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.

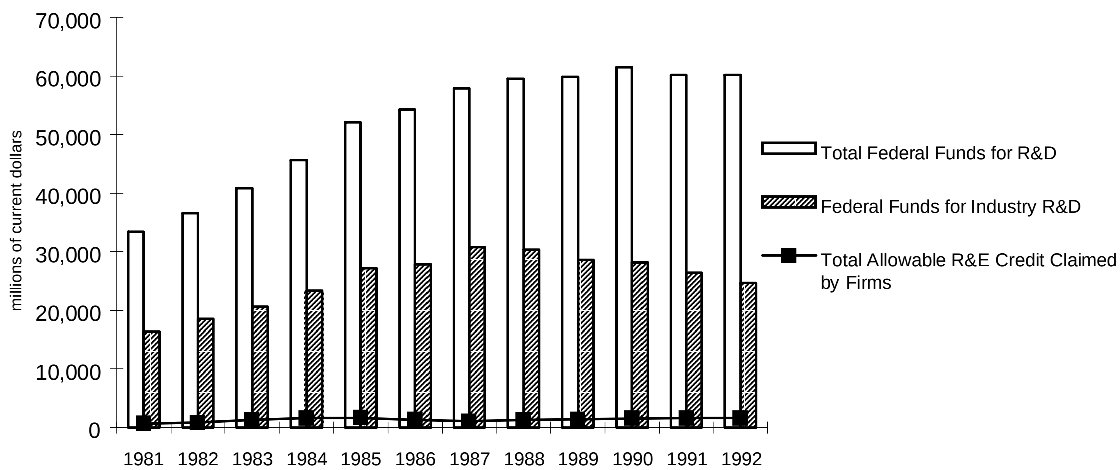
The R&E Tax Credit in the Context of Federal R&D Policy

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%

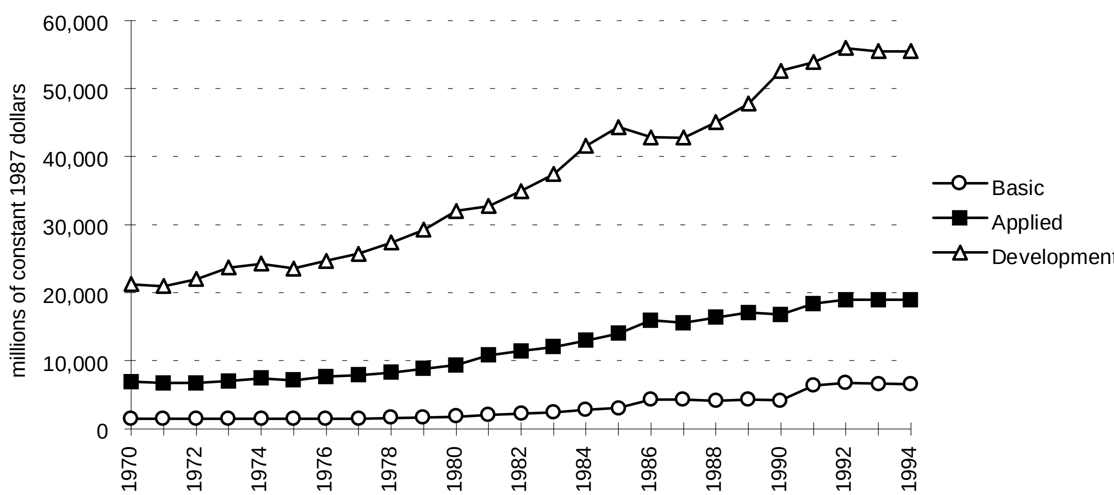
Source: NSF, National Patterns of R&D Resources, 1994, tables B-6, B-9, and B-12 . Totals may vary slightly from 100% due to rounding each category of spending.

[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

---

[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]

---

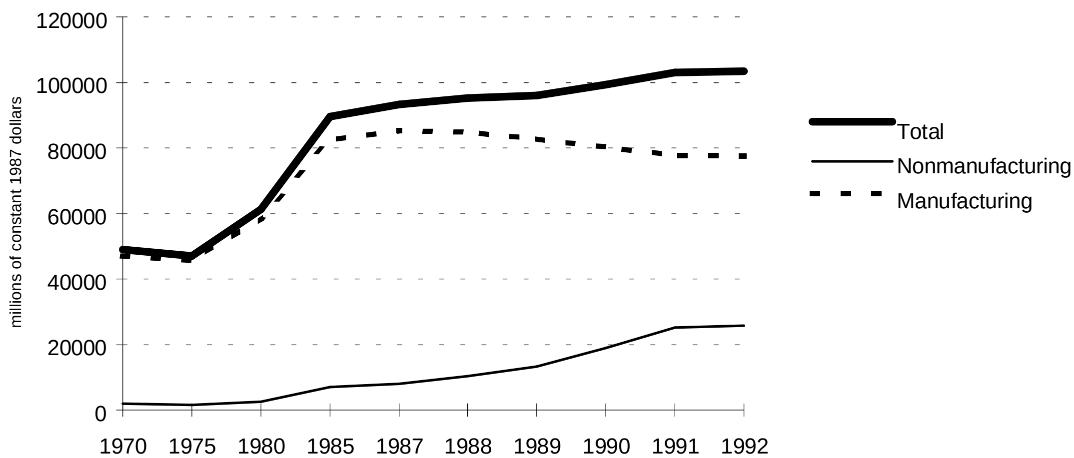
[78] On average between 1981 and 1992, U.S. R&D spending was 53 percent higher than the combined expenditures of European Union member states—it was over 600 percent higher than Germany, the European Union's single largest R&D spender—and 154 percent higher than that of Japan. U.S. Congress, OTA (1994);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

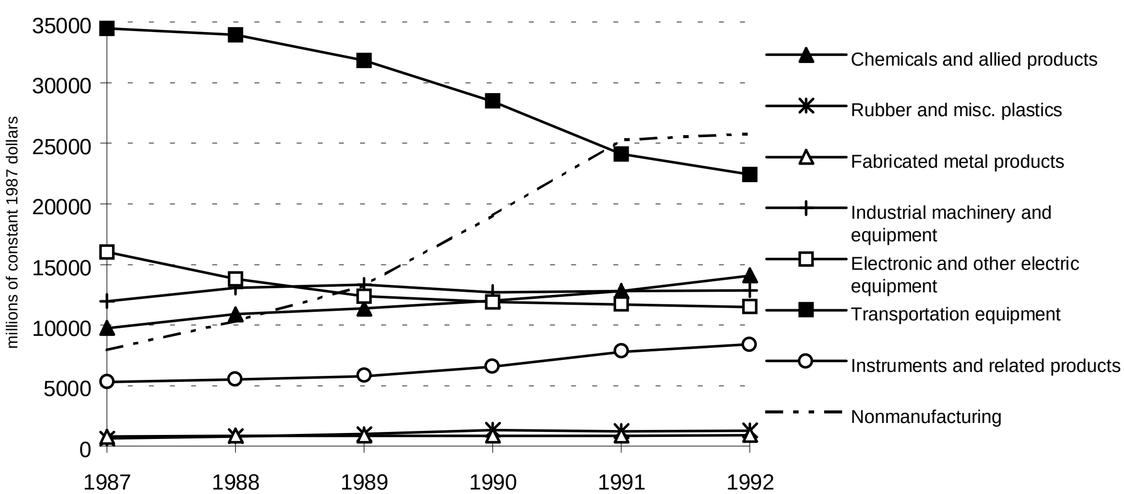
[81] The non-manufacturing category in NSF figures (and the congruent BEA R&D satellite) account includes communications, utility, engineering, architectural, research, development, testing, computer programming, and data processing service industries, as well as hospitals and medical labs. NSF Data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



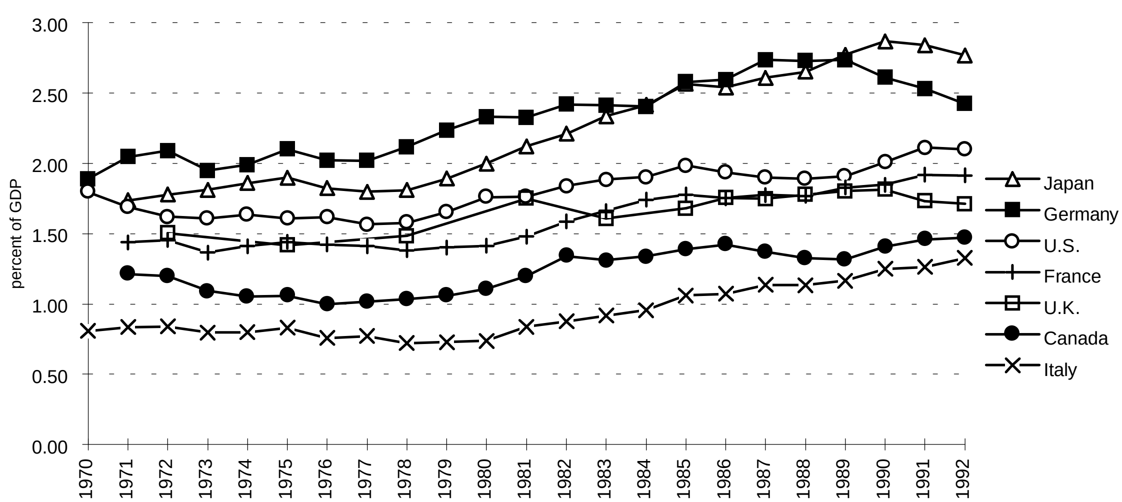
Data source: U.S. Department of Commerce, Bureau of Economic Analysis, R&D satellite account.

---

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).

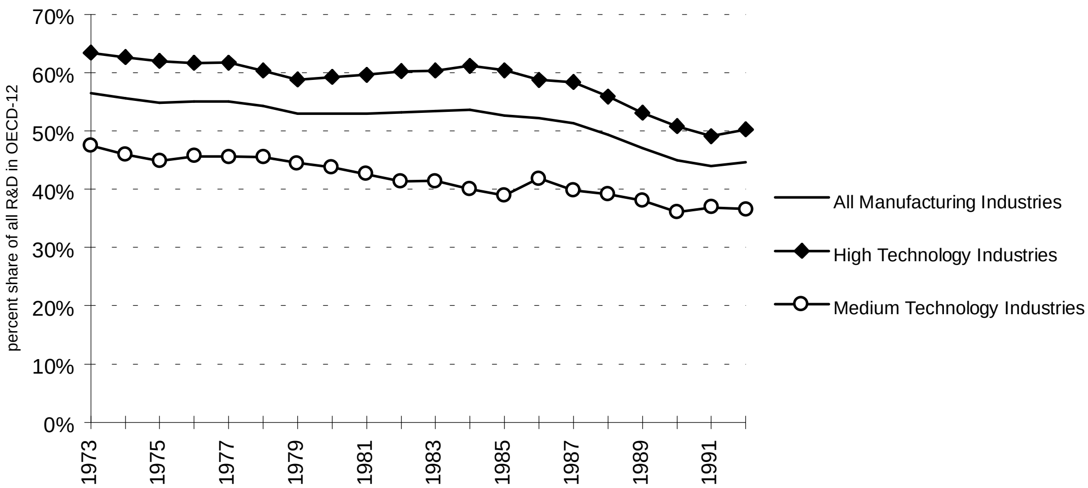
Figure 9: Non-defense R&D as a Percent of GDP, 1970-1992



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

---

[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

---

[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]

---

[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

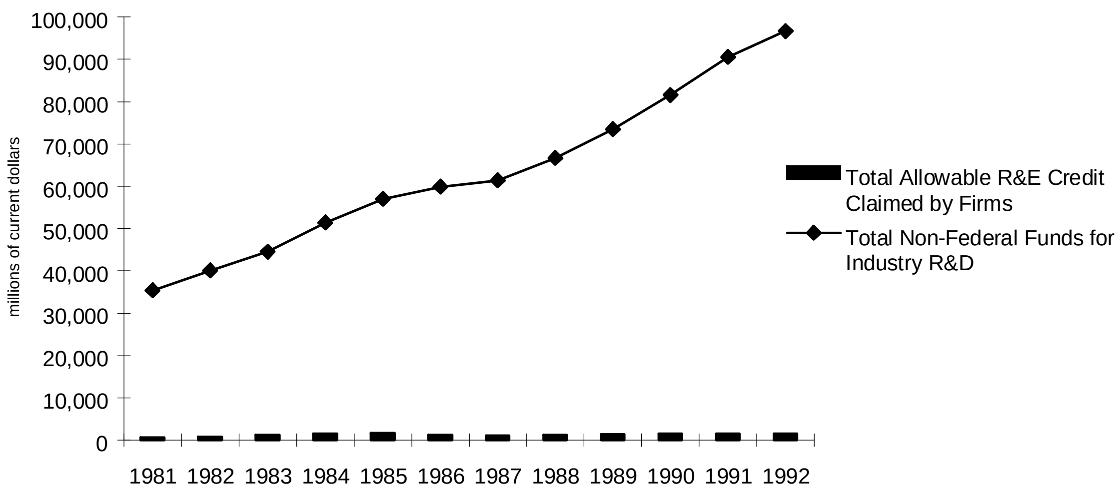
By most accounts, recent changes in industrial R&D strategies and time horizons can be attributed to competitive pressures which, through various channels, have increased cost and performance demands on corporate R&D.[95] In principle, this relatively stringent investment climate may increase the significance 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.

---

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.

---

[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

Capital prec. 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% ildings)	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 ildings) 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		
x; 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
3-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			
3-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.

---

[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
ate	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

---

[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).