The Effectiveness of Research and Experimentation Tax Credits

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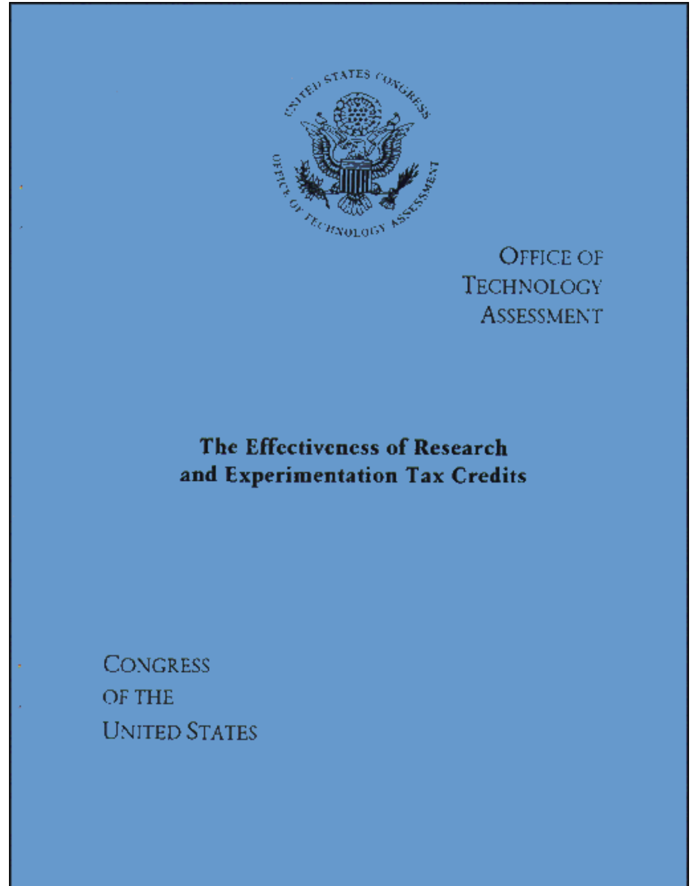

Foreword

In 1981 Congress enacted the research and experimentation (R&E) tax credit, as a means to encourage firms to conduct additional research and development. Congress has never made the R&E tax credit a permanent feature of the tax code; instead, it has extended and modified the policy on numerous occasions, twice after allowing it to expire. The credit once again expired in June 1995, putting Congress back in the position of deciding whether to extend the credit and, if so, for how long and with what terms.

In principle, the R&E tax credit addresses an important public policy goal: stimulating private sector R&D spending, and thereby encouraging advancements in scientific and technological knowledge. As economists have long noted, R&D spending is prone to market failure due to the frequently high returns to society from R&D and the associated difficulty firms often face in appropriating the benefits of their research. Many analysts agree that the R&E tax credit is, in principle, a sensible policy instrument for encouraging the private sector to supply a more socially optimal level of R&D investment. In practice, however, the R&E tax credit often has been criticized for being indefinite in duration and unwieldy in form, for excluding certain types of R&D-performing firms, and for possibly subsidizing research that would take place regardless of the credit. Existing studies of the R&E tax credit are informative in many respects but, as this report demonstrates, are dated, less than comprehensive, or otherwise unsatisfactory.

This background paper responds to requests submitted to OTA by Senator Orrin Hatch, who chairs the Taxation Subcommittee of the Senate Committee on Finance, and Congresswoman Constance Morella, who chairs the Technology Subcommittee of the House Science Committee. The report assesses how well the R&E tax credit is currently understood, identifies inadequacies in the existing data and analyses, investigates implementation issues, considers the tax credit in the context of corporate R&D trends and Federal R&D policy more broadly, draws appropriate international comparisons, and specifies important avenues for further research.

ROGER C. HERDMAN
Director

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David Mowery, *chair*
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University of California, Berkeley

Joseph Cordes
George Washington University

Roseanne M. Cutrone
Scadden, Arps, Slate, Meager, & Flom

Robert Eisner
Northwestern University

Geraldine Gerardi
Office of Tax Analysis
United States Treasury

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Genentech Inc.

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Industrial Technology Institute

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Council of Economic Advisors
Executive Office of the President

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Citizens for Tax Justice

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MCI Communications Corporation

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Internal Revenue Service

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TRW Inc.

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Judith L. Wagner
Office of Technology Assessment

Project Staff

Peter D. Blair, Assistant Director, OTA
Industry, Commerce, and International Security Division

Andrew W. Wyckoff, Program Director
Industry, Telecommunications, and Commerce Program

PRINCIPAL STAFF

Paul N. Doremus, Project Director

Frank Gallo, Analyst
Bronwyn H. Hall, Contractor

ADMINISTRATIVE STAFF

Liz Emanuel, Office Administrator
Karry Fornshill, Secretary
Diane Jackson, Administrative Secretary
Karolyn St. Clair, PC Specialist

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CONGRESS OF THE UNITED STATES

THE EFFECTIVENESS OF RESEARCH AND EXPERIMENTATION TAX CREDITS

I. Introduction and Findings

In 1981 the federal government enacted the research and experimentation (R&E) tax credit, intended to encourage firms to conduct additional research and development.[1] Congress has never made the credit a permanent part of the tax code—instead, it has extended the credit six times, on two occasions (1986 and 1992) after having allowed the credit to expire. On June 30, 1995, the credit expired once again, putting Congress back in the position of deciding whether to extend the credit and, if so, for how long and with what terms. The original justification for making the R&E tax credit temporary was to allow Congress to review the performance of the law before making a decision over its permanence, although the actual reason for avoiding this decision appears to be primarily a matter of Congress' budget scoring process—a permanent credit entails scoring a permanent revenue cost, while the cost of a temporary credit needs to be scored only for the period of extension. Many firms and other observers believe that 15 years has been a more than adequate review period, and that the R&E tax credit's temporary nature has limited its effectiveness because firms cannot include the credit in their long-term R&D budgets.

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[1] The tax credit specifically applies to research and "experimentation," although in practice it is difficult to distinguish that category of activity from the more commonly used " research and development" (R&D). This paper refers to the tax credit using its specific terminology—the R&E tax credit—while referring to research in general terms as "R&D".

In principle, the R&E tax credit addresses an important public policy goal: stimulating private sector R&D spending, and thereby encouraging advancements in scientific and technological knowledge. Technological change catalyzes entirely new industries, transforms existing ones, and consequently represents a fundamental element of economic growth.[2] An entire generation of economic research has shown that technological change enhances productivity growth—for firms, industries, and the economy as a whole—and hence contributes directly to growth in national income and wealth.[3] Moreover, recent research indicates that firms which use advanced technologies tend to have high employment growth rates, high labor skill and wage levels, and high productivity.[4]

Much of the growth in national productivity ultimately derives from research and development (R&D) conducted by private industry.[5] Private enterprise conducts 72 percent of all R&D performed in the United States, compared to 12 percent for academe and 10 percent for the Federal government.[6] In terms of funding, the private sector has become the dominant source of R&D investment, rising from 40 percent of all funding in 1970 to nearly 60 percent by 1994. During this period, government R&D funding decreased from 57 to 36 percent of the total (see figure 1).[7]

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2 Although economists widely agree that technology is an important component of national economic growth, they have great difficulty measuring the effect precisely due to the large number of complex and inter-related variables that shape economic growth. At a minimum, measures of total factor productivity indicate that technology has accounted for 15 to 20 percent of economic growth over the last 20 years. Other estimates, based on different definitions and encompassing technological spillovers and other ancillary factors, attribute half to nearly all of economic growth to technological change.

3 For surveys of this literature, see Hall (1994); Nadiri (1993); Griliches (1992); Nadiri (1980); and Mansfield (1972). For a broad overview of the micro and macroeconomic aspects of technological change, see Rosenberg, Landau, and Mowery (1992). It should be noted that, although productivity growth generally increases national welfare, it can also reduce welfare if the resources released by productivity gains do not move into other economically valuable activities.

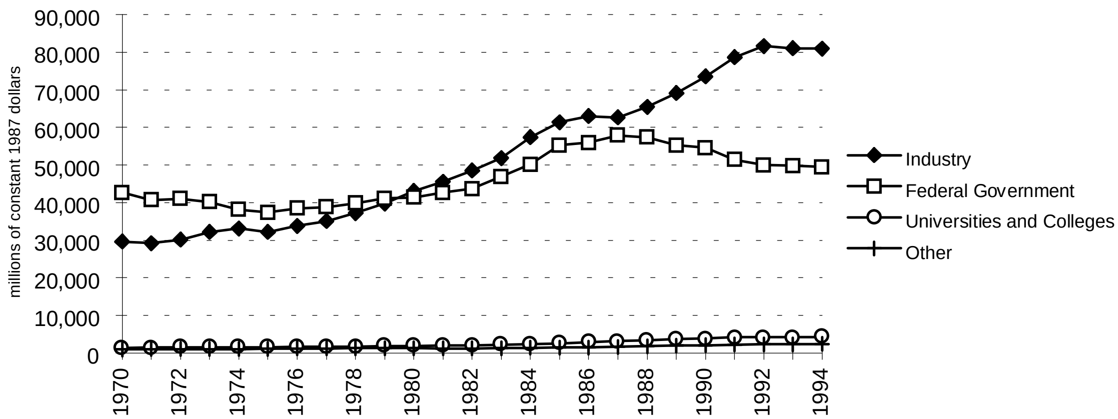
4 U.S. Department of Commerce, *Technology, Economic Growth, and Employment* (1994).

5 See Fagerberg (1994); Lichtenberg (1992); and Nelson (1992).

6 NSF, *National Patterns of R&D Resources* (1994). Figures are for 1994. The distribution of R&D performance has changed slightly over time: business R&D increased from 69 percent of all R&D in 1970 to 74 percent in the mid-`80s, and then declined to 72 percent in 1994; academic R&D stayed relatively constant at 9 percent throughout the `70s and early `80s, at which point it began increasing to reach 12 percent by 1994; and R&D conducted by the Federal government has decreased steadily from 16 percent of all R&D in 1970 to 10 percent in 1994.

7 Universities and other sources account for only 3 and 2 percent, respectively, of all R&D funding in the United States. NSF (1994).

Figure 1: Real R&D Expenditures in the U.S., by Source of Funds, 1970-1994



Source: NSF, *National Patterns of R&D Resources: 1994*, tables B6, B9, B12.

However, from a societal perspective, firms will tend to underinvest in R&D because they typically cannot appropriate all the benefits of their research. Intellectual property rights, trade secrets, and other mechanisms such as first mover advantages allow firms to capture some, but not all, of the benefits that flow from their investments in new knowledge.[8] Much of the benefit from R&D conducted by individual firms accrues to other firms and society at large, through direct channels such as usable knowledge, new products and services, and reduced prices, as well as through indirect channels such as improved product capabilities and enhanced productivity. For example, advancements in semiconductor technologies have promoted subsequent product and process innovations across numerous industries that use semiconductor devices, ranging from computers and consumer electronics to aerospace and autos. Similarly, innovations in applying advanced computing technologies to production processes have reduced costs and increased productivity across many sectors of the economy. And scientific advancements in the biosciences have expanded the scope of numerous technologies, from pharmacology to agriculture, and brought entirely new types of products into the market.

Since other firms and society at large frequently benefit from the "spillover" of R&D conducted by individual firms, the private rate of return for R&D often is substantially lower than the total return.[9] Estimates from both the firm and industry level indicate that the social rate of return to R&D ranges from 20 to 100 percent, depending

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[8] On appropriability problems in general, see Teece (1992).

[9] The presence of spillovers from private R&D is well established in the literature, although again, the complex and variable nature of these spillovers makes them difficult to measure with precision. See, for instance, Nadiri (1993); Griliches (1992); and Mansfield (1984). Some analysts argue that existing measures of R&D spillovers are entirely inadequate and generally too conservative, since they construe technology too narrowly and fail to capture the varied and subtle ways in which new technologies are diffused and used. See Alic et al. (1992).

on the sector, and averages approximately 50 percent.[10] The channels for R&D spillovers are manifold, including but not limited to intra- and interindustry business relationships, supplier-user relationships, personnel flows, interdependencies between public and private sector investment, and interactions among geographically proximate firms. Moreover, spillover channels are increasingly international, driven largely by the expanding business operations of multinational corporations as well as by various forms of scientific and technological exchange and the cross-border exchange of technologically-intensive goods and services.[11] R&D spillovers, in short, signify a classic market failure: because individual firms cannot appropriate the full benefits of their R&D, society will experience suboptimal levels of investment in the search for new knowledge.

In economic theory, market failures of this magnitude and significance justify governmental action. Yet however persuasive in theory, it is quite difficult in practice to determine when and how the Federal government should seek to mitigate market inefficiencies in research and development. When should the government use direct policy mechanisms (i.e. performing or funding nationally relevant R&D that the market would not provide), and when indirect ones (such as the tax policies and other instruments designed to stimulate R&D investment beyond the level encouraged by the private rate of return)? Under what circumstances are particular incentives most effective? Should most incentives be nondiscriminatory, or should they be channeled to those types of R&D and/or business activities that exhibit particularly high social rates of return?

Many analysts agree that the R&E tax credit is, in principle, a sensible policy instrument for encouraging the private sector to supply a more socially optimal level of R&D investment.[12] By design, the R&E tax credit has the advantage of being relatively straightforward and nondiscriminatory—it is oriented toward high technology firms with an expanding ratio of R&D to sales, and beyond that it does not necessarily favor particular firms or technologies, nor does it otherwise interfere with the allocation of research and development resources in the private sector. In practice, however, the R&E tax credit often has been criticized for being indefinite in duration and unwieldy in form,

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[10] By comparison, the net private rate of return to R&D varies from 20 to 30 percent. See Nadiri (1993). The distribution and magnitude of private and social rates of return to R&D vary widely by sector and across time. Generally, spillovers are most prevalent in R&D intensive industries, although estimates of the rate of return as well as the price sensitivity for R&D depend upon the type of data and methods used. On sectoral variations, see Bernstein and Nadiri (1988); and Hall (1993b).

[11] The extent of international R&D spillovers has been a matter of debate. Some studies indicate that R&D spillovers remain relatively localized (see Jaffe et al. (1993)); others indicate that international spillovers occur but are much more significant for small countries than for large ones (see Coe and Helpman (1993)). As with domestic R&D, it is intrinsically difficult to measure international R&D externalities; nevertheless, it is reasonable to expect that contemporary business practices and trends expand the potential for technology transfer and diffusion within and across borders. See U.S. Congress, OTA (1994).

[12] See, for example, Hall (1993), Baily and Lawrence (1987), Bozeman and Link (1984), Collins (1982, especially Mansfield and Nadiri in that volume), Penner, Smith, and Skanderson (1994) among authors that explicitly discuss the tax credit as a policy tool.

for excluding certain types of R&D-performing firms, and for possibly subsidizing research that would take place regardless of the credit. Existing studies of the R&E tax credit are informative in many respects but, as this report demonstrates, are dated, less than comprehensive, or otherwise unsatisfactory.[13]

This background paper is designed to provide Congress with a full review of the available evidence regarding the effectiveness of the credit in spurring private sector R&D, as well as to consider additional information on the practical efficiency of the credit both on its own terms and relative to other policy measures. The study was requested by Senator Orrin Hatch, who chairs the Taxation Subcommittee of the Senate Committee on Finance, and Congresswoman Constance Morella, who chairs the Technology Subcommittee of the House Science Committee.

To clarify the fundamental issues at stake and properly design the research project, OTA convened a panel of experts on the R&E tax credit on July 19, 1995. Panelists reviewed a contractor report prepared for OTA by Bronwyn Hall, and debated a range of issues central to Congressional interest in the topic. This background paper builds upon OTA's contractor report and subsequent critiques, the OTA workshop proceedings, and OTA staff research, including extensive interviews with senior corporate executives responsible for R&D, financial planning, and taxation, as well as discussions with IRS officials, tax lawyers, and tax accountants that specialize in the research and experimentation tax credit. OTA has used these sources of information to assess how well the R&E tax credit is currently understood, identify inadequacies in the existing data and analyses, investigate implementation issues, consider the tax credit in the context of corporate R&D trends and Federal R&D policy more broadly, draw appropriate international comparisons, and specify important avenues for further research.[14]

The analysis conducted by OTA and presented in this background paper supports the following findings:

Findings

- A complete cost-benefit assessment of the R&E tax credit requires information that has not been collected and may be either unavailable or impossible to estimate accurately. On the benefit side of the equation, the return to society of the R&E spurred by

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[13] See, for example, McFetridge and Warda (1983), Brown (1985), Cordes (1989), Penner, Smith, and Skanderson (1994), Harhoff (1994), Warda (1994), and Dumagan (1995).

[14] As explained in this report, current knowledge of the R&E tax credit is insufficient in many respects, and requires new research based on econometric models using IRS tax data as well as survey and interview data. OTA originally planned to conduct this research during the Fall and Winter of 1996, and to provide Congress with final results and a discussion of their policy implications in early Spring 1997. However, OTA will not be able to complete this research due to inadequate Congressional funding for OTA in fiscal year 1996.

the credit cannot be estimated for two fundamental reasons—first, there is no way to measure precisely how much or especially what kind of R&D is induced by the credit; and second, measuring the social rate of return to R&D is intrinsically difficult. On the cost side, there is no way to estimate how much R&D would have taken place in the absence of the credit, nor is much known about the size and significance of administrative costs for either the government or firms.

- Most evaluations of the tax credit assume that there are important spillovers to private sector R&D, and assess the credit simply in terms of whether it generates additional R&D spending. The best and most recent available studies use econometric techniques to estimate the amount of R&E induced by the tax credit. Using firm-level publicly-reported R&D data, these studies generally indicate that for every dollar lost in tax revenue, the R&E tax credit produces a dollar increase in reported R&D spending, on the margin. Based on this criterion and evidence, the R&E tax credit appears to be an effective policy instrument. It is logical to expect that the private sector response would be improved if the credit were made permanent, although it is difficult to predict the magnitude and significance of the effect.

- Current econometric studies do contain data and methodological uncertainties. Among other concerns, the estimated 1:1 sensitivity of R&D spending to the R&D tax rate (e.g., if the tax credit reduces the cost or "price" of R&D by one dollar, R&D spending will increase by one dollar) is considerably higher than estimates of the overall sensitivity of R&D spending to general changes in R&D costs, which range from 0.3 to 0.5:1 (which is to say that a one dollar reduction in the cost of R&D will increase R&D spending by 30 to 50 cents). Researchers cannot easily explain why these two R&D price sensitivity measures differ. Possible reasons include measurement and methodological differences, differences in the time periods used to develop the estimates, or an over-estimation of the tax price of R&D due to the "re-labeling" effect (e.g. estimates of tax-induced spending increases may include pre-existing R&D expenditures that were re-categorized to conform to the tax definition of R&D).

- In 1992 (the most recent available data), the IRS reported that firms filed for nearly $1.6 billion in research and experimentation tax credits, although the dollar value of the credits actually received by firms remains unknown due to several complicating factors that, in all likelihood, reduce the actual tax subsidy provided to firms. Since the policy began, most of the R&E tax credit has been claimed by manufacturing firms, which accounted for three-fourths of the total credit claimed in 1992. Most of the firms that do claim the R&E tax credit are large—in 1992, firms with over $250 million in assets claimed 70 percent of the credit; firms with assets between $10 and $250 million claimed about 19 percent, while firms with $10 million or less in assets claimed approximately 11 percent of the credit. Access to the R&E tax credit varies significantly across firms, due to factors such as variations in tax status, different R&D and sales trajectories, business cycle fluctuations, the type of R&D involved, and whether projects involve either collaborative partners or outside contractors.

- Evidence obtained through OTA interviews and other sources indicates that the R&E tax credit affects firms at the level of general budget considerations, not at the level of strategic R&D choices. Some firms may rely heavily on the credit, as is often the case in industries with rapidly expanding R&D outlays (such as biotechnology and communications) or for firms that have particularly stringent growth strategies. Generally, however, R&D strategies derive from fundamental business and technological objectives, with little or no consideration given to the R&E tax credit per se. In essence, the R&E tax credit represents more of a financial tool than a technology tool.

- There does not seem to be any correlation between the R&E tax credit and the total level of R&D spending in the United States. The credit never has represented a significant portion of total non-Federal funds for corporate R&D—the R&E tax credit peaked at 3.1 percent of industry R&D funds in 1984, and from then it decreased steadily to 1.6 percent of non-Federal industry R&D funds in 1992. Similarly, the credit accounts for only a small percentage of total R&D investment at the level of individual industries. Consequently, the R&E tax credit is unlikely to have a substantial competitive effect on aggregate R&D spending. At the level of individual firms, the R&E tax credit may be much more salient, especially for liquidity-strapped firms, firms on very rapid R&D growth trajectories (as in the communications and information technology industries), and firms whose R&D performance strongly affects their market valuation (biotechnology, for example).

- The R&D tax credit also represents a small fraction of Federal R&D expenditures (2.6 percent of total Federal R&D funding and 6.4 percent of Federal R&D funds for industry). Although indirect incentives like the tax credit often are compared with direct funding mechanisms, the two types of policies perform very different functions. If the policy goal is to increase private sector R&D at the margin, with little or no impact on the allocation of R&D resources across different technologies or types of research, then the R&E tax credit may be an appropriate and relatively effective policy instrument. If the policy goal is to rectify the market's tendency to undersupply basic research or some other particular types of technologies, such as infrastructural or "generic" research, then the R&E tax credit may be relatively ineffective because it does not substantially alter the allocation of R&D resources across different research activities. Policy choices regarding the use and coordination of different R&D subsidy instruments undoubtedly would benefit from further research into the social rate of return to different forms of public and private R&D, as well as into the extent and nature of R&D market failures in the United States.

II. R&E Tax Credit Policy in the United States

Since enacted in 1981, the R&E tax credit has been extended six times and substantively changed four times. It has expired three times—in 1986, 1992, and on June 30th, 1995. After the first two expiration dates, Congress retroactively renewed the credit. Congress once again faces the same decision.

Part II of this report begins by reviewing the evolution of the R&E tax credit and describing the contentious and unresolved issue of defining qualified research under the credit. The subsequent section analyzes the size and distribution of R&E tax credits, with particular attention to the difficulties of assessing the actual value of the credit received by industry.

History and Scope of the R&E Tax Credit

The R&E tax credit was introduced in the Economic Recovery Tax Act of 1981. Originally, it was scheduled to be effective from July 1, 1981, to December 31, 1986. The Tax Reform Act of 1986 extended the credit, in a somewhat reduced form, through December 31, 1988. The Technical and Miscellaneous Revenue Act of 1988 added another year to the credit, as did the Omnibus Budget Reconciliation Act of 1989 and subsequently the Omnibus Budget Reconciliation Act of 1990. The Tax Extension Act of 1991 renewed the credit to June 30, 1992, and the Omnibus Budget Reconciliation Act of 1993 added three more years. On June 30, 1995, the R&E tax credit once again expired.

Most of these pieces of legislation also changed the terms of the credit, whether in the credit rate itself, the qualified expenditure rules, or the base level calculations (see table 1). In essence, however, the basic formula has been consistent: the R&E tax credit is computed by taking qualified R&D expenditures that exceed a certain base level, multiplying by the statutory credit rate, and deducting this amount from corporate income taxes.[15] Congress always has maintained an incremental tax credit structure because it has sought to encourage firms to increase their R&D spending beyond the level that they would do in the absence of any tax incentive. By setting a base period and rewarding only spending beyond that level, Congress can, in principle, avoid providing a tax subsidy for activity that would have taken place regardless.[16]

Initially, tax credit rules compared current year R&E spending with the level spent in the previous three years. This criterion was widely criticized because the more a firm spent on R&E in any given year, the harder it became to receive the credit in subsequent years. Consequently, in 1989 Congress changed the base comparison from the previous three years to a fixed period of taxable years during 1984-1988 (with an exception for start-up firms). Although this amendment has been considered an improvement by most observers, it is not without drawbacks.

The rationale for having a base period is to approximate what firms might have spent on R&D in the absence of the tax credit. This is an inherently difficult task, because industry and firm-level conditions fluctuate so much that no fixed base period necessarily represents a "typical" ratio of R&E spending.[17] The selection of a fixed set of years, such as 1984-88, undoubtedly is unfair to some firms and overgenerous to others, depending on the firm's R&D spending trajectory, its revenue growth trends, and its corresponding business cycle. One alternative is to allow firms to select their own base period, as start up firms can do to a certain extent under current provisions. However, arbitrary base periods would be very difficult to administer, and would likely encourage firms to select a particularly advantageous base period, which again would obscure any determination of a typical R&E spending pattern. If Congress does renew the R&E tax credit, it will eventually have to confront the problem of determining an adequate base period, as the 1984-88 period recedes and becomes increasingly irrelevant to current business practices.[18]

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[15] There is a three-year carryback and fifteen-year carryforward provision for firms with no income tax liability in the current year. After 1988, the credit also reduces the R&D expenditure available for deduction from current income under the old section 174 rules (between 1981 and 1989, the amount of research spending that qualified for the research and experimentation tax credit also could be expensed as well). For additional modifications, see table 1.

[16] As discussed later in the text, it is difficult to estimate how much R&D would actually take place in the absence of the credit. Some observers argue that the credit generally promotes new R&D spending on the margin, as designed, while others hold that credit in large part rewards R&D spending that would take place regardless of the tax incentive.

[17] As discussed above, rolling base periods were used initially, and were discarded because additional R&E spending in one year increases the base level for subsequent years, thereby reducing the incentive effect to conduct more R&D in any given year.

[18] One could easily argue that this is already the case in some industries, such as computing and communications, where there has been an enormous amount of growth and rapid business turnover since 1984-88.

Table 1: History of R&D Tax Treatment in the United States, 1981-1995

Period	Credit Rate	Corp. Tax Rate	Definition of Base	Qualified Expenditures	Effect on Sec. 174 Deduction	Foreign Allocation Rules
July 1981 to Dec. 1986	25%	46%	Max of previous 3-year average or 50% of current year	Excluded: Research done outside U.S. or funded by others; research in the humanities and social sciences.	none	100% deduction against domestic income.
Jan. 1987 to Dec. 1987	20%	40%	same	Narrowed definition to "technological" research. Excluded leasing.	none	50% deduction against domestic income; 50% allocation.
Jan. 1988 to Apr. 1988	20%	34%	same	same	none	64% deduction against domestic income; 36% allocation.
May 1988 to Dec. 1988	20%	34%	same	same	none	30% deduction against domestic income; 70% allocation.
Jan. 1989 to Dec 1989	20%	34%	same	same	-100% credit	64% deduction against domestic income; 36% allocation.
Jan. 1990 to Dec. 1991	20%	34%	1984-88 R&D to sales ratio times current sales; max.16; .03 for startups.	same	-100% credit	same
Jan. 1992 to Dec. 1993	20%	34%	same; startup rules modified.	same	-100% credit	same
Jan. 1994 to June 1995	20%	35%	same	same	-100% credit	50% deduction against domestic income; 50% allocation.

SOURCE: Bronwyn H. Hall, 1993. "R&D Tax Policy During the 1980s: Success or Failure?" *Tax Policy and the Economy* 7: 1-53, updated.

In addition to establishing the term of the base period, the current the law also caps the allowable ratio of R&E spending to gross receipts at 16 percent. Presumably, this feature helps firms that are extremely research-intensive—the higher the base percentage, the more difficult it is for firms to earn credits in future years; conversely, the lower the percentage, the easier it is to accumulate future credits.

In practice, however, high base period R&E intensity ratios may be less of a problem than ratios that are underestimated and consequently too low. Unpublished Internal Revenue Service data indicate that the average base period percentage reported by firms on their 1992 tax returns was only 1.7 percent. The IRS notes that because the fixed base period is relatively far in the past—1984-88—the agency often runs into documentation problems when challenging individual firms' base period calculation. Since gross receipts are more easily verified even for past periods, this means that the IRS usually must accept firms' estimates of how much R&E they funded in the base period. Given the difficulty of documenting past R&E activity, not to mention intrinsic problems in defining qualified research (discussed below), firms may have some latitude to favorably adjust their base period R&E intensity ratio. Anecdotal interview evidence obtained by OTA indicates that some firms indeed "game" the rules either in this manner or by adjusting or "relabeling" their R&E spending categories to meet IRS definitions of qualified research.[19] One corporate executive, representing a company that has received R&E tax credits since 1981, stated that he would prefer to exchange the R&E tax credit for a much simpler tax structure because he ultimately wastes company resources figuring out how to play current tax rules to his advantage. Some analysts have argued that this is a relatively common activity, and that relabeling may account for a significant portion of the apparent increase in R&D spending induced by the tax credit.[20] At the same time, however, prior OTA research on R&D in the pharmaceutical industry found little evidence of relabeling.[21] Divergent evidence along these lines suggests that relabeling may vary across industries given differences in the nature of the R&D enterprise as well as the degree to which the tax definition of R&E accommodates actual R&D practices. Unfortunately, the amount of relabeling that actually takes place is impossible to determine, leaving an element of uncertainty in the equation connecting R&D spending to the R&E tax credit.

Apart from relabeling and other issues associated with base period rules, an additional rule limits the amount of the credit firms can obtain in any given tax year. Firms are allowed to claim the lesser of 1) the difference between their current year R&E spending and the base period multiplied by their average annual gross receipts for the previous four years; or 2) 50 percent of their current year's R&E spending.[22] However, if a firm's current R&D spending is more than double its base period spending, then it must use 50 percent of its current spending as the base from which to calculate the credit. The 50 percent rule has become much more important since the 1989 law replaced the three-year rolling base period with the fixed 1984-88 period—the further the base period

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[19] To the extent that it takes place, R&E relabeling is not unlike many other types of expenditure allocation judgments that taxpayers invariably have to make in the face of ambiguous definitions and other sources of uncertainty in the tax code.

[20] Edwin Mansfield (1984b).

[21] Judith L. Wagner, OTA, personal communication. See also chapter 8of U.S. Congress, OTA (1993).

[22] This rule does not apply to cash payments made for basic research conducted by educational institutions, scientific research organizations, and certain other qualified organizations, as determined under section 41(e) of the Internal Revenue Code. As discussed below, this expenditure category receives separate treatment under the R&E tax credit.

recedes, the more likely firms will be subject to the 50 percent rule. The U.S. General Accounting Office found that almost 60 percent of the corporations that reported R&E spending on their 1992 tax return were limited by the 50 percent rule.[23] These corporations, which accounted for two-fifths of the credit earned, essentially had the incentive effect of the credit cut in half.[24] Small firms are much more likely to be limited by the 50 percent rule than are larger firms, for reasons that are as yet unclear.[25]

Perhaps the most vexing issue in actually determining the actual scope of the R&E credit is the definition of qualified research. The definition of research under section 41 of the Internal Revenue Code, which establishes rules for the R&E tax credit, builds upon the definition of "research and experimental expenses" under section 174, which establishes rules for amortizing or "expensing" R&E expenditures. Corporations have been able to deduct R&E expenses from taxable income since 1954: section 174 of the Internal Revenue Code permits firms to either deduct ("expense") research outlays from taxable income in the year that the spending occurs, or depreciate research spending over a period of at least five years.[26] Except when firms have no tax liability, it is more advantageous to expense than to depreciate.

Originally, section 174 left research undefined except to exclude both expenditures on land or property and spending for mineral exploration. In 1957 the Treasury Department issued regulations defining research under section 174, but deductions were rarely audited because the section was of relatively little benefit and because routine compensation and supplies were frequently treated as deductible by the IRS anyway, which made the choice of expensing through section 174 largely inconsequential.

The situation changed significantly in 1981, when Congress enacted the research and experimentation tax credit (now codified as section 41 of the Internal Revenue Code). Section 174's admittedly vague definition of research suddenly had significant tax consequences, as firms could now claim a credit against their federal tax liability based on

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[23] GAO (1995a); p.11 and appendix IV.

[24] Since 1989, firms have not been able to deduct or "expense" from their taxable income those R&E expenses for which they claim a tax credit. After accounting for the reduced value of expensing, firms generally earn 13 cents for each dollar of R&E over the firm's base amount (the statutory tax credit rate is 20 percent). For firms subject to the 50 percent rule, each additional dollar of R&E also increases the base by 50 cents; consequently, these firms earn 6.5 percent on the additional R&E dollar, or half of that earned by firms not subject to the 50 percent rule. See U.S. Congress, GAO (1995a); p.30. On the expensing provisions in section 174 of the Internal Revenue Code, see the subsequent text above.

[25] One would expect that small firms may be more affected by the 50 percent rule because they generally have a smaller fixed base percentage than large firms. According to the GAO, however, this fact does not fully explain the greater sensitivity of small firms to the 50 percent rule. See U.S. Congress, (1995a); p.32.

[26] Separate rules exist under section 861 for the allocation of foreign source income to R&D expenses. These rules have been changed repeatedly during the 1980s, and remain a particular source of controversy. For analysis of this provision, see Hines (1994a) (1994b) (1993).

R&E expenses that met the criteria of section 174 (among other conditions). That same year, Congress asked the Treasury Department to clarify section 174. Since there was no statutory definition of research in section 174, business representatives questioned whether the Treasury Department had the authority to narrow the scope of deductible research expenses. The debate over section 174 regulations was made largely moot by the 1986 Tax Reform Act, which restricted the definition of allowable research under the R&E tax credit.[27] Clarification of the broader section 174 definition of deductible R&E expenses continued through three sets of proposed regulations, offered in 1983, 1989 and 1993, eventually culminating in final regulations in 1994—13 years after the original request for clarification.[28]

The 1986 amendments to the R&E tax credit gave the Treasury Department the authority to better define qualified research under section 41 of the Internal Revenue Code, which covers the tax credit itself. In 1989, the Treasury Department did issue final regulations for section 41 claims made prior to 1986, yet it has yet to announce final regulations for the R&E tax credit as defined by the 1986 Tax Reform Act and subsequent amendments. The delay in accomplishing this task represents in part the intrinsic difficulties of defining "qualified research" as well as the practical reality that the credit has never been a permanent feature of the tax code.[29]

Consequently, section 174 regulations remain significant in determining qualified research expenditures under the R&E tax credit. The current general rule for section 174 (applicable to tax years beginning after October 1994) defines research or experimental expenditures as those "in the experimental or laboratory sense if they are for activities intended to discover information that would eliminate uncertainty concerning the development of improvement of a product."[30] The term "product" includes "any pilot model, process, formula, invention, technique, patent, or similar property." Several types of spending are specifically disallowed: ordinary testing for quality control, efficiency surveys, management studies, consumer surveys, advertising, historical or literary research, and the acquisition of another's patent, model, production, or process.

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[27] Whether the definition of qualified research established in 1986 is more restrictive or more expansive than previous definitions remains a matter of debate. In general terms, the IRS views the 1986 definition under section 41(d) as more restrictive than prior years, while some in industry argue that it actually is broader in scope. As discussed below, there are no final regulations governing the 1986 definition of qualified research under section 41, and the issue remains controversial.

[28] The final regulations for section 174 are widely considered to be satisfactory, although they were preceded by a considerable amount of controversy. For detailed accounts of the legislative history and evolution of section 174 regulations, along with congruent interpretive debates, see Hudson (1991) and McConaghy and Ruge (1993).

[29] As of June 30, 1995, the IRS had a backlog of over 500 tax provisions awaiting final regulations. Although the IRS continues to devote staff resources to resolving section 41 regulatory issues, one would expect that the lack of permanent tax legislation in this area might retard the final resolution of the R&E tax credit.

[30] Treasury regulations (sec. 1.174-2(a)).

If a firm's R&E expenses meet these criteria, they pass the first test for qualified research expenditures under section 41 of the Internal Revenue Code. Allowable expenditures primarily include wages and supplies used for qualified research services, payments for the right to use computers for qualified research, and a percentage of payments made for contract research. However, section 41 remains rather vague on the meaning of qualified research itself—generally, the credit is available to research "undertaken for the purpose of discovering information" that is "technological in nature" and "intended to be useful in the development of a new or improved business component." Ultimately, the definition is far more specific about the types of research that are excluded than those that qualify for the credit; in addition to the research excluded from section 174, the statute for the credit disallows the following types of research:

- research conducted after commercial production begins;
- research related to style, taste, cosmetic, or seasonal design factors;
- research related to the adaptation of an existing business component to a particular customer's requirement or need;
- routine data collection;
- research conducted outside the United States; and
- any research in the social sciences, arts, or humanities.

The amount of qualified research also is determined by the whether the research is performed in or outside the firm. Sixty-five percent of qualified research conducted by outside contractors can be used toward the R&E tax credit. This 65 percent serves as a rough proxy for the fact that many overhead costs and support staff activities would not qualify for the credit if the research were performed in-house. Rather than requiring contracted organizations to itemize their research expenditures, Congress assumed that 35 percent of the contracted amount was for such extraneous expenditures. In 1992, firms that filed for the credit contracted $8 billion to outside firms for research, of which $5.2 billion (i.e., 65 percent) was allowable for the credit.[31]

Payments made for basic research conducted in universities, certain scientific research organizations, tax-exempt scientific organizations, and certain grant organizations receive separate tax treatment than in-house or other research that is contracted out. However, in practice firms make relatively little use of the basic research provision in section 41(e) of the Internal Revenue Code: in 1992, firms applying for the credit spent only $980 million on basic research performed by universities and other qualified organizations, compared with approximately $35 billion spent in-house and $8 billion spent on outside contractors.[32] After all requisite calculations and adjustments, the tax

[31] IRS, unpublished data provided to OTA. See table 2 regarding the relative magnitude of different types of research expenditures that qualify for the R&E tax credit.

[32] In 1992, total qualified research amounted to $43.3 billion. After subtracting the base amount and making other requisite calculations and adjustments, the total R&E credit claimed was $1.6 billion.

credit provision for basic research payments to qualified organizations amounted to $188 million of the total $1.6 billion in credits claimed in 1992. The relatively modest use of this provision may derive in part from the tax credit's definition of basic research as "any original investigation for the advancement of scientific knowledge not having a specific commercial objective."[33] Presumably, few firms will spend much on research with no commercial objective unless they have philanthropic or other intentions, in which case they may be able to use other tax provisions such as those for charitable deductions.

Although section 41 provides some clarification of qualified research under the credit by specifically excluding certain activities, the general definition of qualified research remains vague and contentious. Stipulating that the credit applies to information that is "technological in nature" provides little guidance to firms or the IRS, nor do the conditions that the technology be "useful" for the development of a "new or improved" component add any additional clarity. Firms frequently dispute the meaning of qualified research with the IRS. In audited cases, the scope of allowable research emerges from a negotiating process among firms and their accounting or legal representatives, the IRS, and sometimes the judicial system. A key component of most audits involves the disposition of employee time between qualified research and other activities (e.g. managerial responsibilities, production or marketing responsibilities, etc.); disputes in this area turn not only on uncertainty over the meaning of qualified research but also on the ability of firms to adequately document qualified wage and supply costs.

Large firms (e.g. those with more than $250 million in assets) are routinely audited; those with fewer assets are audited based on other criteria. Audits typically are performed by general IRS examiners, who may be assisted either by IRS engineers (usually in cases involving large taxpayers) or by an individual or team from the IRS Industry Specialist Program (in cases involving taxpayers with less than $250 million in assets).[34] IRS engineers possess specialized knowledge on particular industries or lines of work, and are best able to answer technical questions on disputes between firms and the IRS over whether certain company activities constitute allowable research. However, due to insufficient staff the IRS rarely assigns engineers to audits involving firms with less than $250 million in assets (such firms accounted for 30 percent of the credit in 1992), and even in cases involving large firms it is not always possible to assign an engineer who has a background relevant to the firms' line of business. Staff from the Industry Specialist Program (ISP) often provide the expertise needed in cases involving smaller taxpayers. However, the ISP program has only one staff person in the country who is responsible exclusively for assisting R&E tax credit examinations across all industries.

Payments made for basic research conducted by qualified organizations accounted for 2.3 percent of all qualified research and 11.8 percent of the total R&E credit claimed in 1992.

[33] Internal Revenue Code, section 41(e)(7)(A). In addition, the provision excludes basic research in the social sciences, arts, or humanities as well as any basic research conducted outside the United States.

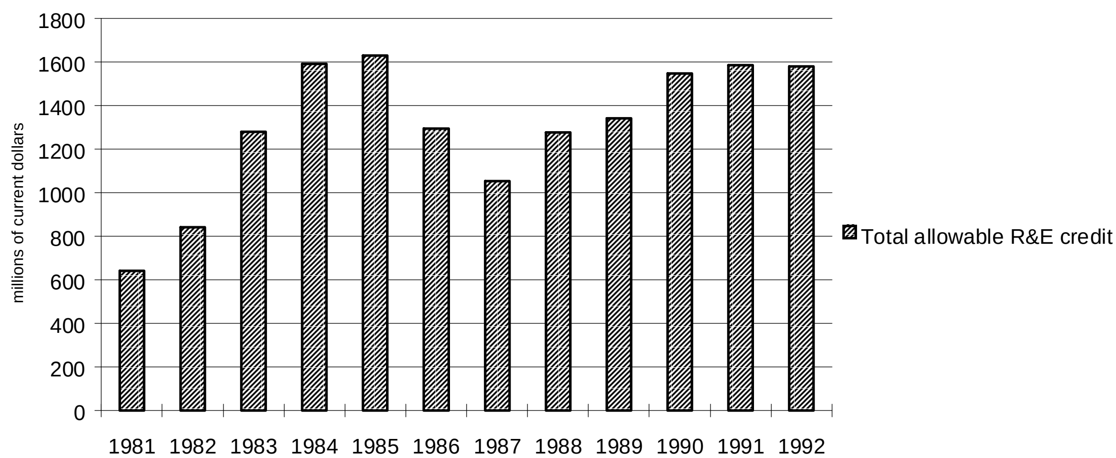
[34] The Industry Specialist Program within the IRS is designed primarily to secure national consistency in tax treatment within particular industries.

As discussed in the next section, the unknown net outcome of the auditing process constitutes but one source of uncertainty over the actual value of R&E tax credits earned by corporations in any given tax year.

The Size and Distribution of R&E Tax Credits

In 1992 (the most recent available data), the IRS reported that firms filed for nearly $1.6 billion in research and experimentation tax credits. This amount has fluctuated since the credit's inauguration in 1981, but has remained steady since 1990 (see figure 2).

Figure 2: R&E Tax Credits Claimed by U.S. Firms, 1981-1992



Source: Internal Revenue Service.

The dollar value of R&E tax credits actually received by firms remains unknown, due to several complicating factors that, in all likelihood, reduce the actual tax subsidy provided to firms. First, the 1986 Tax Reform Act placed the R&E tax credit under the General Business Credit, which consists of twelve different tax credits (including credits for investment, low-income housing, oil recovery and renewable electricity, employee tips, and several types of employment credits). The General Business Credit caps the overall possible credit from its twelve components, and can therefore significantly reduce the value of the research and experimentation tax credit.[35] Available evidence indicates that the General Business Credit can limit the effective allocation of R&E tax credits in a given

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[35] The procedures initiated in 1986 also make it more difficult to determine the effective R&E tax credit rate from public data, and do not provide the same level of industry detail available in prior years because the R&E tax credit was removed as a separate line item in the IRS Statistics of Income. The credit is still listed in one of the tables for the whole corporate sector, but detailed industry breakdowns are no longer available.

year by at least 30 percent—in 1992, for example, corporations filed for nearly $1.6 billion in research and experimentation tax credits, but were able to use only $1.1 billion in General Business Credits (including the R&E credit) that year.[36]

Second, the Tax Reform Act of 1986 also strengthened the alternative minimum tax (AMT) system, which was designed to limit the overall benefits that corporations may derive from tax breaks by ensuring a minimum tax rate of 20 percent. Like the limitation on the General Business Credit, the AMT also can cap the R&E tax credit effectively available to individual firms. For instance, if a firm is subject to the AMT, it cannot claim the R&E tax credit in the current year, but must carry it forward (for up to fifteen years) until it is subject to regular corporate tax. Also, the rate of taxation under AMT is 20 percent, rather than the statutory corporate rate of 34 percent; consequently, firms that are temporarily subject to the AMT will face tax incentives that favor investment in intangibles over tangibles, relative to what they would face under ordinary corporate taxation.[37] In practice, only a small number of large manufacturing firms filed AMT returns in 1988, accounting for 3 percent of the total tax bill paid by manufacturing firms that year (Statistics of Income 1988), so the AMT may have a relatively small effect on the credit. At the same time, however, the AMT is more likely to reduce the R&E tax credit available to firms during recession years, when corporate profits are down. Again, there is no definitive method for gauging the impact of the AMT on the R&E tax credit from publicly available data, but a conservative estimate places the impact at roughly five percent.

Finally, the research and experimentation tax credit is further reduced by IRS audits. Unfortunately, no one—apparently not even the IRS—has any data on either the percentage of R&E tax credit claims that are audited or the net reduction in value of the R&E tax credit after auditing. Complicating the problem is the fact that audits often extend through several tax years, and contested cases often last five or more years. Nevertheless, existing evidence suggests that most audits result in significant downward adjustments in the allowable credit amount. Based on a survey of IRS examiners , the U.S. General Accounting Office estimated that IRS agents proposed reductions in 79 percent of the cases in which the R&E tax credit was audited during the first half of the 1980s, with an average net IRS downward adjustment of nearly 20 percent.[38] Interview evidence conducted by OTA for this report suggests that the audit process continues to reduce the allowable R&E tax credit by approximately the same amount.[39] In addition, definitional uncertainties, documentation problems, and other factors often encourage firms as well as the IRS to settle R&E tax credit disputes solely on the basis of the hazards

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[36] U.S. Congress, GAO (1995a): p.5. Corporations may carry forward some unused tax credits, although the present value of those credits is usually lower due to the effects of inflation, changes in the firm's tax status, and other factors.

[37] See Lyon (1991).

[38] U.S. Congress, GAO (1989); pp.18-19, Table 2.1.

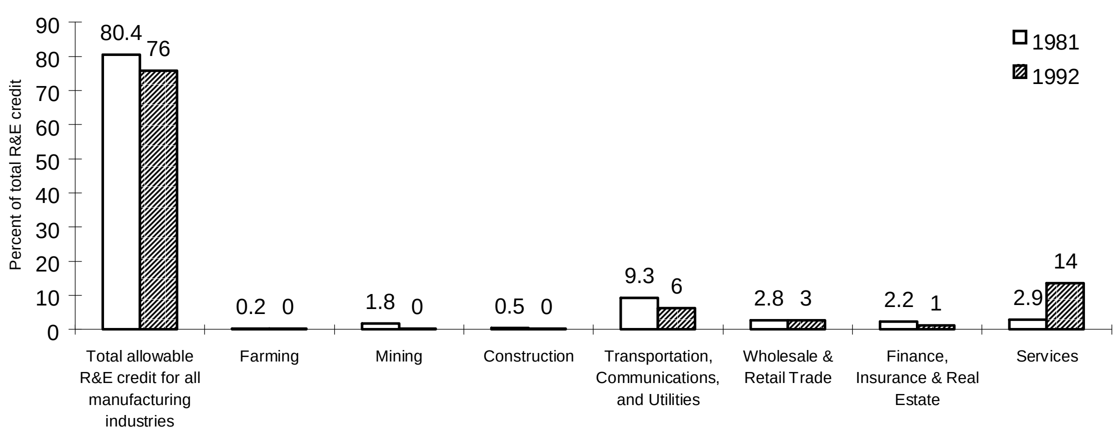
[39] Based on OTA discussions with industry executives, tax consultants in the major auditing firms that handle R&E tax credit cases, and IRS officials.

of litigation, with little if any reference to the actual R&E performed. Moreover, corporate tax settlements typically are complicated affairs that involve numerous disputes at once, which increases the possibility that the effective value of the credit could be determined by unrelated aspects of the firm's tax status and bargaining position.

Given the net downward adjustments to the credit through IRS audits, along with the limits placed on the credit by the General Business Credit and the Alternative Minimum Tax, it is difficult to gauge how much the actual value of allowable R&E tax credits differs from the amount claimed by firms. OTA estimates that the combined effect of these factors can reduce the amount of R&E tax credits actually granted to firms in any given tax year by as much as one-third of the amount claimed. In addition, credits granted can be claimed in different years, as firms can carry forward (for up to 15 years) or carry back (for up to 3 years) the value of the credit, depending on changes in the firm's tax status. This variation further complicates the problem of determining the value of R&E tax credits received by industry in any given year.

Since the policy began in 1981, most of the R&E tax credit has been claimed by manufacturing firms, which accounted for three-fourths of the total credit claimed in 1992 (see figure 3). The share of the credit claimed by manufacturing and mining has declined over time, as several service industries (including health care, education, and various business services) have increased their share. The decline in manufacturing's share is partly if not largely due to the fact that manufacturing has been a shrinking portion of the economy, with its share of total employment falling since 1981 from 22 percent to 16 percent of the work force. Within manufacturing, 80 percent of the credit is claimed by four sectors: chemicals and allied products (30 percent, with pharmaceuticals accounting for 22.1 percent), electrical equipment (18 percent), transportation equipment (18 percent), and machinery (14 percent).[40]

Figure 3: Distribution of R&E Tax Credits by Industry, 1981 and 1992



Data source: Internal Revenue Service.

[40] U.S. Congress, GAO (1995a); Table II.3, p.19 (based on IRS SOI data).

Economic and business trends since the inception of the R&E tax credit have significantly influenced which firms obtain it. Among manufacturing firms, military and aerospace firms benefited greatly from the credit during the 1980s but most no longer can due to declining business in these industries (partly a product of reduced federal spending). Mergers also can affect whether a firm is eligible for the credit. For example, when an R&D-intensive line of business merges with one less intensive, the overall ratio of R&D to sales falls. Obviously, firms make merger decisions based on factors other than the R&E tax credit, but the loss of tax benefits from the credit due to mergers has led some firms to argue that the law should gauge R&E investment by line of business rather than by firm.[41] For example, TRW has noted that because of its operations in space and defense (where its R&D investment has declined) and the automotive business (where its R&D has risen), it receives less benefit from the credit for its automotive research than it would if it operated solely in the automotive industry.[42] The Aerospace Industries Association also has argued that mergers even among firms in the same line of business often results in a lower percentage of sales devoted to R&E (due to economies of scale), and that therefore such mergers result in less benefit from the research and experimentation tax credit.[43]

Large firms account for most of the R&E tax credits actually claimed (see figure 4). In 1992, firms with $10 million or less in assets claimed approximately 11 percent of the credit, while firms with assets between $10 and $250 million claimed about 19 percent; the rest of the credit—70 percent—was claimed by firms with over $250 million in assets. This distribution in part reflects the concentration of R&D in the United States within large firms; as discussed below, however, small R&D-performing firms may have special difficulties using the credit.

Most of the credit that firms claim is for compensation of employees engaged in qualified research, which constituted 62 percent of qualified R&E expenses claimed by all firms in 1992 (see table 2). Supplies represented the second most significant category of qualified research, and contract research the third. Less than $200 million was claimed for the rental or lease of computers, about the same amount that was claimed for basic research payments to qualified organizations (including but not limited to universities); both categories represent less than one-half of one percent of all qualified research.

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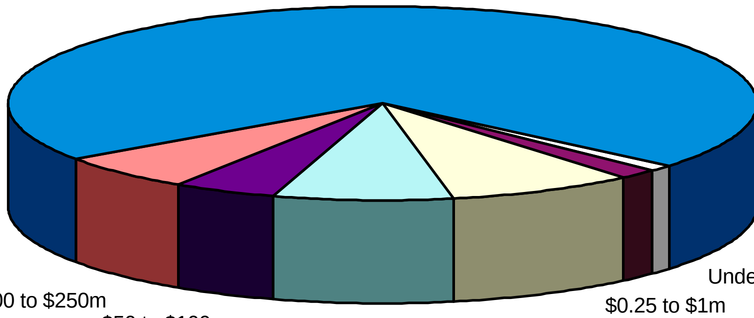
[41] Mergers conceivably could result in the opposite outcome as well: if an R&D-intensive firm merges with a less R&D intensive firm, and the former previously was subject to the 50 percent rule and consequently could not claim a credit for all qualified research performed, then after the merger the new firm could claim a higher R&E tax credit.

[42] Testimony before the House Ways and Means Committee, Subcommittee on Oversight, Hearings on the Research and Experimentation Tax Credit, May 20, 1995.

[43] Testimony before the House Ways and Means Committee, Subcommittee on Oversight, Hearings on the Research and Experimentation Tax Credit, May 20, 1995.

Figure 4: Distribution of R&E Tax Credits by Corporate Size, 1992



Data source: General Accounting Office, based on Internal Revenue Service, Statistics of Income (1992).

Table 2: Distribution of Qualified Research Expenses for the R&E Tax Credit, 1992

Expenditure Category	Amount Claimed (millions)	Percent of Total Qualified Research
Wages	26,845.8	62.0%
Supplies	8,568	19.8%
65% of contract research	5,222.7	12.1%
Rental/lease cost of computers	192.3	0.4%
Basic research payments to qualified organizations	188.4	0.4%
Total qualified research	[43,291]	[94.7%]

Note: "Qualified research" represents the full amount of research expenses allowed under the R&E tax credit. The actual credit received is a function of the fixed base percentage, the base amount for the given tax year, the 50 percent rule and other limitations, and the statutory credit rate of 20 percent. In 1992, the $43 billion of qualified research expenses generated a tax credit value of approximately $1.6 billion. Note also that total qualified research is slightly higher than the sum of the categories listed due to variations in how many taxpayers responded to each individual line on IRS form 6765.

In 1992, firms conducted $43.3 billion of qualified research, which after all requisite calculations generated a tax credit value of approximately $1.6 billion. By comparison, the tax revenue cost of research expensed under section 174 is slightly larger, at approximately $2.0 billion.[44] Unfortunately, the precise tax value of R&E expensing is unknowable, since there is no line item for this feature on corporate tax forms. Firms total their miscellaneous tax deductions under a single line, and attach a list itemizing each deduction, presumably including section 174 amounts. The IRS does not tabulate data on individual miscellaneous deductions, and even if they did, the information would probably be of very limited value. Because most routine compensation may be expensed, it is likely that many firms—whether for administrative convenience or for lack of knowledge of the section 174 provisions—simply lump their deduction for research compensation together with the deduction for routine employee compensation. Moreover, the value of R&E expensing can vary with changes in the overall corporate tax rate. If a firm undertaking R&D investment faces the same corporate tax rate in all periods, the corporate tax rate does not affect that investment because the firm spends after-tax dollars on the investment and receives after-tax dollars as income. However, if the tax rate is changing for one reason or another, or if the firm is moving in and out of taxable status, then changes in the rate will begin to affect the cost of R&D capital faced by the firm.[45] The reduction of the corporate tax rate during the 1980s had a substantial impact on the cost of an R&D dollar, because it reduced the benefit of expensing (relative to other types of capital investment) by at least 12 percent (due to the fall in the corporate tax rate from 46 to 34 percent) and possibly more if the firm faced the alternative minimum tax of 20 percent.

III. Assessing the Effectiveness of the R&E Tax Credit

In principle, the best method for evaluating the effectiveness of the R&E tax credit is to weigh the return to society from the R&D generated by the policy against the opportunity cost of using the tax revenues for other purposes. If the social return from additional corporate research is very high, then Congress may be willing to give up more tax dollars than the actual research induced by the tax subsidy. On the other hand, if the social return is only slightly higher than the private return, then lowering the cost of research might cause the firm to do too much R&D; in these circumstances, even though the tax credit induces more corporate R&D than the lost tax revenue, higher social returns could be achieved by spending the tax revenue on some other activity.

No study ever has accomplished this type of comparison. Nor could one succeed, if attempted. Although the concept of a social rate of return to R&D is indisputable in theory, it cannot be measured easily in practice due to the intrinsic difficulties of establishing adequate price indices for the components of R&D costs specific to individual

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[44] According to Joint Tax Committee estimates. See Joint Committee on Taxation, Estimates of Federal Tax Expenditures for Fiscal Years 1995-1999 (prepared for the Committee on Ways and Means and the Committee on Finance, November 9, 1994). Based on these estimates, the CBO forecasts that the revenue cost of R&D expensing will rise gradually from $2.0 billion in 1995 to $2.3 billion in 1999. See U.S. Congress, CBO (1995); table 2 p.19.

[45] Fullerton and Lyon (1988); Hall (1991).

industries, determining a satisfactory time period within which to assess the productivity gains from R&D, measuring the depreciation rate of R&D capital stocks, and related problems.[46] Likewise, it is inherently difficult to determine the opportunity cost of the R&E tax credit's revenue value. How do the productivity gains from the R&D induced by the approximately $1.6 billion in 1992 R&E tax credits compare to the return to society of $1.6 billion in deficit reduction or some other public purpose? For all practical purposes, this question cannot be settled without considerable dispute.

Unable to reach any conclusion on the relative social rate of return to R&D induced by the tax credit, some analysts consequently have avoided any final assessment of whether the R&E tax credit is an effective and desirable policy instrument.[47] Most analysts simply assume that some form of R&D subsidy is necessary, given the reasonable premise that there are significant social gains from at least some private R&D.[48] Assuming some positive spillovers to society, assessing the effectiveness of the R&E tax credit subsequently becomes a matter of comparing the amount of corporate R&D spending induced by the credit to the dollar value of the credit's revenue cost. The ratio of these two quantities is the benefit-cost ratio: if it is greater than one, the tax credit is considered to be a more cost-effective way to achieve the given level of R&D subsidy; if it is less than one, a direct R&D subsidy would be more cost-effective.[49]

Although conceptually straightforward, existing cost-benefit studies of this sort involve complicated estimates and calculations, and most suffer from data inadequacies, methodological shortcomings, and other problems. The following section of this report outlines the principle methods of estimating the amount of R&D induced by the credit, as well as the methods of estimating the cost of the credit; the text then presents the findings from researchers who have used these methods, and identifies several unresolved empirical issues.

Measuring the Amount of R&D Induced by the Tax Credit

Conceptually, measuring the amount of R&D induced by a tax credit raises a counterfactual question: how much more R&D did firms do because of the tax credit than they would have done if there had been no credit? Counterfactuals cannot be observed,

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[46] For a survey of these issue, see Hall (1994).

[47] See, for example, U.S. Congress, GAO (1995a).

[48] On the social returns to R&D, see Griliches (1992), Mansfield (1965), and Bernstein and Nadiri (1988, 1989).

[49] This simple claim presumes either that the government can efficiently perform the R&D itself, or that the government can fund private R&D without substituting for private funds that would have been spent on industrial R&D regardless. Both of these presumptions are subject to debate.

and researchers consequently rely on various methods to estimating the level of R&D without the subsidy.

One of the two most common methods is to construct an equation that predicts the level of R&D investment as a function of past R&D, past output, expected demand, and other variables such as cash flow and different price variables. A dummy variable is included in the equation, equal to one when the credit is available and zero otherwise. The magnitude of the estimated coefficient of the dummy variable is equal to the amount of R&D induced by the presence of the credit. If this exercise is conducted using firm-level data, the best method is to measure the availability of the credit at the firm level—that is, taking account of the usability of the credit. If it is conducted at the macro-economic or industry level, the identification of the credit effect will come from the variation in R&D demand over time.[50]

The advantage of this method is its relative simplicity, for it eliminates the need to perform relatively complex computations of the actual level of the tax credit subsidy available to each firm. The disadvantage of this method is that the measurement is relatively imprecise, for at least three reasons. First, since firms benefit directly from the amount of R&D qualified to receive the tax credit, they have an incentive to shift or "relabel" spending categories in a way that maximizes the amount of qualified R&E; consequently, the "true" level of R&E induced by the credit may be overstated.

Second, all firms do not face the same magnitude of credit at any given point in time, due to variations in any given firm's taxable income position, whether it is subject to the Alternative Minimum Tax, whether it is subject to General Business Credit limitations, how much foreign income it repatriates, and so forth. Consequently, the R&D investment level and the tax price faced by the firm affect each other, and ordinary regression methodology is inappropriate under these circumstances.[51] For this reason, some analysts have relied on instrumental variables to estimate the price elasticity, albeit with the attendant loss of precision in estimation.

Finally, if the variable occurs over time, it is likely that other forces that strongly affect aggregate industrial R&D spending—such as global economic conditions, trade, and so forth—which are not included in the R&D equation may lead to spurious conclusions about the effectiveness of the tax credit.

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[50] Examples of this method include Eisner, Albert, and Sullivan (1983); Swenson (1992); Berger (1993); Baily and Lawrence (1992); McCutchen (1993).

[51] This is because R&D spending and the tax-adjusted price of R&D are jointly determined in any period by the actions of the firm and market, through their impact on both the cash flow and tax position of the firm. For example, although a lower tax-adjusted price of R&D might induce more R&D spending, *ceteris paribus*, more R&D spending may move the firm into an operating loss position, which will tend to increase the after-tax price of R&D. An effect like this would reduce the apparent responsiveness of R&D to the tax credit, but the estimated elasticity will not be the true price elasticity—that is, it will not correspond to one that would prevail in an environment with a different type of tax credit.

The second most common method for estimating the impact of the R&E tax credit also postulates a R&D equation that controls for the non-tax determinants of R&D, but instead includes a price variable that represents the marginal cost of R&D. This price variable is used to construct a measure of the sensitivity of R&D spending to changes in the price of R&D. Since the tax credit effectively lowers the price of R&D, it should induce firms to supply more R&D. Consequently, if the price variable includes the implicit tax subsidy given to R&D, then this measure should indicate how R&D spending responds to the R&D tax rate.[52]

Even if the price variable does not contain a measure of the tax subsidy, it is possible to use the measured price sensitivity of R&D to infer the response induced by a tax reduction of a given size. For example, if we estimate a price elasticity of -0.5 and the effective marginal R&E tax credit is .05, or a 5 percent reduction in cost, then the estimated increase in R&D spending from the tax credit will be 2.5 percent.[53]

The advantage of this method is that it is well-grounded in economic theory, and it is somewhat more accurate than the first method because it estimates the price response of R&D directly. However, it has its own disadvantages. Absent variations in tax treatment across firms and time, one is forced to use a constructed R&D price deflator as the price variable in an R&D demand equation. These deflators typically are a weighted average of R&D inputs, around half being the wages and salaries of technical personnel, and the other half being some kind of research materials and equipment index. The only real change in this variable is over time. This is a weak basis for estimating the price elasticity of R&D demand, since the estimates will depend strongly on the other factors in the model that vary over time. Some studies have circumvented this problem to a large extent by observing variation in the tax-adjusted cost of R&D across firms, instead of over time.[54]

A third and completely different research method is an event study, where the effect of a policy is inferred by comparing behavior before and after a change in policy is announced. Event studies typically assume that the policy being studied (such as the introduction of a tax credit) is a surprise to the economic agents it affects. They are usually conducted using financial market data, although not in every case. In the case of the tax credit, an event study could take the form of comparing the market value of R&D-oriented firms before and after the tax credit legislation was considered and passed, or of comparing R&D investment plans for the same time period before and after the legislation.[55] This method generally has the great advantage of observing actual behavioral outcomes, obviating the need for the problematic estimation techniques involved in the first two methods described above. The disadvantage of this method is

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[52] Examples of this method include Baily and Lawrence (1992); Hall (1993); and Hines (1993).

[53] See Collins (1983); GAO (1989); and Mansfield (1986).

[54] Hall (1993); and Hines (1994).

[55] An example of the former method is Berger (1993); an example of the latter is Eisner, as reported in Collins (1983).

that it is typically difficult to determine the significance of the given policy change relative to numerous other factors, some known and some not, that could affect the outcome.

The remaining possible techniques for evaluating the R&E tax credit involve interview and survey data. Interview data can provide rich detail about how individual firms respond to factors, such as the tax credit, that may affect their R&D planning. This method has been used surprisingly sparingly, given the inability of other methods to view the R&E tax credit amid the complex array of factors that affect firm-level R&D strategies.[56] The obvious disadvantage of interview data is the researcher's inability to determine which behavioral patterns are unique and which are common. A possible antidote to this problem is to combine focused interviews with a survey instrument, which could be used to test propositions across a wide range of cases. To OTA's knowledge, no one ever has used this method.

Measuring the Costs of the R&E Tax Credit

The second component of a benefit-cost analysis of the R&E tax credit is the computation of total cost. In principle, the total social cost consists of the net tax revenue loss due to the credit, the opportunity cost of using the tax revenue for other purposes, and the costs of administering the credit (both to the firm and to the Internal Revenue Service). In practice, the cost computed has been simply the gross tax credit claimed, inaccurate as this may be.[57] At best this has been done by simply adding up the credits claimed by the firms that use the credit[58], sometimes adding in the unused credits that have been used to offset prior-year liabilities.[59] Occasionally, estimates have been produced relying only on representative or average firm behavior; this method is likely to produce erroneous results given the extreme heterogeneity in the data. Either way, this type of analysis ignores the fact that the existence and use of the R&E tax credit may have implications for the overall tax position of the firm, so that the net change in tax revenue because of the credit is not captured by simply adding up the credits.

The second omission in the conventional computation is the administrative cost of the tax credit. The 1989 GAO Study, updated in 1995 for Congressional testimony, makes it clear that these costs can be high, but offers no estimate of their magnitude.[60] The IRS does not appear to keep any data on the administrative costs of implementing the R&E tax credit, although OTA interviews indicate that the administrative costs may be

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[56] This background paper relies to a certain extent on interview data. See also Mansfield (1986).

[57] See the above discussion regarding the size and distribution of R&E tax credits.

[58] Mansfield (1986); and Hall (1993).

[59] GAO (1989).

[60] GAO (1989); GAO (1995a); and GAO (1995b).

driven up substantially by vagueness in the definition of qualified research. Another possible source of administrative friction concerns the performance of research by outside subcontractors, where the IRS appears to have taken the position that the tax credit should flow to the organization that will pay for the R&D "in the normal course of events," rather than to the organization that bears the risk of the investment.[61]

Individual firms also bear considerable costs in using the R&E tax credit. At some point in time, any firm that seeks to use the tax credit will need to set up an administrative system for collecting sufficient data to stand up to IRS documentation criteria for the R&E tax credit. This is a one-time cost that may or may not be significant, depending on existing accounting methods used by the firm.[62] However, the regular administration of the credit may involve significant additional costs, again largely due to uncertainty in the scope of qualified research.[63] OTA interviews indicate that these costs can be substantial for some firms: some firms indicated that they frequently question the net worth of using the tax credit, given the costs of administering it, the frequent battles with the IRS over the scope of qualified research, and the downward adjustment in the credit after auditing. Other observers suggested to OTA that many firms do not apply for the credit at all, due to its administrative costs and uncertain utility. Again, the magnitude of this problem is difficult to determine, and probably could only be estimated through surveys of R&D performing firms.

Findings from Existing Research on the R&E Tax Credit

Table 3 summarizes the results of the many studies of the U.S. R&E tax credit that have been performed since its inception in 1981.[64] The table presents two standardized results from these quite disparate studies, one regarding the sensitivity of R&D spending to price changes (for a typical firm in the sample), and the other regarding a final estimate of the benefit-cost ratio of the credit. In some studies, the available data is insufficient or not present, requiring either an approximation or no estimate at all.

Table 3 indicates that the first wave of estimates (those using data through 1983) differ substantially from the second (those using data through 1988 and later) in two

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[61] U.S. Government Brief, filed September 3, 1993, in *Fairchild Industries, Inc. v. United States*, 30 Fed. Cl. 839, as quoted in Stoffregen (1995).

[62] In all likelihood these one-time costs are relatively signficant, since the accounting of R&D for book purposes is insufficient for purposes of the R&E tax credit.

[63] See Stoffregen (1995).

[64] Excellent surveys already exist of this evidence. See Collins (1983), Brown (1984), Baily and Lawrence (1987), Cordes (1989), Harhoff (1994), and Penner, Smith, and Skanderson (1994). Rather than repeating these surveys, this background paper focuses instead on the methodologies used, in an attempt to see where they might be improved as well as to find points of consensus among the disparate results.

respects: First, they tend to have lower or non-reported tax price elasticities of R&D (only the later study by McCutchen of large pharmaceutical firms is an exception, and the R&D equation in this study appears to be misspecified[65]); second, they are typically not based on the publicly reported SEC data maintained by Compustat, but on internal Treasury tax data, surveys and interviews, and, in one case, an early Compustat file. This makes it slightly difficult to ascertain whether the differences in results are because the response to the credit varied over time, or because the type of data used was substantially different. Unfortunately, the only early study that used a large set of firms from Compustat contains methodological problems that make it difficult to determine the effect of the tax credit.[66]

Later work using firm-level data from the 1980s tends to reach the same conclusion—the sensitivity of total R&D spending to the rate at which it is taxed, known as the tax price elasticity of R&D, has been approximately one, and perhaps slightly higher. Simply put, the R&E tax credit encouraged at least a dollar of new R&D spending for each dollar in lost tax revenue. Several recent studies have reached this conclusion, each using a different data source within an R&D demand equation containing lagged R&D, current and lagged output, and occasionally other variables such as cash flow.[67]

In short, the available literature reaches a relatively common finding: the firm-level publicly-reported R&D data indicates that the R&E tax credit produces a dollar-for-dollar increase in reported R&D spending, on the margin. This finding is not necessarily inconsistent with earlier studies, to the extent that it took some time in the early years of the credit for firms to adjust to its presence, so the elasticity was somewhat lower during that period.[68] Coupled with the weak incentive effects of the early design of the credit, this low short run elasticity implied a weak response of R&D spending in the initial years, causing researchers to interpret it as zero or insignificant.

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[65] It is difficult to pull the elasticities out of the estimated coefficients in this paper because it appears that R&D intensity was regressed on the absolute size of the claimed tax credit, a specification that implies a very large effect at the high end of the size distribution. McCutchen also presents results using a dummy variable specification, and these indicate an excessively large increase of 19 percent in R&D spending in 1982-1985 over the 1975-1980 period that is attributed to the tax credit. With a marginal effective tax credit of about 5 percent, this would imply a tax price elasticity of about 4, which is far higher than most estimates. One possible explanation for these discrepancies is that the tax credit variable in the study includes the effects of other unmeasured factors that may have pushed up spending in the pharmaceutical industry during the 1980s.

[66] Eisner, Albert, and Sullivan (1983).

[67] See Berger (1993), Hall (1993), Hines (1993), and Baily and Lawrence (1987, 1992).

[68] This is confirmed by interview data reported in Collins (1983), based on interviews with R&D executives in 14 major R&D-performing companies by the Industry Studies Group, National Science Foundation. Among other findings, they report that "As of Spring 1982, some R&D executives did not fully understand the tax credit." (Collins (1983); p. 8).

Table 3: Empirical Studies of the Effectiveness of the R&E Tax Credit

Eisner, Albert, and Sullivan, 1983	Mansfield, 1986	Swenson, 1992	Berger, 1993	Baily and Lawrence, 1987, 1992	Hall, 1993	McCutchen, 1993	Hines, 1993
1981-82	1981-1983	1981-88	1981-88	1981-89	1981-91	1982-85	1984-89
1980	not relevant	1975-80	1975-80	1960-80?	1980	1975-80	not relevant
lcGraw-Hill surveys Compusat IRS ind.	Stratified random survey	Compustat	Compustat	NSF R&D by ind	Compustat	IMS data and 10Ks	Compustat +
-600 firms for R&D 3.4-digit ind for tax	110 firms	263 firms (balanced)	263 firms (balanced)	12 2-digit inds.	800 firms (unbalanced)	20 large drug firms	116 multi-nationals
Dummy R&D equation compared pre- and ost-IRTA; same for R&D above/below base	*Survey* Asked if R&D tax incentive increased spending	*Dummy* Log R&D demand eqn. FE spec.	*Dummy/Event* R&D intensity eqn. FE spec.	*Dummy/Elasticity* Log R&D demand eqn with tax price or credit dummy	*Elasticity* Log R&D demand eqn with tax price var.	*Dummy* Research intensity eqn by strategic grp with tax credit	*Elasticity* R&D demand eqn with tax price for sec 861-8
R&D lag 1&2, Current & lag sales, CF		Log S, change in LT Debt lag 1&2	Lag R/S, Ind. R/S, Inv/S, Ind. Inv/S CF/S, Tobin's q. GNP	Lag R&D, current and lag output (logs)	Lag R&D, current and lag output (logs)	Past NCFs, Divers. CF/Sales, %drug sales	Dom. & for. tax price; dom. to for. sales; ind, firm dummies
insig.	0.35?	?	1.0-1.5	0.75 (0.25)	1.0-1.5	0.28-10?	1.2-1.6
NA	0.30 to 0.60	NA	1.74	1.30	2.00	0.29-0.35	1.3-2.00

dologies described in row 5.

However, the evidence used to reach these conclusions rests upon the response of total R&D spending to changes in the tax-adjusted cost of qualified R&E, not total R&D. Qualified R&E typically accounts for anywhere from 50 to 73 percent of total R&D spending.[69] These studies also rely on rather questionable tax status data, where the effective tax credit rate faced by the firm is inferred using information in the Compustat files on operating losses and taxable income over the relevant years. And where aggregate data are used, no attempt has been made to correct for the usability of the credit. It is probably unreliable to infer the qualified R&E spending by multiplying total R&D reported on the SEC 10-K form by a common correction factor (such as 0.6) and inferring the tax status by looking at the 10-K numbers.[70] The only study that has used the true (and confidential) corporate tax data is that by Altshuler, and unfortunately for our purposes here, it focuses on the weak incentive effect implied by the credit design rather than evaluating the actual R&D induced.[71]

Using a tax price inferred from Compustat data to assess the responsiveness of total R&D spending to tax changes raises two quite distinct problems that deserve further investigation. First, as discussed above, the estimates based on public data involves numerous uncertainties, and may even be misleading. Second, because these estimates are based on the response of reported R&D to the credit itself, they may overestimate the true response of R&D spending to a change in price. This is sometimes called the "relabeling" problem. If a preferential tax treatment for a particular activity is introduced, firms have an incentive to make sure that anything related to that activity is now classified correctly, whereas prior to the preferential treatment, they may have been indifferent between labeling the current expenses associated with R&D as ordinary expenses or R&D expenses. There is some suggestive evidence reported in Eisner, Albert, and Sullivan (1986) concerning the rate of increase in qualified R&E expenditures between 1980 and 1981, when the credit took effect. Using a fairly small sample of firms surveyed by McGraw-Hill, they were able to estimate that the qualified R&D share grew greatly between 1980 and 1981, less so between 1981 and 1982. This is consistent with firms learning about the tax credit, and shifting expenses around in their accounts to maximize the portion of R&D that is qualified. It is also consistent with the tax credit having the desired incentive effect of shifting spending toward qualified activities, although the speed of adjustment suggests that accounting rather than real changes are responsible for some of the increase.

One way around the relabeling problem is to use a method of estimating the inducement effect that does not rely directly on the responsiveness of R&D to the tax

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[69] See U.S. GAO (1989); Altshuler (1989); Penner, Smith, and Skanderson (1994); and Cordes (1989).

[70] Appendix IV of the GAO (1989) study reports on a match of 800 corporations with IRS data to Compustat, yielding 219 corporations with complete data for 1980-1985. The year-to-year spending growth rates for R&D were found to differ significantly across the two files, leading to significant differences in the estimated credit rate. They did not even consider using the tax status data on Compustat, so we have no comparison using tax numbers.

[71] Altshuler (1989).

credit. This is the method used in U.S. GAO (1989) and in Bernstein's 1986 study of the Canadian R&D tax credit. One estimates the price elasticity for R&D, using ordinary price variation and not tax price variation, and multiplies this elasticity by the effective marginal credit rate to get a predicted increase in R&D spending due to the credit rate. For example, if the estimated short run price elasticity is -0.13 (as in Bernstein 1986), and the marginal effective credit rate is 4 percent, the estimated short run increase in R&D spending from the credit would be 0.5 percent. With a long-run elasticity of -0.5 (assuming Bernstein and Nadiri are correct) and a marginal effective credit rate of 10 percent, the estimated increase would be 5 percent. In practice, the difficulty with this method has been that most of the elasticity estimates we have are based on a few studies by Bernstein and Nadiri that rely on the time series variation of a R&D price deflator whose properties are unknown. In addition, they are based on either industry data in the 1950s and 1960s or a very small sample of manufacturing firms. It is unlikely that the R&D demand elasticity with respect to price is constant over very different time periods or countries, so it would be desirable to have more up-to-date estimates in order to use this method. Obviously, one can never be sure that firms will actually respond to a tax incentive in the way implied by the price elasticity and measured credit rate, but it would be useful to have this method available as a check on the more direct approach using tax prices.

The R&E Tax Credit in Context

Apart from the fundamental argument that R&D is prone to market failure, three separate lines of reasoning often are used to assess the general need for and significance of R&D tax credit policies: 1) an R&E tax credit policy is a more efficient and effective way to generate R&D spending than direct public funding; 2) R&E tax credit policies can affect aggregate R&D spending trends and consequently improve the competitiveness of U.S. industry; and 3) other countries use tax credit policies, which not only may affect where corporations decide to locate new R&D projects but also could provide additional evidence that R&D tax credit policies generally work. This section assess the R&E tax credit in the context of each of these lines of reasoning.

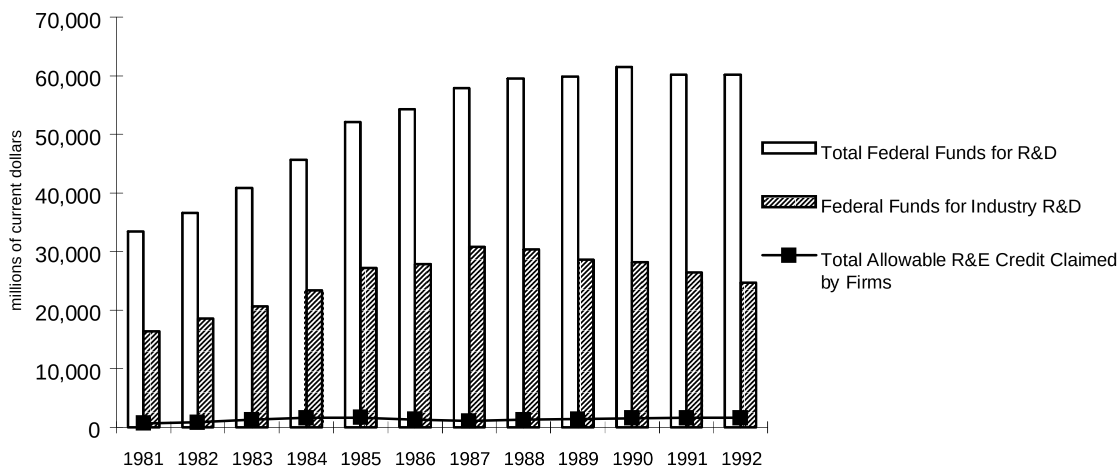
The R&E Tax Credit in the Context of Federal R&D Policy

The R&E tax credit represents one of numerous policy instruments for supporting R&D in the United States. In terms of size, the tax credit is small relative to either total Federal R&D funding or Federal R&D funds distributed to private industry (see figure 5). In 1992, the value of R&E tax credits claimed represented the equivalent of 2.6 percent of total Federal R&D funding and 6.4 percent of Federal R&D funds for industry, both values having increased since 1987 as Federal R&D funding has declined.[72] Clearly, direct

[72] Based on IRS SOI data and NSF data provided in NSF (1994).

funding mechanisms represent the largest component of Federal R&D policy, but size alone does not suggest value or performance: assessing the relative value or effectiveness of R&E tax credits requires comparisons with other policy mechanisms designed to achieve the same outcome.

Figure 5. Total Annual R&E Claims Compared to Federal R&D Funding



Data source: IRS/SOI; NSF, National Patterns 1994.

As discussed in the introduction to this report, the fundamental justification for publicly supporting R&D—whether through direct funding or through indirect measures such as the R&E tax credit—is to remedy at least in part the natural tendency toward market failure in the provision of a quasi-public good. At root, both the R&E tax credit and direct R&D funding represent different policy tools for expanding national R&D spending beyond levels provided solely by the private rate of return.

Unfortunately, there is no readily available empirical method for determining if the tax credit is a more efficient mechanism for overcoming R&D market failures than direct public funding. The analytical challenge is to develop some sort of technique for measuring and comparing the social returns from directly funded R&D with those from R&D induced by the tax credit. Unfortunately, the prospects for doing so are slim at best, for at least three compelling reasons. First, although one can estimate how much R&E spending results from the tax credit, one cannot determine what *kind* of additional research is induced by the tax credit. Second, even if the additional R&E could be observed, the social gains from that research would be very hard to isolate. And third, given the unlikely event that the social gains from subsidized R&D could be estimated, it ultimately would remain a judgment call whether the gains from credit-funded research exceed those from directly subsidized R&D or from some other use of the resources expended.

Moreover, any assessment of the relative effectiveness of different R&D subsidy tools should be based on the nature of the R&D market failure being addressed. If the market failure in private sector R&D spending is uniform across all sectors and types of research, then relatively undifferentiated policy tools such as the R&E tax credit appear appropriate. If R&D market failures vary, however, then the R&E tax credit may be less effective because it provides no explicit mechanism for favoring some types of R&D over others.

Some analysts argue, for instance, that R&D market failures are particularly pronounced in the area of basic research, since estimates of the social rate of return are very high while the ability to appropriate the benefits is typically low.[73] If the central policy goal is defined as a market failure in the provision of basic research, then the R&E tax credit may not represent the most effective policy instrument for two reasons. First, the tax credit encourages industry to do more of what it already does, and industry generally directs comparatively little of its R&D resources to basic research. For the United States as a whole, the Federal government accounts for most basic research funding, while private industry accounts for most development and applied R&D funding (see table 4). Second, the tax credit itself cannot be used to favor basic research spending per se because the definitional criteria for qualified research and experimentation expenses under the tax credit have nothing to do with traditional distinctions between basic, applied, and development research.[74]

Table 4: The Sources of Basic, Applied, and Development Research Funding in the United States, 1994

	Basic	Applied	Development
Business	26.3%	58.1%	69.7%
Government	58.3%	35.3%	29.5%
Academe	10.5%	4.1%	0.4%
Other	4.9%	2.5%	0.5%
Total	100%	100%	100%

Source: NSF, National Patterns of R&D Resources, 1994, tables B-6, B-9, and B-12 . Totals may vary slightly from 100% due to rounding each category of spending.

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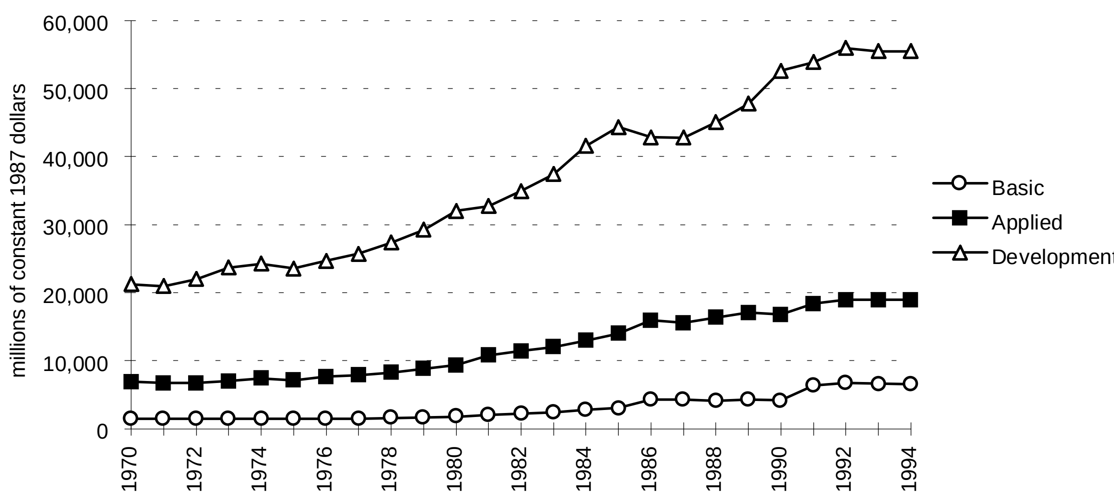
73 For example, see Mansfield (1972); and Mansfield (1965). Several participants in OTA’s R&E tax credit workshop also expressed this view.

74 Section 41(e) of the tax credit represents a partial exception, as it provides separate treatment for direct cash payments for basic research conducted at certain qualified research organizations (such as universities). This provision specificially targets a certain type of basic research spending—cash grants to certain research organizations—and also defines basic research in a unique and relatively limited way.

Citing these two facts, some participants at OTA's workshop suggested that the R&E tax credit is somewhat contradictory in design: it is intended to provide a more socially optimal level of R&D investment, but the firms to which it is directed conduct little of the type of R&D that typically has the highest social rate of return. This apparent contradiction was the source of considerable debate in OTA's workshop on the R&E tax credit. Noting that the high social rates of return are most likely in basic research, some panelists argued that the R&E tax credit is an inefficient policy instrument since it focuses solely on corporate R&D, of which 8 percent or less is directed to basic research (see figure 6). Moreover, the provision in the R&E tax credit that allows firms to take a partial credit for funding basic research in universities and other qualified organizations is rarely used, accounting for only $188 million worth of tax credits claimed in 1992. Others argued that distinctions between basic, applied, and development R&D are artificial and increasingly misleading, and that there can be significant social returns to all types of R&D, not just basic research.

Figure 6: Corporate R&D Funding, by Type of Research, 1970-1994



Source: NSF, *National Patterns of R&D Resources: 1994*, tables B6, B9, B12. Note: Increases shown in basic research funding from 1986-87 and 1990-91 largely are due to changes in the NSF survey design at those points in time.

In short, the effectiveness of the R&E tax credit depends in part upon the definition of the problem, and there appears to be no common understanding of the R&D funding problem. If the policy goal is to increase private sector R&D at the margin, with little or no impact on the allocation of R&D resources across different technologies or research areas, then the R&E tax credit may be an appropriate and relatively effective policy instrument. If the policy goal is to rectify the market's tendency to undersupply basic research or some other particular types of technologies, such as infrastructural or "generic" research, then the R&E tax credit may be relatively ineffective due to its inability to substantially alter the allocation of R&D resources across different research activities.[75]

Given this line of reasoning, OTA's workshop proceedings ultimately concluded that the R&E tax credit and direct R&D subsidies are different types of policy instruments that serve different policy goals. In essence, the R&E tax credit appears to be a relatively efficient mechanism for accelerating the rate of existing R&D spending by private enterprise, yet it does not appear to change the allocation of aggregate R&D resources across different sectors and technologies. Direct funding mechanisms, on the other hand, can be tailored to meet specific market failures. In short, tax credits and direct funding mechanisms are not, in principle, substitutable policy tools—increasing the supply of one does not necessarily decrease the need for the other, and vice versa. Other studies in this area, although sketchy, similarly conclude that the tax credit and direct funding mechanisms are distinct in function and effect.[76] Ultimately, however, any debate over the relative efficiency or utility of direct versus indirect policy mechanisms for supporting industrial R&D is unlikely to progress until there are more refined assessments of the location and magnitude of R&D market failures as well as better measures of the social rate of return to different types of R&D.

Given the difficulty of estimating the social rate of return from the R&E tax credit, not to mention weighing those returns against the social returns to using equivalent tax revenues for other purposes, most analysts either assume that there will be some social gains from additional R&D, or they point to other reasons for justifying the credit's cost. The primary additional reason, in the view of many analysts, is the significance of corporate R&D to national competitiveness.[77] The following section of this paper briefly describes recent trends in corporate R&D, and considers the tax credit in light of those trends.

The R&E Tax Credit in the Context of Corporate R&D Trends and Strategies

By many measures, technologically intensive firms based in the United States are among the most competitive in the world. Not only do U.S. firms devote more money to

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[75] Some analysts have argued that certain types of infrastructural or "generic" research are more prone to market failure because, somewhat like basic research, individual firms cannot easily appropriate the benefits of R&D even though the social returns may be very high. Examples of such research may include certain types of general manufacturing technologies, materials technologies involving properties such as corrosion and wear, highway durability research, and so forth. See Alic et. al. (1992).

[76] For an effort to model the effects of tax and direct funding mechanisms, see Mamuneas and Nadiri (1995). For a discussion of the logic behind viewing these policy mechanisms as functionally distinct, see Tassey (1995).

[77] For example, see Penner, Skanderson, and Smith (1994).

R&D (in absolute terms) than firms in any other country[78], but the United States also has a decidedly strong innovation and competitiveness track record in such high technology sectors as aerospace, instruments, and various sectors based on information and communication technologies. In addition, there are signs of renewed competitiveness in some sectors where U.S. firms have lost substantial market share to foreign competitors, such as consumer electronics.[79] Moreover, substantial trade surpluses in numerous high technology industries have contributed to the U.S. economy's recently strong performance.

However, both the growth rate and composition of private sector R&D expenditures have changed substantially in recent years. In real terms, total business R&D expenditures grew steadily during most of the late `70s and early `80s, but slowed to an average annual rate of just 2.4 percent between 1987 and 1992 (see figure 7).[80] Moreover, real R&D growth rates in manufacturing industries actually were negative throughout most of this period—averaging -1.0 percent—due to spending reductions in the transportation equipment, electronic and other electric equipment, petroleum refining and extraction, and industrial machinery and equipment sectors (see figure 8). Negative R&D growth rates in these sectors contrast sharply with the non-manufacturing category, in which R&D grew at an annual rate of 24.7 percent from 1987 to 1992.[81]

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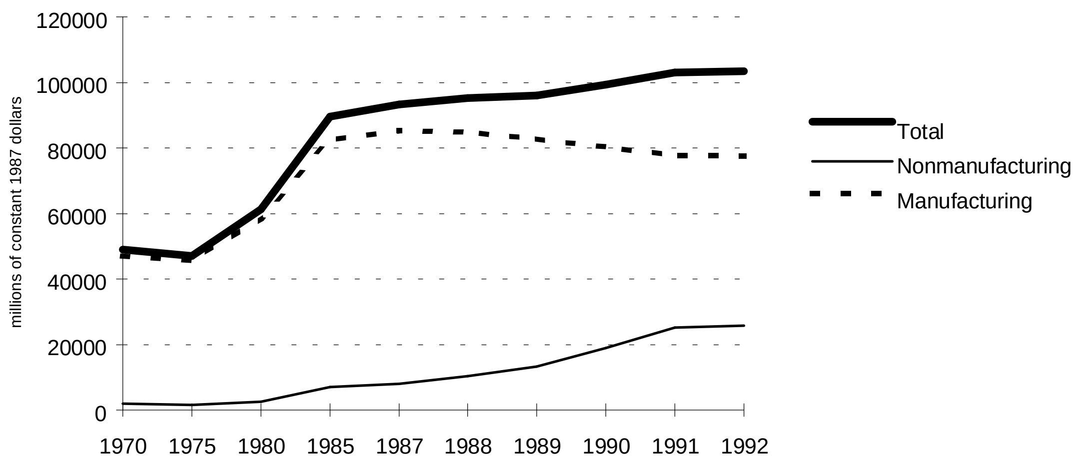
[78] On average between 1981 and 1992, U.S. R&D spending was 53 percent higher than the combined expenditures of European Union member states—it was over 600 percent higher than Germany, the European Union's single largest R&D spender—and 154 percent higher than that of Japan. U.S. Congress, OTA (1994); pp. 65-66.

[79] See Stephen Kreider Yoder, "Back in the Running," *Wall Street Journal*, 6/19/95: R22.

[80] Sectoral breakdowns of real R&D expenditures currently are available only up to 1992.

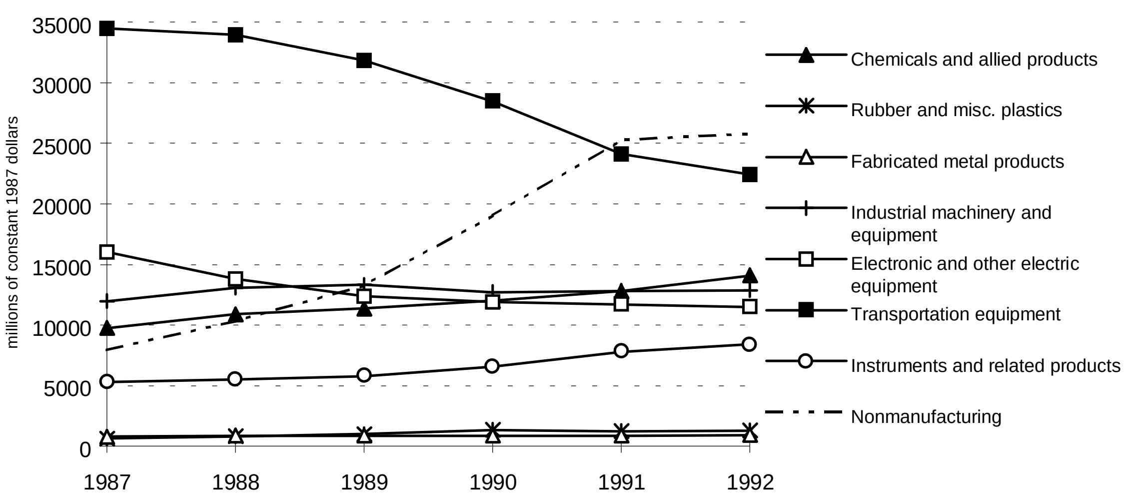
[81] The non-manufacturing category in NSF figures (and the congruent BEA R&D satellite) account includes communications, utility, engineering, architectural, research, development, testing, computer programming, and data processing service industries, as well as hospitals and medical labs. NSF Data Brief, Sept. 9, 1994.

Figure 7: Real Business R&D Expenditures—Total, Manufacturing, and Non-manufacturing R&D Performers, 1970-1992[82]



Data source: U.S. Department of Commerce, Bureau of Economic Analysis, R&D satellite account. Note: Timeline compressed from 1970-1987; annual from 1987-1992.

Figure 8: Real Business R&D Expenditures, by Performing Industry, 1987-1992



Data source: U.S. Department of Commerce, Bureau of Economic Analysis, R&D satellite account.

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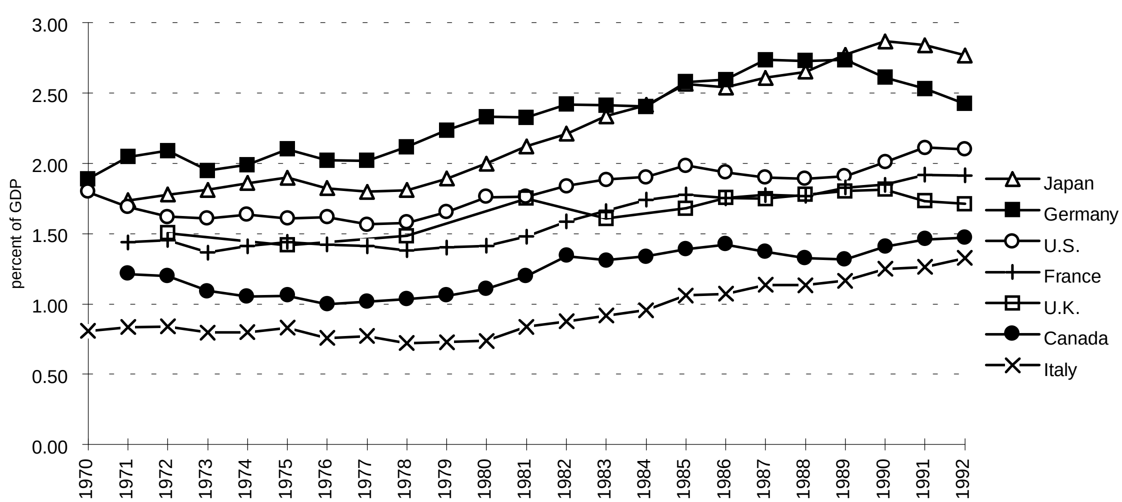
[82] Total real R&D expenditures presented in the BEA satellite account are not equivalent to aggregate business R&D figures provided by the NSF due to the use of different deflation methods (the BEA account uses sector-specific deflators, while the NSF uses the GDP deflator for all aggregated R&D spending). To date, only the BEA satellite account provides sector-specific R&D price deflators, and it does so only for major industry groups. The lack of suitable sectoral R&D price indices is a major shortcoming in the available R&D data, although it is a hard one to remedy due to the intrinsic difficulty of identifying appropriate components of R&D spending and determining a suitable net depreciation rate.

Since 1970, R&D in the non-manufacturing or service sector expanded from 4 percent of total business R&D in the United States to 25 percent, a significant trend with no equivalent in any other major industrial economy (with the partial exception of the United Kingdom).[83] At the same time, industrial R&D spending in other advanced economies grew rapidly relative to the United States, especially in Germany and Japan (see figure 9). This long-term trend, combined with the more recent weak or declining growth rates in manufacturing R&D in the United States (see figures 7 and 8), have reduced the U.S. share of total OECD R&D expenditures across a number of important high and medium technology industries. The U.S. share of OECD R&D expenditures in high technology industries declined from 63.4 percent in 1973 to 50.3 percent in 1992, with declines in all high technology sectors except pharmaceuticals and instruments. Much the same pattern holds for medium technology industries: the U.S. share decreased from 47.5 to 36.6 percent, with long term declines in all sectors except industrial chemicals and transportation equipment (excluding motor vehicles) (see figure 10).

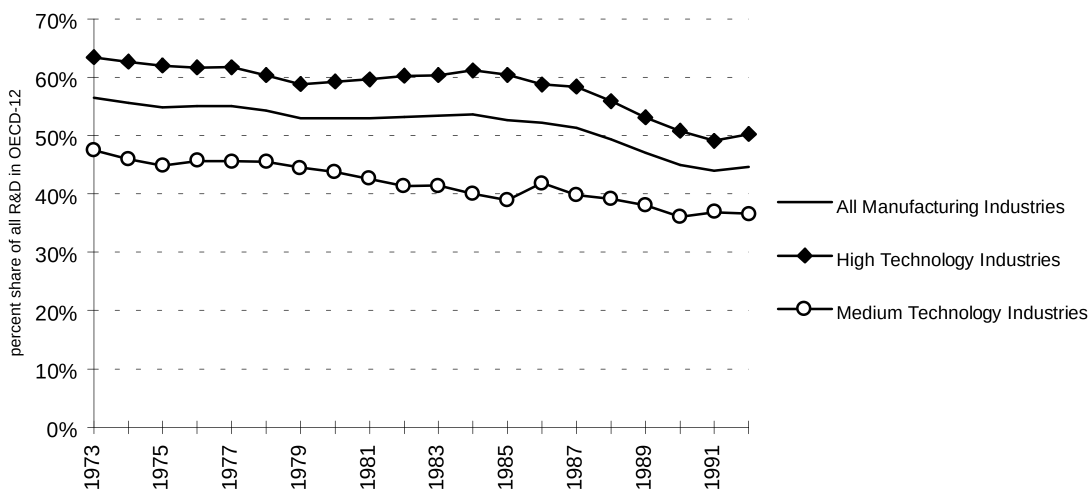
Figure 9: Non-defense R&D as a Percent of GDP, 1970-1992



Data source: NSF, National Patterns (1994).

[83] Unfortunately, little data exist on technology development in the service sector. Several factors may be contributing to this change in the United States' R&D portfolio, including rapid growth in high technology service industries such as software, communications, finance, and engineering; increased outsourcing of manufacturing R&D to research and engineering service firms; measurement changes that reclassified some R&D performers from manufacturing to nonmanufacturing; and more fundamental measurement inadequacies that may have discounted the importance of service sector R&D in prior surveys. On measurement problems in service sector R&D, see Griliches (1994); 10-11; and Alic (1994); 1-14.

Figure 10: U.S. Share of R&D Conducted by OECD Countries, 1973-1992



Data source: OECD, Scoreboard of Manufacturing Indicators (1995).

This long term change in the relative R&D investment position of U.S. manufacturing industries also can be seen in R&D intensity trends.[84] For most of the `70s and `80s, the average U.S. R&D intensity level in high technology industries was substantially above most other major industrial nations, with the exception of the United Kingdom from 1979-1981. After peaking in 1985, however, the U.S. level declined to approximately the level of France and the United Kingdom, and at a point considerably closer to the R&D intensity of high technology industries in Germany and Japan. This aggregate decline during the late `80s and early `90s was led by rapid R&D intensity reductions in aerospace, electronic equipment and components, and to a lesser extent pharmaceuticals; the R&D intensity of the electrical machinery (excluding communications equipment) sector remained largely flat, while that of instruments and office machinery and computers increased markedly.[85] Cross-national differences in the R&D intensity level of medium technology industries also narrowed from 1973 to 1991; in these sectors, the U.S. R&D intensity level did not so much decline as level off to a similar position as in German and Japanese industry.

In short, both the comparative R&D investment level and the relative technological intensity of U.S. manufacturing firms have narrowed over the last two decades, particularly in the last seven to eight years. At the same time, growth rates in industry-funded R&D have been quite slow, even during the expansionary periods of the late `80s. The current economic expansion does not appear to have lifted R&D funding prospects all that much, especially in light of the strong record in corporate profitability during this

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[84] For a comparative analysis of R&D intensities, see OECD, *Manufacturing Performance* (1994); 41-58.

[85] OECD (1994); sectoral R&D intensities expressed as R&D over production.

period. National Science Foundation estimates show a real annual decline of -0.2 percent in industry-funded R&D in 1994 (up from -0.7 percent in 1993), while recent surveys indicate that industry R&D expenditures will show a modest increase in 1995.[86] Many corporations expect to increase their R&D expenditures over the next several years, yet few foresee R&D investment rates returning to the high levels of the early to mid 1980s.[87]

In addition to R&D investment levels, the composition of corporate R&D in the United States also has changed in recent years. Most importantly, many U.S. businesses—particularly in highly global manufacturing industries—appear to be conducting increasingly less basic research, and overall are shifting R&D resources more toward innovative efforts with near term promise of return on investment.

Trends in the time horizon of business R&D are difficult to measure due to data shortfalls as well as substantial variations by sector in R&D performance. To begin with, recent aggregate data on basic research trends are largely unreliable.[88] In addition, there are no acceptable time frame measures for different types of R&D in different sectors. Basic research often is treated as a proxy for long-term research, but the temporal dimension and technological character of basic research varies significantly across sectors. Moreover, basic research often is coordinated with applied and development research, and interdependencies across corporate research programs often blur the lines between different categories of research—in fact, trends in this direction appear to be strengthening.[89]

Nevertheless, there is a substantial amount of evidence that a wide range of manufacturing firms—even those that are science-based—have been shifting research goals and resources from longer-term objectives (often but not always basic research) to

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[86] See Industrial Research Institute, *Annual R&D Trends Forecast* (Washington, DC: IRI, November 1994); Jules Duga, Steve Millett, and Tim Studt, "Battelle-*R&D Magazine* 1995 R&D Forecast," *Battelle Today* (April 1995): 4-7.

[87] Jules Duga, Steve Millett, and Tim Studt, "Battelle-*R&D Magazine* 1995 R&D Forecast," *Battelle Today* (April 1995): 4-7; "Blue-Sky Research Comes Down to Earth," *Business Week*, July 3 1995: 78.

[88] National Science Foundation data on private sector trends in basic research contain anomolous spending spikes in 1986 and 1991, while in intervening and subsequent years basic research spending grew only modestly or actually declined, as it did in 1988, 1990, and 1993-94. The inconsistencies in the data appear to derive from changes made in the NSF survey in those years, when the survey was expanded to cover a broader array of nonmanufacturing firms. Much of the increase in basic R&D spending is being reported by nonmanufacturing firms (principally in communications, engineering and R&D services, and miscellaneous non-manufacturing services), which traditionally have not been sources of basic research. Many of these firms may be over-reporting their basic research spending due to difficulties in differentiating various research activities as either basic, applied, or development, which could be due either to new survey participants' unfamiliarity with the survey and its definitions or to intrinsic difficulties in differentiating basic, applied, and development R&D efforts in these industries.

[89] Jules Duga, Steve Millett, and Tim Studt, "Battelle-*R&D Magazine* 1995 R&D Forecast," *Battelle Today* (April 1995): 7. This and related reports on contemporary business research trends suggest that the traditional disaggregation of R&D into basic, applied, and development research is increasingly artificial and poorly suited for describing contemporary business research practices.

those with more immediate commercial prospects (often but not always applied and development research). Numerous recent accounts of industrial R&D trends indicate that many manufacturing firms are shortening their R&D time horizons in response to financial market demands as well as broader competitive pressures.[90] Available survey evidence largely confirms this story. In addition to showing evidence of a modest increase in total industry R&D spending for 1995, Battelle's recent survey indicates that firms are increasingly emphasizing "short-term R&D for immediate problem solving or near-term development, rather than for basic research," while even basic research is being directed toward corporate product and process needs.[91] The Industrial Research Institute's most recent annual survey draws the same conclusion—continued cutbacks in basic research amid overall R&D increases.[92] Even in science-based industries, such as chemicals and pharmaceuticals, basic R&D declined from 1988-1993.[93]

In short, considerable evidence indicates that longer term research, including but not limited to basic research, has declined as part of an overall rationalization of R&D over the past five to eight years—especially in sectors such as electrical machinery, electronic equipment and components, aerospace, and to a certain extent industrial chemicals. During this period, firms in these sectors have been reconstructing their R&D operations, shifting resources out of central corporate labs and into strategic business units, applying new performance metrics, contracting out increasingly large portions of their R&D, and otherwise seeking more immediate and measurable returns on investment in new technologies.[94]

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[90] See, for instance, "Blue-Sky Research Comes Down to Earth," *Business Week*, July 3, 1995: 78-80; Malcolm W. Browne, "Prized Lab Shifts to More Mundane Tasks," *New York Times*, June 20, 1995: C12; Gautam Naik, "Top Labs Shift Research Goals to Fast Payoffs," *Wall Street Journal*, May 22, 1995: B1; Vanessa Houlder, "R&D Placed Under the Microscope," *Financial Times*, May 22, 1995; Vanessa Houlder, "Revolution in Outsourcing," *Financial Times*, January 6, 1995: 10; "Could America Afford the Transistor Today?", *Business Week*, March 7, 1994: 80;

[91] Jules Duga, Steve Millett, and Tim Studt, "Battelle-*R&D Magazine* 1995 R&D Forecast," *Battelle Today* (April 1995): 7

[92] Industrial Research Institute, *Annual R&D Trends Forecast* (Washington, DC: IRI, November 1994); see also M.F. Wolff, "U.S. Industry Spent $124B on R&D Last Year, as Real-Dollar Decline Appears to Level Off," *Research-Technology Management* 38:3 (May-June 1995): 2-3.

[93] Preliminary survey results provided by Alden S. Bean, Center for Innovation Management Studies, Lehigh University. By this estimate, chemical firms now spend around 3 percent of their R&D on basic, compared to NSF's estimate of 8 percent for all firms.

[94] In addition to streamlining internal R&D operations, firms also are increasingly turning to strategic business alliances to share costs and risks, expand their technological portfolio, and to keep abreast of rapidly changing technologies while focusing internal resources on core technological competencies. As R&D costs increase, and the imperative to innovate sharpens, many firms have turned to acquisitions, joint ventures, or alliances to acquire critical technological capabilities and broaden their technological competence. Alliance strategies have become particularly common in biotechnology, as large pharmaceutical firms with diverse product portfolios and powerful testing and marketing resources combine with smaller biotechnology firms with leading-edge niche technologies. Alliance strategies are

By most accounts, recent changes in industrial R&D strategies and time horizons can be attributed to competitive pressures which, through various channels, have increased cost and performance demands on corporate R&D.[95] In principle, this relatively stringent investment climate may increase the significance of R&E tax credits, at least to the extent that the credit reduces the cost of capital for R&D investments. However, the credit never has represented a significant portion of total non-Federal funds for corporate R&D (see figure 11). In percentage terms, the R&E tax credit peaked at 3.1 percent of industry R&D funds in 1984; since that time, the credit decreased steadily to 1.6 percent of non-Federal industry R&D funds in 1992. Similarly, the credit accounts for only a small percentage of total R&D investment at the level of individual industries. Consequently, the R&E tax credit is unlikely to have a substantial competitive effect in the aggregate.

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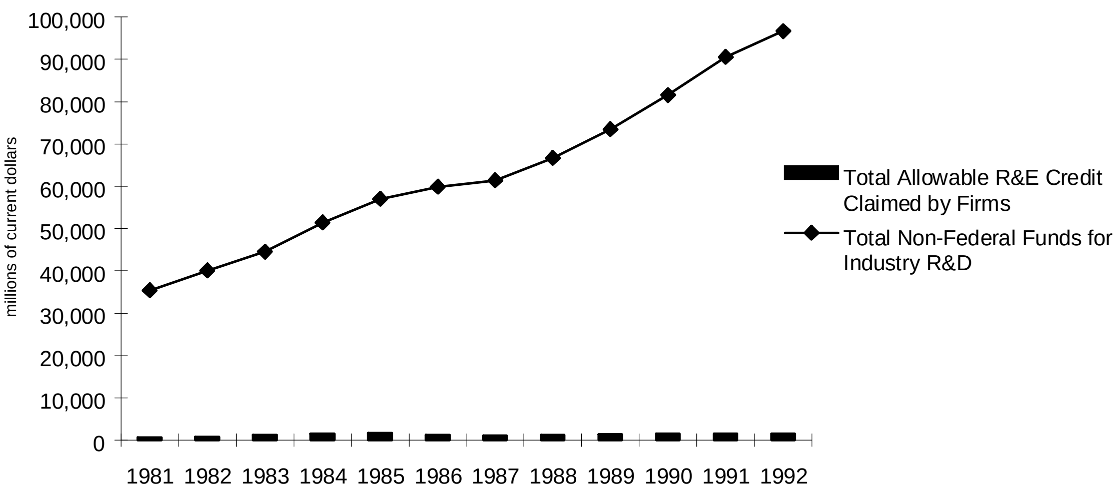
also being used heavily in information, communication, and advanced electronics industries, where firms need to maintain access to a rapidly changing and expanding set of product and process technologies. In addition to pursuing joint technological goals, many firms have used alliance strategies to share production costs and hedge risks, particularly in capital-intensive industries that produce technologically complex products with short life cycles (e.g. semiconductors). In addition, firms often use alliances to establish or improve market access, as is frequently the case in telecommunications. The magnitude of strategic alliance formation is difficult to gauge, as are the implications of alliances for the innovation and commercialization of new technologies in the United States. These alliances are certainly likely, however, to quicken the rate of technology diffusion across firms, industries, and even countries. In the process, R&D spillovers may become more substantial, on both a domestic and international scale.

[95] See, for instance, "Blue-Sky Research Comes Down to Earth," *Business Week*, July 3, 1995: 78-80; Malcolm W. Browne, "Prized Lab Shifts to More Mundane Tasks," *New York Times*, June 20, 1995: C12; Gautam Naik, "Top Labs Shift Research Goals to Fast Payoffs," *Wall Street Journal*, May 22, 1995: B1; Vanessa Houlder, "R&D Placed Under the Microscope," *Financial Times*, May 22, 1995; Vanessa Houlder, "Revolution in Outsourcing," *Financial Times*, January 6, 1995: 10; "Could America Afford the Transistor Today?", *Business Week*, March 7, 1994: 80; Jules Duga, Steve Millett, and Tim Studt, "Battelle-*R&D Magazine* 1995 R&D Forecast," *Battelle Today* (April 1995): 7; Industrial Research Institute, *Annual R&D Trends Forecast* (Washington, DC: IRI, November 1994); see also M.F. Wolff, "U.S. Industry Spent $124B on R&D Last Year, as Real-Dollar Decline Appears to Level Off," *Research-Technology Management* 38:3 (May-June 1995): 2-3; Ann M. Thayer, "Justifying Technology's Value Challenges Industry R&D Managers," *Chemical and Engineering News*, February 6, 1995: 10-14; Linda Geppert, "Industrial R&D: The New Priorities," *IEEE Spectrum*, September 1994: 30-36; Charles F. Larson, "Current Trends in U.S. Industrial R&D," paper prepared for the Workshop on Managing Investment in Research and Development, Canberra, ACT, July 17-18, 1994; Douglas E. Olesen, "A Critical Investment: The Future of Industrial Technology," paper delivered to the Economic Club of Detroit, November 1, 1993.

Figure 11: Total Annual R&E Claims Compared to Total Non-Federal Industry Funds for R&D, 1981-1992



Data source: IRS/SOI; NSF, National Patterns (1994). Note: Total allowable R&E represents credit claimed by firms; actual credits disbursed in any given year are likely to be much lower (see text). Industry R&D funds represent all non-Federal sources of funding.

At the level of individual firms, the R&E tax credit may be much more salient, especially for liquidity-strapped firms, firms on very rapid R&D growth trajectories (as in the communications and information technology industries), and firms whose R&D performance strongly affects their market valuation (biotechnology, for example). However, even for firms in these circumstances, it is not at all clear that the R&E tax credit plays a major role in corporate R&D strategies, apart from general budgetary considerations. OTA's workshop discussion, along with additional OTA interviews with R&D executives, suggest that the R&E tax credit may in some cases generate funds that can be used to speed up the rate of research, but that overall the tax credit does not substantially affect decisions on how much or especially where R&D resources are invested. One possible exception to this tendency is the biotechnology industry, which has extraordinarily high R&D demands, long planning horizons, and unusual revenue trajectories. Unlike any other sector, the market valuation of biotechnology firms depends heavily upon R&D performance. Even in the case of biotechnology, however, R&D strategies derive primarily from fundamental business goals and technological judgments, not the firm's tax status.

The purely financial nature of the R&E tax credit emerged clearly from OTA interviews with various R&D performers. Consistently, tax and financial directors were quite aware of the R&E tax credit and assessed its relevance in terms of its pecuniary value to the firm over time, while technology officers and R&D strategists almost uniformly regarded the tax credit as irrelevant to their planning (indeed, one chief technology officer told OTA that he would be very concerned about the health of any firm that based its R&D decisions on tax considerations). Interview evidence along these lines lends credence to the hypothesis that corporate R&D strategies in the aggregate would not change substantially if the tax credit disappeared altogether. This hypothesis does not maintain that the tax credit is irrelevant—rather, it suggests that the credit is only a weak signal amid a powerful array of forces that shape individual and especially aggregate corporate R&D trajectories. Granted, the R&E tax credit appears to expand the R&D capital available to many research-intensive firms, and in this respect the policy can be considered somewhat successful. Nevertheless, the overall magnitude and scope of the credit indicates that it is a marginal to insignificant determinant of aggregate R&D spending levels by firms in the U.S. economy.

The Structure and Significance of R&E Tax Credits in other Countries

As with industrial R&D trends in general, the globalization of business raises important questions about the environment for innovation in the United States. Foreign tax laws regarding R&D potentially are relevant to R&E tax credit policy in the United States in two very different ways: first, large variations in R&D tax policies may affect where multinational corporations decide to locate their R&D facilities; and second, foreign R&D tax policies can provide additional information about how different types of tax rules affect R&D. This section considers both of these issues, respectively.

There is little evidence to support the hypothesis that foreign R&D taxation policies affect where firms decide to locate their R&D facilities. OTA evidence collected for this and other studies indicates that, although the rate of overseas R&D conducted by U.S. firms has been increasing, R&D nonetheless remains highly centralized.[96] Moreover, the R&D that does tend to move abroad usually follows well in the wake of overseas production facilities, and typically is directed toward supporting production operations, customizing products to local market demands, and developing the capability to learn of and assess foreign technological developments.

Tax policies more broadly may have an important incentive effect on foreign investment generally, as has been discussed so frequently with regard to state-level investment incentive packages. To the extent that these incentives affect corporate location decisions, they typically involve what one OTA workshop participant referred to as "negotiated" tax incentives, not statutory tax incentives. Even in the case of negotiated tax packages, however, the location of foreign investment usually is determined by fundamental business needs and strategies, market projections, technological opportunities, and large factor costs. If they have any effect, negotiated tax incentives may affect location decisions at the margin. Statutory R&D taxation policies, on the other hand, are likely to have a negligible impact on the location of corporate R&D.

In short, the tax treatment of R&D in other countries is relevant to U.S. policymakers less as a source of competition for R&D projects than as a source of alternative data on the incentive effect of different domestic R&D tax policies.

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[96] See U.S. Congress, OTA (1994).

The tax treatment of R&D in other countries tends to be similar to that in the United States, with the exception of the incremental R&D tax credit. This particular feature of the tax code is used by only a few countries, and varies considerably across countries when it is used. However, the users include some of the most R&D-intensive countries in the world.

Tables 5 and 6 summarize the tax treatment of R&D around the world.[97] The second and third columns present the rates at which non-capital R&D and capital R&D are depreciated for tax purposes. Full or 100 percent depreciation means that the quantity can be expensed. In most cases it is also possible to elect to amortize R&D expenditure over 5 years. This could be an attractive option if operating loss carryforwards are not available (to use the R&D expense as a deduction even if no current tax is owed), but in most cases tax losses can be carried forward and back (see column 4). Although almost all countries (except the United Kingdom) treat R&D capital investment somewhat like ordinary investment, many have used complex accelerated depreciation schemes at one time or another to boost investment in R&D capital equipment. Frequently the depreciation involved also is subject to the R&D tax credit. Typically, buildings or plant used by an R&D laboratory are not included in these schemes.

[97] The contents of these tables are drawn from several sources: Asmussen and Berriot (1993), Australian Bureau of Industry Economics (1993), Bell (1995), Griffith, Sandler and Van Reenen (1995), Harhoff (1994), Hiramatsu (1995), Leyden and Link (1993). McFetridge and Warda (1983), Seyvet (1995), and Warda (1994). The description should be accurate as of early 1995, but these laws have changed frequently and some of these incentives may no longer be in place.

Table 5: The Tax Treatment of R&D around the World—G-7 Countries

‹apital ›rec. ‹ate	Carryback and Carryforward	Definition of R&D for Tax Credit	Tax Credit Rate	Base for Incremental Tax Credit	Credit Taxable?	Special Treatment for SMEs	Foreign R&D by Domestic Firms	R&D by Foreign Firms
0% iildings)	7 yr. CF TC refunded	Frascati, excl. soc sci. marketing, routine testing, etc.	20%	0	yes	40% to R=C$200K grant if no tax liab.	0%	20% only?
r SL iildings) erated	3-yr CF 5-yr for OL TC refunded	Frascati, incl. patent dep. contract R. excl. office expenses & support personnel	50%	(R(-1)+R(-2))/2 (real)	no	yes TC<40MFF	no accel dep unless cons. no credit	?
‹ DB - bldgs	1/5 yrs		none	NA	NA			
erated			?	?	?	yes, ceiling		
‹; 4yr SL bldgs	5-yr usual but credit limited to 10% 5-yr CF	Frascati, incl. deprec of P&E	20%	max R since 86	no	6%R instead (cap<Y 100m)	6% credit for coop with foreign labs	?
0% i. res.”	5-yr CF		none	NA	NA			
yr., or bldgs	3/15 yrs	excl. contract R (for doer). ref. engineering, prod, improv., 35% contract R	20%	avg of 84-88 R	yes	R/S 3% for startups	not eligible	same as domestic

tor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, June 1995.

Table 6: The Tax Treatment of R&D around the World—Other Countries

D Capital rec. Rate	Carryback and Carryforward	Definition of R&D for Tax Credit	Tax Credit Rate	Base for Incremental Tax Credit	Credit Taxable?	Special Treatment for SMEs	Foreign R&D by Domestic Firms	R&D by Foreign Firms
-yr SL buildings)	3/10 yrs	Frascati, excl. soc sci, some testing, marketing	none	NA	NA	ceiling; reduced credit for small R&D programs	up to 10% of project cost eligible	no special provisions
celerated	5 yr CF	Dev. & improv. of valuable inventions	none	NA	NA			
-yr SL yr - bldgs	5 yr CF		?	?	?			
nvestment	4 yr CF		none	NA				
100%	5 yr CF	Special tech programmes with EC researchers	?					
0% deprec % - bldgs			10% 25%	0 avg of last 2 yrs	no	yes; special rules for startups	?	no special provisions
SL; 20-yr - bldgs			none	NA	NA			
nvestment	8 yr CF	W&S of R&D leading to prod. dev. (not services)	12.5-2.5%	0	no	yes; ceiling and higher credit rate		
nvestment	10 yr CF (res. reserve)		none	NA	NA			
00% or preciate	5 yr CF w/ OL; 3 yr CF w/ TC		15% (on cap. R&D)	0				
DB; 4% - bldgs	tax liability		none	NA	NA			
nvestment	2 yr CF		sub-contracted research	?	?			

The fifth column of the table describes the definition of R&D that is used for the the tax credit, which often is more restrictive than the definition set out in the OECD Frascati manual. Columns six and seven characterize the tax credit, if there is one. The rate and the base above which the rate applies are shown; when the base is zero, the credit is not incremental, but applies to all qualifying R&D expenses. Currently, only France, Japan, Korea, and the United States have an incremental R&D tax credit, and they each use a slightly different formula for the base.[98] Column 9 shows that many countries also have provisions that favor R&D in small and medium-sized companies. In France, for example, this takes the form of a ceiling on the credit allowed that is equal to 40 million francs in 1991-1993 (approximately $6.7M), which effectively tilts the credit toward smaller firms (while direct R&D subsidies in France go to large firms to a great extent).[99] By contrasts, Australia has a minimum size of research program ($20,000) to which the tax preference of 150 percent expensing applies. This policy seems to be related more to the administrative cost of handling the R&D tax concession than to any factor.[100]

Column eight indicates whether the incremental tax credit is treated as taxable income—that is, whether the expensing deduction for R&D is reduced by the amount of the tax credit. Whether or not this is true typically has a major effect on the marginal incentive faced by a tax-paying firm.

The last two columns describe any differences in tax treatment that apply to R&D conduced abroad by domestic firms or R&D performed in the country by foreign-owned firms. In the former case, typically any special incentives (beyond 100 percent deductibility) will not apply, except that up to 10 percent of the project cost for Australian-owned firms can be incurred outside Australia. Regarding the latter case, it is frequently difficult to tell from the summarized tax regulations. In Korea and Australia, foreign firms do not participate in any of the incentive programs. In the United States and Canada, they are treated like domestic firms, except that they do not receive an R&D grant in Canada when their tax liability is negative.

Few countries have evaluated their incremental R&D tax credit programs as has the United States. Most of these policies have been in place for a shorter time period, and several countries appear to have relied on U.S. policy evaluations for evidence of effectiveness. Finally, internal government studies may have been done, but these are rather difficult to find without a close connection to researchers within the government in question. The only readily available studies are displayed in Table 7. They cover Australia, Canada, France, Japan, and Sweden, although neither the Canadian nor the Swedish studies are currently applicable, as the tax incentives for R&D in these countries have changed substantially since the studies were done.

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[98] The credit in Spain is a credit on capitalized R&D (R&D that is to be amortized over 5 years) rather than on the flow.

[99] Seyvet (1995).

[100] Bell (1995); Australian Bureau of Industry Economics (1993).

7: Empirical Studies of the Effectiveness of the R&D Tax Credit—Other Countries

da	Canada	Sweden	Canada	Japan	Australia	France
ge and 1983	**Mansfield and Switzer, 1985**	**Mansfield, 1986**	**Bernstein, 1986**	**Goto and Wakasugi, 1988**	**Australian BIE, 1993**	**Asmussen and Berriot, 1993**
82	1980-83	1981-1983	1981-88	1980	1984-1994	1985-89
	not relevant	not relevant	1975-80		non-users	
ics da	Stratified survey interview	Stratified random survey	prior estimates		ABS R&D survey IR&D board	INSEE: EAE, DGI, and MRT data
ıate	55 firms (30% of R)	40 firms	firms?		>1000 firms	339 firms
city ity of 0.6 e of R&D	*Survey* Asked if R&D tax incentive increased spending	*Survey* Asked if R&D tax incentive increased spending	*Elasticity* Multiply prior elasticity estimate times credit rate		*Demand/survey* Log R&D demand eqn with credit dummy control/no control	*Demand* R&D demand eqn. with log(credit)* Indicator for ceiling
	No control years, unclear if these are total increases from tax credit	NA			Lag R&D; log size growth; tax loss dummy; gov't support dummy	Logs of gov subsidy, size sq. concentration, immob per head
	0.04-0.18	small	0.13		~1.0	0.26 (.08)
)	0.38-0.67	0.3 to 0.4	0.83-1.73		0.6-1.0	?

Only the last two studies in the table estimate the incentive effects of the R&D tax credit econometrically; the others rely on survey evidence or the price elasticity method described above. The most comprehensive and carefully done of these studies is that by the Australian Bureau of Industry Economics, which generally reaches similar conclusions with respect to the tax price elasticity and benefit-cost ratio as those in recent U.S. studies.[101] The methodology used in this study compares the R&D growth rates for firms able and unable to use the tax credit for tax reasons; this technique has the obvious disadvantage that assignment to a control group is endogenous, and that the full marginal variation of the tax credit across firms is not used, only a dummy variable. In general, the survey evidence that asks firms by how much they increased their R&D due to the tax credit is consistent with the econometric evidence.

The French study encountered some data difficulties having to do with matching firms from the enterprise surveys, R&D surveys, and the tax records, so the sample is somewhat smaller than expected, and may be subject to selection bias. The specification used for the R&D demand equation includes the magnitude of the credit claimed as an indication of the cost reduction due to the credit. If all firms faced the same effective credit rate on the margin, it is easy to compute the tax price elasticity from the coefficient of this variable. Unfortunately, this is typically not true in France, so that this equation is not ideal for the purpose of estimating the tax price elasticity. Even so, Asmussen and Berriot obtain a plausible estimate of 0.26 (0.08), which is consistent with other evidence using similar French data and a true tax price.[102]

Few studies have attempted to systematically compare the effectiveness of various R&D tax incentives across countries, perhaps because of the formidable obstacles to understanding the details of each system. Two studies have constructed estimates of the cost of R&D capital for the G-7 and other major R&D-doing countries.[103] Using 1989 data (the latest available), these estimates indicated that in Japan, Germany, Italy, Sweden, and the United Kingdom, an R&D project was slightly disadvantaged in cost relative to ordinary investment, while such a project was advantaged in the United States, France, Korea, Australia, and Canada. The most advantageous location was Canada, with a required pre-tax benefit-cost ratio of 0.657. The least attractive was Italy, with a ratio with 1.033.

The central conclusion at present from studies in other countries is not different from those using U.S. data—the response to an R&D tax credit tends to be fairly small at first, but increases over time. The effect of incremental schemes with a moving average base (as in France and Japan) is the same as in the United States: they greatly reduce the incentive effect of the credit. The fact that a firm must have taxable income in order to

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[101] This is the only study that attempts to estimate the administrative cost of the tax credit, at least from the government side. It finds that this cost is about 5 percent of the revenue loss.

[102] Isobel Lamare, INSEE/ENSAE, private communication, 1994.

[103] McFetridge and Warda (1983); Warda (1993).

use the credit also diminishes its overall effect, although this is mitigated somewhat in France by the fact that the credit is refundable after four years if unused.

Continuing Analytical and Policy Issues

Measured narrowly, in terms of R&D dollars induced, the R&E tax credit appears to be a relatively successful policy instrument. Broader and arguably more significant measures of effectiveness, such as assessments of the net social rate of return from R&D induced by the credit, have yet to be developed and ultimately may not be available due to fundamental data and methodological problems. This concluding section describes three areas in which significant analytical and policy issues remain unresolved, and in which additional research would be fruitful: 1) obtaining better data and using alternative methods for analyzing the amount and type of R&D spending induced by the credit; 2) determining whether and if so how to renew the R&E tax credit; and 3) comparing the R&E tax credit with other policy instruments.

Alternative Data and Methods for Analyzing the Amount of R&D Induced by the Tax Credit

The best available econometric research indicates that the R&E tax credit does generate additional R&D spending by private industry, at approximately one dollar in spending for every dollar in lost tax revenue. However, the exception of Altshuler, none of these studies have used what appears to be the most appropriate data set—individual corporate tax returns.[104] IRS data would allow researchers to focus directly on the responsiveness of qualified R&E expenditures, rather than having to rely on a proxy equal to some average eligibility rate times total (worldwide) R&D. Tax return data also would contain much better information on the actual tax status of the firms, their exposure to the Alternative Minimum Tax, and the amount of R&E credit they claimed, which would allow much more precise estimates of the responsiveness of qualified R&E spending to the tax credit. If appropriate IRS data were made accessible, it could be applied to a sample set of firms using existing econometric models, such as that developed by Hall, which would improve the estimates of both the induced R&E spending and the corresponding tax revenue loss.[105] Unfortunately, confidentiality requirements severely (and understandably) restrict the use of individual taxpayer data; consequently, should Congress decide to pursue this line of inquiry, it would have to direct the U.S. Treasury to conduct such a research program.

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[104] Altshuler (1989).

[105] Hall (1993).

A second area where internal government data would prove useful is in evaluating the administrative cost of the tax credit in the United States. The U.S. General Accounting Office has conducted some research in this area, but the information is incomplete and dated.[106] OTA interview evidence indicates that the IRS does experience some difficulties in auditing firm data for qualified expenditures, but there are no numerical estimates of the full administrative costs, nor are there apparently any appropriate IRS data available upon which to base such estimates. Moreover, there are no existing estimates of the administrative costs borne by firms. In both cases, relevant information could be generated through survey instruments.

An alternative method for assessing the effectiveness of the R&E tax credit would be to examine whether the private return to R&D fell for those firms that used the credit. The credit clearly is intended to induce firms to increase their R&D to a point beyond the level they would choose in the absence of the credit. If the credit is successful, the private rate of return should fall. However, aggregate measures are inappropriate for this exercise, since the *ex post* private return to R&D will vary over time for reasons unrelated to the presence of the credit. The best way to approach this question would be to compare the returns to R&D for firms in the same industry that do or do not receive the benefit of the credit because of their particular tax situation, such as whether they are subject to the Alternative Minimum Tax. The private rate of return could be computed based on established methods: using a sales productivity equation that adjusts for changes in capital and labor inputs, it would be possible to allow R&D to have a differential impact depending on the tax credit position of the firm; the estimated difference in the coefficient is a measure of the difference in the private returns to R&D for the two groups of firms.[107]

An additional approach would involve international comparisons, which hardly have been tapped. Currently, only macroeconomic estimation would be feasible, given the lack of public data at the individual firm level that adequately captures the information necessary to compute the tax credit for each firm—to say nothing of the detailed knowledge needed of each tax system. Serious work in this area would require the cooperation of researchers in several countries.

New and better data, using econometric models combined with survey and interview data, undoubtedly would improve existing estimates of the amount of R&D spending induced by the tax credit. Ultimately, however, new research is needed to determine what *type* of research the credit induces. This would be the first step toward addressing the vexing problem of weighing the social returns to tax-induced incremental R&D spending against the potential returns to using the foregone tax revenue for direct R&D subsidies or other public purposes. This type of information would have to be obtained through appropriately designed survey and interview instruments.

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[106] GAO (1989).

[107] As described and used in Hall (1993); and Mairesse and Hall (1995).

Whether and How to Renew the R&E Tax Credit

Arguably, existing data problems do not provide an adequate basis for calling the tax credit entirely into question. Although precise numbers may not be known, the available evidence indicates that the tax credit induces additional marginal R&D spending. To the extent that a positive R&D spending response satisfies the policy purpose, it would be logical to extend the credit or even make it permanent—depending, or course, on the acceptability of revenue cost projections. Congress could simply extend the credit in its current form. But if Congress indeed decides to retain the credit, as many expect, it eventually will have to address at least three substantive policy issues: 1) whether to make the credit permanent; 2) whether, and if so how, to make the credit available to a wider array of R&D-performing firms; 3) whether, and if so how, to manage ongoing problems in the definition of qualified research under section 41 of the Internal Revenue Code.

Policy issues involved with making the credit permanent

Although industry positions differ substantially on the proper form of the R&E tax credit, most agree that the uncertain status of the credit limits its effectiveness. The case for making the credit permanent is straightforward and plausible: the frequently long-term nature of R&D projects requires planning horizons that often exceed the statutory length of the credit, which adds a degree of uncertainty regarding the cost of capital for R&D over the expected project duration.[108]

The lack of permanence does not affect all firms equally. Typically, those with longer planning horizons and more fixed types of R&D investment will be more sensitive to uncertainty in the credit's duration than those with shorter time horizons and more flexible forms of R&D investment. For instance, R&D projects in the biotechnology industry frequently involve five year or longer planning cycles and high fixed investment costs, which tends to heighten the effect of uncertainty in the provision of R&E tax credits (as well as other factors affecting the expected cost of capital). By comparison, R&D in the communications industry generally involves much shorter planning horizons, often one year or less, with investment costs typically concentrated in highly mobile R&D personnel (e.g. software programmers operating on contract). In the former case, the lack of permanence in the R&E tax credit can be a major aggravation, while in the latter it is mostly an inconvenience.

By their very nature, R&D projects tend to involve high levels of uncertainty on many fronts, from technological feasibility to various cost of capital considerations. Making the R&E tax credit permanent would likely improve R&D budgeting for some firms and some types of projects. However, there is no way to determine whether a permanent tax credit would substantially increase the level of marginal R&E spending. Again, analysis faces a counterfactual: what would firms do *if* the credit were permanent?

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[108] The basic argument for permanence has been articulated well and frequently in other sources. See, for example, Penner, Smith, and Skandersen (1994); pp.28-29.

Estimating the magnitude of any change is complicated by the fact that some firms already plan as if the credit were permanent, given Congress' history of renewing the statute.[109]

Although there is no direct evidence available for predicting the outcome, it is plausible to assume that making the credit permanent would have at least three beneficial effects: first, firms would be able to plan more effectively and consequently use the tax credit more efficiently; second, it would provide additional impetus for final resolution of the section 41 regulations; and third, to the extent that the first two changes occur, the administrative costs associated with the credit for both firms and the IRS would likely decline.

Simply put, if Congress decides that the R&E tax credit meets the policy's fundamental objectives, then there is no reason—other than the revenue cost implications—for not making the credit permanent.

If made permanent, the credit will have to include some sort of provision for reviewing and eventually altering the base period. The base period currently used cannot be retained indefinitely—as older firms go out of business and newer firms emerge, an increasingly larger share of firms will not be able to work with the fixed 1984-88 base period, while many ongoing firms will find the base period increasingly less representative of their current operations. The selection of a new base period almost certainly would be contentious, given the very different effect of alternative base periods on different firms in different industries.

Policy issues involved with making the tax credit available to more firms

The ink was hardly dry on the original R&D tax credit legislation in the United States when analysts began pointing out two weaknesses: first, the moving base weakened the incentive for incremental R&D, since increased R&D spending in any given year would raise the base level in subsequent years and, consequently, would reduce the future availability of the tax credit; and second, only firms with current or near term tax liabilities could use the credit.[110] The adoption of a fixed base period in 1989 alleviated the first problem, while the second remains as an important source of variation in availability of the credit in any given tax year.

Any tax credit that has a moving base and/or is tied to the existence of taxable income will create variations in the availability of the credit. This creates two general problems, one analytical and the other political. In terms of analysis, any estimate of the incentive and revenue effects of the tax credit that relies on aggregate data will be inaccurate because the aggregate response is unlikely to correctly characterize the responses of a group of heterogeneous firms. Nor are estimates likely to be robust over changes in the tax credit structure or mix of firms in the economy. In terms of politics,

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[109] As suggested in several OTA interviews.

[110] Collins (1983); Eisner, Albert, and Sullivan (1983); and Mansfield (1984).

variation in access to the credit creates distributional effects that may or may not conform to the policy objective.

Apart from the firm's taxable status in any given year, the availability of the credit to individual firms also can vary due to the combined effect of its R&D intensity during the base period as well as recent factors, such as business cycle fluctuations or industrial restructuring, that can affect the firm's current ratio of R&D to sales. Variation in access to the credit primarily is a matter of the credit's very design—it is incremental in structure, and consequently rewards only R&D conducted at the margin by firms with expanding R&D intensities.

If Congress revisits the tax credit and determines that equal access to the credit is an important policy goal, then it will have to consider different ways to change the structure of the credit so that it becomes accessible to all R&D performers. Many of the proposals brought forward to address the equity issue involve some sort of flat tax, either across the board or in combination with an incremental credit. In general terms, a flat credit would have the advantage of simplicity and uniform access, and it would send a strong signal of support for industrial R&D broadly construed (simply making the credit permanent may have this effect as well). However, a flat credit undoubtedly would subsidize a lot of research that would take place in the absence of the credit, and would result in a far larger tax revenue cost than the current incremental credit.[111] If made revenue-neutral, an across-the-board flat credit would have to be approximately 2 percent, which many argue would make the credit relatively insignificant to most firms.

The equity issue could be addressed through other, less drastic methods, such as changing the base period or other rules by which the credit is calculated. Unfortunately, current studies and available evidence provide little basis for predicting the effects of fundamental changes in the credit's structure. If Congress pursues this issue, a serious attempt should be made to evaluate the potential effects of redesigning the credit on its consequences for the benefit-cost ratio, at least as conventionally computed. One possible method for doing this would be to assemble a sample set of firms with accurate tax and R&D spending data, with which it would be possible to simulate the effects of changing the base to, for example, one indexed by the industry R&D-to-sales ratio.[112] This could be done by recomputing the credit faced by each firm, computing the implied R&E spending at that credit rate, and using these numbers to determine both the increase in R&D and the potential tax revenue loss.

Finally, the accessibility of the credit may be affected by the administrative costs of using it, particularly for small firms. Unfortunately, there is no available data on the

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[111] See, for example, Cox (CRS, 1995).

[112] Again, selecting an appropriate base period is likely to be politically contentious. In this case, selecting an industry R&D intensity ratio would require a commonly accepted definition of industrial groupings as well as an accepted method for distributing the R&D activities of any given firm across the different industries in which it operates. Each of these definitional requirements could become a source of dispute between the IRS and taxpayers.

administrative costs incurred by firms, and how they may vary by size or other characteristics of the firm. New survey research could be helpful in this area.

Policy issues involved in the definition of qualified research

As currently defined, qualified research under the R&E tax credit covers approximately 60 percent of all R&D actually conducted, as defined for financial accounting purposes. The primary expenditure categories that do not qualify are property, plant, and equipment costs as well as depreciation on R&D capital goods. Some analysts and corporate representatives have advocated expanding the definition of qualified R&D to cover these costs, as they represent a large portion of corporate R&D expenditures.[113] As with any substantial change in the structure of the credit, Congress would have to reconsider the scope and purpose of the R&E tax credit before legislating a fundamental definitional change of this sort. A broader definition certainly would cover more R&D, but by picking up overhead and depreciation costs it also would be more likely to grant a credit for expenditures that would take place regardless of the credit's presence. In addition, a broader definition of qualified research necessarily would entail a higher revenue cost.

Quite apart from the statutory scope of qualified research, the lack of final regulations that clearly define qualified research under the current tax credit code remains an important source of industry and policy concern. It is unclear what Congress can do on this front other than to make the credit permanent, which presumably will heighten the importance of issuing final regulations for the 1986 amendments to section 41.

Coordinating the R&E Tax Credit with Other Policy Instruments

Despite the obvious importance of research and development to the economy, and the virtual consensus that private sector R&D is prone to market failure, policymakers still have a poor understanding of where market failures are most likely to occur and what sort of policy mechanisms may provide the best remedies. By nature, direct R&D subsidies can be targeted to specific market failures, yet such mechanisms often may be relatively inefficient due to the effects of non-market forces. Indirect methods for subsidizing R&D, such as the R&E tax credit, arguably have the advantage of respecting market signals yet, for that very reason, may not be appropriate mechanisms for addressing certain types of market failure.

In short, on logical grounds alone, the R&E tax credit and other tax methods for subsidizing R&D are functionally distinct from either funding R&D directly or performing R&D in the public sector. Policy choices regarding the use and coordination of different R&D subsidy instruments undoubtedly would benefit from further research into the social

[113] See, for example, Cox (1995).

rate of return to different forms of public and private R&D, as well as into the extent and nature of R&D market failures in the United States.

Assuming that the purpose of the R&E tax credit is simply to encourage more private R&D, some firms interviewed by OTA for this project argued that it would be more effective to focus on policy instruments that have a wider potential for reducing the cost of investment capital, such as deficit reduction and other policy measures that effectively lower interest rates, or perhaps various tax reforms that could increase the incentive for individuals to save and for corporations to invest in new plant and equipment (reduction of the capital gains tax being one frequently offered option). One obvious shortcoming of these suggestions is that they do not necessarily encourage firms to invest in R&D per se, and in this respect are far less refined a policy instrument than the R&E tax credit. Middle ground may be found in targeting indirect incentives to particular activities or sectors, or by changing the criteria used to allocate public R&D resources. However the choices are construed, the broader debate over these policy mechanisms clearly raises questions about the particular role and significance of the R&E tax credit to corporate R&D in the United States, and begs further research on the rather poorly understood matter of capital formation for innovation.

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