ^{b,c}	18.5	28.4	53.0
UNITED STATES ^{b,d}	16.5	34.2	49.3
FRANCE ^e	15.2	42.0	42.8
Other OECD:			
Finland ^b	18.7	38.5	42.8
Ireland ^b	0.8	57.7	41.5
Norway ^b	17.6	44.4	38.0
Sweden ^b	3.7	60.0	36.3
Denmark ^{b,f}	19.8	50.0	30.2
Canada ^b	17.0	54.9	28.1
Netherlands ^b	75.1 ^g	.	24.9
Greece ^b	21.9	56.4	21.7
Italy ^e	43.3	37.4	19.3
Belgium ^e	29.0	59.7	11.3
Spain ^b	37.0	60.5	2.5

- a. Countries are ranked within categories according to the size of the share of Government R&D expenditures devoted to Experimental Development. OECD member nations not included are Australia, Austria, West Germany, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Excluding a share of £34,106th, which could not be broken down by activity.
- d. Including the social sciences.
- e. Total intramural expenditures.
- f. Partial data.
- g. Includes both Basic and Applied Research.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.5, pp. 72-73.

Table E-8

PRIVATE NON-PROFIT R&D BY TYPE OF ACTIVITY IN 1969
(percentage distribution)

Country ^a	T Y P E O F A C T I V I T Y		
	Basic Research	Applied Research	Experimental Development
Major OECD Members:			
UNITED KINGDOM ^{b,c}	41.7	56.6	1.7
UNITED STATES ^{b,d}	22.9	46.1	31.0
FRANCE ^{e,f}	49.2	38.3	12.5
Other OECD:			
Greece ^b	34.6	50.1	15.3
Ireland ^b	41.1	48.5	10.4
Denmark ^{b,c}	19.0	38.6	42.3
Norway ^b	55.6	34.9	9.5
Finland ^b	17.1	32.3	50.6
Belgium ^e	73.2	26.8	--
Sweden ^b	61.9	19.0	19.0
Netherlands ^b	75.1 ^g	.	24.9

- a. Countries are ranked within categories according to the size of the share of Private Non-profit R&D expenditures devoted to Applied Research. OECD member nations not included are Australia, Austria, Canada, West Germany, Iceland, Italy, Japan, Luxembourg, Portugal, Spain, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Partial data.
- d. Including the social sciences.
- e. Total intramural expenditures.
- f. National estimates.
- g. Including both Basic and Applied Research.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.5, pp. 72-73.

Table E-9

HIGHER EDUCATION R&D BY TYPE OF ACTIVITY IN 1969
(percentage distribution)

Country ^a	T Y P E O F A C T I V I T Y		
	Basic Research	Applied Research	Experimental Development
Major OECD Members:			
WEST GERMANY ^b	100.0	--	--
FRANCE ^{c,d}	79.8	20.1	0.2
UNITED STATES ^{b,e}	68.8	21.2	10.1
UNITED KINGDOM ^b	50.0	49.6	0.4
Other OECD:			
Netherlands ^b	85.5 ^f	.	14.4
Belgium ^c	72.5	24.2	3.4
Denmark ^{b,g}	71.3	21.2	7.5
Sweden ^{b,d}	70.0	20.0	10.0
Ireland ^b	66.3	30.7	3.0
Canada ^{b,d,h}	59.5	28.4	12.1
Spain ^b	59.4	40.4	0.2
Norway ^b	58.9	31.7	9.4
Greece ^b	48.3	43.3	8.4
Italy ^c	43.0	55.2	1.8

- a. Countries are ranked within categories according to the size of the share of Higher Education R&D expenditures devoted to Basic Research. OECD member nations not included are Australia, Austria, Finland, Iceland, Japan, Luxembourg, Portugal, Switzerland, Turkey, and the two associate members, Yugoslavia and New Zealand.
- b. Current intramural expenditures.
- c. Total intramural expenditures.
- d. National estimates.
- e. Including the social sciences.
- f. Includes both Basic and Applied Research.
- g. Partial data.
- h. Includes expenditures by both Private Non-profit and Higher Education sectors.

Source: OECD, Survey of R&D in 1969, Vol. 5, Table 3.5, pp. 72-73.

Series F

OBJECTIVES OF GOVERNMENT-FUNDED R&D
IN OECD MEMBER COUNTRIES

Table F-1
TOTAL ESTIMATED GOVERNMENT R&D FUNDING
(in millions of 1961 US dollars)

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	10,334.9	11,807.9	14,251.1	14,174.1	14,944.7	15,257.5	14,883.7	13,682.9	12,525.7	12,071.1	11,681.4	...
WEST GERMANY	422.9	540.3	604.0	715.3	810.6	879.7	992.6	1,008.2	1,104.3	1,240.7	1,417.8	...
FRANCE	601.0	699.0	806.5	995.5	1,186.4	1,283.7	1,430.0	1,419.8	1,383.2	1,336.0	1,527.7	1,345.3
UNITED KINGDOM	1,066.2	1,063.7	1,068.5	1,156.4	1,141.3	1,175.7	1,186.6	1,188.6	1,233.7	1,115.5	1,141.0	1,265.9
JAPAN	231.3	273.0	292.7	332.0	379.9	421.8	465.5	517.2	586.2	...	...	...
Other OECD:												
Canada	206.2	194.5	225.4	254.0	304.3	316.6	369.3	406.6	413.3	425.4	...	...
Italy	...	...	77.8	106.5	142.6	165.9	214.9	227.6	245.6	295.2	304.3	...
Netherlands	65.7	76.1	84.2	107.0	123.3	135.8	149.8	162.9	166.4	182.4	186.8	190.9
Sweden	17.5	127.6	148.0	166.1	170.4	183.3	189.4	199.9	180.7	...	...	...
Belgium	...	...	...	...	73.1	92.2	98.9	102.5	122.7	138.3	162.6	171.0
Norway	21.0	22.5	25.8	28.0	35.9	35.2	41.6	45.2	48.2	47.4	...	...
Spain	...	...	18.9	21.3	26.1	26.2	30.2	35.3	42.1	...	...	...

i. Countries are ranked within categories according to the size of government R&D expenditures in the last year for which data are available. Unless otherwise indicated, OECD member nations not represented in the "P" series of Appendix Tables include Australia, Austria, Denmark, Finland, Greece, Iceland, Ireland, Luxembourg, Portugal, Switzerland, and Turkey and the two associate members, Yugoslavia and New Zealand.

Source: OECD, Changing Priorities for Government R&D, pp. 172-73.

Table F-2

TOTAL ESTIMATED GOVERNMENT R&D FUNDING AS A PERCENTAGE
OF GNP AT MARKET PRICES

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71
Major OECD Members:										
UNITED STATES	2.0	2.1	2.5	2.3	2.3	2.2	2.1	1.9	1.6	1.6
FRANCE	0.9	1.0	1.1	1.2	1.4	1.4	1.5	1.4	1.3	1.2
UNITED KINGDOM	1.4	1.3	1.3	1.4	1.3	1.3	1.3	1.3	1.3	1.1
WEST GERMANY	0.5	0.7	0.7	0.8	0.8	0.9	1.0	0.9	0.9	0.9
JAPAN	0.6	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.5	...
Other OECD:										
Netherlands	0.5	0.6	0.6	0.7	0.8	0.9	0.9	0.9	0.9	0.9
Sweden	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.1	0.9	...
Canada	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.8	0.7	0.7
Belgium	...	...	...	...	0.5	0.6	0.6	0.6	0.7	0.7
Norway	0.4	0.4	0.5	0.5	0.6	0.5	0.6	0.7	0.7	0.6
Italy	...	...	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5
Spain	...	...	0.1	0.1	0.1	0.1	0.1	0.2	0.2	...

a. Countries are ranked within categories according to the size of the share of government R&D expenditures in GNP in the last year for which data are available. It should be noted that the figures in this table differ from those in Table B-4.

Source: OECD, Changing Priorities for Government R&D, pp. 172-73.

Table F-3

ESTIMATED GOVERNMENT R&D FUNDING DISTRIBUTED
BY MAJOR GROUPS OF OBJECTIVES
(in millions of 1961 US dollars)

Country ^a	I. National Security and Big Science			II. Economic Development			III. Community Services			IV. Advancement of Science			V. Other Activities		
	1961	1965	1971	1961	1965	1971	1961	1965	1971	1961	1965	1971	1961	1965	1971
Major OECD Members:															
UNITED STATES ^b	9,272.8	13,080.5	18,964.2	337.5	550.8	946.7	597.5	1,014.3	1,510.0	117.6	234.0	333.2	9.6	16.6	27.2
UNITED KINGDOM ^b	854.9	829.6	689.1	88.5	119.3	260.4	2.6	5.6	21.6	127.6	212.3	330.9	16.2	17.9	20.4
FRANCE ^c	417.5	779.1	660.4	47.0	120.8	270.0	5.2	20.0	45.3	120.0	248.5	343.7	11.3	18.1	25.8
WEST GERMANY	160.4	312.9	528.4	...	71.1 ^c	190.7	...	28.5 ^d	59.1	158.2	306.6	575.2	...	61.4 ^c	64.6
JAPAN ^d	24.7	22.0	60.5	69.6	105.6	135.9	4.9	15.0	24.8	129.3	237.6	359.9	2.8	1.9	5.1
Other OECD:															
Canada ^e	84.4	118.8	108.9	71.1	134.5	216.1	6.6	23.8	50.3	35.6	21.1	43.9	8.5	0.3	5.7 ^d
Italy ^d	...	67.3	100.3	...	6.1	50.6	...	2.2	9.2	...	69.3	143.1	...	1.1	1.0 ^e
Sweden ^b	80.9	106.1	76.5	10.5	18.8	29.6	6.1	11.3	22.8	15.9	34.9	51.7	...	...	0.4 ^e
Belgium ^b	...	19.6	34.1	...	17.8	41.2	...	14.5	42.5	...	21.1	52.6	...	0.2	0.6
Netherlands ^b	10.9	24.5	30.4 ^e	15.8	22.9	31.6 ^d	...	12.4	27.7 ^d	32.4	63.2	98.4 ^d	0.2	0.7	2.8
Spain ^e	4.2	6.7	12.3 ^e	2.6	15.3	22.8 ^d	0.1	0.1	0.1	0.1	4.7	5.7	...	...	...
Norway ^e	4.7	7.2	7.3	5.8	11.9	15.9	1.7	2.3	3.8	8.7	14.8	20.4	...	...	...

a. Countries are ranked within categories according to the size of their government's expenditures on National Security and Big Science R&D in the last year for which data are available.

b. For 1971, read 1972.

c. For 1965, read 1967.

d. For 1971, read 1969.

e. For 1971, read 1970.

Source: Tables F-6, F-14, F-16, F-18, and F-20.

ESTIMATE GOVERNMENT P&D FUNDING FOR MAJOR GROUPS OF OBJECTIVES AS A PERCENTAGE OF TOTAL GOVERNMENT EXPENDITURES ON P&D

[illegible]

3. Countries are listed with one or more of the following: (a) Government; (b) National Security and (c) Social and Political Information. (d) Other information available.

1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379</

[illegible]

Table F-5

ESTIMATED GOVERNMENT R&D FUNDING FOR MAJOR GROUPS OF OBJECTIVES AS A PERCENTAGE OF GNP AT MARKET PRICES

Country ^a	I. National Security and Big Science			II. Economic Development			III. Community Services			IV. Advancement of Science		
	1961	1965	1969	1961	1965	1969	1961	1965	1969	1961	1965	1969
Major OECD Members:												
UNITED STATES	1.73	1.93	1.33	0.06	0.09	0.10	0.11	0.15	0.17	0.02 ^b	0.03 ^b	0.04 ^b
UNITED KINGDOM	1.10	0.92	0.69	0.14	0.16	0.32	0.02	0.03	0.05	0.09	0.14	0.17
FRANCE	0.62	0.93	0.68	0.07	0.14	0.25	0.01	0.02	0.04	0.18	0.30	0.32
WEST GERMANY	0.19	0.31	0.39	...	...	0.09	...	...	0.02	0.19	0.31	0.40
JAPAN	0.05	0.02	0.05	0.13	0.14	0.13	0.01	0.02	0.02	0.24	0.31	0.35
Other OECD:												
Sweden	0.56	0.61	0.37	0.07	0.10	0.14	0.04	0.06	0.11	0.11 ^b	0.20 ^b	0.25 ^b
Canada	0.22	0.24	0.23	0.19	0.28	0.43	0.02	0.06	0.11	0.09	0.04 ^b	0.09 ^b
Netherlands	0.09	0.16	0.19	0.11	0.15	0.22	0.07	0.08	0.11 ^c	0.25	0.41	0.46
Belgium	...	0.13	0.17	...	0.12	0.17	...	0.10 ^c	0.16 ^c	...	0.14	0.21
Italy	...	0.14	0.17	...	--	0.03	...	--	0.01	...	0.15	0.21
Norway	0.09	0.12	0.10	0.12	0.19	0.22	0.04	0.04	0.05	0.18	0.24	0.29
Spain	0.03	0.04	0.06	0.02	0.09	0.11	...	...	--	--	0.03	0.03

a. Countries are ranked within categories according to the size of the share of their government's expenditures on National Security and Big Science R&D in the GNP in the last year for which data are available.

b. Advancement of Research only.

c. Probably overestimated compared with the other countries.

Source: OECD, Changing Priorities for Government R&D, p. 184.

Table F-6
ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP I,
NATIONAL SECURITY AND BIG SCIENCE
(in millions of 1961 US dollars)

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	9,272.8	10,517.1	12,712.9	12,612.3	13,080.5	13,074.3	12,507.0	11,380.6	10,156.4	9,454.9	8,864.2	...
UNITED KINGDOM	854.9	831.6	811.5	868.9	829.6	819.0	739.8	700.0	682.6	599.8	544.8	689.1
FRANCE	417.5	478.2	529.0	633.6	779.1	829.4	862.3	772.9	718.9	692.8	676.2	660.4
WEST GERMANY	160.4	184.2	229.8	299.1	312.9	348.6	446.3	428.2	465.5	483.1	528.4	...
JAPAN	24.7	25.8	21.4	21.4	22.0	25.6	33.0	46.6	60.5	...	...	...
Other OECD:												
Canada	84.4	82.0	87.7	100.5	118.8	112.1	117.0	116.7	109.0	108.9	...	...
Italy	...	...	40.8	56.3	67.3	81.8	100.0	91.8	96.2	90.9	100.3	...
Sweden	80.9	87.5	100.2	112.0	106.1	111.7	112.2	111.0	76.5	...	...	...
Belgium	...	...	...	...	19.6	23.9	26.5	25.3	28.5	28.7	32.1	34.1
Netherlands	10.9	12.4	15.6	20.3	24.5	24.5	29.0	33.3	33.9	34.1	32.6	30.4
Spain	4.2	4.2	4.8	5.3	6.7	8.5	11.1	14.2	13.5	12.3	...	...
Norway	4.7	4.7	5.3	6.6	7.2	5.9	6.4	6.7	7.0	7.3	...	...

a. Countries are ranked within categories according to the size of their government's expenditures on National Security and Big Science R&D in the last year for which data are available.

Source: Tables F-8, F-10, and F-12.

Table F-7

ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP I, NATIONAL
SECURITY AND BIG SCIENCE, AS A PERCENTAGE OF
TOTAL GOVERNMENT EXPENDITURES ON R&D

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	89.8	89.2	89.2	89.0	87.5	85.7	84.0	83.2	81.2	78.3	75.8	...
UNITED KINGDOM	80.2	78.1	76.0	75.1	72.7	69.7	62.4	58.9	55.3	54.0	56.5	54.4
FRANCE	69.5	68.4	65.6	63.6	65.6	64.3	60.3	54.4	51.9	51.9	51.0	49.1
WEST GERMANY	37.9	34.1	38.0	41.7	38.5	39.6	45.0	42.4	42.2	38.9	37.2	...
JAPAN	10.7	9.4	7.3	6.6	5.9	6.2	7.0	9.0	10.4	...	...	...
Other OECD:												
Sweden	71.3	68.6	63.7	67.4	62.3	61.0	59.2	55.5	42.4	...	...	...
Italy	...	...	52.5	52.9	47.2	49.4	46.6	40.4	39.2	30.7	33.0	...
Spain	...	...	25.5	25.4	25.4	32.5	36.9	40.2	32.2	...	...	...
Canada	41.0	42.2	38.9	39.5	39.0	35.4	31.6	28.7	26.4	25.6	...	...
Belgium	...	...	...	...	26.7	26.0	26.8	24.6	23.2	20.7	19.8	19.9
Netherlands	16.6	16.2	18.6	19.1	20.0	18.1	19.5	20.4	20.4	18.6	17.4	15.9
Norway	22.5	20.6	20.8	23.5	20.2	16.6	15.5	14.9	14.6	15.3	...	...

a. Countries are ranked within categories according to the size of the share of their government's expenditures on National Security and Big Science R&D in total government R&D expenditures in the last year for which data are available.

Source: Tables F-9, F-11, and F-13.

Table F-8
ESTIMATED GOVERNMENT FUNDING FOR DEFENSE R&D
(in millions of 1961 US dollars)

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	7,301.8	7,257.5	7,895.1	6,999.2	6,830.4	7,479.6	7,651.4	7,221.2	6,623.2	6,360.9	6,146.6	...
UNITED KINGDOM	690.5	656.9	634.5	668.9	642.3	614.6	554.1	515.2	503.4	441.3	391.7	557.2
FRANCE	265.3	293.7	313.5	345.2	468.8	503.9	498.8	431.6	399.7	385.7	377.1	374.4
WEST GERMANY	94.3	97.3	125.8	144.8	159.9	167.4	211.9	199.6	211.9	219.4	212.7	...
JAPAN	8.6	7.9	6.5	8.2	10.3	12.4	13.6	10.0	12.7	...	...	...
Other OECD:												
Sweden	53.3	58.4	65.3	72.7	73.3	79.9	83.3	78.2	55.8	...	...	...
Canada	44.5	44.0	44.4 ^b	51.0	68.8	55.7	54.9	52.6	46.2	47.0	...	...
Italy	...	...	5.3	6.4	9.6	10.5	10.8	10.6	10.0	12.2	13.3	...
Netherlands	2.7	2.6	4.0	5.1	5.1	6.1	7.1	8.7	9.4	8.6	8.7	8.4
Norway	1.5	1.7	1.8	2.3	2.7	2.1	2.4	2.6	2.8	3.0	...	...
Belgium	...	...	...	...	1.5 ^b	1.6 ^b	1.4 ^b	1.4	1.5	1.4	1.5	1.7
Spain	...	...	0.7 ^b	0.6	1.0	1.5 ^b	2.3	2.8	3.4	1.2	...	...

a. Countries are ranked within categories according to the size of their government's expenditures on Defense R&D in the last year for which data are available.

b. Rough estimate.

Source: OECD, Changing Priorities for Government R&D, pp. 206-207.

Table F-9
ESTIMATED GOVERNMENT FUNDING FOR DEFENSE R&D AS A PERCENTAGE
OF TOTAL GOVERNMENT R&D EXPENDITURES

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	70.7	61.5	55.4	49.4	45.7	49.0	51.4	52.8	52.9	52.7	52.6	...
UNITED KINGDOM	64.8	61.7	59.4	57.8	56.3	52.3	46.7	43.3	40.8	39.6	43.1	44.0
FRANCE	44.1	42.0	38.9	34.7	39.5	39.1	34.9	30.4	28.9	28.9	28.4	27.8
WEST GERMANY	22.3	18.0	20.8	20.2	19.7	19.0	21.4	19.8	19.2	17.7	15.0	...
JAPAN	3.7	2.9	2.2	2.5	2.7	3.0	2.9	1.9	2.2	...	...	...
Other OECD:												
Sweden	47.0	45.8	45.4	43.7	43.0	43.6	44.0	39.1	30.9	...	...	...
Canada	21.6	22.7	19.7	20.1	22.6	17.6	14.8	12.9	11.2	11.0	...	...
Spain	...	...	3.8	3.0	3.7	5.6	7.7	8.0	8.1	...	...	...
Norway	7.2	7.4	7.1	8.1	7.6	5.8	5.7	5.8	5.9	6.3	...	...
Netherlands	4.2	3.4	4.8	4.8	4.2	4.5	4.8	5.3	5.7	4.7	4.7	4.4
Italy	...	...	6.8	6.0	6.7	6.4	5.0	4.7	4.1	4.1	4.4	...
Belgium	...	...	...	...	2.1	1.8	1.4	1.3	1.2	1.0	1.0	1.0

a. Countries are ranked within categories according to the size of the share of their government's expenditures on

Defense R&D in total government R&D expenditures in the last year for which data are available.

b. Partial data.

Source: OECD, Changing Priorities for Government R&D, pp. 206-207.

Table F-10
ESTIMATED GOVERNMENT FUNDING FOR CIVIL NUCLEAR R&D
(in millions of 1961 US dollars)

Country ^a	1961 1961/62	1962 1962/53	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	751.2	785.7	843.6	848.5	812.6	791.9	861.5	741.8	695.3	689.2	600.0	...
WEST GERMANY	66.1	84.2	92.4	122.6	121.8	144.3	177.0	163.7	183.0	197.8	221.6	...
FRANCE	148.9	172.9	193.3	255.5	249.7	269.4	278.9	255.6	237.0	216.2	205.5	196.4
UNITED KINGDOM	156.8	155.4	147.3	151.8	145.9	154.0	143.4	138.9	137.2	127.1	122.9	112.0
JAPAN	16.1	17.9	14.9	13.2	11.4	12.4	17.9	35.1	43.8	...	...	...
Other OECD:												
Italy	...	...	34.4	45.7	51.7	53.6	73.4	69.3	69.5	62.0	69.4	...
Canada	59.9	38.0	43.3	49.1	49.3	53.5	58.4	57.5	55.8	55.9	...	...
Belgium	...	...	...	...	14.7	17.4	19.1	18.2	20.9	21.2	23.8	26.7
Sweden	27.5	28.6	33.9	38.2	31.1	29.5	26.7	30.1	18.2	...	...	...
Netherlands	8.0 ^b	9.5 ^b	11.0 ^b	12.7	13.6 ^b	15.2 ^b	16.9 ^b	18.0	17.6	20.0	16.9	15.7
Spain	3.5 ^b	3.4 ^b	5.3 ^b	3.8	4.9 ^b	5.7 ^b	6.8 ^b	8.3	7.1	8.1	...	...
Norway	3.1	2.9	3.4	4.2	4.3	3.5	3.7	3.7	3.7	3.7	...	...

a. Countries are ranked within categories according to the size of their government's expenditures on Civil Nuclear R&D in the last year for which data are available.

b. Rough estimate.

Source: OECD, Changing Priorities for Government R&D, pp. 226-27.

Table F-11
ESTIMATED GOVERNMENT FUNDING FOR CIVIL NUCLEAR R&D AS A
PERCENTAGE OF TOTAL GOVERNMENT R&D EXPENDITURES

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
WEST GERMANY	15.6	15.6	17.3	17.1	15.0	16.4	17.8	16.2	16.6	15.9	15.6	...
FRANCE	24.8	24.7	24.0	25.6	21.0	20.9	19.5	18.0	17.1	16.2	15.5	14.8
UNITED KINGDOM	14.7	14.6	13.8	12.1	12.8	13.1	12.1	11.7	11.1	11.6	10.8	8.8
JAPAN	7.0	6.5	5.1	4.0	3.0	2.9	3.8	6.8	7.5	...	...	...
UNITED STATES	7.3	6.7	5.9	6.0	5.4	5.2	5.8	5.4	5.6	5.7	5.1	...
Other OECD:												
Italy	...	...	43.0	42.9	35.3	32.3	34.2	30.5	28.3	21.0	22.8	...
Spain	...	...	17.6	18.1	18.7	21.8	22.4	23.4	16.9	...	...	...
Belgium	...	...	...	...	20.0	18.9	19.3	17.7	17.0	15.3	14.6	15.6
Canada	19.4	19.5	19.2	19.3	16.2	16.9	15.8	14.2	13.5	13.2	...	...
Sweden	24.3	22.4	23.6	23.0	18.3	16.1	14.1	15.1	10.1	...	...	...
Netherlands	12.2	12.5	13.0	11.9	11.1	11.2	11.3	11.1	10.6	10.9	9.0	8.2
Norway	14.9	12.8	13.2	14.9	12.0	10.0	9.0	8.1	7.6	7.8	...	...

a. Countries are ranked within categories according to the size of the share of their government's expenditures on Civil Nuclear R&D in total government R&D expenditures in the last year for which data are available.

Source: OECD, *Changing Priorities for Government R&D*, pp. 226-27.

Table F-12

ESTIMATED GOVERNMENT FUNDING FOR CIVIL SPACE R&D
(in millions of 1961 US dollars)

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	1,219.8	2,474.3	3,474.3	4,764.8	5,437.5	4,802.8	3,994.1	3,417.6	2,837.9	2,404.8	2,117.6	...
WEST GERMANY	...	21.7	11.6	31.7	31.2	35.9	57.4	64.9	70.6	65.9	94.1	...
FRANCE	3.7	11.4	13.5	32.9	60.6	56.1	84.6	85.7	82.2	90.9	93.6	89.6
UNITED KINGDOM	7.3	19.3	29.5	48.2	41.4	50.4	42.3	45.9	42.0	31.4	30.2	19.9
JAPAN ^c	...	...	...	0.04	0.3	0.8	1.5	1.5	4.0	...	...	...
Other OECD:												
Italy	...	...	0.1	4.2	6.0	17.7	15.8	11.9	16.7	16.7	17.6	...
Netherlands	...	...	0.6	2.5	3.8	3.2	5.0	6.6	6.9	5.5	7.0	6.3
Canada ^d	...	...	...	0.4	0.7	2.9	3.7	6.6	7.0	6.0	...	...
Belgium	...	...	...	...	3.4	4.9	6.0	5.7	6.1	6.1	6.8	5.7
Spain	9.7 ^b	...	0.8	0.9	0.8	1.3 ^b	2.0 ^b	3.1	3.0	3.0	...	...
Sweden	0.1	...	1.0	1.1	1.7	2.3	2.2	2.7	2.5	...	...	...
Norway	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	...	...

a. Countries are ranked within categories according to the size of their government's expenditures on Civil Space R&D in the last year for which data are available.

b. Rough estimate.

c. Partial data.

d. Including military.

Source: OECD, Changing Priorities for Government R&D, pp. 348-49.

Table F-13

ESTIMATED GOVERNMENT FUNDING FOR CIVIL SPACE R&D AS
A PERCENTAGE OF TOTAL GOVERNMENT R&D EXPENDITURES

Country ^a	1961 1961/62	1962 1962/63	1963 1963/64	1964 1964/65	1965 1965/66	1966 1966/67	1967 1967/68	1968 1968/69	1969 1969/70	1970 1970/71	1971 1971/72	1972 1972/73
Major OECD Members:												
UNITED STATES	11.8	21.0	27.9	33.6	36.4	31.5	26.8	25.0	22.7	19.9	18.1	...
FRANCE	0.6	1.7	2.7	3.3	5.1	4.3	5.9	6.0	5.9	6.8	7.1	6.7
WEST GERMANY	--	0.5	1.5	4.4	3.8	4.2	5.8	6.4	6.4	5.3	6.6	...
UNITED KINGDOM	0.7	1.8	2.8	4.2	3.6	4.3	3.6	3.9	3.4	2.8	2.6	1.6
JAPAN	...	...	...	0.1	0.2	0.3	0.3	0.3	0.7	...	...	...
Other OECD:												
Spain	...	...	4.1	4.3	3.0	5.1	6.8	8.8	7.2	...	...	...
Italy	...	...	2.7	4.0	4.2	10.7	7.4	5.2	6.8	5.6	5.8	...
Belgium	...	...	...	...	4.6	5.3	6.1	5.6	5.0	4.4	4.2	3.3
Netherlands	0.2	0.3	0.8	2.4	4.7	2.4	3.4	4.0	4.1	3.0	3.7	3.3
Canada	...	...	...	0.1	0.2	0.9	1.0	1.6	1.7	1.4	...	...
Sweden	--	0.4	0.7	0.7	1.0	1.3	1.1	1.3	1.4	...	...	...
Norway	0.4	0.4	0.1	0.5	0.6	0.8	0.8	1.0	1.1	1.2	...	...

a. Countries are ranked within categories according to the size of the share of their government's expenditures on Civil Space R&D in total government R&D expenditures in the last year for which data are available.

Source: OECD, Changing Priorities for Government R&D, pp. 248-49.

Table F-14

ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP II,
ECONOMIC DEVELOPMENT, BY OBJECTIVE
(in millions of 1961 US dollars)

Country ^a	Agriculture			Mining and Manufacturing			Economic Services			Total Group II		
	1961	1965	1971	1961	1965	1971	1961	1965	1971	1961	1965	1971
Major OECD Members:												
UNITED STATES	173.8	252.4	238.6	84.2	250.3	437.0	79.5	158.1	271.1	337.5	660.8	946.7
FRANCE ^b	12.5	28.6	46.6	18.4	67.3	179.2	16.1	24.9 ^c	44.2 ^c	47.0	120.8	270.0
UNITED KINGDOM ^b	14.6	15.1	26.6	68.0	88.8	202.4	5.9	15.4 ^c	31.4 ^c	88.5	119.3	260.4
WEST GERMANY ^d	...	23.3	30.2	...	44.1	149.6	...	3.7	10.9	...	71.1	190.7
JAPAN ^e	36.0	58.5	81.8	24.5	32.0	41.2	9.1	15.1	12.9	69.6	105.6	135.9
Other OECD:												
Canada ^f	50.5	60.6	88.9	18.1	55.7	92.2	2.5	18.2	35.0	71.1	134.5	216.1
Italy ^b	...	1.6	4.1	...	0.3	43.8	...	4.2	2.7	...	6.1	50.6
Belgium ^b	...	6.1	10.7	...	9.0	25.2	...	2.7	5.3	...	17.8	41.2
Netherlands ^b	7.3	10.8	14.1	5.7	10.0	13.5	0.8	2.1	4.0	13.8	22.9	31.6
Sweden ^e	5.8 ^c	8.6 ^c	13.8	3.3	4.8 ^c	7.9	1.4	5.4 ^c	7.9	10.5	18.8	29.6
Spain ^e	2.0 ^c	4.5 ^c	8.5	...	9.4 ^c	12.5	0.6 ^c	1.4 ^c	1.8	2.6	15.3	22.8
Norway ^f	4.1	5.5	7.5	1.4	5.4	6.8	0.3	1.0	1.6	5.8	11.9	15.9

a. Countries are ranked within categories according to the size of their Government's expenditures on Economic Development R&D in the last year for which data are available.

b. For 1971, read 1972.

c. Rough estimate

d. For 1965, read 1967.

e. For 1971, read 1969.

f. For 1971, read 1970.

Source: OECD, Changing Priorities for Government R&D, pp. 266-67 (for Belgium, 268-69), 286-87, and 304-305.

Table F-15

ESTIMATED GOVERNMENT FUNDING FOR GROUP II,
ECONOMIC DEVELOPMENT, AS A PERCENTAGE
OF TOTAL GOVERNMENT EXPENDITURES ON R&D

Country ^a	Agriculture			Mining and Manufacturing			Economic Services			Total Group II		
	1961	1965	1971	1961	1965	1971	1961	1965	1971	1961	1965	1971
Major OECD Members:												
JAPAN ^b	15.6	15.4	14.0	10.6	8.4	7.0	3.9	3.2	2.2	30.1	27.0	23.2
UNITED KINGDOM ^c	1.4	1.3	2.1	6.4	7.8	16.0	0.5	1.3	2.5	8.3	10.4	20.6
FRANCE ^c	2.1	2.4	3.5	3.1	5.7	13.3	2.7	2.1	3.3	7.9	10.2	20.1
WEST GERMANY ^d	...	2.4	2.1	...	4.4	10.5	...	0.4	0.8	...	7.2	13.4
UNITED STATES	1.7	1.7	2.0	0.8	1.7	3.7	0.8	1.1	2.3	3.3	4.5	8.0
Other OECD:												
Spain ^b	...	17.2	20.2	...	35.8	29.7	...	4.6	4.3	...	57.6	54.2
Canada ^e	24.5	19.9	20.9	8.8	18.3	21.6	1.2	6.0	8.2	34.5	44.2	50.7
Norway ^e	19.6	15.4	15.9	6.7	15.0	14.4	1.6	2.3	3.4	27.9	32.7	33.7
Belgium ^c	...	8.4	6.2	...	12.3	14.7	...	3.6	3.1	...	24.3	24.0
Italy	...	1.1	1.3	...	0.2	14.4	...	2.0	0.9	...	3.3	16.6
Netherlands ^c	11.1	8.8	7.4	8.8	8.1	7.0	1.2	1.4	2.1	21.1	18.3	16.5
Sweden	5.1	5.0	7.6	2.9	2.8	4.4	1.3	2.9	4.4	9.3	10.7	16.4

a. Countries are ranked within categories according to the size of the share of their government's expenditures on Economic Development R&D in total government R&D expenditures in the last year for which data are available.

b. For 1971, read 1969.

c. For 1971, read 1972.

d. For 1965, read 1967.

e. For 1971, read 1970.

Source: OECD, Changing Priorities for Government R&D, pp. 266-67 (for Belgium, 268-69), 286-87, and 304-305.

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R AND D RESOURCE ALLOCATIONS BY SELECTED FOREIGN COUNTRIES. (U)

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Table F-17
ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP III,
COMMUNITY SERVICES, AS A PERCENTAGE OF
TOTAL GOVERNMENT EXPENDITURES ON R&D

Country ^a	Health		Pollution		Public Welfare		Other Community Services		Total Group III	
	1961	1965	1961	1965	1961	1965	1961	1965	1961	1971
Major OECD Members:										
UNITED STATES	4.8	5.0	8.5	0.2	0.3	0.9	0.4	1.0 ^c	2.4	2.4
JAPAN	0.9	2.2	1.8	...	...	...	0.7 ^c	1.0 ^c	1.7 ^c	1.7 ^c
WEST GERMANY ^d	...	1.8	2.5	...	0.2	0.3	...	0.6 ^e	1.3 ^e	1.3 ^e
FRANCE ^f	0.4	0.8	1.8	...	...	...	0.3 ^c	0.4 ^c	0.7 ^c	0.7 ^c
UNITED KINGDOM ^f	--	0.2 ^g	1.1 ^g	...	...	...	...	...	...	...
Other OECD:										
Belgium ^f	...	13.7 ^h	15.6 ^h	...	0.7	1.1	...	2.6 ^c	4.6 ^c	4.6 ^c
Netherlands ^f	4.8	3.1	4.8	2.5	2.0	2.2	4.0 ^c	3.6 ^c	5.5 ^c	5.5 ^c
Sweden ^b	3.7	4.7	7.6	...	...	1.0 ^k	0.8 ^c	1.2 ^c	2.8 ^c	2.8 ^c
Canada ^j	2.7	7.1	10.4	...	...	0.2	0.1 ^c	0.9 ^c	0.3 ^c	0.3 ^c
Norway ^j	5.0	3.9	4.7	...	...	...	1.9 ^c	1.7 ^c	2.2 ^c	2.2 ^c
Italy ^b	...	1.2	2.3	...	...	...	...	0.3 ^k	0.1 ^k	0.1 ^k
Spain	...	...	...	...	...	...	...	0.2 ^k	0.2 ^k	0.2 ^k

a. Countries are ranked within categories according to the size of the share of their government's expenditures on Community Services R&D in total government R&D expenditures in the last year for which data are available.

b. For 1971, read 1969.

c. Partial data.

d. For 1965, read 1967.

e. Includes both Public Welfare and Other Community Services.

f. For 1971, read 1972.

g. Without the Medical Research Council.

h. Overestimated.

i. Including university hospitals.

j. For 1971, read 1970.

k. Rough estimate.

Source: OECD, *Changing Priorities for Government R&D*, pp. 324-25 (for Belgium 326-27), 342-43, 360-61, and 376-77. Public Welfare data for West Germany derived from *ibid.*, p. 459, and Appendix Table F-1.

Table F-18

ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP IV,
ADVANCEMENT OF SCIENCE, BY OBJECTIVE
(in millions of 1961 US dollars)

Country ^a	Advancement of Research			Advancement of Science via General University Funds			Total Group IV		
	1961	1965	1971	1961	1965	1971	1961	1965	1971
Most OECD Members:									
WEST GERMANY	13.4	25.3	108.2	144.8	281.3	467.0	158.2	306.6	575.2
JAPAN ^b	0.4	3.5	1.1	128.9	234.1	358.8	129.3	237.6	359.9
FRANCE ^c	76.0	132.3	196.4	44.0	116.2	147.3	120.0	248.5	343.7
UNITED STATES	117.5	234.0	333.2	...	...	...	117.6	234.0	333.2
UNITED KINGDOM ^c	68.6	117.9	203.8	58.5	94.4	127.1	127.1	212.3	330.9
Other OECD:									
Italy	...	28.7	56.0	...	40.6	87.1	...	69.3	143.1
Netherlands ^c	2.9	6.2	12.4	29.5	57.0	86.0	32.4	63.2	98.4
Belgium ^c	...	21.1	52.6	...	...	...	...	21.1	52.6
Sweden ^b	1.9	5.9	10.0	14.0	29.0	41.7	15.9	34.9	51.7
Canada ^d	35.6	24.1	43.9	...	...	...	35.6	21.1	43.9
Norway	2.2	2.5	3.7	6.5 ^e	12.3	16.7	8.7 ^e	14.8 ^e	20.4
Spain ^b	...	4.7 ^e	5.3	0.1 ^e	--	0.4	0.1 ^e	4.7 ^e	5.7

a. Countries are ranked within categories according to the size of their government's expenditures on Advancement of Science R&D in the last year for which data are available.

b. For 1971, read 1969.

c. For 1971, read 1972.

d. For 1971, read 1970.

e. Rough estimate.

Source: OECD, Changing Priorities in Government R&D, pp. 394-95 and 406-407.

Table F-19

ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP IV,
ADVANCEMENT OF SCIENCE, AS A PERCENTAGE OF
TOTAL GOVERNMENT EXPENDITURES ON R&D

Country ^a	Advancement of Research				Advancement of Science via General University Funds				Total Group IV			
	1961	1965	1971	1971	1961	1965	1971	1971	1961	1965	1971	1971
Major OECD Members:												
JAPAN ^b	0.2	0.9	0.2	0.2	55.7	61.6	61.2	61.4	55.9	62.5	61.4	61.4
WEST GERMANY	3.2	3.1	7.6	7.6	34.2	34.7	32.9	40.5	37.4	37.8	40.5	40.5
UNITED KINGDOM ^c	6.4	10.3	16.1	16.1	5.5	8.3	10.0	26.1	11.9	18.6	26.1	26.1
FRANCE ^c	12.6	11.1	14.6	14.6	7.3	9.8	10.9	25.5	19.9	20.9	25.5	25.5
UNITED STATES	1.1	1.6	2.9	2.9	...	...	...	2.9	1.1	1.6	2.9	2.9
Other OECD:												
Netherlands ^c	4.4	5.1	6.5	6.5	44.9	46.2	45.1	51.6	49.3	51.3	51.6	51.6
Italy ^d	...	20.1	18.4	18.4	...	28.5	28.6	47.0	...	48.6	47.0	47.0
Norway ^c	10.5	7.0	7.9	7.9	30.8	34.2	35.1	43.0	41.3	41.2	43.0	43.0
Belgium ^c	...	28.8	30.8	30.8	...	...	...	30.8	...	28.8	30.8	30.8
Sweden ^b	1.7	3.5 ^e	5.5	5.5	12.4	17.0 ^e	23.0	28.5	14.1	20.5 ^e	28.5	28.5
Spain ^b	...	18.0 ^e	13.0	13.0	...	0.1	0.9	13.9	...	18.1 ^e	13.9	13.9
Canada	17.3	6.9	10.3	10.3	...	...	...	10.3	17.3	6.9	10.3	10.3

a. Countries are ranked within categories according to the size of the share of their government's expenditures on Advancement of Science R&D in total government R&D expenditures in the last year for which data are available.

b. For 1971, read 1969.

c. For 1971, read 1972.

d. For 1971, read 1970.

e. Rough estimate.

Source: OECD, *Changing Priorities in Government R&D*, pp. 394-95 and 406-407.

Table F-20

ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP V,
OTHER ACTIVITIES, BY OBJECTIVE
(in millions of 1961 US dollars)

Country ^a	Developing Countries			Miscellaneous			Total Group V		
	1961	1965	1971	1961	1965	1971	1961	1965	1971
Major OECD Members:									
WEST GERMANY ^b	...	...	...	...	61.4	64.6	...	61.4	64.6
UNITED STATES	8.3	9.4	22.0	1.3	7.2	5.2	9.6	16.6	27.2
FRANCE ^c	11.3	15.9	22.1	--	2.2	3.7	11.3	18.1	25.8
UNITED KINGDOM ^c	3.6	5.0	6.7	12.6	12.9	13.7	16.2	17.9	20.4
JAPAN ^d	--	--	--	2.8	1.9	5.1	2.8	1.9	5.1
Other OECD:									
Canada ^d	--	--	0.5	8.5	0.3	5.2	8.5	0.3	5.7
Netherlands ^c	0.05	0.32	1.35	0.19	0.35	1.48	0.24	0.67	2.83
Italy	...	0.01	0.01	...	1.1	1.0	...	1.11	1.01
Belgium ^c	...	0.21	0.61	--	--	--	...	0.21	0.61
Sweden ^e	--	--	0.35	--	--	--	--	--	0.35
Norway	--	--	--	--	--	--	--	--	--
Spain	--	--	--	--	--	--	--	--	--

a. Countries are ranked within categories according to the size of their government's expenditures on Other Activities R&D in the last year for which data are available.

b. For 1965, read 1967.

c. For 1971, read 1972.

d. For 1971, read 1969.

e. For 1971, read 1970.

Source: OECD, Changing Priorities for Government R&D, pp. 420-21 and 424-25.

Table F-21

ESTIMATED GOVERNMENT R&D FUNDING FOR GROUP V, OTHER ACTIVITIES,
AS A PERCENTAGE OF TOTAL GOVERNMENT EXPENDITURES ON R&D

Country ^a	Developing Countries			Miscellaneous			Total Group V		
	1961	1965	1971	1961	1965	1971	1961	1965	1971
Major OECD Members:									
WEST GERMANY ^b	...	...	...	...	6.2	4.6	...	6.2	4.6
FRANCE ^c	1.9	1.3	1.6	--	0.2	0.3	1.9	1.5	1.9
UNITED KINGDOM ^c	0.3	0.4	0.5	1.2	1.1	1.1	1.5	1.5	1.6
JAPAN ^d	...	...	...	1.2	0.5	0.9	1.2	0.5	0.9
UNITED STATES	--	0.1	0.2	--	--	--	--	0.1	0.2
Other OECD:									
Netherlands ^c	0.1	0.3	0.7	0.3	0.3	0.8	0.4	0.6	1.5
Canada ^d	...	...	0.1	4.1	0.1	1.3	4.1	0.1	1.4
Belgium ^c	...	0.3	0.4	...	...	...	...	0.3	0.4
Italy	...	--	--	...	0.8	0.3	...	0.8	0.3
Sweden	...	...	...	...	...	...	...	...	...
Norway	...	...	...	...	...	...	...	...	...
Spain	...	...	...	...	...	...	...	...	...

a. Countries are ranked within categories according to the size of the share of their government's expenditures on Other Activities R&D in total government R&D expenditures in the last year for which data are available.

b. For 1965, read 1967.

c. For 1971, read 1972.

d. For 1971, read 1969.

Source: OECD, Changing Priorities for Government R&D, pp. 420-21 and 424-25.

Series G

R&D FINANCIAL ALLOCATIONS BY SELECTED NON-OECD COUNTRIES

Note: The categories listed under "Sector of Performance" and "Sources of Funds" are defined on pages 155-156 and 157-58, respectively.

Table G-1
HISTORICAL TRENDS IN GERD, SELECTED NON-OECD COUNTRIES
(in thousands of local currency units and current US dollars)

Country	Fiscal Year	TOTAL GERD	
		Local Currency	Dollars
Asia:			
South Korea	1965	2,000,660 Won	7,618.7
	1966	3,153,696	11,717.4
	1967	4,845,230	17,683.3
	1968	6,687,491	23,798.9
	1969	9,773,985	32,151.3
India ^a	1958	272,000 Rupee	
	1965	808,000	169,819.3
	1968	1,197,000	158,124.2
	1969	1,357,000	179,300.0
Iran ^{b,c,d,e}	1969	2,404,756 Rial	31,746.0
	1970	2,933,984	38,732.5
Iraq ^f	1966	262 US Dollar	262.0
	1967	912	912.0
	1968	1,361	1,361.0
	1969	1,349	1,349.0
Africa:			
Chad ^{g,h}	1965	176,868 Franc C.F.A.	716.5
	1966	185,800	752.7
	1967	183,900	745.0
	1968	194,575 ⁱ	788.2
	1969	227,060 ⁱ	817.6
Ghana ^{i,j}	1963	1,241 Pound	3,476.2
	1964	1,412	3,954.1
	1965	1,458	4,082.6
Rwanda ^j	1963	21,000 Franc	420.0
	1964	15,900	318.0
	1965	19,500	390.0
	1966	18,500	185.0
	1967	24,400	244.0
Somalia ^j	1963	600 Shilling	84.0
	1964	600	84.0
	1965	700	98.0
	1966	720	100.8
	1967	770	107.8
Sudan ^j	1963	1,000 Pound	2,872.0
	1964	1,200	3,446.3
	1965	1,400	4,020.7
	1966	1,600	4,595.1
Tunisia ^j	1964	159 Dinar	302.9
	1965	172	327.6
	1966	187	356.2
	1967	205	390.5
Latin America:			
Cuba ^c	1968	69,419 Peso	69,419.0 ^k
	1969	91,735	91,735.0 ^k
Argentina	1963	10,245,000 ^j Peso	77,320.8
	1964	11,848,000 ^j	78,515.6
	1965	27,302,000 ^j	144,838.2
	1968	15,400,000 ^{l,m}	44,000.0

Notes for Table G-1:

- a. Not including data for social sciences. It should be noted that a devaluation of the Indian rupee from 4.758 to 7.541 per US dollar took place on June 6, 1966, causing the drop in Indian R&D expenditures for 1968, when these are converted to US dollars.
- b. Not including data for Productive sector.
- c. Also including data for law, humanities, education, and arts.
- d. Not including activities of a military nature or relating to national defense.
- e. Data refer to government funds and special funds only.
- f. Data refer to the Council of Scientific Research only.
- g. Partial data; data given are for the Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux and the Institut de Recherche du Coton et des Textiles Exotiques.
- h. Data relate to General Service sector only.
- i. Not including expenditure for R&D by the University of Ghana. Note that on July 19, 1965, the cedi replaced the Ghana pound at a rate of 2.40 cedis per pound.
- j. Current expenses only (capital expenses not available).
- k. Official rate of exchange.
- l. Also including data for humanities and architecture.
- m. Not including private enterprises. Also, the Argentine peso was radically devalued in March 1967, which accounts for a portion of the decrease in US dollars.

Source: UNESCO Statistical Yearbook 1971, pp. 641-47.

Table G-2

GERD AS A PERCENTAGE OF GNP AT MARKET PRICES,
SELECTED NON-OECD COUNTRIES
(in millions of current US dollars)

Country	Year	GERD ^a	GNP ^a	GERD as % of GNP
Soviet Bloc:				
USSR ^{a,b}	1969	23,848.0	466,000	5.11
Poland	1969	1,000.0	40,500	2.47
Czechoslovakia	1969	1,405.3	28,300	4.97
Asia:				
South Korea	1969	32.2	7,053	0.46
Philippines	1965/66	10.4 ^c	7,570	0.14
India	1969	179.3	42,000	0.43
Pakistan	1968/69	10.9	15,290	0.07
Iran	1970	38.7 ^d	10,900	0.36
Israel	1970	69.7 ^d	5,400	1.29
Iraq	1969	1.4	2,300	0.06
Africa:				
Ghana	1965	4.1 ^d	2,000 ^e	0.21
Kenya	1966	0.8 ^d	975	0.08
Nigeria	1966	21.5	4,060	0.53
Latin America:				
Mexico	1970	41.5 ^d	29,550 ^e	0.14
Argentina	1968	44.0	14,375	0.31
Bolivia	1967	0.7	642	0.11

a. Also including data for law, humanities, education and arts.

b. "Expenditure on science," from the national budget and other sources.

c. Current expenses only.

d. Current expenses only.

e. Estimated.

Source: GNP--for Soviet bloc and India, The Military Balance 1970-71, pp. 10-16 and 62; for Iran and Israel, The Military Balance 1971-72, pp. 28 and 29; all others, UN Statistical Yearbook 1970, pp. 603-605.
GERD--UNESCO Statistical Yearbook 1971, pp. 611 and 641-47.

Table G-3

GERD BY SOURCE OF FUNDS, SELECTED NON-OECD COUNTRIES
(in millions of current US dollars and as percentage of total)

Country	Fiscal Year	Total	SOURCE OF FUNDS			
			Government	Special Funds	Productive Enterprise	Foreign Funds
Soviet Bloc:						
Poland	1969	1,000.0	520.76	508.18	571.07	--
Percent		100.0	52.1	50.8	57.1	--
Czechoslovakia ^a	1970	1,405.5	648.0	--	757.3	--
Percent		100.0	46.1	--	53.9	--
Asia:						
South Korea	1969	7.5	25.5	--	3.3	2.8
Percent		100.0	75.2	--	10.1	8.6
Philippines ^b	1965/66	10.4	5.4	--	1.7	0.8
Percent		100.0	51.9	--	16.6	2.5
India ^c	1969	173.5	164.2	--	15.1	25.7
Percent		100.0	91.6	--	8.4	--
Iran ^{d,e}	1970	48.7	38.1	0.7	--	--
Percent		100.0	98.5	1.7	--	--
Israel	1970	59.1	59.1	--	6.3	24.3
Percent		100.0	56.2	--	9.0	34.8
Iraq ^f	1969	1.5	0.6	0.9	--	0.1
Percent		100.0	37.5	58.6	--	3.9
Africa:						
Chad ^{g,h}	1969	0.7	0.5	--	--	0.3
Percent		100.0 ^k	49.8	--	--	49.8
Nigeria ^{h,j}	1966	16.2	12.6	--	--	3.6
Percent		100.0	78.0	--	--	22.0
Zambia	1969	32.8	20.0	5.8	4.5	10.0
Percent		100.0	61.0	17.8	18.3	2.9
Latin America:						
Mexico	1970	41.6	39.5 ^l	--	1.7	0.6
Percent		100.0	94.5	--	4.1	1.4

a. Also including data for law, humanities, education, and arts.

b. Not including 110,000 pesos for which breakdown is not available.

c. Not including data for social sciences.

d. Not including activities of a military nature or relating to national defense.

e. Data refer to government funds and special funds for Higher Education and General Service sectors only.

f. Data refer to the Council of Scientific Research only.

g. Partial data; data given are for the Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux and the Institut de Recherche du Coton et des Textiles Exotiques.

h. Data relate to General Service sector only.

i. Amount negligible (\$2880).

j. Not including Productive Enterprise funds.

k. The figure shown here for total expenditures, from p. 626, UNESCO Statistical Yearbook 1971, does not agree with that shown for total expenditures by sector of performance in the same source, on p. 618. We are unable to account for the discrepancy, but have in each case used the figures as shown in the respective sources.

l. Funds from institutions of higher education are included with government funds.

Source: UNESCO Statistical Yearbook 1971, pp. 626-54.

Table G-4

GERD BY SECTOR OF PERFORMANCE, SELECTED NON-OECD COUNTRIES
(in millions of current US dollars)

Country	Fiscal Year	Total All Sectors	SECTOR OF PERFORMANCE			
			Productive Sector		Higher Education	General Service
			Integrated R&D	Non-integrated R&D		
Soviet Bloc:						
Poland ^a	1969	1,000.0	371.0	415.1	19.5	94.3
Percent		100.0	37.1	41.5	12.0	9.4
Czechoslovakia ^a	1970	1,405.3	562.2	589.4	39.4	214.3
Percent		100.0	40.4	41.9	2.8	15.3
Asia:						
South Korea	1969	32.2	3.3	8.1	1.1	19.7
Percent		100.0	10.2	25.2	3.4	61.2
Philippines	1965/66	10.4		1.5	2.5	6.4
Percent		100.0		14.0	24.0	62.0
India ^b	1969	179.3		15.1	2.8	161.4
Percent		100.0		8.4	1.6	90.1
Israel ^{b,c}	1970	69.7	11.1	--	45.7	12.9
Percent		100.0	16.0	--	65.6	18.4
Iran ^{a,d}	1970	38.7 ^{e,f}	...	...	3.8	34.9
Percent		100.0			9.8	90.2
Africa:						
Chad ^{g,h}	1969	0.8		0.1	...	0.7
Percent		100.0 ⁱ		12.5	...	87.5
Nigeria	1966	21.5 ⁱ	...	...	2.0	19.5
Percent		100.0	...	...	9.3	90.7
Zambia	1969	32.8		14.0	9.7	9.1
Percent		100.0		42.7	29.5	27.8
Latin America:						
Mexico	1970	41.6		2.3	13.2	26.1
Percent		100.0		5.5	31.7	62.8

- a. Also including data for law, humanities, education, and arts.
b. Not including data for social sciences.
c. Data refer to civilian sector only.
d. Not including activities of a military nature or relating to national defense.
e. Not including data for Productive sector.
f. Data relate to government funds and special funds only.
g. Partial data; data given are for the Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux and the Institut de Recherche du Coton et des Textiles Exotiques.
h. Not including data for Higher Education sector.
i. For General Service sector only. Also, the figure shown here for "Total All Sectors," from UNESCO Statistical Yearbook 1971, p. 618, does not agree with that shown for total expenditures by source of funds in the same source, on p. 626. We are unable to account for the discrepancy, but have in each case used the figures as shown in the respective sources.

Source: UNESCO Statistical Yearbook 1971, pp. 618-25.

Table G-5
GOVERNMENT AND PRODUCTIVE ENTERPRISE FUNDS EXPENDED FOR R&D
AS A PERCENTAGE OF GROSS NATIONAL PRODUCT,
SELECTED NON-OECD COUNTRIES

Country	Fiscal Year	Government Funds	Productive Enterprise Funds
Soviet Bloc:			
Poland	1969	0.79	0.92
Czechoslovakia	1970	2.29	2.68
Asia:			
South Korea	1969	0.33	0.05
Philippines	1965/66	0.07	0.02
India	1969	0.39	0.04
Iran	1970	0.35	...
Israel	1970	0.72	0.16
Iraq	1969	0.03	...
Africa:			
Chad	1969	0.13 ^a	...
Nigeria	1966	0.31	...
Zambia	1969	1.46	0.31
Latin America:			
Mexico	1970	0.13	0.01

a. GNP estimated from UN Statistical Yearbook 1970, p. 597.

Source: Table G-3 for Government and Productive Enterprise Funds, Table G-2 for GNP.

Table G-6

GOVERNMENT AND PRODUCTIVE ENTERPRISE FUNDS EXPENDED FOR R&D,
AS A PERCENTAGE OF GERD, SELECTED NON-OECD COUNTRIES

Country	Fiscal Year	Government Funds	Productive Enterprise Funds
Soviet Bloc:			
Poland	1969	32.08	37.11
Czechoslovakia	1970	46.11	53.89
Asia:			
South Korea	1969	72.98	10.25
Philippines	1965/66	51.92	16.35
India	1969	91.58	8.42
Iran	1970	98.45	...
Israel	1970	56.10	9.04
Iraq	1969	40.00	...
Africa:			
Chad	1969	42.86	...
Nigeria	1966	77.78	...
Zambia	1969	60.98	13.11
Latin America:			
Mexico	1970	94.47	4.09

NOTE: The percentages on this table were computed on a slightly different basis from those accomplished by UNESCO and referenced in Figure 38 and Table G-3. In a few instances this resulted in minor variations from the UNESCO percentage figures.

Source: Table G-3.

Table G-7
CURRENT EXPENDITURES FOR R&D BY TYPE OF R&D ACTIVITY,
SELECTED NON-OECD COUNTRIES
(in millions of current US dollars and percentage of total)

Country	Year	Total	Fundamental Research	Applied Research	Experimental Development
Soviet Bloc:					
Poland ^{a, b}	1969	754.7	226.4		528.3
Percent		100.0	30.0		70.0
Czechoslovakia ^b	1970	1214.6	217.1	524.6	472.9
Percent		100.0	17.9	43.2	38.9
Asia:					
South Korea ^c	1969	32.2	6.4	10.4	15.4
Percent		100.0	19.9	32.2	47.9
Philippines	1965/66	10.4	2.8	7.6	
Percent		100.0	27.1	72.9	
Pakistan ^d	1968/69	6.4	-	-	6.4
Percent		100.0	-	-	100.0
Iraq ^{c, e}	1969	1.5	-	1.5	-
Percent		100.0	-	100.0	-
Africa:					
Chad ^{f, g, h}	1969	0.8	-	0.7	-
Percent		100.0		82.7	
Zambia	1969	22.0	3.9	7.8	10.3
Percent		100.0	17.8	35.3	46.9
Latin America:					
Argentina	1968	33.1	10.0	16.1	7.0
Percent		100.0	30.0	48.7	21.3

- a. Source for exchange rate: The Military Balance 1971-72, p. 9.
b. Also including data for law, education, humanities, and arts.
c. Data refer to total expenditure distributed by type of R&D activity.
d. Data refer to the Pakistan Atomic Energy Commission and the Pakistan Council of Scientific and Industrial Research only.
e. Data relate to the Council of Scientific Research only.
f. Partial data; data given are for the Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux and the Institut de Recherche du Coton et des Textiles Exotiques.
g. Not including data for Higher Education sector.
h. Not including data for social sciences.

Source: UNESCO Statistical Yearbook 1971, pp. 615-17.

Series H

R&D MANPOWER ALLOCATIONS BY SELECTED COUNTRIES WORLDWIDE

Note: The categories listed under "Sector of Performance" are defined on pages 155-56.

Table H-1

HISTORICAL TREND OF TOTAL PERSONNEL ENGAGED IN R&D, SELECTED YEARS

Country	Year	Total	Scientists and Engineers	
			Number	Percent of Total
Major Non-European OECD:				
UNITED STATES ^a	1963	...	480,500	...
	1966/67	725,391 ^b	507,486	70.0
	1969/70	785,600	535,500	68.2
Canada ^{a,c}	1963	31,700	11,500	36.3
	1965	40,700	15,100	37.1
	1967	51,800	19,350	37.4
	1969	53,258	21,052	39.5
JAPAN ^d	1966	427,435	214,600	50.2
	1967	440,339	230,400	52.3
	1968	477,881	258,000	54.0
	1969	487,707	259,150	53.1
	1970	527,374	286,439	54.3
Major EEC Members of OECD:				
FRANCE ^a	1965	169,080	43,260	25.6
	1966	189,120	48,270	25.5
	1967	201,420	52,530	26.1
	1968	206,380	55,650 ^d	27.0
	1969	204,440 ^d	59,020 ^d	28.9
GERMANY ^a	1964	132,060 ^b	51,785	39.2
	1967	208,944 ^d	63,110	30.2
	1969	248,819 ^d	76,332 ^d	30.7
Netherlands ^a	1959	30,100 ^c	...	...
	1964	43,140 ^c	11,540 ^c	26.8
	1967	50,200 ^c	15,700 ^c	31.3
	1969	57,583 ^d	19,660 ^d	34.1
Belgium ^a	1965	27,393	9,171	33.5
	1967	20,957	9,010 ^d	43.0
	1969	25,165 ^d	10,070 ^d	40.0
Italy ^a	1963	42,329 ^c	18,742 ^c	44.3
	1965	46,182 ^c	19,994 ^c	43.3
	1967	49,939 ^c	19,670 ^c	39.4
	1969	59,082 ^d	25,214 ^d	42.7
UNITED KINGDOM ^{c,e,f,g}	1964/65	151,213 ^b	53,865 ^h	35.6
	1968	150,014 ^b	43,588 ^h	29.1
Other European OECD:				
Spain ^{a,i}	1963	9,889	2,175	22.0
	1964	10,859	2,355	21.7
	1965	11,921	2,774	23.3
	1966	12,628	3,132	24.8
	1967	12,988	3,486	26.8
Switzerland ^{c,j,k}	1966	11,440	10,096	88.3
	1967	12,446	10,939	87.9
	1968	13,724	12,052	87.8
	1969	14,403	12,543	87.1

Country	Year	Total	Scientists and Engineers	
			Number	Percent of Total
Soviet Bloc:				
USSR ^{a,d}	1966	2,138,000 ¹	827,513	38.7
	1967	...	894,266	...
	1968	...	955,670	...
	1969	...	1,026,805	...
	1970	...	1,079,353	...
Poland ^{a,d}	1965	118,410	37,430	31.6
	1966	132,300	41,080	31.1
	1967	145,903	44,978	30.8
	1968	163,000	48,000	29.4
	1969	184,500	54,500	29.5
Czechoslovakia ^{a,d}	1967	130,874	40,734	31.1
	1968	137,397	34,425	25.1
	1969	144,102	35,889	24.9
	1970	137,667 ^m	36,927 ^m	26.8
Asia:				
India ^c	1958/59	18,043 ^{a,b}	...	...
	1970	62,349	...	...
Pakistan	1965	719	206	28.7
	1966	969	274	28.3
	1967	1,000	359	35.9
	1968	1,023	414	40.5
	1969	3,015	1,054	35.0
South Korea ^f	1965	5,256	2,765	52.6
	1966	5,873	2,962	50.4
	1967	6,698	4,061	60.6
	1968	11,081	5,024	45.3
	1969	12,145	5,337	43.9
Iraq ^{a,n,o}	1966	101	33	32.7
	1967	172	70	40.7
	1968	176	72	40.9
	1969	169	84	49.7
Israel ^{c,p}	1967	...	1,840	...
	1970	...	2,800	...
	1971	...	2,960	...
Africa:				
Chad ^{a,q}	1965	154 ^a	19 ^q	12.3
	1966	156 ^q	19 ^q	12.2
	1967	267 ^r	21 ^r	7.9
	1968	265 ^r	20 ^r	7.5
	1969	269 ^r	19 ^r	7.1
Gabon	1969	84	6 ^s	7.1
	1970	86	8 ^s	9.3
Latin America:				
Mexico	1965	3,184	1,355	42.6
	1966	3,711	1,548	41.7
	1967	5,569	2,483	44.6
	1968	6,069 ^b	2,696	44.4
	1970	4,222 ^b	3,665	86.8
Guatemala ^{a,t,u}	1967	46	18	39.1
	1968	46	19	41.3
	1969	46	20	43.5
	1970	50	25	50.0
	1971	53	28	52.8
Chile	1967	4,515 ^{c,f}	2,214 ^{c,f}	49.0
	1969	8,703 ^{a,v}	4,904 ^{a,v}	56.3

Notes for Table H-1:

- a. Data are in full-time equivalents.
- b. Data do not include auxiliary personnel.
- c. Not including data for social sciences.
- d. Also including data for law, humanities, education, and arts.
- e. Not including data for Higher Education sector.
- f. Data relate to full-time personnel only.
- g. Not including Northern Ireland; not including data for medical sciences.
- h. Not including persons with university degrees or equivalent qualifications actually performing as technicians (12,983 in 1968).
- i. Also including data for humanities.
- j. Data for technicians and auxiliary personnel are for Higher Education sector only.
- k. Not including data for private nonprofit organizations.
- l. Source: Organisation for Economic Cooperation and Development, Science Policy in the USSR (Paris, 1969), p. 534. In this source the OECD makes both a cautious estimate and a generous estimate of total Soviet manpower engaged in R&D, for the following years:

	<u>1 Dec 1957</u>	<u>1 Dec 1962</u>	<u>15 Nov 1965</u>	<u>15 Nov 1966</u>
Cautious estimate:	683,000	1,413,000	1,718,000	1,811,000
Generous estimate:	924,000	1,923,000	2,336,000	2,465,000
Mean:	803,500	1,668,000	2,027,000	2,138,000

For illustrative purposes only, we have used a figure halfway between the two estimates for the year 1966 in this table and for the years shown in Figure .

- m. Of military R&D, only that part carried out in civil establishments is included.
- n. Data refer to the Council of Scientific Research only.
- o. Not including scientists and engineers engaged in the administration of R&D (32 in 1969).
- p. Data refer to civilian sector only.
- q. Partial data; data given are for the Institut d'Élevage at de Médecine Vétérinaire des Pays Tropicaux.
- r. Partial data; data given are for the Institut d'Élevage at de Médecine Vétérinaire des Pays Tropicaux and the Institut de Recherche du Coton et des Textiles Exotiques.
- s. All foreigners.
- t. Data relate to Higher Education sector only.
- u. Data are for the University of San Carlos and relate to permanent personnel only.
- v. Also including data for law, humanities, and arts.

Source: UNESCO Statistical Yearbook 1971, pp. 635-40.

Table H-2
TOTAL PERSONNEL ENGAGED IN RED BY SECTOR OF PERFORMANCE

Country and Year	All Sectors	Productive Sector		Higher Education Sector		General Service Sector	
		Number	Percent	Number	Percent	Number	Percent
Major Non-European OECD:							
UNITED STATES - 1969/70	7,770 ^{a,b,y}	540,400 ^d	74.0 ^d	104,500	13.8	92,800 ^{c,e}	12.2
Canada ^f - 1969	53,258 ^b	19,189	36.0	8,044	15.1	10,655	20.0
JAPAN ^g - 1970	27,374	251,531	47.7	10,550	2.0	50,437	9.6
Major EEC Members of OECD:							
FRANCE ^g - 1969	204,440 ^b	105,290	51.5	13,771	6.7	46,785	22.9
GERMANY ^g - 1969	248,819 ^b	167,215	67.2	7,576	3.0	37,475	15.1
Netherlands ^g - 1969	57,583 ^b	32,828	57.0	776	1.3	13,866	24.1
Belgium ^g - 1969	25,165 ^b	13,308	52.9 ^d	2,362	9.4	2,329	9.5
Italy ^g - 1969	59,082 ^b	34,854 ^d	59.0 ^d	...	...	11,695	19.8
UNITED KINGDOM ^{f,h,i,j} - 1968	150,014 ^{a,k}	119,084 ^d	...	...	...	30,930	...
Other European OECD:							
Spain ^l - 1967	12,388 ^b	2,362 ^d	27.8 ^d	5,110	39.4	4,561	35.1
Switzerland ^{l,m} - 1969	12,542 ^b	7,966 ^d	63.5	...	...	838	6.7
Soviet Bloc:							
Poland ^g - 1969	184,500 ^b	11,200	27.8	105,300	57.1	17,400	9.4
Czechoslovakia ^{g,o} - 1970	137,667 ^b	58,975	42.8	53,613	39.0	20,796	15.1
Asia:							
India ^f - 1968/69	52,349 ^{a,b}	3,281 ^d	5.3 ^d	...	...	51,290	82.2
Pakistan - 1969	3,015 ^b	...	...	...	...	3,015	...
South Korea ^g - 1969	12,141 ^b	2,564	21.1	1,229	10.1	5,291	43.6
Iran ^g - 1969	70 ^b	...	...	...	...	201	...
Iran ^g - 1970	4,127 ^b	...	...	...	...	2,762	...
Israel ^g - 1971	2,960 ^c	560 ^d	18.9 ^d	...	...	900	30.4
Africa:							
Chad ^{b,s} - 1969	269	68 ^d	25.3 ^d	...	...	201	74.7
Sudan - 1965/66	273 ^b	62 ^d	22.7 ^d	46	16.8	165	60.5
Zambia - 1969	11,197 ^{b,t}	7,005 ^d	62.6 ^d	943	8.4	3,249	29.0
Latin America:							
Argentina ^{u,v} - 1969	14,140 ^{w,x}	4,471 ^d	31.6 ^d	781	5.5	3,342	23.7
Chile ^y - 1969	8,703 ^b	291 ^d	3.4	...	...	1,674	19.2

4. Data do not include auxiliary personnel.
b. Data are in full-time equivalents.
c. Not including data for technicians in the General Service sector.
d. Data refer to both integrated and non-integrated RED in the Productive sector.
e. Data include all private nonprofit organizations.
f. Not including data for social sciences.
g. Also including data for law, humanities, education, and arts.
h. Not including data for Higher Education sector.
i. Not including data for medical sciences.
j. Not including Northern Ireland.
k. Data relate to full-time personnel only.
l. Also including private nonprofit organizations.
m. Not including private nonprofit organizations.
n. Data refer to scientists and engineers.
o. Of military RED, only that part carried out in civil establishments is included.
p. Data refer to the Council of Scientific Research only.
q. Not including data for Productive sector.
r. Data refer to civilian sector only.
s. Partial data: data given are for the Institut de l'Élevage et de Médecine Vétérinaire des Pays Tropicaux et the Institut de Recherche du Coton et des Textiles Exotiques.
t. Not including 48 scientists and engineers engaged in administration for which breakdown is not available.
u. Not including data for private enterprises.
v. Also including data for humanities and architecture.
w. Data refer to net man-years.
x. Not including 392 persons for which breakdown by sector is not available.
y. Also including data for law, humanities, and arts.

Source: UNESCO Statistical Yearbook 1971, pp. 599-602.

Table H-3

SCIENTISTS AND ENGINEERS ENGAGED IN R&D AS A PERCENTAGE OF
NATIONAL TOTALS FOR SELECTED COUNTRIES

Country and Year	Total Population ^a (millions)	Total Scientists and Engineers	Scientists and Engineers Engaged in R&D		
			Number	Per 1,000 Population	As percent of Total Scientists and Engineers
Major Non-European OECD:					
UNITED STATES - 1969	203,213	1,694,300	535,600	26.35	0.32
Canada - 1969	21,089	...	21,089	9.98	...
JAPAN ^b - 1970	102,521	...	286,439	27.99	...
Major EEC Members of OECD:					
FRANCE ^b - 1969	50,320	992,000 ^d	59,020 ^e	11.73	0.06
GERMANY - 1969	58,707	...	76,332	13.00	...
Netherlands ^{b,e} - 1969	17,873	...	19,660 ^{b,e}	15.27	...
Belgium - 1969	9,646	69,965 ^f	10,070 ^{b,e}	10.44	0.14
Italy ^b - 1969	5,170	...	25,214 ^g	4.74	...
UNITED KINGDOM ^{g,h} - 1969	5,744	211,231 ⁱ	43,588 ^{j,k}	7.85	0.20
Other European OECD:					
Spain ^l - 1967	2,944	188,000	3,486 ^e	1.06	0.02
Switzerland ^{l,m} - 1969	2,204	...	12,543	20.15	...
Soviet Bloc:					
USSR ^b - 1970	240,767	7,612,000 ⁿ	1,074,100 ^e	44.67	0.14
Poland - 1969	21,200	67,000 ⁿ	44,500 ^e	16.74	0.10
Czechoslovakia ^b - 1969	15,318	77,148 ⁿ	36,377 ^{e,o}	20.61	0.13
Asia:					
India - 1970	5,980	984,800	6,440 ^e	1.16	0.07
Pakistan - 1969	111,840	27,207 ^{p,q}	1,024 ^r	0.94	0.04
South Korea - 1969	31,149	141,477 ^{b,s}	6,337 ^t	1.71	0.04
Philippines - 1969	27,148	81,600 ^v	6,000 ^{e,u}	1.51	0.07
Indonesia - 1969	4,390	...	116	0.12	...
Thailand - 1970	5,800	76,000 ^v	3,960 ^{j,w}	10.43	0.08
Africa:					
Egypt - 1968	2,901	...	4,100 ^x	1.01	...
Tunisia - 1969	2,600	5,137	167	0.19	0.02
Nigeria - 1969	4,960	2,354	1,773 ^j	0.27	0.44
Yuban - 1969	1,186	1,668	100	0.07	0.06
Latin America:					
Mexico - 1970	48,372	...	3,660 ^y	0.75	...
Argentina - 1969	27,383	240,000 ^{b,y}	4,400 ^z	1.86	0.02
Bolivia - 1967	4,804	10,925	400 ^e	0.83	0.04
Uruguay - 1969	2,802	13,970	...	...	...

- a. Mid-year estimates.
- b. Also including data for law, humanities, education, and arts.
- c. Of total, 68,100 are part-time. Also, OECD 1969 survey shows total of only 172,000.
- d. For 1968.
- e. Data are in full-time equivalents.
- f. For 1966/67.
- g. Not including data for social sciences.
- h. Not including data for medical sciences; not including Northern Ireland.
- i. For 1965.
- j. Data relate to full-time personnel only.
- k. Not including data for Higher Education sector.
- l. Also including data for humanities.
- m. Not including data for private nonprofit organization.
- n. Also including data for humanities, education, and arts.
- o. Of military R&D, only that part carried out in civil establishments is included.
- p. Not including data for Productive sector.
- q. For 1966.
- r. Data refer to the Pakistan Atomic Energy Commission and the Pakistan Council of Scientific and Industrial Research only.
- s. Data refer to college graduates 1964-69.
- t. Data refer to the Council of Scientific Research only.
- u. Data refer to civilian sector only.
- v. Data refer to number economically active.
- w. For 1971.
- x. Not including data for the former Eastern Region.
- y. Estimates based on 1960 census.
- z. Not including data for private enterprises; data refer to net man-years; also including data for humanities and architecture.

Source: UNESCO Statistical Yearbook 1971, pp. 584-90.

SCIENTISTS AND ENGINEERS ENGAGED IN R&D BY SECTOR OF PERFORMANCE,
SELECTED NON-OECD COUNTRIES

Country and Year	Productive Sector			Higher Education	General Service
	All Sectors	Integrated R&D	Non-Integrated R&D		
Major Non-European ECEDs:					
UNITED STATES ^a - 1961/72	33,000	18,000	...	62,100	92,800 ^c
Canada ^a - 1969	21,000 ^b	7,000	7,401	7,740	3,400
JAPAN ^c - 1970	285,411	27,000	6,098	185,844	23,547
Major EEC Members of ECED:					
FRANCE ^d - 1969	11,000	1,100	1,710	10,160	10,370
GERMANY ^e - 1969	76,000 ^b	4,000	7,816	14,621	11,854
Netherlands ^f - 1969	11,000 ^b	1,200	...	3,478	5,118
Belgium ^g - 1969	10,000	1,747	648	4,607	1,068
Italy ^h - 1969	21,718	10,200	...	9,728	5,250
UNITED KINGDOM ⁱ - 1969	41,000	34,700	...	...	8,855
Other European ECED:					
Spain ^{j,k} - 1969	1,000	104	1,110	249	1,214
Switzerland ^l - 1969	15,400	5,000	...	1,739	838
Other ECED:					
Sweden ^m - 1969	32,000 ^b	2,000	10,000	7,000	7,000
Finland ⁿ - 1969	9,000	1,000	10,000	1,100	9,000
Other:					
USSR ^o - 1969	1,000	...	...	...	1,000
USSR ^o - 1970	1,000	...	...	...	1,000
USSR ^o - 1971	1,000	...	...	...	1,000
USSR ^o - 1972	1,000	...	...	...	1,000
USSR ^o - 1973	1,000	...	...	...	1,000
USSR ^o - 1974	1,000	...	...	...	1,000
USSR ^o - 1975	1,000	...	...	...	1,000
USSR ^o - 1976	1,000	...	...	...	1,000
USSR ^o - 1977	1,000	...	...	...	1,000
USSR ^o - 1978	1,000	...	...	...	1,000
USSR ^o - 1979	1,000	...	...	...	1,000
USSR ^o - 1980	1,000	...	...	...	1,000
USSR ^o - 1981	1,000	...	...	...	1,000
USSR ^o - 1982	1,000	...	...	...	1,000
USSR ^o - 1983	1,000	...	...	...	1,000
USSR ^o - 1984	1,000	...	...	...	1,000
USSR ^o - 1985	1,000	...	...	...	1,000
USSR ^o - 1986	1,000	...	...	...	1,000
USSR ^o - 1987	1,000	...	...	...	1,000
USSR ^o - 1988	1,000	...	...	...	1,000
USSR ^o - 1989	1,000	...	...	...	1,000
USSR ^o - 1990	1,000	...	...	...	1,000
USSR ^o - 1991	1,000	...	...	...	1,000
USSR ^o - 1992	1,000	...	...	...	1,000
USSR ^o - 1993	1,000	...	...	...	1,000
USSR ^o - 1994	1,000	...	...	...	1,000
USSR ^o - 1995	1,000	...	...	...	1,000
USSR ^o - 1996	1,000	...	...	...	1,000
USSR ^o - 1997	1,000	...	...	...	1,000
USSR ^o - 1998	1,000	...	...	...	1,000
USSR ^o - 1999	1,000	...	...	...	1,000
USSR ^o - 2000	1,000	...	...	...	1,000
USSR ^o - 2001	1,000	...	...	...	1,000
USSR ^o - 2002	1,000	...	...	...	1,000
USSR ^o - 2003	1,000	...	...	...	1,000
USSR ^o - 2004	1,000	...	...	...	1,000
USSR ^o - 2005	1,000	...	...	...	1,000
USSR ^o - 2006	1,000	...	...	...	1,000
USSR ^o - 2007	1,000	...	...	...	1,000
USSR ^o - 2008	1,000	...	...	...	1,000
USSR ^o - 2009	1,000	...	...	...	1,000
USSR ^o - 2010	1,000	...	...	...	1,000
USSR ^o - 2011	1,000	...	...	...	1,000
USSR ^o - 2012	1,000	...	...	...	1,000
USSR ^o - 2013	1,000	...	...	...	1,000
USSR ^o - 2014	1,000	...	...	...	1,000
USSR ^o - 2015	1,000	...	...	...	1,000
USSR ^o - 2016	1,000	...	...	...	1,000
USSR ^o - 2017	1,000	...	...	...	1,000
USSR ^o - 2018	1,000	...	...	...	1,000
USSR ^o - 2019	1,000	...	...	...	1,000
USSR ^o - 2020	1,000	...	...	...	1,000
USSR ^o - 2021	1,000	...	...	...	1,000
USSR ^o - 2022	1,000	...	...	...	1,000
USSR ^o - 2023	1,000	...	...	...	1,000
USSR ^o - 2024	1,000	...	...	...	1,000
USSR ^o - 2025	1,000	...	...	...	1,000
USSR ^o - 2026	1,000	...	...	...	1,000
USSR ^o - 2027	1,000	...	...	...	1,000
USSR ^o - 2028	1,000	...	...	...	1,000
USSR ^o - 2029	1,000	...	...	...	1,000
USSR ^o - 2030	1,000	...	...	...	1,000
USSR ^o - 2031	1,000	...	...	...	1,000
USSR ^o - 2032	1,000	...	...	...	1,000
USSR ^o - 2033	1,000	...	...	...	1,000
USSR ^o - 2034	1,000	...	...	...	1,000
USSR ^o - 2035	1,000	...	...	...	1,000
USSR ^o - 2036	1,000	...	...	...	1,000
USSR ^o - 2037	1,000	...	...	...	1,000
USSR ^o - 2038	1,000	...	...	...	1,000
USSR ^o - 2039	1,000	...	...	...	1,000
USSR ^o - 2040	1,000	...	...	...	1,000
USSR ^o - 2041	1,000	...	...	...	1,000
USSR ^o - 2042	1,000	...	...	...	1,000
USSR ^o - 2043	1,000	...	...	...	1,000
USSR ^o - 2044	1,000	...	...	...	1,000
USSR ^o - 2045	1,000	...	...	...	1,000
USSR ^o - 2046	1,000	...	...	...	1,000
USSR ^o - 2047	1,000	...	...	...	1,000
USSR ^o - 2048	1,000	...	...	...	1,000
USSR ^o - 2049	1,000	...	...	...	1,000
USSR ^o - 2050	1,000	...	...	...	1,000
USSR ^o - 2051	1,000	...	...	...	1,000
USSR ^o - 2052	1,000	...	...	...	1,000
USSR ^o - 2053	1,000	...	...	...	1,000
USSR ^o - 2054	1,000	...	...	...	1,000
USSR ^o - 2055	1,000	...	...	...	1,000
USSR ^o - 2056	1,000	...	...	...	1,000
USSR ^o - 2057	1,000	...	...	...	1,000
USSR ^o - 2058	1,000	...	...	...	1,000
USSR ^o - 2059	1,000	...	...	...	1,000
USSR ^o - 2060	1,000	...	...	...	1,000
USSR ^o - 2061	1,000	...	...	...	1,000
USSR ^o - 2062	1,000	...	...	...	1,000
USSR ^o - 2063	1,000	...	...	...	1,000
USSR ^o - 2064	1,000	...	...	...	1,000
USSR ^o - 2065	1,000	...	...	...	1,000
USSR ^o - 2066	1,000	...	...	...	1,000
USSR ^o - 2067	1,000	...	...	...	1,000
USSR ^o - 2068	1,000	...	...	...	1,000
USSR ^o - 2069	1,000	...	...	...	1,000
USSR ^o - 2070	1,000	...	...	...	1,000
USSR ^o - 2071	1,000	...	...	...	1,000
USSR ^o - 2072	1,000	...	...	...	1,000
USSR ^o - 2073	1,000	...	...	...	1,000
USSR ^o - 2074	1,000	...	...	...	1,000
USSR ^o - 2075	1,000	...	...	...	1,000
USSR ^o - 2076	1,000	...	...	...	1,000
USSR ^o - 2077	1,000	...	...	...	1,000
USSR ^o - 2078	1,000	...	...	...	1,000
USSR ^o - 2079	1,000	...	...	...	1,000
USSR ^o - 2080	1,000	...	...	...	1,000
USSR ^o - 2081	1,000	...	...	...	1,000
USSR ^o - 2082	1,000	...	...	...	1,000
USSR ^o - 2083	1,000	...	...	...	1,000
USSR ^o - 2084	1,000	...	...	...	1,000
USSR ^o - 2085	1,000	...	...	...	1,000
USSR ^o - 2086	1,000	...	...	...	1,000
USSR ^o - 2087	1,000	...	...	...	1,000
USSR ^o - 2088	1,000	...	...	...	1,000
USSR ^o - 2089	1,000	...	...	...	1,000
USSR ^o - 2090	1,000	...	...	...	1,000
USSR ^o - 2091	1,000	...	...	...	1,000
USSR ^o - 2092	1,000	...	...	...	1,000
USSR ^o - 2093	1,000	...	...	...	1,000
USSR ^o - 2094	1,000	...	...	...	1,000
USSR ^o - 2095	1,000	...	...	...	1,000
USSR ^o - 2096	1,000	...	...	...	1,000
USSR ^o - 2097	1,000	...	...	...	1,000
USSR ^o - 2098	1,000	...	...	...	1,000
USSR ^o - 2099	1,000	...	...	...	1,000
USSR ^o - 2100	1,000	...	...	...	1,000

engineers, 11 technicians; 8¹ auxiliary personnel

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Table H-5
SCIENTISTS AND ENGINEERS ENGAGED IN R&D BY FIELD OF SCIENCE

Country and Year	FT, PT FTE ^a	Total	Natural Sciences	Engineering and Technology	Medical Sciences	Agriculture	Social Sciences
Major Non-European OECD:							
UNITED STATES - 1969	FTE	62,100	24,900	10,600	15,600	5,600	5,400
Canada - 1967	FTE	19,350 ^b	6,670	6,920	3,760	1,900	...
JAPAN ^c - 1970	FT	218,339	58,405	72,153	27,202	17,132	43,447 ^c
	PT	68,100	...	...	...	...	...
Major EEC Members of OECD:							
FRANCE ^c - 1969	FT	39,550	...	...	...	...	...
	PT	41,350	...	...	...	...	...
	FTE	59,020 ^d	23,380	20,865	8,735	1,620	4,420
Netherlands ^c - 1969	FT	4,570 ^d	...	...	...	...	...
	PT	2,659 ^d	...	...	...	...	...
	FTE	19,660	...	...	...	...	...
Belgium - 1969	FTE	6,323 ^{c,e}	2,019	1,301	735	542	568
Italy ^c - 1969	FT	13,508	...	...	...	...	...
	PT	20,133	...	...	...	...	...
	FTE	25,214	5,373	13,339	2,927	1,084	1,287 ^f
Other European OECD:							
Spain ^g - 1967	FT	3,174 ^h	2,170	834	344	245	249 ^g
	PT	668 ^h	...	...	...	...	...
	FTE	3,486	...	...	...	...	...
Soviet Bloc:							
USSR ^c - 1970	FT	1,079,353	230,469	474,695	59,688	42,149	83,491 ^f
	PT	...	...	...	...	...	...
Poland ^c - 1969	FT	46,600	2,800	30,200	1,900	4,200	1,500 ^c
	PT	28,800	6,800	10,600	6,100	3,000	2,300 ^c
	FTE	74,400	4,500	39,400	3,500	5,000	2,100 ^c
Czechoslovakia - 1967	FT	41,265 ^c	3,953	26,354	1,869	2,725	5,690
	PT	...	...	...	...	...	...
Asia:							
India - 1968/69	FTE	62,349	...	...	...	...	...
Pakistan ⁿ - 1969	FT	467	270	70	10	115	2
South Korea - 1969	FT	5,337 ^j	1,224	1,156	737	1,573	647
Iraq ^k - 1969	FT	116 ^j	52	8	1	15	...
Africa:							
Egypt - 1968	FT	6,422	1,289	949	1,086	1,314	1,884
Ghana - 1966	FT	167	53	14	24	71	5
	PT	...	...	...	...	...	...
Nigeria ^k - 1969	FT	1,723 ^l	558	79	375	510	201
Zambia - 1969	FT	745 ^l	52	348	69	173	55
Latin America:							
Argentina ^m - 1969	FT	5,454 ^{g,n}	2,290	711 ⁿ	1,027	867	402
	PT	5,373	963	464 ⁿ	2,411	290	826
Chile ^o - 1969	FT	4,244	1,538	705	530	489	579
	PT	1,980	417	265	633	129	214
	FTE	4,904	1,677	793	742	532	650

- a. FT: full time; PT: part time; FTE: full-time equivalent.
b. Not including data for social sciences.
c. Also including data for law, humanities, education, and arts.
d. Not including data for Higher Education sector.
e. Not including data for Productive sector.
f. Data refer to social sciences and law.
g. Also including data for humanities.
h. Data refer to the Pakistan Atomic Energy Commission only.
i. Data refer to the Council of Scientific Research only.
j. Including 32 persons engaged in the administration of R&D for which breakdown is not available.
k. Not including data for the former Eastern Region.
l. Including 48 persons engaged in the administration of R&D for which breakdown is not available.
m. Not including data for private enterprises.
n. Also including architecture.
o. Also including data for law, humanities, and arts.

Source: UNESCO Statistical Yearbook 1971, pp. 592-98.

Table H-6

GRADUATES AT THE THIRD LEVEL BY STAGE OF DEGREE OR DIPLOMA AND BY BROAD FIELDS OF STUDY

Country and Year	Stage of Degree/Diploma	Humanities, Education, Fine Arts	Law, Social Sciences	Natural Sciences	Engineering	Medical Science	Agriculture	Not Specified
Major Non-European OECD:								
UNITED STATES - 1968	A	350,131	228,863	83,693	41,248	32,352	11,111	183,279 ^a
	B	121,908	43,790	24,721	18,617	4,350	2,769	16,787
	C	-	-	-	-	-	-	3,789
Canada ^b - 1969	A	39,841	5,211	6,789	3,550	4,229	833	-
	B	4,205	2,737	1,821	1,212	581	257	-
	C	-	-	-	-	-	-	30
JAPAN - 1969	A	42,950	55,326	73	13,001	1,890	1,281	2,186
	B	49,518	99,597	6,838	43,414	9,353	8,478	607
	C	1,912	1,607	1,636	4,426	1,864	850	-
Major EEC Members of OECD:								
FRANCE ^c - 1966	A	-	1,395 ^d	-	-	310	-	-
	B	13,637 ^d	3,881 ^d	8,972	7,337 ^e	5,118	1,080 ^e	-
	C	5,808 ^d	1,708 ^d	6,588	-	111	-	-
GERMANY - 1968	A	-	-	-	13,322 ^f	-	-	-
	B	41,020 ^f	8,737	2,966	5,128 ^f	6,634	615	-
	C	1,329 ^f	1,453	2,109	766 ^f	4,392	428	-
Netherlands ^g - 1969	A	15,790	2,721	-	5,717	-	552	1,136
	B	2,055	255	310	-	-	-	-
	C	1,046	2,100	883	1,247	993	242	-
Belgium - 1965	A	-	-	-	-	-	-	-
	B	1,098	1,767	673	661	998	136	-
	C	568	340	489	16	337	31	114
Italy - 1968	A	1,848	204	-	-	-	-	-
	B	18,979	11,922	5,338	4,402	4,454	665	88
	C	-	-	-	-	-	-	-
UNITED KINGDOM ^h - 1968	A	-	-	-	-	-	-	-
	B	12,710	10,257	12,216	7,230	3,965	736	-
	C	9,242	3,178	4,080	2,804	1,858	364	-
Other European OECD:								
Spain - 1969	A	2,715	2,249	1,787	1,725	3,188	576	-
	B	110	75	165	-	180	10	-
	C	-	-	-	-	-	-	-
Sweden - 1969	A	218 ^f	170	-	-	1,271	43	-
	B	5,480 ^f	5,793	2,153	1,577 ^f	1,096	131	-
	C	176 ^f	171	363	152 ^f	139	32	-
Yugoslavia - 1968	A	8,313	6,232	127	2,492	607	460	-
	B	2,401	4,080	863	2,973	1,754	954	-
	C	117	116	131	89	94	107	-

[illegible]

Country	Stage of Degree/Diploma	Humanities, Education, Fine Arts	Law, Social Sciences	Natural Sciences	Engineering	Medical Science	Agriculture	Not Specified
Africa:								
Egypt - 1968	A B C	6,266 156	9,470	1,713	5,481	2,679	4,520	-
Ghana ^d - 1968	A B C	63 423 68	56 191 4	- 73 6	41 38 1	6 60 3	43 21 3	-
Liberia - 1969	A B C	78 ¹	16 ¹	12	-	3	7	-
Nigeria - 1967	A B C	179 322 69	56 261 5	- 134 22	- 60	- 93 3	2 65 3	-
Sudan - 1968	A B C	533 460 15	12 516 2	- 41 13	- 152 2	48 76	84 56 10	-
Zaire - 1968	A B C	147 273 8	52 146 2	51 51 1	- 48 10	- 23	8	-
Latin America:								
Mexico - 1969	A B C	442 9	2,489 4	452 11	2,593 26	2,662 3	387	-
Brazil - 1969	A B C	12,768 308	18,438 126	4,797	8,542 16	8,452 538	2,045 163	-
Chile ^m - 1969	A B C	1,077 56	46 589	6 78	12 214	251 459	75 100	-
Colombia - 1969	A B C	183 1,007 66	174 845 4	101 235	185 801 161	110 760 69	19 638	79 17
Uruguay - 1965	A B C	14 54	2 156	-	6 32	178 256	18 59	-
Venezuela - 1966	A B C	7 865	1,192 25	45	445	41 727	169	-

Notes for Table H-6:

Note: "Third-level" institutions of education are defined as follows: "degree-granting and non-degree-granting institutions of higher education of all types (such as universities, teacher-training colleges, technical colleges, etc.), both public and private. As far as possible, the figures include part-time teachers and part-time students, but those for correspondence courses are generally excluded." UNESCO Statistical Yearbook 1971, p. 331. Stages of degree/diploma are defined as follows:

Stage A: Diplomas and certificates which can be obtained before completion of studies normally leading to a first (college) degree (generally less than three years). They include, for example, certificates awarded to certain types of technicians, nursing diplomas, land-surveying diplomas, etc.

Stage B: Diplomas and certificates awarded after a normal period of college study (usually four to five years). They include the bachelor's degree, the license, etc.

Stage C: Diplomas and certificates obtained by continuing studies beyond the first degree. They include the post-graduate diploma, the master's degree, the doctorate, etc.

- a. Not including higher teacher training.
- b. Data refer to universities and equivalent degree-granting institutions only.
- c. Data refer only to the principal degrees and diplomas awarded by public universities and the schools of engineers and exclude intermediate degrees and diplomas which constitute the lower cycle of study, as well as those for which the awards are heterogeneous.
- d. Certain of the social sciences are included with humanities.
- e. Engineering degrees and diplomas are classified under Stage B. However, it should be noted that these degrees and diplomas cannot be classified by stage as the courses of study are at very different levels with regard to admission requirements and duration.
- f. Architecture is included with engineering.
- g. The degrees awarded by the universities are shown under Stage C, which refers exclusively to those degrees.
- h. Data refer to degrees and diplomas awarded by the universities only. The source of the figures is Education Statistics for the United Kingdom, published by the government statistical service, and refers to the United Kingdom as a whole.
- i. Not including graduates from evening and correspondence courses of whom there were 7,313 in 1968-69.
- j. Data refer to the principal degrees and diplomas awarded. Not included are the intermediate and undergraduate diplomas and certificates which in 1965 totalled 215,619. The distribution by field of study is as follows: humanities, 40,198; education, 63,916; fine arts, 1,923; social sciences, 30,025; natural sciences, 30,416; engineering, 32,648; medical science, 3,206; agriculture, 8,322; and a further 4,965 unspecified. Pre-university certificates are also excluded.
- k. Including arts and sciences colleges at the intermediate level. Stage B includes certain degrees and diplomas at the lower stage.
- l. Social sciences are included with humanities.
- m. University of Chile only.

Source: UNESCO Statistical Yearbook 1971, pp. 450-59.

Series I

PROJECTIONS OF R&D EXPENDITURES IN
FIVE MAJOR OECD COUNTRIES

Table I-1

**DERIVATION OF GERD PROJECTIONS FROM PROJECTIONS OF
GNP AND OF GERD AS A PERCENTAGE OF GNP**

Country		1969	1970	1971	1972	1973	1974	1975
Gross National Product ^a (in billions of current US dollars)								
UNITED STATES		930.3	977.1	1,055.5	1,155.2	1,288.0 ^b	(1340)	(1400)
FRANCE		139.7	145.7	162.0	195.7	251.5 ^c	(270)	(280)
WEST GERMANY		153.7	187.3	207.6	256.9	342.5 ^d	(360)	(380)
JAPAN		175.0	203.5	239.9	310.4	415.2 ^e	(450)	(490)
UNITED KINGDOM		111.6	122.4	135.5	160.1	(180)	(190)	(200)
GERD as a Percent of GNP								
UNITED STATES	A	2.18	2.80	2.80	2.80	2.80	2.80	2.80
	B	<u>2.81</u>	<u>2.72</u>	<u>2.59</u>	<u>2.52</u>	<u>2.34</u>	2.20	2.10
FRANCE	A	1.90	1.90	1.90	1.90	1.90	1.90	1.90
	B	<u>1.89</u>	<u>1.83</u>	<u>1.72</u>	1.64	1.56	1.48	1.40
WEST GERMANY	A	1.70	1.70	1.70	1.70	1.70	1.70	1.70
	B	<u>1.72</u>	<u>2.03</u>	<u>1.99</u>	2.00	2.00	2.00	2.00
JAPAN	A	1.50	1.50	1.50	1.50	1.50	1.50	1.50
	B	<u>1.69</u>	<u>1.85</u>	<u>1.89</u>	2.00	2.10	2.20	2.30
UNITED KINGDOM	A	2.40	2.40	2.40	2.40	2.40	2.40	2.40
	B	<u>2.57</u>	<u>2.49</u>	<u>2.34</u>	2.20	2.10	2.00	1.90
Gross Expenditures on R&D (in millions of US dollars)								
UNITED STATES	A	26,048	27,358	29,554	32,346	36,064	37,520	39,200
	B	<u>26,179</u>	<u>26,566</u>	<u>27,315</u>	<u>29,150</u>	<u>30,100</u>	29,480	29,400
FRANCE	A	2,654	2,768	3,078	3,718	4,779	5,130	5,320
	B	<u>2,640</u>	<u>2,666</u>	<u>2,786</u>	3,209	3,923	3,996	3,920
WEST GERMANY	A	2,613	3,184	3,529	4,367	5,823	6,120	6,460
	B	<u>2,644</u>	<u>4,308</u>	<u>4,131</u>	5,138	6,850	7,200	7,600
JAPAN	A	2,625	3,053	3,599	4,656	6,228	6,750	7,350
	B	<u>2,958</u>	<u>3,765</u>	<u>4,534</u>	6,208	8,719	9,900	11,270
UNITED KINGDOM	A	2,678	2,938	3,252	3,842	4,320	4,560	4,800
	B	<u>2,868</u>	<u>3,048</u>	<u>3,171</u>	3,522	3,780	3,800	3,800

Note: In section of table showing GNP, amounts in parentheses are projections; see footnote a below for procedure used to derive the projections. In section of table showing GERD as a percentage of GNP, underlined percentages were derived from data in national currencies for GNP and GERD; percentage figures not underlined are rough projections of trends apparent in the underlined data. In section of table showing gross expenditures on R&D, all figures were generated by applying the ratios for the respective countries and series listed under the heading "GERD as a Percent of GNP" to the data listed under the heading "Gross National Product."

Notes for Table I-1:

- a. Original data for Japan in yen have been converted at the following rates: for one US dollar, 360 yen in 1969-70, 338 yen in 1971, 308 yen in 1972, and 280 yen in 1973. It should be stressed that these exchange rates are at best approximate. GNP figures refer to Japanese fiscal years. Original data for France, West Germany, and the United Kingdom in units of account (UA) have been converted at the following rates: for one UA, one US dollar in 1969-71 and 1.085 US dollars in 1972. French and West German projections for 1973 were expressed in terms of francs and marks, respectively, and have been converted at the rate of 4.604 francs and 2.669 marks to one US dollar. GNP has been projected to 1975 according to the following procedure: first, the average annual rate of growth for 1969-1972/73 has been derived from statistics on GNP expressed in national currencies; second, in an effort to compensate to some extent for the effects of the energy crisis, this rate has been arbitrarily cut in half; and, third, this reduced rate has been used to obtain a projection for the years 1973/74-1975. (In the case of the United Kingdom, the unadjusted rate has been used for 1973.) The rates used are listed below.

Country	Time Period	Average Annual Rate	Reduced by 50%
UNITED STATES	1969-73	8.5	4.2
FRANCE	1969-73	12.1	6.0
WEST GERMANY	1969-73	10.9	5.4
JAPAN	1969-73	16.5	8.2
UNITED KINGDOM	1969-72	10.8	5.4

- All projections made according to this procedure are enclosed in parentheses.
- b. US Department of Commerce estimate.
- c. French government preliminary figures.
- d. West German government projection.
- e. Japanese government estimates as of December 1973.

Source: GNP data: United States: US Department of Commerce.
 Japan: GNP data in yen: Office of the Prime Minister, Economic Planning Agency, Annual Report on National Income Statistics (Tokyo, 1973). Information on exchange rates was obtained from Japan-United States Trade Council.
 France, West Germany, and the United Kingdom: GNP data in units of account: Statistical Office of the European Communities, General Statistics: Monthly Statistics, Issue No. 10, 1973.
 France: GNP data in francs: Embassy of France, Washington, D.C.
 West Germany: GNP data in marks: Embassy of the Federal Republic of Germany, Washington, D.C.
 United Kingdom: GNP data in pounds: British Embassy, Washington, D.C.
 GERD as a Percent of GNP: For Series A for all countries: Straight-line projections of figure for last year available in Table A-4. For GNP data used in the preparation of Series B for all countries, see preceding source note. Data on GERD were drawn from the following sources:
 United States: National Science Foundation, National Patterns of R&D Resources, Funds and Manpower in the United States, 1953-1973, NSF 73-303 (Washington, D.C., 1973), Table B-1, pp. 26-27.
 France, West Germany, and the United Kingdom: NSF estimates published in National Science Foundation, National Science Board, Science Indicators, 1972 (Washington, D.C., 1973), Appendix Table 1, p. 102.
 Japan: Office of the Prime Minister, Bureau of Statistics, Report on the Survey of Research and Development in Japan, 1970, Summary Table 2, pp. 44-45 (for 1969), and 1972, p. 18 (for 1970 and 1971).

Series J

EXCHANGE RATES

A. EXCHANGE RATES FOR OECD MEMBER NATIONS

All data on R&D expenditures in the OECD area are expressed in US dollar figures drawn directly from OECD sources.

The primary OECD sources for the data for the 1961, 1963, and 1967 surveys (shown in this report in the tables in Series A, B, C, and D) of these years give no indication of the exchange rates used. Other OECD publications, however, suggest that current official exchange rates were employed. The source for the statistics on the 1969 survey year (which appear in Series A through E) does provide information on exchange rates. This has been used in the preparation of Table J-1 below.

A more complex procedure was used to generate the data on estimated government R&D funding in US dollars that appear in Series F. In the words of the OECD statisticians,

we had to use the standard OECD exchange rates. In order to assure logical consistency and to avoid the complications of devaluations, data are ... presented in United States dollars at 1961 prices and at 1961 exchange rates. This means that they give a reasonably accurate picture of changes in the level of R&D funding for the various objectives by individual governments but that they situate the efforts of each country only rather approximately in relation to the others, particularly for the latest years.¹

1. Organisation for Economic Co-operation and Development, Changing Priorities for Government R&D (Paris, July 1973), p. 133. (Emphasis in original.)

Table J-1

EXCHANGE RATES FOR OECD MEMBER NATIONS IN 1969
(in national currency equivalents of one US dollar)

Country	Unit	Exchange Rate
Austria	Schilling	26.00104
Belgium	Franc	50.00000
Canada	Dollar	1.081081
Denmark	Krone	7.5001875
Finland	Mark	4.199916
FRANCE	Franc	5.1750459
WEST GERMANY	D. Mark	3.9339257
Greece	Drachma	30.003
Ireland	Pound	0.4166666
Italy	Lira	625.0
JAPAN	Yen	359.99971
Netherlands	Guilder	3.6200012
Norway	Krone	7.1428571
Spain	Peseta	70.00007
Sweden	Krona	5.1731986
Switzerland	Franc	4.3250163
Turkey	Lira	9.000009
UNITED KINGDOM	Pound	0.4166666
UNITED STATES	Dollar	1.0

Source: OECD, Survey of R&D in 1969, Vol. 5, table on p. 19.

B. EXCHANGE RATES FOR COMMUNIST BLOC COUNTRIES

Data on R&D expenditures by Communist bloc countries appear in two sets of appendix tables: Series A and Series G. The exchange rates used to convert the local currencies into US dollars are shown in Table J-2.

Table J-2

EXCHANGE RATES FOR COMMUNIST BLOC COUNTRIES
IN 1967 AND 1969
(in national currency equivalents of one US dollar)

Country	Unit	Exchange Rate
USSR	Ruble	0.42
Czechoslovakia	Crown	8.5
Poland	Zloty	15.9
East Germany	Ostmark	3.39
Hungary	Forint	17.4
Rumania	Lei	9.4
Bulgaria	Leva	1.16 ^a
Cuba	Peso	

Sources: For all countries other than Cuba: the Institute for Strategic Studies, The Military Balance, 1967-1968, p. 24 (for 1967), and 1969-1970, pp. 5, 12-14 (for 1969).

a. For 1968-69, official rate.

Data on R&D expenditures by selected non-Communist, non-OECD countries appear in Series G tables. The exchange rates used for those countries are shown in Table J-3.

Table J-3

EXCHANGE RATES FOR NON-COMMUNIST, NON-OECD COUNTRIES
(in national currency equivalents of one US dollar)

Country	Year	Unit	Exchange Rate
Argentina	1968	Peso	350
Bolivia	1967	Peso	11.88
Brazil	1968	Cruzeiro	3.83
Chad	1965-68	CFA Franc	246.85
	1969	CFA Franc	277.71
Chile	1969	Escudo	8.71
Egypt	1968	Egyptian pound	0.4348
Gabon	1967	CFA Franc	246.85
Ghana	1965	New Cedi	1.0204
India	1969	Rupee	7.57
Iran	1970	Rial	75.75
Iraq	1969	Dinar	0.3571
Israel	1970	Israeli Pound	3.5
Kenya	1966	Shilling	7.143
Mexico	1970	Peso	12.49
Nigeria	1966	Pound	0.3571
Pakistan	1968	Rupee	4.787
Philippines	1965-66	Peso	3.9
Rwanda	1963-67	Franc	100
Somalia	1963-67	Shilling	7.143
South Korea	1965-69	Won	304
Sudan	1963-66	Pound	0.3482
Tunisia	1964-67	Dinar	0.525
Zambia	1969	Kwacha	

Source: United Nations Statistical Yearbook, pertinent years.

C. EXCHANGE RATES USED IN PROJECTIONS

Various methods were used to generate estimates of future gross expenditures on R&D. For the projections that were based on extrapolations of past levels of expenditures expressed in US dollars, no conversion was necessary (see Lines A' and A" in Tables 50 through 53).

For the projections that were based on extrapolations of GNP and GERD as a percentage of GNP, the historical data on GNP for Japan were expressed in the national currency and were converted into US dollars at the rates shown in Table J-4 (refer to Lines B and B' in Table 52).

Table J-4.

EXCHANGE RATES USED IN PROJECTIONS OF JAPANESE GNP
(in national currency equivalents of one US dollar)

	Exchange Rate				
	1969	1970	1971	1972	1973
Yen	360	360	338	308	280

Source: Japan-US Trade Council.

For West Germany, France, and the United Kingdom, however, most of the GNP data were expressed in terms of units of account. These were converted into US dollars at the rates shown in Table J-5. Additional information was available in national currencies for 1973 for France and West Germany. These, too, appear in Table J-5' (refer to Lines B and B' in Tables 50, 51, and 53). No attempt was made to estimate future exchange rates. (For the procedure used to project GNP in dollar figures out to 1975, see section A.2. of Chapter VII and Table I-1.)

Table J-5

EXCHANGE RATES USED IN PROJECTIONS OF GNP FOR FRANCE,
WEST GERMANY, AND THE UNITED KINGDOM
(in units of account and national currency equivalents
of one US dollar)

Country	Unit	Exchange Rate				
		1969	1970	1971	1972	1973
FRANCE WEST GERMANY UNITED KINGDOM	Unit of Account	1	1	1	1.085	
FRANCE	Franc					4.604
WEST GERMANY	D. Mark					2.669

Sources: For 1969-1971: Statistical Office of the European Communities, General Statistics: Monthly Statistics, Issue No. 10, 1973. For 1973: Embassies of France and the Federal Republic of Germany.

The conversion rates used in preparing the remainder of the data displayed in Tables 50 through 53 will be found in Table J-6.

Table J-6
EXCHANGE RATES USED IN GERD PROJECTIONS
(in national currency equivalents of one US dollar)

Country/ Line	Unit	EXCHANGE RATES												
		1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
France	Franc	4.902	4.900	4.902	4.952	4.908	4.948	5.558						
C														
C'									5.520	5.224				4.604
D														4.604
E									5.520	5.224				
WEST GERMANY	D. Mark													
C									3.648	3.268				
JAPAN	Yen													
C		360	360	360	360	360	360	360	360	338				
C'											308	280	300	300
D									357.6	314.8				
UNITED KINGDOM	Pound													
C									.4178	.3918				

Sources: United Nations, Statistical Office, Statistical Yearbook, 1970 and 1972 (for France: C, C' [except for 1975], and E; West Germany: C; Japan: D; and the United Kingdom: C).
Statistical Office of the European Communities, General Statistics: Monthly Statistics, Issue No. 10, 1973 (for France: C' [1975] and D). Japan-US Trade Council (for Japan: C and C').