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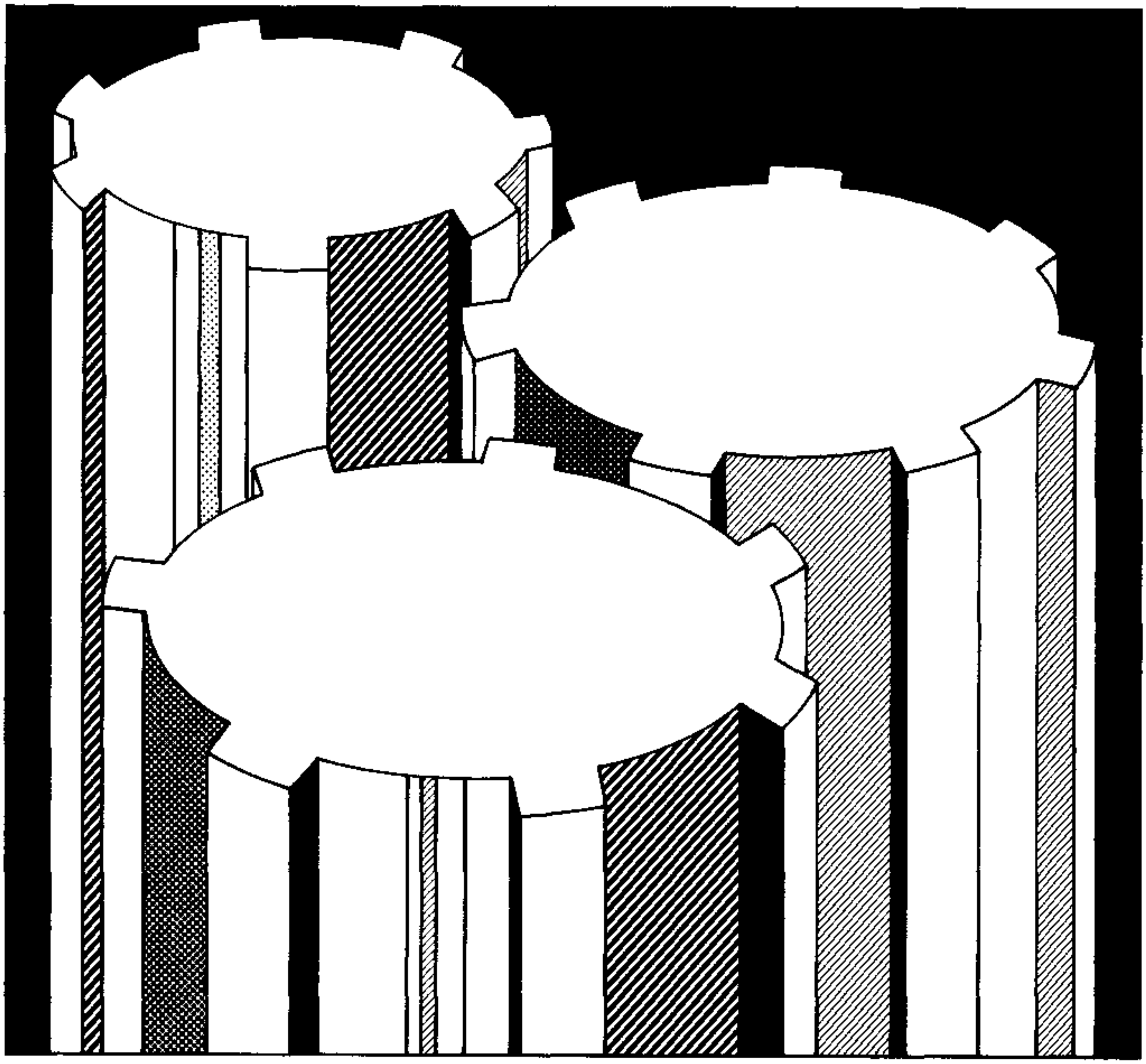
Federal Financial Support for High-Technology Industries



CBO STUDY

FEDERAL FINANCIAL SUPPORT FOR HIGH-TECHNOLOGY INDUSTRIES

The Congress of the United States
Congressional Budget Office

PREFACE

U.S. technological primacy is being challenged internationally as never before. There is a perception that much of this competition is subsidized by foreign governments, while the U.S. government gives relatively little assistance to high-technology industries. This study, made at the request of the Senate Budget Committee, attempts to show how much support the federal government gives to high-technology industries and presents options for change. In keeping with the mandate of the Congressional Budget Office (CBO), the report makes no recommendations.

Philip Webre of CBO's Natural Resource and Commerce Division prepared the report under the supervision of David L. Bodde and Everett M. Ehrlich. Paul Sedlack and Carmen Rodriguez provided valuable computational and research assistance. The author would like to thank members of the Tax Analysis Division for their generous assistance. He also appreciates the comments and suggestions of Gwynn Adams, Valerie Amerkhail, Kenneth Brown, Marc Chupka, Kenneth Ericson, Jane Gravelle, Christopher Hill, James Hodder, Barry Holt, Charles Hulten, Robert Lucke, Robert Merriam, Douglas Olin, Wendy Schacht, Elliot Schwartz, and Eric Toder. Any errors, however, remain the responsibility of the author. Francis Pierce edited the report and Kathryn Quattrone, Deborah Dove, Patricia Joy, and Mechita Crawford typed the many drafts. Kathryn Quattrone prepared the report for publication.

Rudolph G. Penner
Director

June 1985

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SUMMARY

Congressional concern over the future of U.S. high-technology industries flows from the perception that, left to its own resources, the market will underinvest in these industries. It is generally recognized that research benefits the nation more than it benefits any individual company, and that private firms tend to devote less resources to research and development (R&D) than the public interest would warrant; this is particularly true for the high-technology industries, which perform roughly half of all commercial R&D in the United States. A second, and less widely accepted view is that these industries are "strategic" because their technological advances and potential for rapid growth contribute more to the economy than other industries with similar levels of activity. Because private companies respond to profit and not strategic needs, the market will have a tendency to underinvest in industries that confer these benefits.

Whatever the validity of these views, neither gives any sense of the magnitude of the underinvestment, nor of the extent to which the Congress should be concerned to correct it. Both, however, underlie arguments that the federal government ought to give special assistance to high-technology industries. This report analyzes current federal policies toward those industries and presents some options for changing them. In general, it finds that the government is already spending large sums to enhance the competitive position of high-technology industries, although the effectiveness of many of its programs is open to question. 1/

RESEARCH AND DEVELOPMENT COSTS AND FEDERAL POLICY

To stimulate research by private industry, the Congress has tried to lower the cost of private R&D through a combination of tax policy, direct spending, and patent legislation.

1. For purposes of this report, high-technology industries are defined as research-intensive industries growing more rapidly in employment than the all-industry average. These industries include drugs, industrial chemicals, computers, communication equipment, electronic components, aerospace, and instruments. Each has above-average levels of R&D spending and above-average levels of employment growth. This list should be considered as illustrative of high-technology industries, not exhaustive.

Tax Policy and Research

The Congress has developed three tax mechanisms to support R&D: allowing firms to deduct qualified research and experimentation (R&E) expenses in the year incurred; giving them a 25 percent credit on increases in qualified R&E expenses above the previous three years' average; and permitting them to fund research through limited partnerships. (The tax code makes a distinction between basic research and product development. While basic research costs are eligible for the credit and other tax benefits, only development costs incurred in the course of experimentation in the laboratory sense are eligible for special tax consideration. Other development costs must be capitalized.)

The R&E Tax Credit. The R&E tax credit passed by the Congress in 1981 provides only weak incentives for research and may, under a wide range of circumstances, give incentives to defer such projects. A firm that steadily increases its R&E spending--that is, responds in the manner the Congress intended--will receive less credit per dollar of incremental R&E spending than the firm that raises its R&E spending for only one year. Perhaps most important, the credit does not help firms reverse a downward trend or even a one-year drop in R&E spending. (Roughly 15 percent of all firms fit into this category.) Nor does the tax credit reach new firms, which appear to be the most innovative.

R&D Limited Partnerships (RDLP). The federal government reduces the cost of R&D to high-technology firms by permitting tax shelters for R&D projects. An RDLP is typically sponsored by a corporation which may also serve as a general partner, seeking to fund research projects without incurring the disadvantages of more conventional financing. The limited partners, who are usually persons in high tax brackets, provide the funds; they can immediately deduct most of their investment from income and receive their return in the form of tax-advantaged long-term capital gain. Like most such shelters, RDLPs use the tax laws to drive a wedge between what investors earn and what the issuing firms must pay; the wedge is revenue loss to the Treasury. If the research pays off, the revenue loss may be as high as 80 percent of the research costs. Anecdotal evidence suggests that, unlike the R&E tax credit, the RDLP provides a strong incentive for new projects: without the tax benefits of the RDLP, many of the research programs would not be undertaken.

Direct Spending on R&D

In the aggregate, the federal government spends $8.4 billion to develop new technology with commercial potential, although not all of this goes to high-technology industries. In some instances, whole agencies are devoted to sponsoring research of relevance to high-technology industries. The National Institutes of Health sponsor or conduct $1.6 billion in applied research and product development with potential use in pharmaceutical and biomedical industries. The National Bureau of Standards also works closely with high-technology industries to develop measurement techniques and standards. The role of the National Science Foundation (NSF) in promoting high-technology development is not as direct, since NSF spends 95 percent of its funds on basic research.

Individual programs to aid high-technology industries include the independent R&D program (IR&D), which allows federal contractors to increase their costs by the amount they spend on R&D for projects with potential federal agency use. IR&D costs the federal government $1.7 billion per year. The bid and proposal program (B&P) is similar, allowing firms to inflate their bidding costs. Its annual cost is $1.0 billion. The National Aeronautics and Space Administration (NASA) spends over $500 million yearly for civilian-oriented aeronautical research on civil aircraft energy efficiency, pollution, noise emissions, and safety. The Manufacturing Technology (Mantech) program improves the manufacturing abilities of Department of Defense (DoD) contractors; its costs approach $200 million. The Very High Speed Integrated Circuit (VHSIC) program was intended to design and produce very-high-speed circuits for defense use. The program costs roughly $70 million to $100 million per year.

While not all of these programs result in commercially successful technologies, they are meant to help high-technology industries. Unlike noncommercial federal R&D contracts, many of these programs carry no commitment to deliver a specific technology to the government, such as a new fighter. Because federal oversight is often low, their contribution to the competitiveness of high-technology industries cannot be assessed. Nonetheless, they provide significant levels of R&D support to high-technology industries.

HIGH-TECHNOLOGY CAPITAL INVESTMENT AND FEDERAL TAX POLICIES

Some analysts suggest that federal tax policies regarding investment do not provide adequate support for high-technology industries. They say, first, that investment in equipment is taxed at a higher rate in high-technology industries; second, that high-technology industries do not make many investments in depreciable assets and so do not benefit from many of the depreciation provisions in the tax law; and, third, that R&D expenses receive worse tax treatment than ordinary investments.

Tax Rates. Investments made by high-technology firms (in depreciable assets and in R&D projects) receive tax treatment at least as favorable as the average new investment in manufacturing. Investments in depreciable assets by high-technology industries typically face effective tax rates lower than those of most manufacturing industries. While the effective tax rate on income from new investment in depreciable assets averages 22 percent in manufacturing industries, high-technology industries face a rate no higher than 23 percent. Even when allowance is made for the rapid rate of capital obsolescence in high-technology industries, most of them face effective tax rates comparable to or less than the manufacturing average. (These estimates assume that firms have taxable income against which to make deductions. A large proportion of high-technology firms may be too young, however, to have taxable income.)

Capital Investment. High-technology investments in capital assets are higher than the average in manufacturing. In 1981, all manufacturing invested an average of 3.9 percent of output in depreciable assets, while high-technology industries invested 5.1 percent. Furthermore, most high-technology goods are used as inputs by other industries, and presumably reap some of the benefits of capital investment tax incentives through increased sales. In 1983, all industries purchased $223 billion in capital equipment. Of this, high-technology industries manufactured $82 billion, or 37 percent.

Research Expenses. Finally, research investments receive tax treatment at least as favorable as many investments in depreciable assets. With the R&E tax credit, the Congress provides an actual tax subsidy to each firm that can use it. Even without the credit, the tax treatment of R&E spending is better than that given structures (but not equipment) and is less subject to uncertainty than equipment depreciation, which is spread over several years.

OPTIONS FOR ASSISTANCE TO HIGH-TECHNOLOGY INDUSTRIES

In general, the federal government can support high technology through two avenues: by reducing the cost of research or by reducing the cost of capital. The Congress is currently considering a wide range of options for supporting high technology. The incremental R&E tax credit expires this year. The President has proposed extending it, with modifications, for three years. The Congress is also reviewing the Stevenson-Wydler Technology Innovation Act, which is scheduled for reauthorization this year, in the context of general authorizations for federal R&D spending. Finally, the high-technology industries may be especially affected by overall tax reform proposals, such as those now being considered.

R&E Tax Credit

The R&E tax credit, currently costing $1.5 billion per year in lost revenues, expires at the end of 1985. If the credit is extended, the Congress could modify it in three ways: by refocusing the credit; by eliminating disincentives; and by expanding benefits to new areas.

Refocusing the Credit. Primary emphasis could be placed on basic research, where the federal interest is greatest, as the President has proposed. This change would be difficult to police, but many of the activities where federal involvement is obviously not justified could be eliminated from the qualified expenditure category.

Eliminating Disincentives. The Congress could reduce disincentives in a variety of ways. For example, a 4 percent to 6 percent credit on all qualified R&E would have little effect on revenues and would ensure that all firms received some positive incentive to perform more R&E. On the other hand, firms that would have increased their R&E without the credit would receive windfall gains.

Expanding Benefits to New Areas. New entrants and startup firms could be made eligible for the credit, and equipment depreciation could be included in qualified expenses. The first change would eliminate many cases where the credit provides incentives to defer research. Under current law, new entrants into a market are not eligible for the credit, but their R&E spending will be counted in their base for future years. Thus, to obtain maximum credit, such firms might defer research projects. On the other hand, making new entrants eligible would increase the federal cost of the credit and make it more difficult to police. Including equipment depreciation would have a small effect because depreciation costs are such a small part of research costs.

Direct Federal R&D Spending

Direct federal spending could take a commercially-oriented approach or a technology-oriented approach. In the former case, federal agencies would seek to collaborate with the private sector in developing technology for the marketplace. This is currently done by the Department of Defense in its Very High Speed Integrated Circuit (VHSIC) program, with apparent success. The Centers for Generic Technology (COGENT), which were authorized under the Stevenson-Wydler Act but not funded, would be another option in a market-oriented approach. The centers were to have provided grants for the development of generic manufacturing technologies where the market was too fragmented to provide such research. The major drawback to the use of COGENT in this fashion is that its mandate is not as narrowly focused as that of the National Bureau of Standards (NBS), or VHSIC, and so it might be carried into projects with unclear commercial potential.

If VHSIC provides the clearest example of commercially oriented R&D, the National Science Foundation (NSF) provides the clearest example of the technology-oriented research effort. The National Institutes of Health (NIH) fall in the middle. In this type of effort, the agency focuses on the answers to technical questions, disseminates the information, and allows the market to take its own course. A National Technology Foundation, within or outside NSF, could serve as the institutional base; or the Congress could simply increase the funding of NBS, NIH, and the NSF offices that perform applied research.

Using federal procurement as a means of stimulating technological development is often suggested as another avenue of support. While the role of the federal government in stimulating high-technology industries' technological development is long and filled with successes (and many failures), the conditions under which it has succeeded are very restrictive. The evidence suggests that federal procurement best pulls technology forward when the federal market is large, both in absolute terms and relative to the market as a whole, and when federal technology development is parallel to that of the civilian market. Even under these circumstances, attempting to develop new technology in the course of accomplishing a mission increases costs and often results in suboptimal performance.

The Effects of Tax Reform

General tax reform, along the lines now being considered in the Congress, would affect high-technology industries in many ways. The report considers the effects that changes in the tax treatment of royalty payments and of large limited partnerships would have on RDLPs, the effects that changes in the treatment of long-term capital gains would have on venture capital, and the President's proposed system of capital asset depreciation.

Changing the Tax Treatment of RDLPs. The President is considering a reduction in the portion of royalty income that would qualify for preferential capital gains treatment, which would lower, perhaps substantially, the returns from such partnerships. In addition, many tax reformers have suggested treating limited partnerships with more than 35 members as corporations for tax purposes. Tax shelters use limited partnerships because the tax deductions flow directly to the limited partners, often high-income persons seeking to reduce their taxes. Changing the tax treatment of royalty payments and of large limited partnerships would make RDLPs less attractive, and would probably reduce their size and number. This might slightly reduce the level of private research. Since RDLPs represent less than 3 percent of private research, and many of their projects are marginal, the reduction would probably be very small.

Changing the Tax Treatment of Capital Gains. Under current law, a taxpayer is not taxed on 60 percent of the gains on assets held six months or longer. The President has proposed reducing the exemption to 50 percent. In combination with the proposed maximum tax rate for individuals of 35 percent, this would result in a maximum rate of 17.5 percent averaged over the entire gain, down from the current 20 percent. Starting in 1991, taxpayers would have the alternative of using the above system or of adjusting the capital gain to remove inflationary gains and taxing the inflation-adjusted gain at ordinary rates. The first method favors investments that have appreciated much more rapidly than inflation, while the latter favors those that have appreciated only slightly more rapidly than inflation.

The effects of these proposals on the venture-capital industry, which provides a substantial portion of the funds for start-up high-technology companies, would not differ significantly from current law. This is because venture-capital investors are more sensitive to the taxation of their most successful projects than to the return on the remainder of their investments, most of which never pay off. Under the proposed maximum tax rate of 17.5 percent, the effective tax rate on the most successful venture-capital investments would decrease slightly. The second option--paying ordinary tax rates on inflation-adjusted capital gains--would not be used because it would be more advantageous to investors to pay 17.5 percent on their nominal gain.

If the alternative tax on inflation-adjusted gains were all that were available, the inflation-adjusted tax rate could almost double. But those rates would not be far beyond the levels venture capitalists experienced during the 1978-1981 period when venture-capital investment began its rapid growth.

Venture-capital investment may not be as sensitive to tax rates as many suggest. First, half of the venture-capital funds come from tax-exempt institutions or foreign sources. Neither of these groups of investors are known to be sensitive to domestic tax changes. Second, investment by venture-capital firms seems to respond to market opportunity more than to tax changes. This is shown by the rapid rise in high-technology electronics output starting in the late 1970s, which was followed by an upsurge in venture-capital investments in these industries. Had the venture-capital boom been driven by taxes, not by the market, investments would not have been concentrated so heavily in the electronics industries. Third, following the 1981 Tax Act, the after-tax proceeds from capital gains income fell relative to that of ordinary income. Despite this relative fall in after-tax proceeds, the funds going to venture-capital investments increased, while aggregate investment stagnated. Thus, venture-capital investment grew relative to ordinary investment even when its relative tax rate rose.

Changing the Current Capital Asset Depreciation System. The President has proposed eliminating the investment tax credit (ITC) and replacing the current capital asset depreciation system with the capital cost recovery System (CCRS). CCRS would modify the current system in two ways. First, it would include an inflation adjustment in the tax depreciation calculations. Thus rather than providing very large depreciation allowances, part of which are intended to compensate for inflation, the CCRS would take account of it directly and thus reduce the level of uncertainty regarding the inflation-adjusted value of the depreciation allowances. Second, the CCRS would lengthen the tax lives of assets to approximate more closely their economic lives. This would ensure that the tax rates on different classes of assets, for instance equipment and structures, would be closer than they are under current law.

Under CCRS, high-technology industries would face tax rates on their investments in depreciable assets no higher than the manufacturing average. However, because many of these industries are treated advantageously by the current system, some might experience substantial increases in their effective tax rates. If CCRS understated the rate of technological obsolescence experienced by some high-technology assets, it might result in effective tax rates slightly higher than the manufacturing average.

CHAPTER I

INTRODUCTION

High-technology industries in the United States have grown rapidly in recent years. Nevertheless, many people in these industries, and many members of Congress, question whether such high growth rates can be maintained in the future and whether the U.S. industries may lose their commercial and technological leadership to foreign competitors. Among the reasons cited for concern are the decline in U.S. industries' share of the world market, the rapid increase of foreign competitors' shares in specific "leading edge" technologies and the movement of high-technology manufacturing jobs to other countries. These concerns have led some to call for more federal financial support of U.S. high-technology industries. This report discusses the need for such support, analyzes current federal support policies, and presents some options for the future.

The arguments for federal support for high-technology industries rely on two propositions. The first centers on the failure of the commercial marketplace to channel enough resources into research and development (R&D). In its most common form, this "market failure" argument suggests that high-technology industries tend to underinvest in R&D because they cannot capture all the benefits from that investment. They underinvest even though the economy at large would be better off if these investments were made. The second proposition is that high-technology industries are "strategic"--that is, they are essential to national economic growth and competitiveness. Those who cite the need to respond to foreign inroads in these industries usually use, implicitly or explicitly, the "strategic" industry argument. 1/

THE MARKET FAILURE ARGUMENT

A firm that is guided only by the market may have relatively weak incentives to attempt long-term, highly innovative research. Not only is success

1. See, for example, *The Effect of Government Targeting on World Semiconductor Competition* (Semiconductor Industry Association: Cupertino, California, 1983), p. 1.

in such endeavors highly uncertain, but, even if successful, the inventing firm is not likely to receive all the benefits. Many inventions find uses in ways not foreseen by the inventing firm, and from which the inventing firm cannot benefit. Such inventions are worth more to the nation as a whole than to the inventing firm, and so it is in the national interest to support them. 2/ Even in the original market, the inventing firm may not receive all the benefits: an imitator may simply copy the results of the R&D investment and capture a portion of the market.

Because of the uncertainty and portability of research results, private firms tend to emphasize R&D that is most likely to bring short-term success. Thus, about three-quarters of private R&D funds are invested in the final stage of research. 3/ Similarly, many firms defer research projects until their estimates of success are quite high: one survey of industrial research discovered that 75 percent of projects initiated in private laboratories had success probabilities estimated at 80 percent or more, while only 2 percent had estimates of less than 50 percent. 4/

On the other hand, firms may overinvest in some kinds of R&D when competing firms knowingly duplicate each others' work. 5/ In the electronics industry, for instance, a great deal of research involves "reverse engineering"--that is, examining a product in an attempt to duplicate how it was made. While licensing agreements may be avoided that way, little new from society's viewpoint is discovered.

In principle, federal interest in R&D should be not only to increase the aggregate level of spending, but also to shift it toward long-term projects in which the social returns may exceed private ones. In practice, however, distinctions between long-term and short-term research projects and between projects with higher risk and those with lower risk may be difficult for the government to make or enforce. Neither can federal agencies discourage overinvestment in duplicative R&D, because it is usually in a firm's commercial interest to perform it. Thus, in practice, the federal role has usually been limited to encouraging more R&D, regardless of the type.

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2. See Congressional Budget Office, *Federal Support for R&D and Innovation* (April 1984).

3. National Science Foundation, *Science Indicators 1982* (Washington, D.C.: Government Printing Office, 1983), pp. 237-241.

4. F.M. Scherer, *Industrial Market Structure and Economic Performance*, 2nd ed. (Chicago: Rand McNally, 1980), p. 416.

5. See Pankaj Tandon, "Innovation, Market Structure and Welfare" *American Economic Review* (June 1984) for a recent discussion of overinvestment in R&D.

The concept of market failure gives little information regarding the severity of that failure or how much the federal government should be willing to pay to correct it. Some studies have suggested that the social return to innovation is on average twice that of the private return (see Chapter II). But those studies must be viewed as suggestive rather than as a guide to action. The federal government has no method, therefore, of determining its level of interest in R&D exactly or of communicating this to firms in advance of their decisionmaking.

THE STRATEGIC INDUSTRY ARGUMENT

The second proposition underlying arguments for support of high-technology industries is that they are "strategic"--that they potentially contribute more to national economic growth and welfare than other industries with similar levels of activity. Proponents of the "strategic industry" view identify three characteristics of such an industry: first, it is technically advanced; second, its growth offers widespread benefits; and third, those benefits accrue disproportionately within the nation's borders. 6/

The first two characteristics of a "strategic industry" originate in the association between long-term economic growth and surges in technological innovation--the notion that clusters of innovations in leading industries are critical to driving and shaping overall economic progress. These industries are important because their technological advances provide opportunities for innovation in related industries. In doing so, strategic industries provide benefits external to themselves--to the customers and other firms that use their products, to the suppliers that provide their inputs, and eventually to the economy at large. Enhanced defense capabilities and even national prestige are often included in the calculus of external benefits. But if these industries are to warrant governmental support, their external benefits must accrue in disproportionate measure within national boundaries. To the extent that the benefits are shared internationally, the strategic nature of the industry diminishes.

Railroads in the 19th century are frequently cited as an example of a strategic industry. Their demand for large amounts of high-quality steel

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6. Richard R. Nelson, *High Technology Policies: A Five-Nation Comparison* (Washington, D.C.: American Enterprise Institute, 1984), pp. 1-4. To a large extent, this argument is a specific case of the market not providing the "right" amount of R&D in every area: the technological spillovers and "widespread benefits" are the benefits of R&D not captured by the innovating firms.

was central to the growth of the steel industry. Their expansion opened new markets for agricultural products and simultaneously allowed manufactured goods to reach agricultural areas. In the early 20th century, the automobile may have had an analogous role. Many assert that the electronics industry is strategic today.

The concept of strategic industries is, however, itself a matter of controversy. Evidence that certain industries have these strategic characteristics is lacking; and while the concept cannot be refuted from quantitative evidence, neither can it be confirmed. Moreover, traditional economic theory does not suggest that establishing a strong national position in some industries in preference to others is necessarily beneficial. Rather, theory suggests that in a world of competitive fully-employed economies each country does best to specialize in producing those goods for which it enjoys a "comparative advantage," which is revealed in the marketplace through prices and profits. Of course, where an industry has a clear efficiency advantage, this can be increased through public investment--for example, by building roads over which goods can be shipped. Such investment, however, would in theory be guided best by comparing social rates of return and not by some notion of what is strategic. For these reasons, the question of whether the government should foster strategic industries remains an open one.

CURRENT SUPPORT PROPOSALS

The most fundamental way in which the federal government can assist technology-based industries--and, for that matter, all industry--is through fiscal and monetary policies that promote overall economic growth. But even if the economy enjoyed a sustained high rate of growth, special treatment might be proposed for high-technology industries for the reasons mentioned above: that they tend to underinvest in R&D, or that they are strategic for national economic development. Questions would still remain, however, as to the proper amount of federal assistance and the form in which it should be delivered.

Many proposals for assistance to high-technology industries are now before the Congress. In the tax area, there are two kinds of proposals: targeted proposals, and proposals for more general changes that might affect high-technology industries. Targeted measures include a tax credit for increasing certain research activities, originally passed in 1981 as part of the Economic Recovery Tax Act and scheduled to expire in 1985. The President has proposed a three-year reauthorization for the credit. Other proposals are addressed to a general reform of the tax system. These include changing the current tax treatment accorded to long-term capital gains and changing the current system of capital asset depreciation, among others. Some of them, however beneficial to the economy as a whole, could have an important effect on high-technology industries by reducing the special incentives already built into the tax code. For example, proposals to change the tax status of all limited partnerships could reduce the attractiveness of the R&D limited partnerships that supported $800 million of R&D projects in 1983.

In addition to changes in the tax code, several proposals would extend direct support to high-technology industries. These include technology grants, perhaps administered through a National Technology Foundation analogous to the National Science Foundation; direct spending through activities such as the Very High Speed Integrated Circuit program; and reauthorization of the Stevenson-Wydler Technology Innovation Act of 1980.

A FRAMEWORK FOR REVIEW

This report provides an analytical framework within which to consider the merits of policies aimed at assisting high-technology industries. Chapter II defines such industries and assesses which ones might be candidates for federal financial aid. Proponents of such aid argue for two objectives: to reduce the costs of research and development, and to lower the cost of capital for high-technology industries. Chapter III analyzes current federal policies affecting private R&D costs, and Chapter IV addresses capital costs. Chapter V analyzes the relevant aspects of the President's proposal for comprehensive tax reform and other options that might be considered.

CHAPTER II

CHARACTERISTICS OF HIGH-TECHNOLOGY INDUSTRIES

Before discussing proposals to extend federal aid to high-technology industries, it is helpful to identify who would receive it and why. This report uses two characteristics to identify a high-technology industry: high research intensity and rapid growth. Typically, the research intensity of an industry is measured by two standards: R&D expenditures as a percent of industry output (measured by sales or value added); and employees engaged in research as a percent of total employees. 1/ Deciding at what point on such scales an industry becomes "research-intensive" is an arbitrary matter, of course, since there is no clear boundary that must be crossed. In this study, a ratio of R&D to sales one-third higher than the manufacturing average is used to define high research intensity. Similarly, an industry is considered to be one of rapid growth if its 10-year increase in employment is above the average for all manufacturing industries. When combined, these characteristics yield the list of industries shown in Table 1.

These industries produce roughly 16 percent of all output in manufacturing and employ 17 percent of all persons working in manufacturing. In absolute terms, their aggregate 1982 output exceeded $300 billion and their 1982 employment exceeded 3.1 million (see Table 2 for industry detail). They account for roughly half the $38.7 billion in private manufacturing research performed in the United States in 1982. 2/

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1. For a discussion of the theoretical and methodological issues, see Ann Lawson, "Technological Growth and High Technology in U.S. Industries," *Industrial Economics Review* (Spring 1982); Richard Riche and others, "High Technology Today and Tomorrow: A Small Slice of the Employment Pie," *Monthly Labor Review* (November 1983); Amy Glasmeir and others, "Defining High Technology Industries," Institute of Urban and Regional Development, University of California, Berkeley (1983); and Catherine Armington and others, "Formation and Growth in High Technology Businesses: A Regional Assessment," The Brookings Institution (September 1983).

2. Exact data are not available because the National Science Foundation tabulations combine industrial organic chemicals--one of the industries considered here--with industrial inorganic chemicals and plastics. CBO assumed that all research spending in these industries was divided in proportion to the split of applied research spending among them. See the National Science Foundation, *Research and Development in Industry, 1982* (1984).

Although the industries included in Table 1 would appear on most high-technology lists, two caveats must be recognized. First, the listing is a dynamic one. In the future, new industries are likely to rise out of what now appear to be laboratory curiosia or specialized submarkets--as did the personal computer. Other industries may drop from the list as their growth diminishes or they become less innovative; the railroads, once at the forefront of growth and technology, are an example of this. Second, many observers use only research intensity as the defining characteristic, without regard to the industry's growth. This yields a somewhat longer list, as shown in Table 3 (although both sets are quite small compared with the hundreds of industries identified at the three-digit level of the Standard Industrial Classification).

TABLE 1. HIGH-TECHNOLOGY INDUSTRIES
(By Standard Industrial Classification)

Industry Group	SIC Code	Company R&D as Percent of Net Sales	1972-1982 Employment Growth (In percents)
All Manufacturing Industries		2.5	20.1
Drugs	283	7.1	25.5
Industrial Organic Chemicals	286	3.4	22.1
Office and Computing Machines	357	10.3	88.6
Communication Equipment	366	7.2	21.2
Electronic Components	367	5.5	60.3
Aircraft and Parts	372	5.1[a]	23.6
Missiles and Space Vehicles	376	5.1[a]	37.5
Instruments	380	7.5	44.9

SOURCES: Richard Riche, Daniel Hecker, and John Burgan, "High-Technology Today and Tomorrow: A Small Slice of the Employment Pie," in *Monthly Labor Review* (November 1983), p. 52, and National Science Foundation, *Research and Development in Industry, 1982* (1984), p. 24.

a. Reported jointly.

TABLE 2. CONTRIBUTION OF HIGH-TECHNOLOGY INDUSTRIES TO OUTPUT, EMPLOYMENT, AND EXPORTS, 1982
(Shipment, export, import, and research figures in billions of current dollars)

Industry Group	SIC Code	Shipments	R&D Expenditures	Employment (In thousands)	Exports	Imports
All Manufacturing		1,909.1	38.7	18,781	139.7	144.0
Drugs	283	24.7	2.5	166	2.3	1.1
Industrial Organic Chemicals	286	37.5	2.8[a]	138	5.9	2.0
Office and Computing Machines	357	43.0	4.7	402	9.1[b]	2.3[b]
Communication Equipment	366	46.7	3.6	608	3.2	2.6
Electronic Components	367	34.5	1.4	515	5.5	5.8
Aircraft and Parts	372	53.8	3.9[c]	561	14.1	4.2
Missiles and Space Vehicles	376	14.4	c	146	1.0	0.0
Instruments	380	53.7	3.4	627	9.8	4.6
All High Technology		308.3	22.3	3,163	50.9	22.6

SOURCES: U.S. Department of Commerce, *1985 U.S. Industrial Outlook*; National Science Foundation, *Research and Development in Industry, 1982* (1984); and *Economic Report of the President* (February 1985).

a. Also includes companies classified in SIC groups 281 and 282.

b. Electronic computing equipment (SIC industry 3573) only.

c. Reported jointly.

TABLE 3. LISTS OF TECHNOLOGY-INTENSIVE MANUFACTURING INDUSTRIES (By Standard Industrial Classification)

Industry Group	SIC Code	A	B	C	D	E	F
Industrial Inorganic Chemicals	281	x	x	x	x	x	
Plastic Materials, Synthetics	282	x	x	x	x	x	
Drugs	283	x	x	x	x	x	x
Soap	284		x	x			
Paints	285		x	x			
Industrial Organic Chemicals	286	x	x	x	x	x	x
Other Chemicals	287		x	x		x	
Miscellaneous Chemical Products	289	x	x	x	x		
Petroleum Refining	291	x	x	x	x		
Reclaimed Rubber	303		x				
Ordnance	348	x	x	x			
Engines and Turbines	351	x	x	x			
Construction, Related Machinery	353	x	x				
Metal Working Machinery	354		x				
Special Machinery	355			x			
General Industrial Machinery	356	x	x				
Office and Computing Machines	357	x	x	x	x	x	x
Electric Distributing Equipment	361		x	x	x	x	
Electrical Industrial Apparatus	362	x	x	x	x	x	
Radio/TV Receiving Equipment	365	x	x	x	x	x	
Communication Equipment	366	x	x	x	x	x	x
Electronic Components	367	x	x	x	x	x	x
Other Electrical Machinery	369			x	x	x	
Motor Vehicles	371				x	x	
Aircraft	372	x	x	x	x	x	x
Railroad Equipment	374		x				
Missiles	376	x	x	x	x	x	x
Instruments	380	x	x	x	x	x	x

NOTES:

A: Catherine Armington, Candee Harris, and Marjorie Odle, "Formation and Growth in High-Technology Businesses: A Regional Assessment," Brookings Institution (September 1983).

B: Amy Glasmeier, Ann Markusen, and Peter Hall, "Defining High Technology Industries," Working Paper 407, Institute of Urban and Regional Development, University of California, Berkeley (June 1983).

C: Richard Riche, Daniel Hecker, and John Burgan, "High-Technology Today and Tomorrow: A Small Slice of the Employment Pie," *Monthly Labor Review* (November 1983). User Group III.

D: Above-average 1981 R&D expenses as percent of value added.

E: Above-average 1981 R&D expenses per thousand employees, National Science Foundation, *Research and Development in Industry, 1981* (1983).

F: This report.

This necessary imprecision suggests that the list of industries in Table 1 should be considered illustrative of high-technology industries rather than as definitive. The central issue is the characteristics that make them important to the economy: significant technological advances and rapid growth.

TECHNOLOGICAL ADVANCES AND RAPID GROWTH

High-technology firms interact with the rest of the economy in ways that have important policy implications. Three characteristics stand out:

- Research done in these industries appears to yield large social returns;
- High-technology industries achieve much of their growth through new firms, which are less able to use tax assistance than established firms; and
- High-technology industries may or may not fit into the concept of a strategic industry.

Social Returns to R&D

Many studies have attempted to quantify the difference between the private returns to an investment in R&D and the public returns to that same investment. Although such estimates must cope with major conceptual and informational difficulties, they generally suggest that the public benefits significantly exceed the private benefits. For example, one cross-industry analysis found that the median social rate of return to R&D was 56 percent, while the median private rate was 25 percent. Although the rates of return appeared to vary considerably among industries, the social returns were consistently higher than the private.[3] This supports arguments that the research and development activities of high-technology industries warrant public assistance.

3. Edwin Mansfield and others, "Social and Private Rates of Return from Industrial Investment," *Quarterly Journal of Economics*, vol. 91, no. 2 (May 1977), pp. 221-240.

Growth and New Firms

Rapid market growth creates many opportunities for new firms to enter an industry: when existing firms are unable to meet the greater demand; when more specialized market segments come into being; and when the new firms can exploit aspects of technology that do not fit into existing firms' product lines. The extent to which new firms account for growth in high-technology industries is difficult to quantify. The available evidence, however, suggests that the number of firms in high-technology industries is growing more rapidly than the number of firms in the economy as a whole. For example, a Brookings Institution study showed that the number of firms in high-technology industries grew by almost a quarter between 1976 and 1980, while the number of firms in the manufacturing sector grew by 12 percent (see Table 4). 4/

TABLE 4. NUMBER OF FIRMS BY INDUSTRY TYPE, 1976 AND 1980 (In thousands)

Industry	1976	1980	Percent Change
Research-Intensive, High-Growth	36.5	44.9	23
Research-Intensive	53.7	63.7	19
Manufacturing and Business Services	574.6	643.7	12
All Industry	3,629.6	3,853.0	6

SOURCE: Catherine Armington, Candee Harris, and Marjorie Odle, "Formation and Growth in High Technology Businesses: A Regional Assessment," Brookings Institution (September 1983), appendix tables.

NOTE: A firm is defined as one establishment in a single-establishment firm or a headquarters establishment of a multi-establishment firm. The research-intensive and high-growth category in this study is slightly different from that used elsewhere in this report.

4. The Brookings definition of high-technology, high-growth industry includes services and hence is somewhat broader than that used in this report. The statistical results, however, are not very sensitive to minor definitional changes. See Candee Harris, "High Technology Entrepreneurship in Metropolitan Areas," The Brookings Institution (March 1, 1984); and Catherine Armington, Candee Harris, and Marjorie Odle, "Formation and Growth in High-Technology Businesses: A Regional Assessment," Brookings Institution (September 1983).

New firms tend to be less profitable than older firms, for two reasons. First, many years of expenses typically precede the introduction of their products; the revenues from which later profits will derive are delayed for younger firms. Second, new firms tend to have single product lines, making them more vulnerable to fluctuations in demand than other companies. As a result, new firms may pay less taxes, and so may be less able to take advantage of the federal incentives that are provided through the tax system. 5/

The Strategic Nature of High-Technology Industries

As defined in Chapter I, "strategic" industries are those that meet three criteria: (1) they are technologically dynamic; (2) the benefits of this technological change spread widely to other industries that supply their inputs and purchase their output; and (3) these benefits accrue disproportionately within the United States.

The high-technology industries listed in this chapter probably fulfill the first two criteria. They are technologically dynamic by definition, since they were selected for their R&D intensity, which in turn is evidence of a high rate of technological innovation. Second, their influence is pervasive: they produce over one-third of the capital goods currently purchased in the United States, and the advanced technology embodied in these goods is rapidly transmitted to the rest of the economy.

The third criterion--that their external benefits accrue disproportionately within this country--is more problematic because there is no systematic way to measure the extent of the external benefits, let alone how much of them accrues within U.S. borders. Nevertheless, arguments can be made that the benefits flowing from high-technology products fall more than proportionately to the country where these goods are manufactured. The strongest of these has to do with the way knowledge is disseminated. A second argument focuses on the high wages paid by these industries. There are also arguments that the production and export of knowledge-intensive goods is necessary to maintain high wage rates in the United States and promote national security. Less well founded are arguments about exports and economic development.

The Dissemination of Technical Knowledge. The strongest spillover from R&D is free knowledge. With it, technological followers are often able to

5. For an analysis of the federal incentives provided through the tax system, see Congressional Budget Office, *Federal Support of U.S. Business* (January 1984).

retrace at low cost the thoughts of innovators, and to learn from them. Knowledge is transmitted in various ways: through analysis of the products themselves; through formal communications channels, such as journals; and through informal channels, such as telephone calls and lunches. All of these forms of communication are most effective within national borders, since international communication linkages are not as comprehensive, cheap, or efficient. Thus, the knowledge-generating aspects of high-technology manufacture will confer strategic benefits upon the nation in which these activities take place.

Knowledge is also transmitted through the creation of expertise--embodied in engineers and technicians, who later change jobs and bring this knowledge to the next firm. While there is an international trade in engineers and technologists, this flow does not match that among firms in the United States. The benefits of the "human capital" so created remain disproportionately onshore.

This reasoning would exclude from public concern those aspects of high-technology manufacture that do not generate public knowledge or human capital. Only the technology-intensive segments of production would be strategic; the bulk of the employment created by high-technology manufacture would not be included. For instance, semiconductor manufacture can be split into two phases: fabrication, in which the silicon wafers are transformed into electronic devices, and the assembly process in which these devices are packaged into functional units. Most of the knowledge creation is in the first phase. By contrast, most of the employment is generated in assembly, and since the mid-1960s semiconductor firms have used plants outside the United States to perform much of their assembly. 6/

Wages and Knowledge-Intensive Goods. A second argument suggests that the benefits of high-technology industries are retained through wages. It derives from the observation that goods are first produced in high-wage countries where the demand for them originates and where a technically skilled work force is available for production. As production becomes routinized, manufacture tends to move to areas with cost advantages in wages or raw materials. Such competition with low-wage areas pressures United

6. William F. Finan, *"The International Transfer of Semiconductor Technology Through United States-Based Firms,"* (Cambridge, Mass.: National Bureau of Economic Research, 1975), pp. 54-68. See also, Kenneth Flamm, "Internationalization in the Semiconductor Industry," in Joseph Grunwald and Kenneth Flamm, eds., *The Global Factory: Foreign Assembly in International Trade* (Washington, D.C.: The Brookings Institution, 1985), p. 100.

States manufacturers toward the introduction of new goods that take advantage of the U.S. endowment of technological skills.

Converting this observation into an argument for federal support requires two separable claims: first, that high-technology industries have the potential to increase the living standard of U.S. workers; and second, that high-technology products from U.S. firms enable other industries in the United States to become more competitive than they would be if they bought similar products from foreign firms.

The first claim depends upon the number of jobs created and the wages they command. Evidence suggests that high-technology industries are simply too small to provide significant numbers of jobs, despite their above-average employment growth. 7/ In 1982, these industries employed about 3 percent of the labor force, and even under optimistic assumptions about growth the percentage is not likely to increase significantly. On the other hand, salaries and wages in most high-technology industries are higher--in some cases, substantially so--than the average for manufacturing, which in turn is higher than that of the private sector as a whole. (The only high-technology industry below average in this respect is electronic components.) The salary structure may also be flatter for high-technology industries than for industry as a whole. 8/

With regard to the second claim, the principal way in which other industries might be made more competitive is through the expertise embodied in the technicians from high-technology industries. To the extent that they raise the general level of know-how in other industries, through employment change or service contracts, they make these U.S. industries more competitive. Such arrangements are more difficult for offshore manufacturers.

National Security. Special aid to high-technology industries is often justified on grounds of national security. They are held essential for the produc-

7. See Richard Richie, Daniel Hecker, and John Burgan, "High Technology Today and Tomorrow: A Small Slice of the Employment Pie," *Monthly Labor Review* (November 1983), pp. 50-58.

8. For wages and salaries by industry, see Bureau of Labor Statistics, *Supplement to Employment and Earnings* (various issues). See also Bureau of the Census, *Annual Survey of Manufactures, Statistics for Industry Groups and Industries* (various years). The limited information on dispersion of salary by industry is taken from a survey of New England employment in Barry Bluestone and Bennett Harrison, *The Deindustrialization of America: Plant Closings, Community Abandonment and the Dismantling of Basic Industry* (New York: Basic Books, 1982), p. 96.

tion of defense goods, and for providing a cadre of technical experts needed in time of national mobilization. A national ability to produce military goods rather than import them is held to be important for defense purposes. There is no simple way of measuring the relationship between industrial technology and defense needs, since there is a synergy between the civilian sector of an industry and its defense sector--that is, advances in one sector may contribute to advances in the other. At any rate, it is not simply a matter of showing that an industry devotes a high percent of its capacity to meeting defense requirements. 9/ This unfortunately gives no insight into how defense preparedness varies with the size of the domestic high-technology industry.

Exports. High-technology industries contribute to exports at more than twice their share of output. In 1982, for example, the manufacturing balance of trade was slightly negative, but the high-technology industries had nearly a $30 billion trade surplus: high-technology goods accounted for 36 percent of exports, but only 16 percent of imports. 10/ In recent years, however, the international competitiveness of high-technology industries may have eroded. According to one industry observer, the imported share of high-technology capital goods had risen to over 40 percent by early 1984, up from 26 percent at the end of 1982. 11/

Advocates of supporting these industries emphasize their contribution to net exports. 12/ In a world of flexible exchange rates, however, support for high-technology industries that led to increased exports of their goods might push up the value of the dollar, tending to drive down the exports of less favored industries. This might not entirely cancel out the increase in net exports--other factors such as capital flows and currency speculation affect exchange rates--but would certainly reduce them, perhaps substantially.

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9. For measures of federal demand relative to industry size, see Bureau of the Census, *Shipments to Federal Government Agencies, 1982* (Washington, D.C.: Government Printing Office, 1984).

10. U.S. Department of Commerce, Bureau of Industrial Economics, *1985 U.S. Industrial Outlook*: (Washington, D.C.: Government Printing Office, 1985); Bureau of the Census, *Highlights of U.S. Export and Import Trade* (December 1983); and Council of Economic Advisers, *Economic Report of the President* (Washington, D.C.: Government Printing Office, 1985).

11. Stephen S. Roach, "*Trading Away the Capital Spending Recovery,*" Morgan Stanley (February 1985).

12. Semiconductor Industry Association, ibid.

Regional Economic Development. Finally, progress in high-technology industries can encourage economic development in a region as a whole. Such spillover effects, however, are probably local rather than national. The examples of Silicon Valley in California, Route 128 around Boston, and the Research Triangle in North Carolina, among others, suggest that while state or local governments may have a "strategic" interest, the federal interest is less clear.

CURRENT ARGUMENTS FOR FINANCIAL SUPPORT

Policy discussions about financial support for high-technology industries tend to be dominated by two specific objectives. The first is to reduce the cost of R&D to U.S. firms, and thereby enhance their ability to compete internationally. The second objective is to lower their capital costs, principally through changes in the tax system, which is held to be biased against them. The chapters that follow address these questions. Chapter III discusses the federal role in reducing the R&D costs of high-technology industries. Chapter IV outlines the relationship between federal tax policy and the cost of capital in high-technology industries.

CHAPTER III

CURRENT FEDERAL POLICIES AFFECTING PRIVATE R&D COSTS

High-technology industries are characterized by a high level of research investment. In the aggregate, their R&D spending represents over half of all private manufacturing R&D, although their output is only one-seventh of total manufacturing output.

In the belief that such research is of public benefit, the federal government provides tax relief and direct spending programs to reduce the burden. Tax assistance includes the R&D tax credit, which is scheduled to expire in December 1985, and the research and development limited partnership, which is being encouraged by the Commerce Department. Direct spending includes several research programs of the Department of Defense intended to develop independent industrial R&D capacity, as well as the programs of the National Bureau of Standards and other federal agencies.

This chapter first analyzes the tax policies and then discusses the direct spending programs. It concludes that federal policy currently provides significant support for R&D--amounting to roughly $1.5 billion in tax credits in 1984 and $8.4 billion in direct outlays in 1983, the last year for which complete data are available. Much of this goes to high-technology industries, although its efficacy is mixed.

THE TAX TREATMENT OF R&D

Two kinds of federal tax policies affect R&D costs: targeted tax incentives and general tax provisions. The first are provisions specifically designed to reduce research costs. The second are general provisions of the Internal Revenue Code that interact in such a fashion as to provide tax subsidies for research costs. Examples of targeted incentives are the provision for deducting qualified research costs in the year they are incurred, and the credit for increasing certain research costs. An example of a benefit that arises because of the interactions of several general provisions of the tax code is the R&D limited partnership (RDLP). All of them use tax subsidies to increase the returns to R&D. Targeted incentives are available in much smaller units, while an RDLP is usually of economic advantage only for large, discrete projects. Most R&D funded by RDLPs would probably not have been performed otherwise. The research credit, on the other hand, has been claimed by many corporations that would have performed R&D even in the absence of the credit. This section discusses each of the tax subsidies in turn.

Expensing of Certain Research Expenditures

Under Section 174 of the Internal Revenue Code, firms are allowed to deduct the entire cost of certain research activities--mainly direct labor and materials--in the year they are undertaken, even though the activities are designed to produce income over a series of years. Alternatively, firms can deduct the costs over a period of five years.

This early deduction of costs (termed "expensing") represents the equivalent of an interest-free loan to the taxpayer of his or her deferred tax liability. In exchange for reduced liabilities in the first year, the taxpayer is allowed no further deductions and so in later years must pay higher taxes than if the entire expense had been spread over five years. The cost to the federal government of providing these interest-free loans is estimated to be $3.7 billion in fiscal 1986 (see Table 5).

This treatment of research expenses raises two policy issues. First, how strong are its special benefits to R&D now that the Congress has expanded general investment incentives? Second, does it fit well with the reasons for government action discussed in Chapters I and II?

Under the 1981 and 1982 tax acts, investments in equipment and some structures are given special treatment that amounts to expensing at low

TABLE 5. ESTIMATED REVENUE LOSS RESULTING FROM EXPENSING CERTAIN RESEARCH EXPENDITURES, FISCAL YEARS 1984-1989 (In billions of current dollars)

	1984	1985	1986	1987	1988	1989
Revenue Loss	3.3	3.5	3.7	4.0	4.2	4.4

SOURCE: Joint Committee on Taxation.

rates of inflation and interest. In some instances, the present value of depreciation deductions and investment tax credits may exceed the original cost of the investments. This has reduced the relative benefit to be derived from expensing research costs in comparison to using depreciation. The chief difference is that the treatment of qualified research expenses is more certain because it occurs in one year, whereas equipment depreciation is spread over five years and hence is more subject to transient events that may reduce its value.

The second important question is whether the treatment of research expenses addresses the problem of market failure. The cost deduction applies to research and experimentation (R&E) in the laboratory sense. (Development costs that are not experimental are not eligible for this treatment.) But these experiments can occur in the process of product development, as opposed to basic research, and may duplicate research elsewhere. The need for federal subsidy of this type of research is not clear. Since the bulk of private industrial spending on R&D is for product development, a significant fraction of the subsidy must support research for which strong private incentives exist. It would be difficult, however, to write enforceable tax regulations that would only subsidize research activities that would not otherwise occur.

The Incremental R&E Tax Credit

When the Congress passed the Research and Experimentation (R&E) tax credit in 1981, it intended to provide a "substantial tax credit" to reduce R&E costs and encourage private firms to make these investments. 1/ At the same time, the Congress was increasing the tax benefits of other investments. To continue the traditional tax advantages of research relative to other forms of investment, the Congress granted firms a tax credit equal to 25 percent of the increase in qualified R&E expenditures above the average of such costs for the three previous years. (See box on page 22.)

By focusing on increased or incremental expenditures, the Congress intended to encourage R&D activities that might not have occurred otherwise and to avoid giving windfall tax gains to firms that did not change behavior. The design of the R&E tax credit, however, especially its emphasis on incre-

1. Joint Committee on Taxation, *General Explanation of the Economic Recovery Tax Act of 1981* (Washington, D.C.: Government Printing Office, 1981), p. 120.

HOW THE R&E TAX CREDIT WORKS

Suppose a firm has been averaging $1,000,000 per year in qualified R&E expenses. The firm is deciding whether to undertake a new research project--the X-type--that will cost $500,000 over five years, as follows: $50,000 the first year, $100,000 the second, $200,000 the third, $100,000 the fourth year, and $50,000 the last year (see table). In the first year of the X-type, the firm increases its spending by $50,000 and receives a $12,500 tax credit ($12,500 = 0.25 x $50,000). The second year, the firm spends $100,000 on the X-type, but does not receive a $25,000 tax credit. Instead it only receives a $20,833 credit. This is because the additional $50,000 spending from year one increased the base average from $1,000,000 to $1,016,667 and so reduced the credit by $4,167 ($4,167 = 0.25 x $16,667). Total credits over the five years are not $125,000 ($125,000 = 0.25 x $500,000), but rather $70,833--a 14 percent credit on the total. Note that, in the last two years of the project, the firm is ineligible for credits.

	Previous Years	Year One	Year Two	Year Three	Year Four	Year Five
	(In thousands of dollars)					
Other Projects	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
X-type	0.0	50.0	100.0	200.0	100.0	50.0
Total R&E Costs	1,000.0	1,050.0	1,100.0	1,200.0	1,100.0	1,050.0
Credit base (Three year average)	1,000.0	1,000.0	1,016.7	1,050.0	1,116.7	1,133.3
Tax Credit	0.0	12.5	20.8	37.5	0.0	0.0

mental research, reduces the value of the credit below its nominal 25 percent level and provides actual disincentives for research under a broad range of circumstances. The Economic Recovery Tax Act of 1981 (ERTA) specified that the credit was to be 25 percent of "qualified R&E expenditures" (primarily direct wage and material costs) above a base level, usually the average of three previous years' qualified expenses. But these incremental expenditures then enter into the base for the following years and lower the potential credits for those years proportionately. An incremental dollar of R&E spending yields 25 cents in credits the year it occurs, but increases the base in each of the next three years by 33 cents. Thus it reduces the potential credits in those years by 8.3 cents (25 percent of 33 cents) each year for a total of 25 cents. For a firm in this situation, the R&E credit lowers taxes by postponing them, providing interest on the value of the credit in the interim. 2/

Commercial R&D Spending Since the Credit. Little evidence is available regarding the credit's actual effects on commercial R&D. Though total commercial R&D has grown both in nominal and constant dollar terms since the credit was passed, it had begun to increase significantly even before then. Between 1970 and 1977, commercial R&D averaged 1.01 percent of gross national product (GNP). In 1979, it rose to 1.06 percent of GNP and reached 1.16 percent in 1980. The tax credit was passed in August of 1981, but was unlikely to have affected 1981 R&D spending by a significant amount because of the time required to plan projects. Since that time, commercial R&D has continued strong by recent historical standards, averaging over 1.3 percent of GNP from 1982 through 1984. 3/

There is not yet sufficient evidence to identify the factors that caused the rise in R&D spending. The rapid increase of high-technology goods as a percent of total output obviously played a role, as has the decrease in inflation and inflationary expectations. Foreign competition certainly has stimulated the automobile industry to do more research and may be driving other industries, including high-technology industries, to increase their R&D spending. It is likely that the tax credit has also played some part.

The credit is generally going to industries that perform a great deal of R&D. High-technology industries account for 50 percent to 55 percent of incremental R&D expenditures and receive about 40 percent to 45 percent

2. Robert Eisner, Steven H. Albert, and Martin A. Sullivan, "The New Incremental Tax Credit for R&D: Incentive or Disincentive?," *National Tax Journal* (June 1984), pp. 171-183.

3. National Science Foundation, *National Patterns of Science and Technology Resources 1984* (1984), p. 28 and Council of Economic Advisers, *Economic Report of the President* (Washington, D.C.: Government Printing Office, 1985), p. 232.

of the credit. 4/ The data do not disclose whether the most innovative firms are making greatest use of the credit and whether the resulting R&D has a high social payoff.

The Joint Committee on Taxation (JCT) estimates that the fiscal year 1984 loss in tax revenue through the R&E tax credit approached $1.4 billion. Since the act is scheduled to expire, the loss may decline after 1985. The Treasury will still incur losses even if the act expires, however, because firms can carry forward their unused credits (see Table 6). There are no estimates of the revenue loss if the Congress were to extend the act without modification.

Issues in the Design of the Credit. The design of the R&E credit, especially its incremental feature, raises questions regarding its role in the recent turnaround in commercial R&D. Although the Congress intended to give substantial aid, the design of the credit reduces its incentive value to many of the firms it was intended to reach.

TABLE 6. REVENUE LOSS ESTIMATES RESULTING FROM THE R&E TAX CREDIT, FISCAL YEARS 1984-1989 (In billions of current dollars)

	1984	1985	1986	1987	1988	1989
Revenue Loss	1.4	1.5	1.1	0.5	0.3	0.2

SOURCE: Joint Committee on Taxation.

NOTE: The estimates assume that the credit will expire in 1985.

4. The greatest difference is found in the aircraft and missiles industries, which performed substantial amounts of R&D but were suffering substantial losses and, hence, had few tax liabilities to offset with the tax credit. In 1981, these firms spent $3.4 billion on R&D, yet received only $14 million in tax credits. There are also differences in classification of industries between the National Science Foundation data and the Internal Revenue data. See National Science Foundation, *Research and Development in Industry, 1981* (1983), and Internal Revenue Service, *Source Book, Statistics of Income, 1981 Corporation Income Tax Returns* (1984).

Level of Incentive Depends on the R&E History of the Firm. The firm that steadily increases its R&E spending--that is, behaves in the manner the legislation was intended to encourage--will receive less credit per dollar of incremental R&E spending than will the firm that just raises its spending for one year. Perhaps more important, the credit does not provide an incentive for a firm to reverse a downward R&E trend or even a one year drop. For example, a firm with planned R&E expenditures below its three-year base would receive a greater tax subsidy from deferring a marginal R&E project than from advancing it. This is because incremental expenditures below the three-year base would not qualify for the credit, but would count in the firm's average for future credit. In one survey, 15 percent of all firms were characterized by declining R&E bases. 5/

Many High-Technology Firms Are Excluded. In its current form, the credit excludes potentially important subsets of high-technology firms--those that are not sufficiently profitable to take full advantage of the tax credits, new firms, and firms entering new markets. (These sets are not exclusive, since many new ventures are also unprofitable in their early years.) Much evidence, however, suggests that these new, high-technology firms are among the most innovative. 6/ The efficacy of the incentives is clearly diminished by the exclusion of this group.

The Credit Benefits All R&E Independent of Public Benefit. Although firms cannot claim the credit for R&E aimed at cosmetic or stylistic changes, other spending qualifies even if it offers no special return to society. Thus, firms are eligible for the credit even if their efforts are duplicative and represent an overinvestment in R&E. Since the bulk of commercial research is for product development, a significant portion of the R&E claimed for the credit may fall into this category, perhaps contrary to the intent of the Congress.

Some R&E Expenses Are Not Covered. Only direct wage expenses and materials are eligible. Building and equipment costs and indirect labor are excluded. This may introduce a bias into firms' decisions. The magnitude of the bias, however, is likely to be small relative to other influences on research investments.

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5. Eisner and others, "The New Incremental Tax Credit."

6. See, for example, L. Bollinger, K. Hope, and J. Utterback, "A Review of Literature and Hypothesis on New, Technology-Based Firms," *Research Policy*, vol. 12 (1983), pp. 1-14.

Research and Development Limited Partnerships and R&D Costs

Existing tax laws enable U.S. companies to finance research and development through Research and Development Limited Partnerships (RDLPs), rather than through their own equity, debt, or retained earnings. In essence, some corporations can lease research results from an RDLP instead of investing the capital, and assuming the risks, themselves. Of the $44 billion spent by industry on R&D in 1983, $400 million to $1 billion was spent through RDLPs. 7/ RDLP funding has been used to help develop not only high-technology products, such as high-performance computers, space equipment, and viral detection systems, but also products farther from the technological frontier such as truck engines and sports cars. Like most tax shelters, RDLPs offer significant savings to investors in top income tax brackets. 8/

RDLP Structure. A typical RDLP consists of a group of limited partners and a general partner (see box on page 27). The limited partners are high-tax-bracket, individual investors who provide almost all of the capital. They, like corporate shareholders, only risk their investments and are not subject to personal liability. The general partner is the sponsoring high-technology firm that wants to fund an R&D project. The RDLP itself, like all partnerships, is not taxed. Its net income or loss is reflected on the tax returns of individual partners. Under an RDLP, income and tax losses are typically allocated 99 percent to the limited partners and 1 percent to the general partner.

The RDLP agrees to provide capital to the general partner in return for the general partner's performance of the research. The RDLP owns the results, if any, of the research, but the general partner owns an option to acquire the results. Should the project produce a commercially exploitable product, the general partner would then exercise its option. The RDLP

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7. Richard Meyer, "Commerce Pushing Research and Deduction," *People and Taxes* (June 1984), p. 9. See also Department of Commerce, Industrial Technology Partnership Program, "Research and Development Partnerships, Illustrative Listing of 1978-1984 RDLP Activity" (December 1984), and Department of Commerce, *The Stevenson-Wydler Technology Innovation Act of 1980, Report to the President and the Congress from the Secretary of Commerce* (February 1984).

8. Throughout this section, this report uses the current interpretations of the law for RDLPs. However, because the widespread use of RDLPs is so recent, many features and interpretations of the law in the RDLP agreements have not been fully tested or agreed upon by the Internal Revenue Service. Consequently, as the courts interpret the law for RDLPs, this analysis and these revenue estimates may change dramatically.

AN EXAMPLE OF A SUCCESSFUL RESEARCH AND DEVELOPMENT LIMITED PARTNERSHIP

The research and development limited partnership (RDLP) raises funds through capital contributions from 99 limited partners and a general partner. The sponsoring corporation acts as the general partner. Each partner contributes $20,000 in year one, $30,000 in year two, $30,000 in year three, and $20,000 in year four. Hence, $10 million will be available over a four-year period. The present value of this investment (in year one) equals $8.2 million. CBO assumes 50 percent marginal tax rates for limited partners, a 46 percent marginal tax rate for the general partner, and a 15 percent discount rate.

The sponsoring corporation exercises its option to buy the resulting technology from the RDLP in year five. Product sales by the sponsoring corporation total $2.3 billion during the 11 years from year five to year fifteen. Royalties are paid by the sponsoring corporation to the limited partners at a rate equal to 8 percent of sales until payments reach 200 percent of the investment. The royalty rate drops to 4 percent of sales thereafter, ending in year fifteen. This stream of payments results in a cost of funds to the sponsoring corporation of 28 percent.

The limited partners' rate of return on their investments is 45 percent after tax. They are allowed to deduct 90 percent of their initial investment. The bulk of the royalty payments receive long-term capital gains treatment, with only a small portion of the payment being treated as ordinary income. (If the technology were patentable, the entire royalty payment would be treated as capital gains.)

The revenue loss to the government is the difference between the cost to the sponsoring corporation and the return to the limited partners (28 percent and 45 percent, respectively). The present value of the Treasury revenue loss is $6.5 million--about 80 percent of the $8.2 million. About 40 percent of the revenue loss results from expensing R&D costs and the rest results from the favorable capital gains treatment. The Treasury loss figures are net of the revenue loss associated with a non-tax preferred investment of comparable magnitude and life span.

For a more complete discussion of R&D limited partnerships' characteristics and variants, see Anthony Spohr and Leslie Wat, *Forming R&D Partnerships: An Entrepreneur's Guidebook* (New York: Deloitte, Haskins and Sells, 1983). See also, Department of Commerce, *Information and Steps Necessary to Form Research and Development Limited Partnerships* (Springfield, Virginia: National Technical Information Service, 1983).

would sell the results to the general partner in return for royalties on subsequent sales. 9/

RDLP Benefits to the Limited Partners. Limited partners in RDLPs receive two major tax benefits. 10/ The primary benefit to the limited partners is a deduction from income of 90 percent of their investment in the year the expenses are incurred. The 10 percent that limited partners are typically not allowed to deduct are the legal and placement fees. Because limited partners characteristically are in the 50 percent marginal tax bracket, deducting their investment from current taxable income virtually doubles their potential return. The limited partners in a typical RDLP also may have the income from their investment taxed at long-term capital gains rates, a maximum of 20 percent, as opposed to a maximum rate of 50 percent on ordinary income. 11/ RDLPs are not eligible for the incremental R&E credit.

The combination of immediate deduction of 90 percent of investment with payout income at the long-term capital gains tax rate can yield very large returns for the limited partners. RDLPs are sold with an expectation of after-tax rates of return up to 45 percent and 55 percent, even after fees. These high rates also reflect the high risk inherent in R&D.

RDLP Benefits to the Sponsoring Corporation. As compared with other financing options, RDLPs can offer sponsoring corporations significant benefits. In terms of cash flow, R&D spending is offset by RDLP contract revenue so that the sponsoring corporation's earnings are not decreased by R&D expenditures.

As compared with equity financing, an RDLP allows the sponsoring corporation's current owners to retain more of the firm's future income since they do not trade it away to stockholders. A sponsoring corporation that compensates limited partners with royalty rights can completely avoid dilution of equity as long as it generates sufficient cash to make royalty payments. Even a sponsoring corporation that compensates limited partners

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9. To qualify for long-term capital gains tax treatment, the RDLP must sell all substantive rights. Thus, the RDLP royalty income is not like most other royalty income, which is treated as ordinary income.

10. These benefits are not unique to RDLPs. An individual sponsoring R&D on his or her own could make use of the same benefits.

11. See Anthony Spohr and Leslie Wat, *Forming R&D Partnerships: An Entrepreneur's Guidebook*, (New York: Deloitte, Haskins and Sells, 1983), pp. 94-98.

with equity interest in the sponsor will suffer less dilution than a pure equity placement would bring. Because an RDLP limited partner, unlike a conventional investor, can immediately deduct the bulk of the investment, the limited partner requires less equity interest than would a conventional investor to achieve equal after-tax returns.

As compared with debt, RDLP financing is advantageous for two reasons. First, RDLP funds are not recorded as a liability, thus resulting in a lower debt-equity ratio for the sponsoring corporation. RDLP financing can instead be recorded on the books as contract research for the sponsoring corporation. Second, because royalty payments do not begin until sales of a product have commenced, RDLP financing does not produce early negative cash flow as is typical of debt. [12]

RDLP Costs to the Federal Government. These benefits to RDLP partners represent a cost to the government. The amount of the cost depends on whether or not the project is successful. If the RDLP produces no salable technology, the cost to the government is the same as for any other unsuccessful investment--the project is written off by the investors. But a successful project can result in tax revenue losses of amounts greater than the initial investment, and the more successful the project the greater the federal costs. This is because some or all of the royalty payments may be treated as long-term capital gains, which are subject to a lower tax. Presumably, the more successful the technology developed by the RDLP, the higher will be the sales of the products incorporating the technology and the higher the royalties. If the technology is patentable, then the entire royalty payment will receive capital gains treatment. If the technology is not patentable, only a portion of the royalty payment will receive such treatment.

Policy Issues and the RDLP. The RDLP provides an incentive to private research and development by lowering the cost of such investments and thereby raising the rate of return. Like the R&E tax credit, it is consistent with a view that underinvestment in R&D is caused by the divergence between public and private returns discussed in Chapter II.

The RDLP does not overcome all of the hindrances to R&D investment. For example, many firms may be too small to hold a diverse portfolio of R&D investments. They may not be able to reduce to acceptable levels

12. An additional advantage to the corporation is the acquisition of funds without having another set of active participants, since limited partners must remain passive.

the risks of high-payoff projects. 13/ Increased return is not an incentive to undertake such projects, because for these firms the issue is survival, not profit.

Another difficulty is that projects undertaken through RDLPs are oriented toward product development, a research activity yielding less of the external benefits of public knowledge than more basic research activities. To the extent that product development is "defensive," intended to duplicate the proprietary knowledge of other firms, it has no public benefits.

DIRECT FEDERAL SPENDING

Direct spending by federal agencies has played a major role in enhancing the competitive position of high-technology industries. For example, commercial development of the integrated circuit (IC) was a result of programs in the Department of Defense (DoD) and National Aeronautics and Space Administration (NASA). The Minuteman, Apollo, and other federal programs paid for most of the technology development and for the first IC production lines, and the federal government bought all the early output. 14/ Similarly, many advances in the aircraft industry resulted from federal research programs or from manufacturers' efforts to meet federal needs. Much of the Boeing 747 and McDonald Douglas DC-10 technology was developed in the course of competition for the federal jumbo cargo carrier contract, eventually won by Lockheed's C-5A. Federal space and defense programs were also responsible for the development of many plastics and other materials now commonplace in such items as the non-stick frypan.

The amount of this direct federal support is large, but difficult to estimate because it is scattered through the budgets of many agencies. Most obviously, the Department of Defense and the National Aeronautics and Space Administration provide aid that enables firms either to improve the general state of their technology or to do research at their own discretion. Other agencies supporting high-technology industrial research include the National Bureau of Standards, the National Science Foundation (although most of its work is for basic research), and the Department of Health and

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13. Richard R. Nelson, *High Technology Policies: A Five Nation Comparison* (Washington, D.C.: American Enterprise Institute, 1984).

14. See Anthony M. Golding, "The Semiconductor Industry in the United States and Britain: A Case Study of Innovation, Growth and the Diffusion of Technology," unpublished D. Phil thesis, University of Sussex, 1971. See also John G. Linvill and Lester Hogan, "The Intellectual and Economic Fuel for the Electronics Revolution," *Science* (March 18, 1977).

Human Services and its institutes, which support drug and medical technology. [15] Some of the larger programs are listed in Table 7.

Some analysts have argued that because it is not commercially motivated, most federal research goes unused. While the rate of federal

TABLE 7. DIRECT FEDERAL AID TO HIGH-TECHNOLOGY INDUSTRIES (In millions of current dollars)

Outlays	Fiscal Year 1983
Department of Defense	
Independent R&D Reimbursement	1,579
Bid and Proposal Reimbursement	948
Very High Speed Integrated Circuit Program	50
National Aeronautics and Space Administration	
Aeronautical Research	539
Independent R&D Reimbursement	76
Bid and Proposal Reimbursement	55
Health and Human Services	
National Institutes of Health	3,538
Other Health and Human Services	554
Department of Commerce	
National Bureau of Standards	113
National Science Foundation	992
Total	8,444
Department of Defense	
Manufacturing Technology Program	131[a]

a. The Manufacturing Technology Program budget is total obligational authority and hence cannot be compared directly with the other figures. No outlay estimate is available.

15. For a complete breakdown of agency by agency support for innovation, see Office of Management and the Budget, *Special Analyses, Budget of the United States Government, Fiscal Year 1986: Research and Development*. Aid for high-technology development is only a portion of the total.

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patent use is low, this does not necessarily mean that federal direct spending on R&D is of no use to high-technology firms. A recent survey of the information sources of private R&D managers and executives found that high-technology industries made much more use of government research than did other industries. 16/

Most of the programs in Table 7 do not obligate the participating firms to produce a specific product or technology. Rather, these programs are designed to enhance the productive capabilities of industries, usually high-technology industries, in a wide variety of areas without limiting the technology to purely federal use. For that reason most DoD and NASA R&D contracts are not included in the funding totals of Table 7, because these contracts usually call for the development of goods for agency use. Similarly, overall revenue flows from the federal government to industries were not included nor was funding where the federal government was acting primarily as a consumer. (The one exception to this rule is the Very High Speed Integrated Circuit program, where the defense applications are virtually identical with commercial uses of the technology.) 17/

Independent R&D Reimbursement

The DoD and other agencies permit contractors to add an overhead charge of 3.5 percent to 4.0 percent on their sales to the federal government. The overhead charge, usually in the form of reimbursement for costs incurred, is to be spent on R&D projects with potential federal relevance. The cost of the Independent R&D (IR&D) program was $1.7 billion in 1983, the latest

16. Richard Levin and others, *Survey Research on R&D Appropriability and Technological Opportunity* (paper prepared under National Science Foundation Grant PRA-8019779, July 1984).

17. The programs listed herein constitute only a portion of all of the R&D done by the government in these industries. This is because not all federal R&D funds are to provide support: a great deal of the federal R&D spending in these industries is for products it intends to purchase. In 1980, federal R&D funds for high-technology industries amounted to 2.7 percent of sales; this was three times the manufacturing average of 0.9 percent. While the average is skewed by the aerospace industries, which received federal research funds equivalent to 9.9 percent of their net sales, only two of the industries had less than the national average. National Science Foundation, *Research and Development in Industry, 1982*, (1984), pp. 23 and 24. For reasons of confidentiality, federal research funds by industry are not available for years after 1980.

year for which estimates are available. [18] Of the total, the DoD accounted for $1.6 billion. [19] NASA provided most of the remaining $100 million.

IR&D aid goes only to federal contractors, thus excluding many high-technology firms. Mitigating this, however, is the fact that large federal contractors tend to perform substantial R&D. The level of government oversight in the IR&D program is much less than that for research contracts or grants, so that it is difficult to evaluate the program's success in generating commercially viable innovation. [20]

Bid and Proposal Reimbursement

Defense and other federal contractors are also permitted to inflate their bid and proposal (B&P) costs as an incentive for engineering and technical work of potential use to the government. This program is similar to the IR&D program, and the two are usually classified together. B&P reimbursements were estimated to have cost DoD $950 million in 1983. The comments made above concerning IR&D also apply to B&P reimbursement.

Manufacturing Technology

The Manufacturing Technology (Mantech) program of the DoD assists defense contractors in upgrading their productive capabilities. The intent is to improve process technology and disseminate the improvements to the industry at large. Much of the aid involves high-technology manufacturing, such as electronics, computer-aided design and manufacture (CAD/CAM), and jet engine manufacture.

Unlike procurement contracts, which contain, implicitly or explicitly, funds to maintain productive capacity, Mantech support is not directed at

18. For program details, see Franklin Long, "Indirect Support for U.S. Programs of Research, Development, and Innovation," in National Science Foundation, *Papers Commissioned as Background for Science Indicators-1980*.

19. Defense Contract Audit Agency, "Summary of Independent Research and Development and Bid and Proposal Costs Incurred by Major Defense Contractors in the Years 1982 and 1983" (March 1984).

20. Most of the DoD personnel assigned to assess the IR&D programs admit to being technically unqualified or only able to judge individual projects in the most general way. For a review of IR&D monitoring by the DoD, see *Report to the House Appropriations Committee, DoD Appropriations for 1983*.

the production of one specific item. Thus, while individual DoD procurement items may receive Mantech contracts, the intent is to improve the production process in a way that can be applied to many other procurement items. For instance, Mantech contracts have been used to improve the production of high resistivity silicon, which presumably benefits all semiconductor manufacturers that use high resistivity silicon.

Like the IR&D, Mantech funds go only to DoD contractors and therefore the commercial impact of the support is indirect. No systematic studies have been made of the penetration of Mantech-originated process technologies into the marketplace. 21/

Aeronautical Research--The First "A" in NASA

NASA spends over $500 million every year on commercially oriented aeronautical R&D. The agency maintains large wind tunnels and other test facilities, which are widely used to improve the state of technology among civil aircraft manufacturers. The replacement value of these facilities is around $8 billion. The research areas on which NASA concentrates include fuel efficiency, noise and emission reduction, and safety--areas in which the external effects of the technology are greatest. In response to the challenge to U.S. domination of the helicopter market, NASA also launched a rotorcraft research program. 22/

The Very High Speed Integrated Circuit (VHSIC) Program

In the late 1970s, the DoD had difficulty in interesting semiconductor manufacturers in designing circuits for its use. Consequently, it began a program to encourage semiconductor makers to concentrate on Very High Speed Integrated Circuits (VHSIC). These circuits are needed because weapons systems must process information much more rapidly than in most civilian applications. Military designers had previously relied on versions of civilian integrated circuits that emphasized high reliability, radiation hardness, and

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21. For more details on the Mantech Program, see Department of Defense, *Proceedings of the Thirteenth Annual DoD Manufacturing Technology Conference* (1981). See also, General Accounting Office, *DoD Manufacturing Technology Program--Management Is Improving but Benefits Hard to Measure,* November 30, 1984.

22. For more detail on this program, see Office of Science and Technology Policy, Executive Office of the President, *Aeronautical Research and Technology Policy* (November 1982).

ability to function under a wide range of temperatures. Some industry analysts suggested that the military was not making the best use of the available technology, and that further demands would distract the industry from competition with Japan.[23] Nevertheless, in 1979, the DoD let out contracts to six VHSIC design teams. Phase I was to spend $150 million between fiscal years 1979 and 1984. Phase I devices are now being delivered to the DoD, but the cost has been closer to $350 million. The entire program is currently projected to cost almost $750 million by 1989.

Initial reports on VHSIC suggest that the program has been a success in several ways. First, the contractors are delivering semiconductor devices that often exceed initial projections of performance.[24] Second, and perhaps more important, VHSIC programs seem to have stimulated work of commercial relevance among the six contractor teams, several of which are among the top 10 U.S. semiconductor manufacturers (International Business Machines, Texas Instruments, Motorola, National Semiconductor). Much of the work needed to meet VHSIC designs is also useful in the commercial market, because the program has emphasized improved use of conventional materials and technologies rather than radically new approaches. For instance, both the military and the civilian markets have shown an interest in improving lithography in order to produce integrated circuits with smaller features. Many of the VHSIC devices are being manufactured with the use of Complementary Metal-Oxide-Semiconductor (CMOS) technology, which is widely employed in the latest generation of commercial semiconductor devices. Finally, the VHSIC program may have played a catalyst role by encouraging companies to further their own commercial research.[25]

Because VHSIC has generally followed the trajectory of commercial technological development, it is unclear whether VHSIC has accelerated technological advance or merely subsidized firms for performing R&D necessary for continued participation in the semiconductor market. VHSIC clearly increased the cooperation among participant firms and so reduced

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23. For an early discussion of the potential effects of VHSIC, see David Moore and William Towle, *The Industry Impact of the Very High Speed Integrated Circuit Program: A Preliminary Analysis* (Arlington, Virginia: The Analytic Sciences Corporation, 1980).

24. Philip Klass and Benjamin Elson, "VHSIC Chips Emerge," *Aviation Week and Space Technology* (July 30, 1984).

25. "CMOS Circuits Edge Below 1 Micrometer," *Electronics Week* (September 10, 1984).

duplication and costs. 26/ There are also signs of commercial exploitation--some VHSIC participants have petitioned the DoD for permission to sell these devices on the open market. 27/ Anecdotal evidence of this kind suggests that the VHSIC program has been a combination of catalyst and subsidy.

National Bureau of Standards

The National Bureau of Standards (NBS) provides industry with broad-based support in measurement technology and standardization. As industrial technology has become more complex, so has the mission of NBS. A century ago, making measurements was fairly straightforward (a screw of x diameter, with so many threads to the inch, having a given pitch). Present-day industrial processes require not only measurements, but also new methods by which to establish those measurements. When the semiconductor industry needed commercial standards for silicon resistivity and thermal conductivity, for example, the NBS had to develop the technology for establishing them. 28/

NBS research clearly enhances the commercial capabilities of high-technology industries. Its development of measurement techniques responds to an especially severe case of market underinvestment in R&D. In order to become an industry standard, a measurement technique has to be widely diffused and so cannot be proprietary. Individual firms have little interest in developing the measurement technologies needed for industry standards; yet, such development is necessary for commercial markets to function.

In order to ensure that it is developing the appropriate measurement tools, NBS has to maintain relatively close contact with the industries concerned. Conversely, firms maintaining close ties with NBS have a clear competitive advantage over those that remain distant. Evidence suggests

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26. See Klass and Elson, above.

27. One recent study suggests that the security and export control regulations surrounding the VHSIC technologies will reduce resulting commercial applications. See Leslie Brueckner and Michael Borrus, "Assessing the Commercial Impact of the VHSIC Program" (Berkeley:Berkeley Roundtable on the International Economy, University of California/Berkeley, 1984).

28. See Gregory Tassey, "The Economic Role of the National Bureau of Standards" (1985). Also by the same author, "The Role of the Government in Supporting Measurement Standards for High Technology Industries," *Research Policy 11* (1982), pp. 311-320.

that firms with close NBS contacts have had a higher rate of patenting than other firms in the field. 29/

NBS is a relatively small agency. Its entire R&D budget was $95 million in 1984, of which $75 million was for applied research and development. Thus, although it is the agency with the broadest mission of those listed here, it is also the one with the smallest budget.

National Institutes of Health

The National Institutes of Health (NIH) do considerable research related to drug and biomedical equipment. The percentage of the NIH budget spent on such research is difficult to estimate. Of $4.4 billion NIH spent on R&D in 1984, $1.5 billion was for applied research or development, which are more likely to be immediately useful to drug and equipment firms than basic research.

NIH seeks actively to transfer its technology to potential users. It sponsors clinical trials, specialized centers, conferences, and demonstration projects. Its medical applications office holds 8 to 10 meetings per year (50 since the mid-1970s) where the efficacy and safety of a new technology and/or clinical procedure are discussed. These panels attempt to present to the relevant community the experience and range of expert opinion on tools and procedures developed under NIH aegis. 30/

NIH efforts to transfer its research results to private parties appear to be successful. Its role in the development of biotechnology has often been called pivotal: in 1982, NIH spent $300 million to $350 million on various R&D projects relating to biotechnology. 31/ Similarly, NIH has provided R&D money to develop medical devices. While its funding accounts for only

29. Charles River Associates, *Productivity Impacts of National Bureau of Standards Research and Development: A Case Study of the Semiconductor Technology Program* (Gaithersburg, Maryland: National Bureau of Standards, 1981). The evidence may be biased insofar as NBS would want to choose firms with high reputations, and technologically dynamic firms are likely to seek out sources of new information. This does not necessarily refute the contention that NBS helps the industry and that some firms benefit more than others.

30. For a more complete analysis of NIH's efforts at technology transfer, see NIH, *Technology Assessment and Technology Transfer in DHHS* (submitted to the Department of Commerce, 1984).

31. For a more complete description of the NIH role in biotechnology, see Office of Technology Assessment, *Commercial Biotechnology: An International Analysis* (Washington, D.C.: Government Printing Office, 1984), pp. 310 and following.

a small amount of the research spending in the field, NIH grants may have been significant in the development of specific devices. [32] Some of its efforts in producing biomedical devices have even found applications outside the health field: NIH grants supported much of the early research done on fiber optics, while trying to devise diagnostic tools. [33]

Other Health and Human Services Agencies

Although NIH accounts for close to 90 percent of the Department of Health and Human Services' (HHS) research budget, other HHS agencies may also contribute to high technology research: most notably, the Alcohol, Drug Abuse, and Mental Health Administration, the Center for Disease Control, and the Food and Drug Administration (FDA). In these agencies, the bulk--and, in some case, all--of the spending is for applied research and development. Together they spent $404 million in 1983 on applied research and development, while their total spending came to $554 million. As with the NIH, the likely high-technology beneficiaries of this research are the drug and medical equipment manufacturers. It should be noted that the federal government's role in the drug and medical devices industries is not only that of support. Federal safety regulations may slow the introduction of new drugs and medical devices to ensure the public safety. The FDA does the bulk of the research connected with these regulations. [34]

The National Science Foundation

The National Science Foundation (NSF) has the mission of aiding basic research in science. Its budget is oriented toward basic research rather than product development and applied research. In 1984, 95 percent of its funding went for basic research, while it devoted only $66 million to applied projects.

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32. For more details, see Office of Technology Assessment, *Federal Policies and the Medical Devices Industry* (Washington, D.C.: Government Printing Office, 1984), pp. 70-80.

33. For a catalog of cases where NIH technology has seen widespread use outside of the health field, see NIH, *Biomedical Discoveries Adopted by Industry for Purposes Other Than Health Services* (March 1981).

34. For an analysis of both aspects of the federal role, see Henry Grabowski and John Vernon, "The Pharmaceutical Industry," in Richard R. Nelson, ed., *Government and Technical Progress: A Cross-Industry Analysis* (New York: Pergamon Press, 1982), pp. 283-360.

Many useful inventions and findings have resulted from NSF-sponsored research, but the bulk of its results find no immediate commercial use. Attempts to determine whether in the long run NSF-sponsored research, and basic research in general, have contributed to market growth are mired in theoretical and methodological debates. 35/

Other Programs

Other federal agencies also have programs to aid the technological advance of emerging industries. In many other areas, federal agencies fund, research, collaborate, and mediate to enhance the competitive and technological capabilities of these industries. Limitations of space prevent their inclusion in this report individually. A general discussion of individual agencies' R&D mission is presented in the President's budget for 1986. 36/

35. See Congressional Budget Office, *Federal Support for R&D and Innovation* (March 1984) for a discussion of the lack of clear links between basic research and measures of economic growth. See also Gordon Gayer, *Multi-Case Studies of Technological Innovation: A Survey and the State of the Art* (Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1974).

36. Office of Management and the Budget, *Budget of the United States Government, Fiscal Year 1986, Special Analysis K: Research and Development.*

CHAPTER IV

CAPITAL COSTS AND FEDERAL POLICIES

Proponents of increased financial support for high-technology industries argue that these industries have higher capital costs than do other industries, in part because they do not receive the full benefits of tax deductions for plant and equipment. This is held to occur for two reasons: high-technology industries do not make as large an investment in plant and equipment as the more mature industries, but rather invest in research; and the equipment in high-technology industries becomes obsolete much more rapidly than conventional depreciation guidelines allow. 1/ In this chapter, some of these assertions are analyzed.

AVERAGE TAX RATES OF HIGH-TECHNOLOGY CORPORATIONS

Investments in depreciable assets in high-technology industries receive the same tax treatment as those of other industries; nevertheless, there is a widespread perception that these industries are taxed at higher rates. 2/ Factual support for this point is mixed: the observed tax rate for an industry depends quite crucially on how the "tax rate" is defined and what data are used.

Recent studies have used economic data and definitions, book data and definitions, and tax data and definitions. One recent study using economic data suggests that the technology-oriented sectors pay slightly more in taxes as a percent of economic profits than manufacturing as a whole. 3/ The study also found that the high-technology sector's tax rate was 16 per-

1. See American Electronics Association, Computer and Business Equipment Manufacturers Association, Electronic Industries Association, Scientific Apparatus Makers Association, and Semiconductor Industry Association, *High Technology Tax Policies for the 1980's* (January 1984).

2. See Congressional Budget Office, *Federal Support of U.S. Business* (1984) for a list of sector-specific tax benefits.

3. Economic profits equal books profits adjusted to reflect capital consumption adjustments and inventory valuation changes. See Charles Hulten and James Robertson, "The Taxation of High Technology Industries," *National Tax Journal* (September 1984), p. 333.

cent higher than that of the mature portion of the manufacturing sector. Although suggestive, these results are only partially applicable because the study aggregated industries into sectors at the two-digit SIC major industry-group level. Except for instruments, the present report uses the narrower three-digit industry groups in which the trends of the high-technology industries are less likely to be obscured. (For instance, the computer and office machine industry group accounts for only 10 percent of the shipments of the two-digit major industry group of which it is a part.)

A second approach, taken by the Joint Committee on Taxation, samples the firms in each industry and estimates their average tax rate from accounting data in their annual reports. The sample usually includes the largest firms in each of 30 industries. Using this sample, 1983 tax rates were found to be slightly higher for high-technology firms than the all-industry average: 20 percent versus 17 percent.[4] The average of 1980, 1981, 1982, and 1983 had a smaller spread: 20 percent versus 18 percent. Sampling only large firms, however, may introduce a significant bias since small firms and new startups are likely to have a much different tax rate.

Tax data present a different view. Statistics of Income, published by the Internal Revenue Service, suggests that the average tax rate for high-technology industries is slightly less than that for manufacturing in general. This average, however, masks significant differences among high-technology industries. Some, notably the electronic components industry and the instruments industry, pay rates that are consistently higher than average, while others pay much less.[5] These figures, shown in Table 8, should be interpreted with caution. The denominator, taxable income, is not adjusted for capital consumption or inventory profits and so the ratio may misstate the economic tax rate. The IRS data also combine domestically earned income with foreign-source income. Moreover, they reflect preaudit tax returns, which may differ from the final returns. Finally, these industries are defined at the level of the firm, thus distorting the information from multiproduct firms. (For example, U.S. Steel is classified as an oil company, because more of its income comes from oil than from steel as a result of its purchase of Marathon Oil.)

In sum, no interindustry comparisons of tax rates are without flaw. Some studies suggest that high-technology industries do pay higher taxes,

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4. See Joint Committee on Taxation, *Study of 1983 Effective Tax Rates for Selected Large U.S. Corporations* (Washington, D.C.: Government Printing Office, 1984), p. 20.

5. The Joint Committee on Taxation study reports a similar wide dispersion in high-technology industry tax rates.

but the IRS data imply that this claim must be narrowed considerably. Indeed, all studies indicate a wide variability of tax rates within the high-technology community. The strongest statement that can be made with confidence is that some segments of the high-technology community seem to bear a higher than average tax burden, but not necessarily the community as a whole.

This observation by itself does not lead to a policy conclusion that financial assistance is warranted. In any distribution of tax burden, some industries must be above the average and some below. Thus, it is important to inquire whether high-technology industries are characteristically unable to use some of the tax advantages the Congress intended for them.

TABLE 8. AVERAGE TAX RATES (Percent of net income less deficits)

Industry Group	1981	1980	1979	Average
Manufacturing	26	26	26	26
Drugs	18	20	22	20
Chemicals	N/A	N/A	N/A	N/A
Computers and Office Equipment	15	16	18	16
Communication Equipment	25	26	23	25
Electronic Components	35	32	32	33
Aircraft and Missiles	N/M	N/M	26	N/M
Instruments	26	32	30	29

SOURCE: Internal Revenue Service, *Source Book: Statistics of Income, Corporation Income Tax Returns*, various years.

NOTE: Because of the large deficits in the aircraft and missiles industries, the numbers in the tables do not reflect the taxes paid by the firms actually making profits. The average tax rates for those firms in 1980 and 1981 were 24 percent and 23 percent, respectively. For other industries, the relative positions are not affected by deficit adjustments. N/A = Not Available. N/M = Not Meaningful.

TAXATION OF INCOME FROM CAPITAL INVESTMENTS

This section analyzes the tax treatment of capital investments in high-technology industries. First, the level of investment in depreciable assets in different industries is examined, to investigate the claim that the depreciation laws do not aid high-technology industries. Then the report analyzes the tax treatment of incremental investments to see the effects of rapid obsolescence in high-technology industries.

Investment in Depreciable Assets

Not all high-technology industries invest less in depreciable assets than do other industries. Measured as a percent of output, high-technology industries spend on average either almost as much as or more than manufacturing in general on depreciable assets. While some high-technology industries have depressed investment levels (in some cases because their plant and equipment is provided by the Department of Defense), most have investment levels comparable with or higher than the manufacturing average. 6/ Capital investment for all manufacturing in 1981 was 3.9 percent of output (see Table 9). Many high-technology industries invested in amounts over 5 percent of output. Excluding from the overall average the aerospace industries, where government-owned defense equipment is concentrated, the high-technology investment average rises to almost 6 percent. (See Appendix C for other views of capital investment in high-technology industries.)

Effective Tax Rates for Depreciable Assets

Analysis of effective tax rates suggests that high-technology firms do not pay higher taxes on their new investments in plant and equipment than manufacturing in general. The "effective tax rate" as used here is the difference between the pretax rate of return and the post-tax rate of return on new investments. It is a "marginal" rate because it applies to new investments rather than the average of all investments. Of course, this effective rate may not apply to every firm in every industry. Firms with no current tax liabilities cannot use their allowable tax benefits. In most cases, however, the effective tax rate can suggest how much the federal tax system increases costs.

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6. For a measure of the importance of DoD capital plant and equipment--the so-called GOCO (Government-Owned, Contractor-Operated) plants--see Department of Defense, Defense Industrial Resources Support Office, *Annual Report on the Status of Defense Industrial Reserve* (various years).

The effective tax rates for depreciable assets were calculated according to the formula in Appendix B. The effective tax rates facing high-technology industry investments proved to be lower than those facing manufacturing industries on average (see Table 10). While manufacturing industries on average had an effective tax rate of 22 percent, the high-technology industries had an overall effective tax rate of 19 percent. In two high-technology industries, the effective tax rate roughly equalled the man-

TABLE 9. INVESTMENT IN DEPRECIABLE ASSETS (In percent of output)

Industry Group	SIC Code	1977	1981
All Manufacturing		3.4	3.9
Drugs	283	4.0	4.6
Industrial Organic Chemicals	286	11.1	6.9
Office and Computing Machines	357	4.7	6.1
Communication Equipment	366	2.9	4.9
Electronic Components	367	4.9	8.0
Aircraft and Parts	372	1.9	3.0
Missiles and Space Vehicles	376	2.6	3.0
Instruments	380	3.2	4.1

SOURCE: Congressional Budget Office, calculated from Bureau of Census, *Annual Survey of Manufactures, Statistics for Industry Groups and Industries* (various years).

NOTE: Output is defined as value of shipments plus changes in inventory from the previous year. Depreciable assets include structures and equipment, but not land, which is not depreciable.

ufacturing average. The reason for this difference is that high-technology industries invest in equipment to a greater extent than manufacturing in general, which is more weighted toward structures. Combining accelerated depreciation and the investment tax credit, equipment may receive more than the present-value equivalent of simply deducting the equipment costs as incurred, while structure depreciation allowances are less generous. The 1984 changes in depreciation for structures, which increased the recovery period from 15 to 18 years, have made this difference even sharper. 7/

TABLE 10. EFFECTIVE TAX RATES (In percents)

Industry Group	Normal Economic Depreciation	Rapid Obsolescence
Manufacturing	22	---
Computers and Office Equipment	23	26
Communication Equipment	20	23
Electronic Components	17	19
Aircraft	10	10
Instruments	23	26

SOURCE: Congressional Budget Office.

NOTE: See Appendix B for the effective tax rate formula. Inflation was assumed to be 4.2 percent and the nominal interest rate 15 percent. Appendix B presents CBO's effective tax rate model. The normal depreciation column used economic depreciation rates estimated from capital assets sales data. In the rapid depreciation column, the depreciation rates were arbitrarily increased for high-technology industries assets by 50 percent, or, equivalently, the economic lives of assets were shortened to simulate technological obsolescence.

7. Jane Gravelle of the Congressional Research Service found that the effective tax rate on new investment in the electronics industry was not significantly higher than the tax rate for all industries (23 percent and 22 percent respectively), assuming a 4 percent inflation rate and a 6 percent discount rate. See Jane Gravelle, "Effect of Higher Discount Rate on Tax Burdens in High Technology Firms," Congressional Research Service (unpublished memo, February 27, 1984). Slight differences in functional forms and industry definition explain the discrepancy between her estimate and this one.
(Continued)

This conclusion also holds when correction is made for the rapid technological changes that characterize high-technology industries. The tax laws can require these firms to keep a piece of equipment on the books long after technological advance has made it obsolete. This divergence between economic life and tax life could cause a higher tax burden to be placed on assets in high-technology industries. 8/

To test this argument, the rates of economic depreciation of all assets of high-technology firms were increased arbitrarily by 50 percent. For instance, in the aircraft industry, the average asset, including buildings, was depreciated at 18 percent a year, instead of 12 percent--the normal rate for that industry. 9/ When these changes were made, the effective tax rate did rise, as shown in Table 10, but remained at or below the manufacturing average for three of the five high-technology industries. In two industries, the rate was higher than that of the manufacturing average, but not substantially. 10/

THE STRUCTURE OF FINANCING IN HIGH-TECHNOLOGY INDUSTRIES

Firms can raise capital through interest-bearing debt, through equity instruments (such as common stock), and through retained earnings. The ratio of

7. (Continued)
Similarly, Charles Hulten and James Robertson, using slightly different, but still comparable definitions of high technology, found that the marginal effective tax rate for the high-technology sector was slightly lower than that of "smokestack industry." Again, differences in functional form and in industry definitions resulted in different absolute values. See Charles Hulten and James Robertson, "The Taxation of High Technology Industries," *National Tax Journal* (September 1984), p. 333. It should be noted that all three studies overstate the effective tax rate on high-technology investments, because R&D investments are not included. To the extent to which such investments qualify for expensing or the credit, their effective tax rate is zero or even negative. Since the high-technology industries have higher than average R&D investments, this effect should be greater for them than for the average of all industry.

8. American Electronics Association, Computer and Business Equipment Manufacturers Association, Electronic Industries Association, Scientific Apparatus Makers Association, and Semiconductor Industry Association, *High Technology Tax Policies for the 1980's* (January 1984).

9. In the aircraft industry, 12 percent is the weighted average annual depreciation rate. For the depreciation rates and a general discussion of how they are derived, see Charles R. Hulten and Frank C. Wykoff, "The Measurement of Economic Depreciation," in Charles Hulten, ed., *Depreciation, Inflation and the Taxation of Income from Capital* (Washington, D.C.: The Urban Institute, 1981), pp. 81-123.

10. Jane Gravelle obtained parallel results. See footnote 7.

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debt to the sum of equity and retained earnings indicates the extent to which debt has been used to provide a larger amount of working capital. Firms with a large amount of debt relative to their net worth, such as airlines, are considered highly "leveraged." Firms in growing or cyclical industries, on the other hand, tend to be less leveraged.

Firms in high-technology industries tend not to be highly leveraged. Recent surveys of corporations show that high-technology firms generally have a significantly lower debt-to-capital ratio than industry as a whole. For all manufacturing, debt averaged 31.6 percent of capital, defined as debt plus stockholders' equity, during the 1981-1983 period. By contrast, high-technology industries' debt averaged 26.7 percent of capital for the same period. (See Table 11 for specific industry figures.) 11/ This occurs

TABLE 11. CORPORATE DEBT BY INDUSTRY (As a percent of invested capital)

	1980	1981	1982	1983	Average
All Manufacturing	30.4	31.1	32.5	31.2	31.6
Drugs	24.7	26.1	25.5	25.1	25.4
Industrial Chemicals	34.9	34.7	36.4	35.0	35.5
Computers and Office Equipment	N/A	N/A	N/A	N/A	N/A
Electrical and Electronics	28.8	27.5	27.7	26.8	27.7
Aircraft and Missiles	26.1	27.2	28.9	25.6	27.0
Instruments	19.8	18.2	18.1	17.4	18.4

SOURCE: Congressional Budget Office from Bureau of the Census, *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations* (various issues).

NOTE: N/A = Not Available. Invested capital is the sum of total debt, retained earnings, and capital stock (valued at its initial offering price) less stock that has been repurchased by the firm. Debt consist of both long- and short-term debt.

11. The financial surveys from which these data are derived use industry definitions differing from those of this report in several ways. The industrial chemicals and electrical and electronics industry groupings are broader than those used here, and thus their averages may not be identical to the industry grouping average. The data for the computer and office equipment industry were buried in a much larger industry group and therefore not available. Aircraft and missiles were reported jointly.

for several reasons. First, high-technology firms face considerable risk in turning their research into products. Even when the general outlines of a product are known, its market success may depend on specific attributes that are not yet known. Firms are always introducing new products with high risks of failure. Stockholders are required to share these risks, while creditors are not. An unprofitable firm with a large schedule of debt repayments could be forced into bankruptcy. 12/ Regular debt payments also consume the cash needed to continue growing, whereas equity investors can take their returns in capital gains.

On the other hand, the cost of equity may be high for a successful firm. Giving up a portion of all the firm's future income in return for capital funds invested in the current year may prove a very expensive exchange. One may note, for example, the implicit cost of selling $100,000 in Apple Computer equity in the mid-1970s: that stock is now worth in the tens of millions of dollars.

Thus, in the aggregate, it is hard to determine whether high-technology firms indeed pay more for their capital funds. 13/ Some startup firms clearly do, but that may be largely because they are perceived as more risky. To the extent that high-technology companies, whether startup or mature, are perceived as more risky than others, their capital fund costs are likely to be higher and the appropriate federal response may very well be to leave the market to determine how to evaluate risk.

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12. Much the same is true for industries with a high degree of cyclical variation in output. Firms in these industries have to hold their fixed payments down to levels bearable at the low point of the business cycle. Since many high-technology industries are cyclical, they should also conform to this pattern. For one case, see Federal Trade Commission, *The Semiconductor Industry: A Survey of Structure, Conduct, and Performance* (Washington, D.C.: Government Printing Office, 1977).

13. Interactions between debt and equity and the tax system make it difficult to determine the relative costs of these means of financing. Firms in the United States, with its highly developed capital markets, will presumably choose a mix of equity and debt that minimizes their expected cost of funds. Barring imperfections in the capital markets, one would assume that, at the margin, the expected cost of each should be the same. The different risk and cost associated with each form of capitalization are difficult to quantify in the abstract or the aggregate--for instance, the added cost of equity that comes with added debt. Moreover, firms can work only with their expected costs: all forms of financing involve some uncertainties, and these are beyond the control of the firm. Considerations of relative costs also depend on whose cost is being analyzed. Management's perspective of risk and return may be very different from that of the existing stockholders.

Tax Policies Regarding Debt and Equity

Payments on debt (interest) and on equity (dividends) receive very different tax treatment, and this may exacerbate differentials in capital funds costs. Some analysts note that interest payments are deductible to the corporation, while dividend payments are taxed twice both as corporate income and as stockholders' income; hence, this is held to bias firms' capital costs. There are substantial limits to the tax advantages of debt, however. The deductibility of interest payments may make net income small enough that a firm finds itself unable to use all its depreciation allowances and has to carry them forward one or more years. If that occurs, then the user cost of equipment and structure investments will rise and reduce, perhaps substantially, the advantage of debt. 14/

The preferential treatment given long-term capital gains offsets the advantage of interest deductibility less than completely, and under limited circumstances. Investors tend to hold high-technology stocks more for their capital appreciation than for the dividend stream, which often does not exist. Since long-term capital gains receive a 60 percent exclusion, this lowers the overall taxes on that part of capital income. But the tax treatment of capital gains is asymmetrical. Capital loss deductions are limited in size. Typically, capital loss deductions cannot exceed capital gains plus $3,000. (Under specific circumstances, the actual limit may be different.)

Thus many have argued that the differential treatment of debt and equity can interact with the low leverage typical of high-technology firms in a way that raises their capital costs above those of other firms that are equally risky because they are more highly leveraged. Other parts of the tax code can, however, offset this disadvantage, so that it is impossible to determine whether the tax system as a whole confers a net reward or penalty on high-technology firms. For example, as noted in the previous section, the present system of depreciation allowances often combines with those firms' patterns of investment in plant and equipment to produce a lower effective tax rate on their new investments than for manufacturing as a whole.

THE ROLE OF CAPITAL GAINS TAXES IN VENTURE-CAPITAL INVESTMENT

A form of equity that has been very important in high-technology industries is venture capital. Venture-capital investors typically invest in new ven-

14. See Congressional Budget Office, *Revising the Corporate Income Tax* (May 1985).

tures or startup companies in exchange for a share of the ownership. They receive few, if any, dividends; rather, their return comes when a firm is sold to another company or issues publicly traded stock. Their returns are thus mostly in the form of capital gains and are sensitive to the tax treatment of capital gains.

Many of the most successful high-technology startup companies have been funded by venture-capital firms. These play a crucial role as intermediaries between persons seeking to start high-technology or other companies and persons wishing to invest in them. Along with their role in locating and screening investments, they often also play a role in the management of these startup companies. The small but active venture-capital industry should not be confused with other entrepreneurial activity: most starting companies, including many in the high-technology industries, do not depend on venture capital. Venture-capital firms tend to be active, however, in the startup of enterprises with the highest perceived opportunity for rapid growth. (These new enterprises have no monopoly on innovative activity or high-technology investment. As noted in previous chapters, existing firms in high-technology industries tend to have above-average rates of R&D and capital investment.)

Previous Changes in Capital Gains Taxes

After the Congress reduced the maximum tax rate on capital gains in 1978, the amount committed to venture-capital funds skyrocketed from $39 million in 1977 to $4.5 billion in 1983. Some venture-capital investors hold that this growth resulted from the capital gains reduction. They note that when the rate was raised in 1969, investment in venture capital fell by half and remained stagnant throughout the 1970s (see Table 12).

While the figures are certainly dramatic, other forces also played a part. The military spending decline of the early 1970s was severely felt in the electronics industries, especially at the high-technology end. 15/ These "recession-proof" industries hit their first slowdown in a decade, and the prices of their stocks plummeted. The phasing in of the capital gains tax increase of 1969 may have further depressed stock prices by providing an incentive to sell sooner rather than later. Moreover, any highly speculative period in the stock market tends to be followed by a period of correction; this may have discouraged venture investment in the early 1970s. The

15. For a discussion of the role of the 1970s recessions in the high-technology industries, see Philip Webre, "Technological Progress and Productivity Growth in the U.S. Semiconductor Industry" (Ph.D. Dissertation, American University, 1983).

energy crisis that followed brought a very deep recession. Capital spending dropped. Once again electronic sales, and especially high-technology sales, stagnated.

The High-Technology Boom

As the economy began to recover from the 1974-1975 recession, the demand for high-technology electronic goods boomed. Their shipments began a rapid

TABLE 12. VENTURE-CAPITAL INDUSTRY ESTIMATED FUNDINGS (In millions of dollars)

Year	Net New Private Capital Committed to Venture-Capital Firms[a]	Size of Total Investment Pool
1969	171	2,500-3,000
1970	97	2,500-3,000
1971	95	2,500-3,000
1972	62	2,500-3,000
1973	56	2,500-3,000
1974	57	2,500-3,000
1975	10	2,500-3,000
1976	50	2,500-3,000
1977	39	2,500-3,000
1978	600	3,500
1979	300	3,800
1980	700	4,500
1981	1,300	5,800
1982	1,800	7,600
1983	4,500	12,100
1984[b]	4,000	16,000

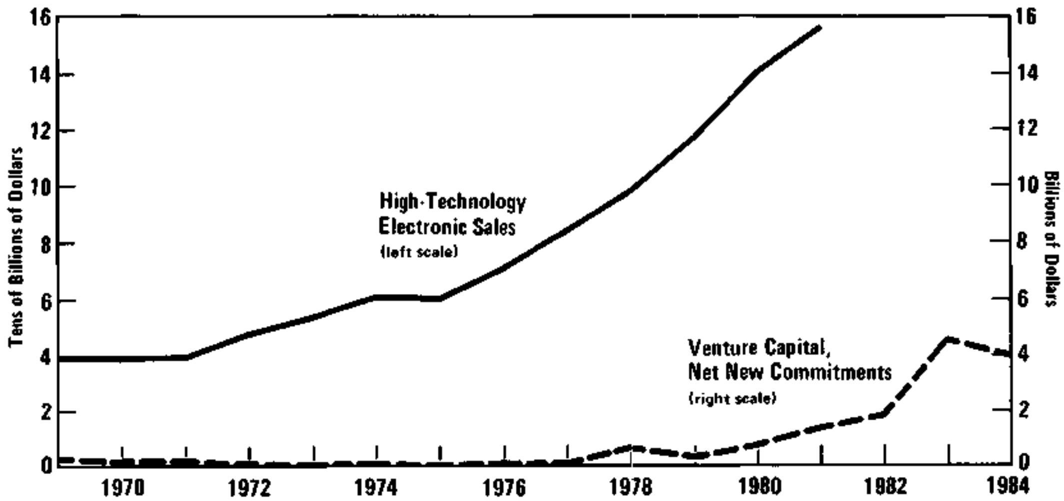
SOURCE: Venture Economics, Wellesley Hills, Massachusetts.

a. Total new private capital less capital withdrawals.

b. Figures for 1984 are preliminary estimates.

rise that continued unabated for six straight years. 16/ The rapid rise in the demand for and consumption of high-technology electronic goods presented venture capitalists with many market opportunities. As Figure 1 shows, the rise in venture-capital commitments followed the rise in high-technology electronic goods shipments, presumably representing a response to market opportunities.

Figure 1.
Venture-Capital Investment and High-Technology Electronic Sales, 1969-1984



SOURCE: Congressional Budget Office, based on data from Bureau of the Census, *Annual Survey of Manufactures, Statistics for Industries and Industry Groups*, various years, and Venture Economics, Wellesley Hills, Mass.

While the 1982 recession reduced the demand for some electronics goods, it did not, as in 1975-1976, quash venture-capital commitments. The capital gains tax reductions may have played a supporting role, while the boom in personal computers and other newer high-technology goods may have compensated for the decline in semiconductors and other high-technology goods. It is true that venture-capital funds--committed before the reduction in the capital gains rate--were largely responsible for the invention of the personal computer. But neither venture capital nor the lower

16. High-technology electronics goods for purposes of this analysis include electronic components, computers, communication equipment, and instruments. This is the group defined in Chapter II as high-technology minus the drugs, chemicals, and aerospace industries.

capital gains tax created the demand for personal computers. Rather, the demand created new market opportunities that attracted a supply of new venture capital.

Venture-capital funds have done quite well in the 1980s, though other business formation has not. The Commerce Department index of new business formation declined from a high of 1.23 in 1979 to a low of 1.13 in 1982 --the lowest figure since 1969--and has averaged 1.17 in the 1980s. The fact that high-technology startups boomed while the aggregate number of businesses stagnated offers further evidence that market opportunity is the more important variable in determining investment.

Venture-Capital Investment Patterns

Venture capital is concentrated in the most rapidly growing industries--where the market opportunities lie. Two-thirds of the funds are devoted to pure electronic investments. These include computer hardware and software, communication equipment, and miscellaneous electronic equipment. If one includes investments in medical equipment and industrial automation, such as robotics, that have large electronic components then electronic investments account for 75 percent of venture-capital investments. 17/ Conversely, since 1980 venture-capital investments in oil and gas have dropped from 20 percent of the total to 3 percent.

Tax Status of Venture Capitalists

One reason why venture capital may be less tax-sensitive than often thought is that many of the investors already have tax advantages. Table 13 shows that pension funds, endowments, and foundations, which are tax-exempt and hence insensitive to the tax treatment of capital gains, provide 40 percent of the total funds. 18/ Foreign investors have almost doubled their participation. Since the latter face higher taxes abroad or are often seeking political refuge and a stable economic environment, they are presumably not as affected by changes in the U.S. individual income tax as are domestic investors. Table 13 also shows that families and individuals--the group most

17. *Venture Capital Journal* (May 1984, June 1983, and June 1982).

18. On the other hand, if the perceptions of the tax-exempt institutions and other tax-advantaged investors are affected by changes in the tax status of other venture-capital investors, they might withdraw from the funds in response to an increase in capital gains income taxation.

affected by decreases in the capital gains tax rate--have been declining in importance as sources of venture capital, while pension funds have been increasing. Before 1978, pension-fund participation in venture capital was prohibited by federal regulations.

TABLE 13. SOURCES OF VENTURE-CAPITAL COMMITMENTS (Independent private firms only)

	Percent of Total Capital Committed			
	1981	1982	1983	1984 [a]
Pension Funds	23	33	31	34
Individuals and Families	23	21	21	15
Foreign	10	13	16	18
Corporations	17	12	12	14
Insurance Companies	15	14	12	13
Endowments and Foundations	12	7	8	6
Total	100	100	100	100

SOURCE: *Venture Capital Journal* (January 1984).

a. Figures for 1984 are preliminary.

CHAPTER V

OPTIONS FOR FEDERAL SUPPORT

Most proposals for financial assistance to high-technology industries can be subsumed under two general approaches: special tax reductions and direct spending. Proposals for tax support assume the federal government understands very little of the specific problems facing each industry, or can do little to help other than provide financial incentives and leave each firm to determine its best course of action. Direct spending programs, on the other hand, are often based on the assumption that the federal government can understand and act effectively to remedy a specific problem--that the hurdles to increased innovation and high-technology investment are not just financial, but informational or institutional.

In the first half of the chapter, proposals to assist high-technology firms by reducing their R&D costs are analyzed. These include extending or modifying the incremental R&E tax credit, changing the status of limited partnership provisions, and increasing direct aid to high-technology industries, either through existing agencies or newly created ones. The second half of the chapter analyzes the President's proposals to alter the current tax treatment allotted long-term capital gains and to alter the current capital depreciation system. Modifying the tax treatment of capital gains might affect the equity costs of startup firms in high-technology industries, while modifying the capital depreciation system might change the capital costs of all high-technology firms. Some of these options are specially targeted, while others involve interactions of various aspects of the tax code.

REDUCING R&D COSTS

Reducing the cost of research and development would provide an incentive for private firms to undertake more of it, thus increasing the high social benefits commonly attributed to R&D. All proposals for lowering these costs, however, must share three caveats: first, it is difficult to say by how much individual firms' R&D costs would be reduced; second, the amount of new R&D that would result from such reductions is uncertain; and finally, there is no way to know how much is enough.

The Research and Experimentation Tax Credit and the Costs of Doing Research

The effect on research costs of the current tax credit and its alternatives can be estimated by considering research as an investment rather than as an expense. Any firm must assign a target rate of return to that investment, or a "hurdle" that proposed research projects must clear before they are undertaken. Policies that lower research costs to the firm allow more projects to clear this hurdle, and hence encourage a greater number of research projects. Of course, tax expense is not the only factor that can influence the balance between research costs and expected rewards--indeed, it is often not a principal factor. The state of the economy also plays a role, as do the individual firm's prospects for extraordinary gain and its available technological choices.

The after-tax cost of R&D projects was measured by the "user cost" of the capital invested in research projects. User cost is determined by the duration of the economic benefits; prevailing interest and inflation rates; and the tax treatment of various assets and of debt (see Appendix B). The R&D projects were assumed to be composed of wages and materials, which are eligible for the credit, and of overhead costs and plant and equipment depreciation, which are not eligible for the credit. Eligible costs constituted two-thirds of total expenditures. This analysis used illustrative project lifespans of 5, 10, 15, and 20 years, and assumed a nominal interest rate of 15 percent and an inflation rate of 4 percent. A higher interest rate would increase the present value of the credit, but it would also increase the cost of capital. (For a lower rate, the converse would be true.) The firms undertaking these investments were assumed to be profitable, with R&E expenditures increasing steadily in nominal terms.[1] Firms were also assumed to take full advantage of all tax benefits available and for which they qualified, including the R&E tax credit. These are optimistic assumptions about the value of the credit. As pointed out earlier, because the credit is based on increases in R&E expenses above the average of the previous three years, it can actually take on negative values--if for instance a firm finds itself below its three-year average--and so increase rather than decrease the cost of doing research.[2]

1. As noted in Chapter III, only development costs incurred in the course of experimentation (in the laboratory sense) are eligible for expensing and the credit. Other product development costs are treated like ordinary investments. Basic and applied research costs are eligible for favorable treatment.

2. For a more complete description of several of the most likely permutations of credit and cost interactions, see Statement of Rudolph G. Penner, Director of the Congressional Budget Office, before the Oversight Subcommittee of the House Ways and Means Committee, August 2, 1984.

Table 14 displays the effects of the credit on the after-tax cost of capital invested in research under the above assumptions. A 10-year project in a firm that planned steadily rising R&E expenditures, for example, would face a cost of capital of 13 percent.[3] If there were no credit, the cost of capital would be 14 percent, but with the full 25 percent credit for incremental R&E investments the cost of the capital invested would drop to 10 percent.

The R&E tax credit expires at the end of 1985. The President has proposed extending it for three years and revising it as part of his comprehensive tax reform.

Letting the Credit Expire. If the Congress allowed the credit to expire, firms would still receive a considerable tax advantage from expensing R&E, but the relative advantage would be less than before the 1981 and 1982 tax

TABLE 14. USER CAPITAL COSTS OF INDUSTRIAL R&D RESULTING FROM R&E TAX TREATMENT: FOUR CASE STUDIES (In percent per year)

Tax Policy	Economic Life of R&D Investment: 5 Years	10 Years	15 Years	20 Years
Actual Credit	22	13	10	8
Alternatives				
No credit	24	14	11	9
Statutory credit	16	10	7	6
Two-year lag in base period	21	12	9	8
Including equipment depreciation	22	13	10	8
Expensing R&D capital costs	22	13	10	8

SOURCE: Congressional Budget Office.

NOTE: Assumes 15 percent annual interest rate and 4 percent inflation. Also assumes a profitable firm that is steadily increasing R&D spending in nominal terms. The firm is also able to take full advantage of all tax benefits for which it is eligible. Methodology outlined in Appendix B.

3. As noted in Chapter III, for a firm in these circumstances, the present value of the credit would be 6 percent, not 25 percent. See text box on p. 22 for fuller explanation.

legislation, which greatly reduced tax burdens on other investments. Allowing it to expire would contribute in a small way to deficit reduction at the loss of a special incentive of uncertain effectiveness. Furthermore, since most industrial R&D spending is for product development rather than basic or applied research, the economic arguments regarding market failure due to underinvestment in R&D are less applicable. In fact, it is at the product development level that the overinvestment in R&D discussed in Chapter I might occur.

A tax credit (unless refundable) is of limited effectiveness because roughly half of all corporations in the United States have no tax liabilities. In 1981, between 20 percent and 60 percent of the firms in high-technology industries, depending on the industry, had no net income and could not make full use of the existing tax benefits, including the R&E credit. 5/ Some 23 percent of the potential R&E tax credit went unused in 1981, although it could be carried forward. 6/

If the Congress allowed the R&E tax credit to expire, high-technology firms would still receive federal support through many direct spending programs. These programs are more narrowly focused and have greater government oversight; they may be more cost-effective from a federal viewpoint than the R&E tax credit if they add to the total amount of research rather than rewarding firms for doing what they would have done anyway.

Extending the Credit. The case for extension rests on the view that research and development activity should receive special incentives, either because of a tendency toward underinvestment or because the sectors concerned are held to be "strategic." Indeed, without the credit, investment in equipment might receive more favorable tax treatment than R&E. This is because in many cases the government is subsidizing purchases of equipment: the current value of the tax credits and deductions for a piece of equipment (at after-tax interest rates under 10 percent) may be greater than the equipment's cost. 7/ (The subsidy is offset by the greater certainty

5. Internal Revenue Service, *1981 Statistics of Income, Source Book: Corporation Income Tax Returns*.

6. Statement of Ronald Pearlman, Acting Assistant Secretary of the U.S. Department of the Treasury, before the Oversight Subcommittee of the House Ways and Means Committee, August 2, 1984.

7. See Executive Office of the President, *The President's Tax Reform Proposals to the Congress for Fairness, Growth, and Simplicity* (Washington, D.C.: Government Printing Office, 1985), p. 136.

of R&E tax treatment, even in the absence of the credit. R&E expenditures can be deducted from income in the year they are incurred, while equipment depreciation allowances are typically spread over five years. This means that a firm is vulnerable to future business downturns that could make it unable to use its equipment depreciation allowances.)

While the federal government has many other programs to encourage technological development, most of them are focused on specific targets. For example, the largest single federal effort to promote semiconductor development has only six contracting teams, while roughly 12,000 firms claimed some amount of R&E tax credit in 1981. (The latter number may exaggerate the contrast. According to unaudited 1981 corporate tax returns, 53 firms accounted for half of the tax losses resulting from the R&E tax credit.) 8/

If the Congress wished to extend the credit either on a permanent or temporary basis, it could consider changes to reduce the difficulties noted in Chapter III. It could do this by:

- **Refocusing the credit** toward basic and applied research;
- **Reducing disincentives** to R&E; and
- **Expanding the benefits** into new areas.

Refocusing the Credit. The R&E tax credit now is available both for the development work connected with getting current products to the market and for research on potential future products. The divergence between social and market benefits is likely to be greatest in basic and applied research. The President has proposed to refocus the credit in that direction. This would help to fund projects now least likely to receive adequate private support. It would also reduce the cost of the credit while encouraging firms to do research of importance to society.

In practice, it is very difficult to distinguish basic and applied research from development. Writing such a distinction into tax law would be likely to create administrative difficulties. But many of the activities where federal

8. Statement of John E. Chapoton, Assistant Secretary, Department of the Treasury, before the Subcommittees on Taxation and Debt Management and Savings, Pension, and Investment Policy of the Senate Finance Committee, February 24, 1984.

involvement is obviously not justified could be eliminated from the qualified expenditure category. 9/

Reducing Disincentives. The current credit may work to discourage incremental R&E, especially for firms with a pattern of declining R&E investment. Several direct ways to reduce this disincentive would be to eliminate the incremental feature, retarget the qualifying base, "lag" (delay) the base period, or make the credit refundable. Changing the credit in any of these ways would not, of course, eliminate the problems involved in defining qualified expenditures and in policing firms.

Make the Credit Non-Incremental. At current interest and growth rates, a 4 percent to 6 percent credit on all qualified research spending would neither increase nor decrease federal revenues significantly. It would ensure that all firms received some incentive to increased research and that few, if any, received negative incentives. This tax would be simpler for firms to understand and incorporate into their planning, since there would be no feedback from one year to another. Its impact on the cost of doing research would be comparable to that of the current credit. On the other hand, it would increase the windfall for firms that would have undertaken their research without the credit.

Retarget the Base. The Congress could limit the credit to firms with R&E expenditures (adjusted for firm size) greater than an economywide or industrywide average, rather than a firm-specific average as under current law. This modification would eliminate the "feedback" of the base on the credit, and increase the credit to its statutory value. For qualifying firms, the cost of doing research would drop by the full amount of the credit--from 14 percent to 10 percent for a typical 10-year project, as shown in Table 14. But amending the credit in this manner would target incentives toward firms that already do more research than others in their industry, and it would eliminate any incentive for those doing little research. Defining the relevant industry might also pose problems.

Lag the Base. The firm-specific base could be retained, and the credit's disincentives to research could be reduced by redefining the base as the average of the three years ending two years before the current year--that

9. See American Electronics Association, Computer and Business Equipment Manufacturers Association, Scientific Apparatus Makers Association, and Semiconductor Industry Association, "The Case for the R&D Tax Credit," submitted to the Oversight Subcommittee of the House Ways and Means Committee, September 1984, pp. 48-57. See also Executive Office of the President, *The President's Tax Proposals to the Congress for Fairness, Growth, and Simplicity* (Washington, D.C.: Government Printing Office, 1985), pp. 301-303.

is, lagging the base period by two years. A lagged base (possibly indexed for inflation) would raise the credit's present value for firms with a history of rising R&E expenditures. The cost of research for such a firm planning a 10-year project would drop from the current 13 percent to 12 percent (see Table 14). An extreme version would be to fix the base permanently for each firm at a given three-year average and adjust this permanent base for inflation. The credit would increase to its full value and, after a few years, cease to be incremental.

On the other hand, lagging the base could increase the disincentives to do marginal research for firms that, because of recession or other business problems, had been forced to reduce their R&E spending. For example, a firm at the trough of a recession could be measured by its performance in more prosperous earlier years.

Some of these changes in the treatment of the base would increase the cost of the credit to the government. They would also expand the windfall element of the credit by rewarding more firms for actions they would have taken anyway.

Making the Credit Refundable. Making the credit refundable would ensure that a firm received some value from the credit independent of its tax liabilities. For a firm with growing R&E expenses, the current credit loses half its value if carried forward one year, and it has no value if carried forward three years. In 1981, one-fourth of the potential credits went unused, largely because of limited tax liabilities; high-technology industries received less of the credit than would be indicated by their shares of R&D. Alternatively, the base calculation could be modified to ensure that the base was increased only if a credit was actually received. The latter approach would be less costly to the government, but less valuable to firms.

Expanding the Benefits into New Areas. Proposals have been made to expand the credit into two new areas: first, to new entrants, and second, to include equipment depreciation.

New Entrants. At present, only expenditures incurred in carrying on an existing product line are eligible for the credit. Existing firms moving into new business lines and new firms just starting up are not eligible. For these firms, the credit is in fact negative: the expenditures they make count in their future base-period calculations but do not earn the credit when they are making the investment. The disincentives provided to new entrants are especially significant in the case of high-technology industries, where new entrants occur at four times the national rate.

Existing firms entering a new line of business could be made eligible for the credit, and they would then benefit as other firms do. But making start-up firms eligible might not provide them with comparable benefits, since they are not typically profitable in their initial period and have few if any tax liabilities to offset. Moreover, this would increase both the federal cost of the credit and the difficulty of policing it.

Equipment Depreciation. Some analysts have proposed making research equipment depreciation eligible for the credit, arguing that the current system may bias the decisions of firms toward more labor-intensive projects. But this might not decrease research costs substantially. No systematic data exist on the percent of research costs attributable to equipment depreciation. CBO assumed it would be less than the depreciation share of manufacturing costs, which is roughly 10 percent of the non-direct costs--that is, costs after labor and material costs. 10/ As noted above, labor and material costs represent two-thirds of R&D costs. Consequently, equipment depreciation may represent at most 10 percent of one-third--or only several percent--of average R&D costs. Because depreciation expenses represent such a small portion of the R&D effort, their inclusion in the credit would lower the cost of doing research by less than a tenth of a percent.

Alternatively, capital purchases could be expensed, thus granting the same treatment as R&E labor and material costs before enactment of the tax credit. Expensing equipment and structures would reduce research costs by only a tenth of a percent for a typical 10-year project.

Permanent vs. Temporary Extension. The Administration has proposed extending the R&E tax credit for three more years, noting that not enough is known to determine who is using the credit and for what purposes. Indeed, detailed tax data exist only for the tax year 1981, with some preliminary tabulations for 1982. Even these tax returns are pre-audit; and the complexity of the R&E tax credit suggests that post-audit credits may not resemble pre-audit credits.

However, the effectiveness of the credit also depends upon its certainty. For it to be fully effective, corporate managers must feel able to count on the R&D tax credit over a multiyear research campaign. Otherwise, they may either ignore it entirely or else rearrange, rather than increase, their spending to take advantage of the tax benefits. To the

10. Internal Revenue Service, *1981 Statistics of Income, Source Book: Corporation Income Tax Returns*.

extent that R&D planners have time horizons longer than three years, a three-year extension would not give them any certainty of its eventual permanent approval.

Changing the Tax Status of Research and Development Limited Partnerships

Many of the proposals for comprehensive tax reform now before the Congress would have collateral effects on R&D. One of the ways general reform could affect R&D would be by changing the treatment given limited partnerships. General reform would change the tax treatment of research and development limited partnerships (RDLPs) in two ways. First, many proposals would treat all limited partnerships with over 35 limited partners as corporations.[11] Second, the President is considering a reduction in the portion of royalty income that receives capital gain tax treatment by the amount that the costs of developing the technology were claimed as deductions against ordinary income.

These changes would reduce the attractiveness of the RDLPs in two ways. First, the tax losses sustained by a large partnership in the research phase could not be passed through to individual partners. The limited partners would not be able initially to deduct up to 90 percent of their investment, as is often now the case. Second, the income stream generated by the RDLP would be taxed as ordinary income rather than as capital gains. (As discussed in Chapter III, since the income of the RDLP comes from licensing technology, it is able to receive capital gains treatment for the royalty payments. The preferential tax rates on the royalty income can account for over half of the Treasury loss on an RDLP.)

Effects of Changes in Membership Size Limitations. No breakdown is available of RDLPs by number of limited partners. The proposed limits on membership size need not constrain the formation of moderate-size RDLPs, however. Most RDLPs currently require minimum investments of $100,000 to $150,000. With a limit of 35 partners, an RDLP could still be capitalized at $3 million to $5 million. But the $20 million to $30 million RDLP would become a thing of the past, unless would-be partners were willing to forgo the tax passthrough or individually to place much larger amounts at risk.

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11. See, for instance, Department of the Treasury, *Tax Reform for Fairness, Simplicity and Economic Growth* (November 1984). See also, Congressional Budget Office, *Reducing the Deficit: Spending and Revenue Options* (February 1985).

Effects of Changes in Tax Treatment of Royalty Income. Any changes in the tax treatment of capital gains would affect all RDLPs, regardless of size. Depending on the success of a project, over half the return to investors could be affected. Unlike most capital gains income, that from an RDLP is not the difference between a purchase price and a selling price. Rather, the entire income (minus imputed interest, if relevant) is treated as a capital gain. The President's proposal to reduce the level of royalty income given long-term capital gains tax treatment by the level of R&E deductions would substantially reduce benefits of the RDLP. RDLP agreements typically offer to pay royalties of at most two to four times the original investment. Since as much as 90 percent of the original investment qualifies for the R&E deduction, the proposed change would substantially reduce the level of royalties that qualify for preferential tax treatment.

Current prospectuses suggest that RDLP projects may provide rates of return of up to 40 percent and 50 percent. (Since most RDLPs are new, it is impossible to determine the frequency with which such promises are fulfilled.) This may leave room for RDLP investors to accept a lower expected rate of return. If the current level of payback reflects the riskiness of the projects, however, then corporations might simply have to pay higher royalties to the limited partners. This would make RDLPs less attractive compared with internal financing of R&D.

Any changes in the membership size requirements would affect all limited partnerships, while the change in the treatment of capital gains would only affect RDLPs and other capital gains-oriented tax shelters. Thus, if the Congress only limited the capital gains preferences, tax-oriented investors might simply move from RDLPs to non-capital gains-oriented limited partnerships. On the other hand, if it eliminated all large limited partnerships, many tax-oriented investors would have fewer options for avoiding taxes.

Economic Consequences. Although a lower level of RDLP activity would certainly reduce the number of marginal projects, it might not seriously affect technological advance. RDLPs currently fund less than 3 percent of the private R&D undertaken in the United States. Of this 3 percent, the Treasury pays for at least half and often closer to three-quarters through forgone taxes. The projects undertaken through RDLPs are very often product development, a stage of research where federal support is less clearly needed and where it ought to be denied if the R&D is duplicative.

Direct Spending Programs to Support High-Technology Industries

Increasing the use of direct aid for high-technology industries would reverse two recent trends. First, the share of the federal R&D budget subsumed by applied civilian research has dropped while the share of basic science and military research and development has increased. 12/ Second, the Administration has regarded the primary responsibility of government as providing incentives to bring research to market, but leaving most decisions to private actors. Tax-oriented support meshes well with this approach. By contrast, direct support for high-technology industries implies a higher level of government involvement in the process of technical advance.

Direct spending programs differ in their degree of federal participation. Programs oriented toward resolving generic technical issues involve the lowest degree of federal direction. Here the federal role is reactive, responding with a decision to support--or not to support--proposals from outside the government. The programs of the National Science Foundation typify this approach. In a different approach, the federal government may take the initiative to assist private firms in developing technical capabilities that it believes to be in the national interest. The Very High Speed Integrated Circuit program that accelerated the development of the integrated circuit is an example of this. Finally, federal procurement has proved to be a powerful tool in creating the initial demand for advanced technologies. Each of these approaches to direct funding has characteristic advantages and disadvantages.

Support for Generic Technology. The government could make grants for applied research in areas of generic interest to high-technology industries. The rationale is similar to that of extending support through the tax system: both approaches are consistent with a view that federal guidance of technological choices should be minimized, and both leave the initiative to nonfederal parties. The support could be provided by amending the mission of existing agencies, such as the National Science Foundation, or by creating a new "technology foundation" with generic research as its mission. 13/

Several issues should be considered. First, the technical information gained from the research would be publicly available, thus benefiting foreign as well as domestic industries. Thus, this approach would be difficult to

12. Congressional Budget Office. *Federal Support of R&D and Innovation* (1984). See also Office of Management and Budget, *Budget of the United States Government, Fiscal Year 1986, Special Analyses: Research and Development.*

13. For a complete discussion of the technology foundation, see Congressional Research Service, *Direct Federal Support for Technological Innovation: Issues and Options* (May 1984).

reconcile with a "strategic industries" view of high-technology support. Second, the level of grant assistance would have to be quite large in order to replace tax-based support. Even at equivalent funding levels, grants and tax support are imperfect substitutes for each other since the former supports technology of interest to many firms, while the latter supports proprietary technology.

Developing Private Technical Capabilities. Direct support for the development of commercial products could be extended to areas the federal government believes to be of national importance. The commercial orientation would require a somewhat greater degree of federal oversight than would a technology grants program.

This approach could take several forms. For example, the VHSIC program, described in Chapter III, was begun in response to a military need for integrated circuits, but appears to have led to developments of commercial importance. The VHSIC approach could be adapted for nonmilitary technologies as well. Alternatively, special grant-giving institutions could be considered--perhaps similar to those envisioned in the Stevenson-Wydler Technology Innovation Act of 1980, scheduled for reauthorization in 1985.[14] Finally, activities such as the measurement and standards programs of the National Bureau of Standards (NBS) can support commercial innovation by removing technical barriers.

The principal danger in any commercially-oriented research initiative is that federal planners lack the incentives and information feedback necessary to avoid supporting technologies that are no longer commercially attractive. This danger becomes acute when the federal government is involved in the demonstration of commercial technologies of which it is not a major consumer.[15] In energy, for example, commercial demonstration of the breeder reactor was supported long after electric utilities had lost interest.

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14. For a full discussion of the status of the Stevenson-Wydler Act, see Herbert I. Fusfeld, Richard N. Langlois and Richard R. Nelson, *The Changing Tide: Federal Support of Civilian-Sector R&D* (New York: New York University, Center for Science and Technology Policy, 1981), pp. 83-89. See also, Department of Commerce, *The Stevenson-Wydler Technology Innovation Act of 1980, Report to the President and the Congress from the Secretary of Commerce* (February 1984).

15. For a lengthy list of such projects, see Walter Baer, Leland Johnson, and Edward Merrow, *Analysis of Federally Funded Demonstration Projects: Final Report* (Santa Monica, Calif.: Rand, 1976).

In general, federal efforts to encourage the commercialization of technology have had their greatest successes when the changes were incremental, when they followed the general thrust of technological development in the industry, when they did not attempt to leapfrog entire stages of technological development, and when participating firms could expect clear, short-term commercial benefits. This experience is not unique to the United States. When the Japanese government wished to advance the state of semiconductor technology in its domestic industry, it clearly identified the next stage of development, targeted its support directly to potential manufacturers, and demanded financial commitment from the relevant firms. 16/

The potential difficulties of federal involvement could be lessened by restricting federal efforts to generic research, or by providing federal aid only when the federal government is a major customer. For example, NBS concentrates on measurement technology (applied research), not on the construction of specific measurement devices (product development). This focus on "infratechnology"--technology that allows an industry to produce, but is not part of its production--keeps NBS out of competition with private firms yet corrects a significant market failure. 17/

An additional issue to be considered in the reauthorization of the Stevenson-Wydler Act is the climate for private innovation, which has changed since the late 1970s. As noted above, private R&D spending has begun to grow as a percent of GNP. Further, the last few years have witnessed a great deal of technical advance in many fields, to the point where an entirely different set of programs may be needed. Before the Congress funds the Centers for Generic Technologies, it may wish to consider the new institutional and technological setting.

Federal Procurement as R&D Support. Another way to support high-technology industries is through procurement of high-technology goods. Federal procurement played a major role in the development of the

16. For a discussion of the Japanese semiconductor efforts, see Semiconductor Industry Association, *The Effect of Targeting on World Semiconductor Competition* (1983). For a different perspective, see Gary Saxonhouse, "The Micro- and Macro-economics of Foreign Sales to Japan," in William R. Cline, ed., *Trade Policy in the 1980s* (Cambridge, Mass.: MIT Press, 1983), pp. 295-297.

17. For a discussion of the issues of infratechnology and market failure, see Gregory Tassey, "Infratechnologies and the Role of Government," *Technological Forecasting and Social Change* (1982). See also, by the same author, "The Role of Government in Supporting Standards for High Technology Industries," *Research Policy* (1982).

semiconductor industry, and many argue that it could also be used to develop products such as supercomputers and photovoltaic cells. The central issue is whether the support provided by procurement should be considered as a deliberate policy instrument or simply the fortuitous byproduct of purchases for governmental needs. As a deliberate policy, it could lead to conflicts of interest. For example, in trying to pull integrated circuit technology forward in the early 1960s, the Department of Defense often had to accept parts that did not meet its standards. Battles over specifications were common. As late as 1967, press reports suggested that major problems in the electronic components of the Minuteman II Missile had put as many as 40 percent of the missiles out of action.[18] While high levels of waste may be unavoidable in certain military programs, their cost may be prohibitive elsewhere.

Two conditions would be central to the success of such a program. First, the federal market would have to be large, both relative to the whole market and in absolute terms. In the instance of the integrated circuit, the federal market was not only the entire market but a large market as well: the Minuteman and Apollo programs called for integrated circuits by the hundreds of thousands at a time when industry capacity was negligible.[19] It is less clear that a supercomputer effort could be pulled forward by federal demand, since federal needs are simply not large relative to capacity. Similarly, VHSIC procurement is not likely to be large relative to total market demand and so commercial demand rather than federal purchases is likely to pull the technology forward.[20]

Second, the potential civilian uses of the technology have to be very clear and the financial benefits to the participating firms almost immediate. Much VHSIC technology parallels that being developed in civilian markets--lithography at a very high level of resolution, and a facility with so-called CMOS technology. VHSIC allows firms to develop in both these areas, and they can expect to market VHSIC devices almost immediately--provided the DoD allows dissemination of the technology. Similarly, Boeing and other aircraft manufacturers were able to use the engine technology developed for

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18. See Philip Webre, "Technological Progress and Productivity Growth in the U.S. Semiconductor Industry" (Ph.D. Dissertation, American University, 1983), p. 109.

19. Herbert Kleiman, "The Integrated Circuit: A Case Study of Product Innovation in the Electronics Industry," (D.B.A. Dissertation, George Washington University, 1966).

20. For instance, the demand for the latest memory circuit--the so-called 256K DRAM--is projected to hit 300 million units by 1986, the second year of its introduction. See "DRAM Makers Gird for 256-K," *Electronics Week* (January 14, 1985), p. 13.

the large military cargo airplanes almost immediately in their wide-bodied passenger airplanes. 21/

TAXATION OF VENTURE CAPITAL

The President's recently proposed comprehensive tax reform package would change the current treatment given long term capital gains. 22/ As noted above, investors in high-technology companies often receive their return in capital gains, rather than as dividend or interest payments. Thus changes in the treatment of long term capital gains might change the level or pattern of investments in these industries. This section discusses the President's proposal and some variants and their effects on high-technology investment.

The President proposes two different tax treatments for long term capital gains: one to begin July 1, 1986, and one to begin January 1991. Currently, when an asset is sold at a gain, if the asset has been held for six months or longer, 60 percent of the gain is excluded from taxation, resulting in a lower level of tax on the entire gain. To compensate for a lower maximum tax rate (35 percent as opposed to 50 percent) under his new proposal, the President would only exclude 50 percent of the gain from taxation. In combination, the change would drop the maximum tax on the entire gain from 20 percent to 17.5 percent. Beginning in 1991, taxpayers would have the alternative of adjusting their gains for inflation and paying tax on the inflation-adjusted gains at ordinary rates. Each year, taxpayers would be allowed to choose whether to have all their gains realized that year subject to the preferential rates or adjusted for inflation and taxed at ordinary rates. In general, the first proposal would favor more successful investments, while the alternative would tax successful investments more heavily. This might result in some tax gamesmanship, in which all the less successful investments would be realized one year and the inflation adjustment chosen, followed by a year in which successful investments would be realized and taxed at the preferential rates. The ability of many taxpayers to indulge in this type of tax gamesmanship is likely to be limited, however, because of the volatility in the value of many capital assets--notably, common stock.

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21. For an analysis of the federal role in civilian aircraft development, see David Mowery and Nathan Rosenberg, "The Commercial Aircraft Industry," in Richard R. Nelson, ed., *Government and Technical Progress* (New York: Pergamon Press, 1982).

22. Executive Office of the President, *The President's Tax Proposals to the Congress for Fairness, Growth, and Simplicity* (Washington, D.C.: Government Printing Office, 1985), pp. 164-173.

The two areas where changing the current tax treatment of capital gains could have substantial effects on specific high-technology investments are in the prices of equities of existing high-technology corporations and in the prices and level of venture-capital investments. Because investors are willing to be paid in capital gains, many high-technology companies can avoid dividend payments. Should the taxation of capital gains change, investor preferences might change. It is not clear how this would affect the prices of existing high-technology stocks. On the other hand, the effect on venture-capital investments can be more clearly understood and will be the topic of the remainder of the section. 23/

Issues in the Design of Capital Gains Taxes

Within the venture-capital community, the change in capital gains taxes might be significant. These investors make a series of investments, most of which never pay off. The few that do pay off are expected to provide sufficient gain to compensate for all the others. 24/ Since venture capitalists presumably care more about the tax rate on the big gain than about the taxes on their failures and near-failures, they would be sensitive to any tax reform that had its heaviest impact on gains from the most successful investments.

Under both current law and proposals to tax inflation-adjusted gains, there is a benefit to holding an asset in terms of deferring taxes. The investor pays taxes when the gain is realized, not when it is accrued. (Administratively speaking, taxing on accrual would be difficult.) 25/ Because of the compounding nature of gains, deferral provides a substantial benefit.

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23. Changes in the prices of outstanding high-technology stocks will obviously affect all investment in these industries, including venture-capital investments. However, since venture-capital investments can take years to mature, it is not clear how stock prices in any given period affect venture-capital investment.

24. The most complete survey of the success rate of venture-capital firms suggests that roughly 1 in 10 investments increase in value by five or more times. By contrast, over half of investments remain at or below their original value. See Horsley, Keogh & Associates, Pittsford, New York (1984).

25. See Congressional Budget Office, *Revising the Corporate Income Tax* (May 1985), pp. 128-130.

Capital Gains Taxes and the Cost of Venture-Capital Investments

The current debate over the effect of changes in capital gains tax treatment on venture-capital investments has centered on the quantity of such investments that will be made, not their price. 26/ Obviously, any .ecrease in the after-tax rate of return will raise the cost of venture funds to the startup company. Lack of detailed data on venture-capital investments makes it impossible to say by how much these costs would rise. Nevertheless, it is possible to estimate the change in price that would be necessary to compensate fully for a change in taxes, and this provides an outer bound.

Percent of Ownership. A straightforward measure of the price of venture capital is percent of ownership in the startup company: the larger the share of ownership a given amount of money buys, the higher is the cost of that money. Investors receive a specified number of equity shares in return for a specified amount of money. (The remainder is typically held by the founders or entrepreneurs.) These shares entitle them to a given percent of the value of the company when it is sold to another company or to other investors. If capital gains taxes are increased, then in order to provide investors a given level of after-tax return the cost of each share would have to be reduced; conversely, the percent of outsider ownership would have to be increased. If capital gains taxes are lowered, the percent of outsider ownership can be lowered while still providing the same after-tax rate of return to outside investors.

Currently, venture-capital investors as a group acquire on average 50 percent ownership of the startup company. 27/ The average investor owns 13 percent and there are typically 3.6 investors per project. The following analysis assumes an investor currently in the 50 percent tax bracket, an inflation rate of 4 percent annually, and an investment that is sold after seven years. The analysis contrasts current law treatment of the investor's capital gains with the President's proposal for excluding 50 percent of the gain, as well as the alternative of taxing only inflation-adjusted gains. It compares the effects under several different maximum rates, ranging from 20 percent to 35 percent. (For a non-taxed investor, such as a pension fund, the change would have no effect on after-tax return. See Chapter IV for details on these investors.)

26. The relative illiquidity of venture-capital investments and the specialized knowledge they involve may mean that venture-capital investments are imperfect substitutes for other capital investments. If so, the quantity of venture-capital funds becomes important. Home mortgage funds were in a similar position until the secondary mortgage market for home mortgages became widely used and financial institutions were deregulated.

27. Venture Economics, Wellesley Hills, Mass. The actual figure is 47 percent, rounded to 50 percent for computational ease.

This analysis shows that, while the President's proposal would lower the taxes for all investments, investors in very successful projects would be better off if they chose the preferential treatment, rather than the alternative tax on inflation-adjusted gains. In fact, the exemption and preferential rate were designed specifically to reduce the tax rate on the successful investor. The alternative under which capital gains are indexed would be of benefit mainly to less successful investments as compared to current law. Under the President's proposed 17.5 percent tax rate, the level of ownership needed to provide the same return to investors would fall: substantially in the case of less successful investments, minimally in the case of very successful projects. Table 15 shows estimates for investments with differing levels of success. (See Appendix D for calculations.)

If the alternative tax on inflation-adjusted gains were all that were available, tax and ownership levels would rise significantly. For a project growing in value at 25 percent per year in nominal terms, changing to this tax would increase the inflation-adjusted tax rate from 14 percent to 24 percent (see Table 15). Under these circumstances, the level of ownership needed to provide the same inflation-adjusted after-tax rate of return would exceed 100 percent. 28/ (As noted above, this is the outer bound estimate necessary for perfect compensation; the actual level would be lower by some unknown amount. This is especially true since it is impossible to predict how fast the investment will grow. It should also be noted that, while higher than current law, indexing and then taxing at 35 percent would be for most investments less than or equal to the treatment received in the 1978-1981 period, when the taxes were first lowered on capital gains. Even for investments growing at 40 percent annually, the increase in taxes beyond the 1978-1981 level would only require investor ownership to increase from the current 50 percent to 62 percent, which is well within the range of venture capital deals currently consumated.)

Table 15 presents alternative results for taxing inflation--adjusted gains under different maximum tax rates. If a capital gains tax differential were felt necessary, the Congress could still tax only inflation-adjusted gains but at a lower rate. 29/

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28. These estimates are sensitive to the rate of inflation. As inflation rises, indexing becomes the preferred alternative for more investors. At 6 percent inflation, for instance, investments growing at 10 percent annually would have lower taxes under an indexed tax plan (with a maximum rate of 35 percent) than under current law. At 4 percent inflation, the reverse is true.

29. For a discussion of the rationale for a differential, see Executive Office of the President, *The President's Tax Proposals to the Congress for Fairness, Growth, and Simplicity* (Washington, D.C.: Government Printing Office, 1985), pp. 170-171.

TABLE 15. VENTURE-CAPITAL OWNERSHIP OF STARTUP COMPANIES NECESSARY TO MAINTAIN REAL RETURNS FOR INVESTORS (In percent)

	Annual Rate of Nominal Appreciation				
	4	5	10	25	40
			Current Policy		
Effective Real Tax Rates	a/	89	27	14	11
Ownership Level	50	50	50	50	50
			President's Proposal Maximum Individual Rate: 17.5 percent		
Effective Real Tax Rates	a/	78	23	13	9
Ownership Level	a/	0	36	43	45
			Taxation of Inflation-Indexed Gains Maximum Individual Rate: 35 percent		
Effective Real Tax Rates	0	34	31	24	20
Ownership Level	a/	0	79	118	104
			Taxation of Inflation-Indexed Gains Maximum Individual Rate: 30 percent		
Effective Real Tax Rates	0	29	27	20	17
Ownership Level	a/	0	50	83	79
			Taxation of Inflation-Indexed Gains Maximum Individual Rate: 25 percent		
Effective Real Tax Rates	0	24	22	17	13
Ownership Level	a/	0	33	60	61
			Taxation of Inflation-Indexed Gains Maximum Individual Rate: 20 percent		
Effective Real Tax Rate	0	20	18	13	11
Ownership Level	a/	0	22	45	48

SOURCE: Congressional Budget Office calculations.

NOTES: Assumes seven-year investment, 4 percent inflation, and investors in 50 percent tax bracket under current law and in top bracket under the President's and indexing plans. Also assumes investors can offset losses against other income. See Appendix D for calculations. The real effective tax rate is the amount of taxes paid on the gain after adjustment for inflation. See Appendix D for calculations.

a. Not meaningful. Under current law and the President's proposal, if nominal gains are less than or equal to inflation, an inflation-adjusted capital gains tax rate would be infinite, because there is no real income; yet, there are taxes.

Capital Gains Taxes and the Level of Venture-Capital Investments

Although the preferential treatment given capital gains is partly responsible for the growth of the funds committed to venture capital, it is not the entire story: other factors have been important in this growth. As noted in Chapter IV, the rise in venture-capital investments followed the rapid rise in high-technology demand, suggesting that venture-capital investors were ex ploiting market opportunities as much as they were using their tax advantages. Insofar as capital gains taxes do not affect the demand for high technology goods, these market opportunities will continue to exist.

Venture-capital investment grew despite the relative fall in after-tax returns on capital gains income after the 1981 tax act. In the first period of venture-capital growth, 1978-1981, the maximum statutory rate on long-term capital gains was 28 percent. The maximum rate dropped to 20 percent in 1981, an increase in after-tax proceeds of 11 percent. At the same time, the maximum rate on all other income from capital fell from 70 percent to 50 percent, an increase in after-tax proceeds of two-thirds. Between 1978 and 1981, the ratio of the after-tax proceeds of capital gains income to ordinary income was 2.4 (72 percent divided by 30 percent). In 1981, this ratio dropped to 1.6 (80 percent divided by 50 percent). 30/ (The President's proposal would further reduce this ratio to 1.27--82.5 percent divided by 65 percent.) Despite the rise in relative tax burden, the amount of capital committed to venture-capital firms quadrupled between 1981 and 1983. 31/ During the same period, gross private domestic investment remained stagnant--no doubt because of the recession. 32/

If investors still found it in their interest to participate in venture-capital investments after 1981, it was because the rate of return on venture capital was quite high. The most recent survey on venture investments shows that the average rate of return on venture capital partnership funds going back to the early 1970s has been 35 percent. 33/ This high rate of return also explains why tax-advantaged institutions have participated in this market.

30. In fact, before 1978 the ratio was higher than it was after 1981. With a maximum capital gains rate of 49 percent and a maximum rate on unearned income of 70 percent, the ratio was 1.7.

31. *Venture Capital Journal* (January 1984), p. 10.

32. *Economic Report of the President (1984)*, p. 220.

33. *Horsely, Keogh & Associates*, Pittsford, New York (1984).

CHANGING THE CURRENT SYSTEM OF CAPITAL ASSET DEPRECIATION

The President has proposed changing the system of depreciation of assets from the current accelerated cost recovery system (ACRS) to a new capital cost recovery system (CCRS). Simultaneously, he proposes to eliminate the investment tax credit (ITC). These changes taken together could significantly shift the tax burden faced by investments in depreciable assets in high-technology industries. Since firms in high-technology industries tend to invest in more equipment, which is eligible for the ITC, than either the manufacturing or economywide average, the loss of the ITC could affect them especially. As noted in the previous chapter, however, high-technology industries have benefited substantially from the current system of depreciation allowances and their effective tax rate is significantly below the manufacturing average. Thus, while the change to CCRS and elimination of the ITC might increase their tax rate more than average for all manufacturing, they might still remain at the manufacturing average. This section of the report first presents the President's proposal and then outlines its likely effect on high-technology industries' tax rates.

The President's Proposal

The President's proposal would modify ACRS in several ways. First, the new system of capital depreciation allowance would take explicit account of inflation. Rather than compensate for inflation by giving overly generous deductions, CCRS would include inflation in the calculation of the depreciation allowances. Each year the undepreciated balance of each asset would be increased to reflect inflation, and the depreciation allowance for tax purposes would be based on the indexed undepreciated balance. For instance, if an asset had $100,000 undepreciated balance and inflation for that year had been 5 percent, then the depreciation allowance would be based on $105,000, not $100,000. If the asset was a Class 4 (the catchall equipment class) asset in its third year, the depreciation allowance would be 22 percent of the undepreciated balance, or $23,100. Without the inflation adjustment it would have been $22,000, or $1,100 less. Including inflation in the depreciation system should reduce the uncertainty surrounding the inflation-adjusted value of the depreciation allowances.

Second, the President has proposed a new classification of asset lives that would more nearly approximate the economic lives of the depreciable assets, resulting in more neutral taxation. ACRS was, conceptually at least, simple. All assets were placed in one of four categories and depreciated accordingly. The depreciation schedules did not approximate the economic lives of assets, but rather were accelerated. At least part of the justification for the rapid depreciation was that, in periods of high inflation, the system that preceded ACRS understated the actual rate of depreciation. 34/ The CCRS asset lives would be longer than the ACRS asset lives. Structures, for example, would be depreciated over 28 years under CCRS, while current law permits structures to be depreciated in 18 years. For most categories of depreciable assets, CCRS would increase the tax life by one to three years. 35/ The reason for this change is that the difference between ACRS lives and economic lives was so great, and varied so much between assets, that it resulted in very different tax burdens on different types of assets and encouraged, as well, the proliferation of tax shelters, which used this differential to shelter other income. 36/

Other elements of the corporate tax structure would also be changed at the same time as the depreciation schedule. As noted above, the President proposes to eliminate the investment tax credit. Equally important, the President proposes to reduce the top rate on corporate income from 46 percent to 33 percent.

Effects on High-Technology Industries

Using the effective tax rate methodology presented in a previous chapter and in Appendix B, CBO analyzed the effect of implementing the President's proposal. In addition to changing from ACRS to CCRS, the model was also changed in two major ways: the ITC was eliminated from the calculations and the top marginal corporate tax bracket was reduced to 33 percent. CBO also assumed that the inflation-adjusted, after-tax rate of return remained constant with the change. The effective tax rate as used here is defined as the difference between the pre-tax rate of return and the post-tax rate of return on new investments in depreciable assets. It is a marginal rate because it applies to new, not average, investments. These rates are calculated assuming that the firms in the industries can use all their legally allowed tax benefits. To the extent they cannot, these estimates will understate their true rate. Finally, the estimates are industry averages and hence do not apply to every firm in each industry.

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34. Congressional Budget Office, *Federal Support of U.S. Business* (January 1984), pp. 18-20.

35. Executive Office of the President, *The President's Tax Proposals to the Congress for Fairness, Growth, and Simplicity* (Washington, D.C.: Government Printing Office, 1985), p. 145.

36. Ibid, p. 137.

Table 16 presents the results of the analysis. The President's proposal would leave effective tax rates on high-technology investments at the manufacturing average rate of 21 percent. Under the current system, the range has varied from 10 percent to 23 percent. Some high-technology industries may experience increases that are larger than average, but only because they are relatively advantaged under the current system. CCRS would be comparatively neutral and should reduce the interindustry investment distortions of the current system.

TABLE 16. EFFECTIVE TAX RATES ON INVESTMENTS IN DEPRECIABLE ASSETS (In percents)

Industry Group	Current Law: Normal Economic Depreciation	Current Law: Rapid Obsolescence	President's Proposal: Normal Economic Depreciation	President's Proposal: Rapid Obsolescence
Manufacturing	22	---	21	---
Computers and Office Equipment	23	26	22	26
Communication Equipment	20	23	20	25
Electronic Components	17	19	21	25
Aircraft	10	10	21	26
Instruments	23	26	22	26

SOURCE: Congressional Budget Office.

NOTE: See Appendix B for the effective tax rate formula. Inflation was assumed to be 4.2 percent and the inflation-adjusted after-tax interest rate 3.9 percent. Appendix B presents CBO's effective tax rate model. The normal depreciation column used economic depreciation rates estimated from capital assets sales data. In the rapid depreciation column, the depreciation rates were arbitrarily increased for high-technology industries' assets by 50 percent, or, equivalently, the economic lives of assets were shortened to simulate technological obsolescence.

As noted above, some high-technology assets may depreciate more rapidly than average because of technological obsolescence. For these assets the effective tax rate under CCRS would be higher than for others because they must be held on the books for tax purposes long after their economic life has ended. In order to analyze this potential extra taxation, the economic depreciation rates of high-technology assets were arbitrarily increased by 50 percent. For instance, in the aircraft industry the average asset was depreciated at 18 percent per year rather than the typical 12 percent. It should be noted that this method overstates the potential extra taxation, because only some of the assets used in high-technology industries experience such a rapid rate of technological obsolescence.

Increasing the economic depreciation rates by 50 percent resulted in effective tax rates for high-technology industries that were slightly, but consistently higher than the manufacturing average (see Table 16). Since these estimates represent an illustrative outer bound, and the actual number of assets experiencing premature obsolescence is only a fraction of the total in any industry, the analysis suggests that this slight differential should not be a major concern. Furthermore, the 50 percent increase was chosen arbitrarily. The actual differential will vary in direct proportion to whether the 50 percent is too high or too low. In any event, even the larger estimates remain well below the proposed statutory rate.

APPENDIXES

APPENDIX A

R&D AND PROFITABILITY IN HIGH-TECHNOLOGY INDUSTRIES

Profits from one generation of a firm's products typically allow it to undertake research for succeeding generations of products. In emerging technology industries, product generations are short and firms have less time in which to recover their research investments. The continual introduction of new products may also depress prices and profits on earlier products. Because of these competitive pressures, firms may not be in a position to undertake longer-term research. Some analysts have suggested that the incremental R&D tax credit be extended to offset these pressures.

A glance at the evidence, however, suggests that profits in these industries are not depressed overall. In 1983, for example, the average profit on stockholders' equity for all manufacturing industries was 16.4 percent. In emerging technology industries, the average was 19.9 percent (see Appendix Table A-1 for industry detail). The financial data categories were

TABLE A-1. INDUSTRY PRETAX PROFITS, 1981-1983
(As percent of stockholder equity)

Industry Group	1981	1982	1983
All Manufacturing	21.4	14.1	16.4
Drugs	24.2	27.0	29.2
Industrial Chemicals	18.2	7.2	10.3
Computers and Office Equipment	N/A	N/A	N/A
Electrical and Electronics	23.3	17.1	15.3
Aircraft and Missiles	25.2	17.9	22.2
Instruments	25.7	20.2	22.5

SOURCE: Bureau of the Census, *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations* (various issues).

NOTE: N/A = Not Available.

broader than the SIC industry definitions, so some individual sectors--specifically, the industrial chemicals and the electrical and electronics sectors--may have had different profit histories from the average. Excluding these industries, the other emerging technology industries all had above-average profit rates. (No data were available for the computer and office equipment industry.) Profits in the industrial chemicals industry are generally lower than the manufacturing average, but this probably has as much to do with worldwide excess capacity as with the R&D expenditures by firms in the industry.

APPENDIX B

USER COSTS OF CAPITAL SERVICES AND EFFECTIVE TAX RATES

The user cost (or rental price) of capital services is determined by inflation, the interest rate, the depreciation rate, the tax treatment of an investment, and the corporate income tax in general. Most important, the difference between the tax treatment and economic depreciation will determine the degree of subsidy or additional tax burden on an investment. Since this differential varies between projects, there is no reason to assume that there is one user cost for all capital. An average cost of capital services can be calculated, however, and many formulations exist, each of which emphasizes one or another aspect of the costs and relationships. A common formulation for equipment investments is:

$$c_i = \frac{1}{(1-u)} (r + d_i) (1 - k_i - u\, t_i (1 - Dum\, k_i))$$

where

r	=	$R(1-u) - P$, assumed 3.9 percent
c_i	=	user cost of capital services of the ith type of capital equipment
u	=	the marginal corporate tax rate, assumed 46 percent under current law, and 33 percent under the President's proposal
d_i	=	the economic depreciation rate of the ith type of capital equipment
t_i	=	the present value of tax allowances for depreciation on the ith type of equipment
k_i	=	the investment tax credit rate on the ith type of equipment; 10 percent and 6 percent under current law, 0 percent under the President's proposal
Dum	=	dummy variable to adjust the depreciation allowance for the investment tax credit
R	=	the nominal interest rate, and
P	=	percent change in the general price deflator, assumed 4.2 percent.

Because of the lack of investment tax credit allowance on structures, the formula for the rental price on structures excludes the investment tax credit expressions. For further discussion, see Congressional Budget Office, "Sectoral Impacts of Changes in Interest Rates" (June 1984).

The user costs of capital services for each industry were weighted by the value of the capital stock by asset for each industry. This analysis began with estimates of 1980 capital stock arranged by type of asset. 1/ The analysis then assumed that each asset was distributed among industries in proportion to each industry's investment in that asset. 2/ In addition, the survey used input-output categories that were not identical to the SIC categories used throughout this report; drugs, industrial organic chemicals, and missiles were all included in much larger categories and so had to be excluded from this analysis. For analysis of the costs of performing R&D, this analysis assumed that roughly two-thirds of R&D costs are composed of wages, salaries, and materials consumed. The remainder was overhead, including structure and equipment depreciation. 3/

The user cost of capital services can then be used to compute the effective tax rate. The difference between the rental price and the average economic depreciation rate is the pretax inflation-adjusted rate of return (mathematically expressed as $r^* = c - d$). The effective tax rate is the wedge between the pre-tax inflation-adjusted rate and the after-tax inflation-adjusted rate expressed as a percent of the former, or $(r^* - r)/r^*$. 4/

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1. There are 26 different types of depreciating assets ranging from furniture to electronic equipment. For 1980 estimates of the capital stock of these assets, see Jane Gravelle, "Effects of the 1981 Depreciation Revisions on the Taxation of Income From Business Capital," *National Tax Journal* (March 1982).

2. The most recent survey of industrial investment by asset was made in 1972. To the extent to which the composition has changed, the estimates may be misleading. See Peter G. Coughlin and the Interindustry Economics Division Staff, "New Structures and Equipment by Using Industries: 1972," *Survey of Current Business* (July 1980), pp. 45-55.

3. National Science Foundation, *Research and Development in Industry, 1981*, p. 53.

4. For a recent exposition of the subject of user cost of capital and effective tax rates, see Charles Hulten, ed., *Depreciation, Inflation and the Taxation of Income from Capital* (Washington, D.C.: The Urban Institute, 1981).

APPENDIX C

CAPITAL INVESTMENT IN HIGH-TECHNOLOGY INDUSTRIES

Proponents of measures to aid high-technology firms argue that because they are growing so rapidly, these firms need more capital than the market is ready to supply. A study of the evidence shows, however, that--with two exceptions--the relationship between current income and current investment in these industries is roughly comparable to that in manufacturing as a whole.

High-technology firms might need a large amount of capital for two reasons: if their output is growing, and if their technological progress renders their capital equipment obsolete long before it has physically depreciated. Investment in these industries is high, possibly for both reasons. Two factors complicate the story, however. First, in several industries government-owned capital plays a central role in production. Second, not all measures of capital investment show that it is significantly higher in these industries than in manufacturing industries as a whole.

When viewed as physical additions to a stock, the high technology industries, other than the ones with significant government-owned capital, seem to have a very high level of capital investment. New capital investment in manufacturing as a whole represented 12.9 percent of fixed assets in 1977, and in high-technology industries 14.8 percent. If the aerospace industries, where most of the government-owned capital equipment is to be found, are excluded, the high-technology average rises to 16.1 percent. This differential continued in 1981, when gross investment in the high-technology industries was 19.4 percent of assets as against only 13.6 percent in all manufacturing. Again, if the aerospace industries are excluded, the differential rises (see Table C-1 for details). The differential is even greater when only investment in equipment, excluding structures, is measured. In 1981, the manufacturing average for that measure was 15.4 percent of equipment in place, while for high-technology industries it was 20.8 percent.

When viewed in context of the industrial income stream, however, capital investment does not seem larger in high-technology industries than in manufacturing as a whole. One way to measure the relative size of capital investment is to see what portion of capital's share of industry income it represents. A simple way of calculating capital's share is to

TABLE C-1. CAPITAL INVESTMENT IN HIGH-TECHNOLOGY INDUSTRIES (In percent)

Industry Group	SIC Code	Depreciable Assets		Equipment in Place		Capital Share	
		1977	1981	1977	1981	1977	1981
All Manufacturing		12.9	14.5	14.2	15.4	16.2	20.6
Drugs	283	12.2	14.3	15.0	15.7	8.2	10.1
Industrial Organic Chemicals	286	16.4	12.0	16.1	12.4	35.5	28.7
Office and Computing Machines	357	25.0	30.9	25.6	32.0	15.7	20.7
Communication Equipment	366	14.4	24.1	17.6	23.3	12.1	18.9
Electronic Components	367	15.7	23.7	17.9	24.6	20.1	30.2
Aircraft and Parts	372	9.2	17.4	11.8	20.6	10.1	16.9
Missiles and Space Vehicles	376	12.5	18.4	16.4	20.6	11.6	13.1
Instruments	380	12.7	18.4	14.6	20.4	9.5	11.5

SOURCES: Calculated from Bureau of Census, *1977 Census of Manufactures, Gross Book Value of Depreciable Assets, Capital Expenditures, Retirements, Depreciation, and Rental Payments; 1981 Annual Survey of Manufactures, Expenditures for Plant and Equipment, Book Value of Fixed Assets, Rental Payments for Building and Equipment, Depreciation and Retirement*; and *Statistics for Industry Groups and Industries* (various years).

NOTES: Capital investment as a percent of depreciable assets is the ratio of all new capital investment to all depreciable assets. Capital investment as a percent of equipment in place is the ratio of new investment in equipment to equipment in place. Capital investment as a percent of capital share is the ratio of all new capital investment to capital share, where capital share is defined as industry value added minus total labor compensation.

subtract total labor compensation from industry value added. What remains is a reasonable proxy for the income of capital in that industry. Capital income has to cover dividends, payments on borrowed funds, rents, corporate income, taxes, and replacement and new investment. Everything else being equal, firms with higher investment as a percent of capital share should be obliged to seek external funding more regularly than those with lower investment as a percent of capital share. Investment in high-technology industries as a percent of capital share is comparable to that in manufacturing as a whole, with two notable exceptions. Table C-1 shows that the average for manufacturing was 20.6 percent in 1981. The average for high-technology industries, even excluding aerospace, was 20.0 percent. The two exceptions are inorganic industrial chemicals and electronic components, which devoted 29 percent and 30 percent, respectively, of capital share to investment. (But electronic components had a high investment level because of the semiconductor industry, which invested roughly 40 percent of its capital share, while the rest of the electronic components industries had investment levels much nearer the manufacturing average. Excluding semiconductors, investment in the electronic components industries was 21 percent of capital share.)

In a world of perfect capital markets, the ratio of investment to capital share would have no clear meaning. Presumably, investors would lend or invest funds in these industries until the marginal returns were equal. If there is some capital rationing, however, then industries with high investment rates may find themselves with investment needs that meet or exceed the costs of capital, but without funds or ability to get funds.

APPENDIX D

CAPITAL GAINS AND OWNERSHIP LEVELS

The changes in ownership level needed to compensate current venture capital investors perfectly were calculated according to the following formulas.

Before-Tax Rate of Return:

$$Rg = (I - P)/(1 + P) \quad (1)$$

where

Rg is the before-tax real rate of return

I is the annual rate of nominal appreciation

P is the inflation rate, assumed to be 4 percent.

After-Tax Rate of Return (Current Law and President's Proposal):

$$Rc = [((1+Rg)^{k}x(1\text{-}(Tcx(1\text{-}Eg)))) + (((1\text{-}Eg)xTc)/(1+P)^{k})]^{1/k}\text{-}1 \quad (2)$$

where

Rc is the after-tax real rate of return under current law

k is the number of years to sale, assumed 7

Eg is the long-term capital gains exclusion (60 percent under current law; 50 percent under the President's proposal)

Tc is the investor's current marginal tax bracket, assumed to be 50 percent under current law, 35 percent under the President's proposal

Other terms are as in equation 1.

After-Tax Rate of Return (Indexed Proposals):

$$Rt = [((1 + Rg)^{k} x(1\text{-}Tt)) + Tt]^{1/k}\text{-}1 \qquad (3)$$

where

Tt is the investor's proposed marginal tax bracket, assumed to be 20, 25, 30, and 35 percent

Other terms are as in equations 1 and 2.

Effective Tax Rate:

$$Etr = (Rg - Ri)/Rg \qquad (4)$$

where

Etr is the effective tax rate

Ri is either Rc or Rt depending on the tax plan.

New Ownership Level:

$$Ot = Oc\,(Rc/Rt)^{k} \qquad (5)$$

where

Ot is percent of ownership needed to equalize gross after-tax return under alternative plans and current law

Oc is current ownership level, assumed 50 percent (current average)

Other terms are as in the above equations.