OFFICE OF TECHNOLOGY ASSESSMENT

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.

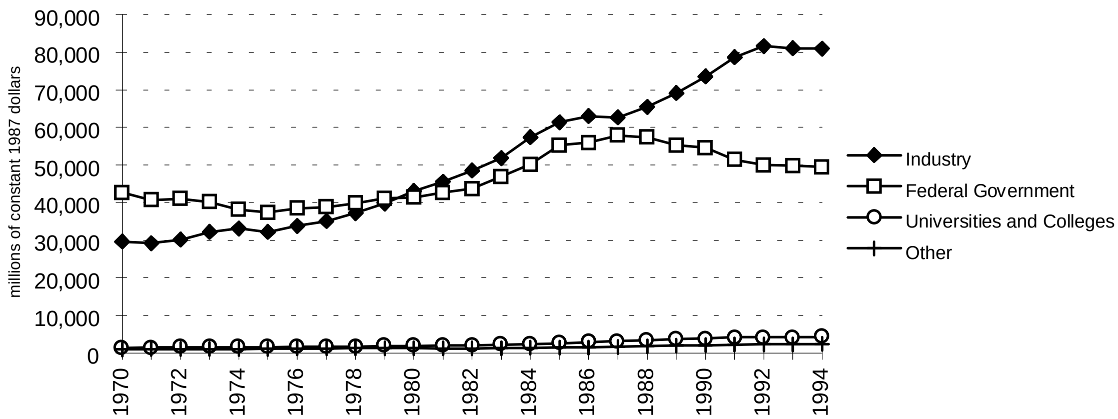
[4] U.S. Department of Commerce, *Technology, Economic Growth, and Employment* (1994).

[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