J Technol Transfer (2007) 32:605–615
DOI 10.1007/s10961-007-9045-z

Tax incentives for innovation: time to restructure the R&E tax credit

Gregory Tassey

Published online: 1 August 2007
© Springer Science+Business Media, LLC 2007

Abstract The R&E tax credit has never been effective and subsequent attempts to restructure it have not addressed the major deficiencies. Moreover, in the 25 years since the R&E tax credit was enacted, a steadily increasing number of countries have implemented or expanded competing tax incentives, which in many cases are better structured and larger in size. As a result, the relative impact of the US credit is now negative in terms of incentives to conduct R&D within the domestic economy. The inadequacy of the credit stems largely from its small size and its incremental format. The impact of an R&D tax incentive is affected by its scope of coverage, the ability of industry to take advantage of it over the entire R&D cycle, the magnitude of the incentive relative to other nations' tax policies, and its ease of implementation. In the end, a tax incentive must sufficiently lower the user's cost of R&D to overcome barriers to allocation of private-sector resources commensurate with the potential rates of return on such investments. As a policy instrument, a tax incentive for R&D should be most effective if its form is a flat rate applied to all R&D.

Keywords R&E tax credit · Tax policy · Innovation policy · R&D policy · R&D investment · Innovation

JEL Classification O31 · O38 · H25

1 Introduction

Tax policy has an important role in stimulating research and development (R&D) as a response to high levels of risk associated with this category of investment. The realization

Adapted from Tassey (2007). The author is indebted to Gary Anderson for a number of helpful comments on a draft of this paper.

G. Tassey (✉)
Program Office, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 1060, Gaithersburg, MD 20899, USA
e-mail: tassey@nist.gov

that other economies, particularly Japan, had begun to increase R&D spending in the 1970s stimulated the use of this policy tool in the form of the Research and Experimentation (R&E) tax credit, which was enacted by the US Congress in 1981 to encourage US companies to conduct more technology-based research.

The inability of individual companies to "self-insure" against excessive risk causes less investment in all types of R&D. Such risk results from a number of factors, including spillovers to competing firms of the knowledge produced, high discount rates that must be applied to long gestation periods required to develop new technologies, small average firm size, highly segmented industry structures that focus on only a few of the many market applications that are typically possible from breakthrough technologies, and the fact that little or no collateral can be provided (as is the case with other investments) to encourage capital markets to finance R&D.

Conservative economists and policy makers prefer tax incentives based on the belief that tax policy is market neutral, in contrast to direct funding which targets particular technologies or phases of the R&D cycle. This philosophy has dominated economic growth policy in the United States for decades, in spite of an occasional argument to the contrary (Surrey 1969; Bozemen and Link 1984, 1985; Tassey 1996, 2007). However, tax incentives have some serious drawbacks, which must be understood and addressed to make this policy instrument effective.

2 The nature of the R&E tax credit

The credit was designed to emphasize significant advances in technology, as opposed to incremental improvements, product engineering, etc. (hence, the name "R&E," rather than "R&D," tax credit). As such, it was a response to a growing point of view in the late 1970s that the composition of industrial R&D was shifting toward shorter-term objectives at the expense of the longer-term, higher-risk research that is necessary to provide new technology platforms for future economic growth. This intended focus of the R&E tax credit is evidenced by the many tax rules written by the Treasury to define "qualified research expenditures" for which the credit applies. For example,

- The taxpayer must be attempting to obtain knowledge that exceeds, expands, or refines the common knowledge of skilled professionals in a particular field of engineering. and the (R&D) process must rely on principles of physical or biological sciences, engineering, or computer science (Treasury Regulations Sect. 1.41-4(a)(3));
- Substantially all of the research activities must be part of an experimentation process. Under Treasury Regulations Sect. 1.41-4(a)(5) and (6), at least 80% of the research costs must be due to developing hypotheses, designing experiments to test and analyze those hypotheses, conducting experiments, and refining or discarding the hypotheses.
- Before or during the early phases of the project, the taxpayer must document the principal questions to be answered and the information sought (Treasury Regulation Sect. 1.41-4(d)).[1]

3 The impact of the credit

NSF and IRS data show that real dollar claims for the credit over the first two decades of its existence (1981–2001) totaled $58.6 billion. This amount is 47 percent of the $124.4 billion

[1] Sawyer (2004).

in total real increases in industry-funded R&D and could be viewed as representing the approximate share of the growth in industry R&D attributable to the credit, assuming a unit price elasticity of demand for R&D (that is, a dollar-for-dollar impact from the credit).

However, the most readily available data are claims for the credit, but not all claims are allowed. In fact, it is estimated that approximately 20% of claims are denied. Second, whatever the allowed credit, the IRS requires that the deduction for qualified R&D expenses on corporate income tax returns must be reduced by that amount. If one assumes an average marginal tax rate of 30 percent, a rough "adjusted" credit would account for 26 percent of the cumulative increase in industry-funded R&D spending over the two decades.

With respect to the price elasticity of demand, economic studies are in disagreement over the level of responsiveness. Several studies estimated an impact of as little a 15–35 cents in increased spending for every dollar of tax expenditure. Other studies estimated a short-term impact of one dollar of increased spending for each dollar of tax expenditure and two dollars of increased spending over time (General Accounting Office 1996).

A major problem with these studies is that they do not take the strategic nature of R&D into account and therefore may not be correctly specifying the relationship between the tax incentive and corporate decision-making. That is, other factors affecting R&D expenditure trends are not explicitly addressed. In fact, the importance of R&D for long-term corporate success implies a relatively low price elasticity of demand for R&D, which, in turn, implies that the credit's impact on fluctuations in R&D spending may be over estimated. In fact, the same emerging technological capabilities of other economies that led to the enactment of the credit in 1981 were perceived earlier by US industry and led to strategic shifts in R&D spending during the 1970s before the credit was enacted.

Such trends do not mean that R&D tax incentives are ineffective, only that they must be large enough to significantly lower the user cost of R&D and thereby affect strategic resource allocations within the corporation.

4 Problems with the structure of the R&E tax credit

As hinted at in the above discussion, a number of serious weaknesses characterize the current structure of the tax credit. First, and perhaps most important, the potential for a significant and lasting effect on company R&D spending is muted by the R&E tax credit's incremental structure. Whereas, a flat credit affects total R&D spending year after year through a permanent price subsidy for all company R&D, the majority of the cost-reducing impact of an incremental credit is limited to a calculated increment of total R&D spending. Moreover, that subsidy is generally realized at a declining rate due to base creep, as discussed below. In effect, the price of the eligible incremental R&D will most likely quickly go back up in the years after the credit is first taken.

Second, the extensive rule writing and constant audits of claims for the credit necessary to enforce compliance for such a targeted tax incentive have created a substantial time and cost burden on the Treasury. According to one source, a quarter of the audit resources of the IRS' small and midsize business division are allocated to examining claims for the R&E credit. Consequently, in 2001, the Treasury proposed changing the existing set of rules to broaden coverage of the tax credit and thereby reduce the administrative burden of assuring compliance, as well as increase the credit's impact (Herman 2001).

Such problems emphasize the difficulty in managing a targeted credit and imply that tax policy may not be effective at changing the composition of R&D. What should be included in R&D is enough of a challenge, but defining boundaries of particular types of R&D or distinguishing among the phases of the R&D cycle is difficult at best. Thus, in spite of the substantial resources expended by the Treasury for rule writing and audits, it is likely the case that unqualified expenditures are receiving the credit and qualified expenditures are being rejected.

Third, that the R&E tax credit has never been made a permanent part of the tax code (it has been renewed 11 times during its 25-year history) and has been modified several times since its enactment indicate a lack of understanding and hence consensus on the part of policy makers with respect to the precise roles and expected impacts of different tax incentives for R&D. For example, the credit was originally 25 percent of the increase in R&D spending relative to a base level determined by formula. The Tax Reform Act of 1986 reduced the credit to 20%. Further, the formula used to calculate the credit originally defined the base amount of R&D as a moving average of the previous three years of R&D spending. As R&D spending increases in most years for the typical firm, the resulting "base creep" reduced the potential value of the credit with expanding R&D investment.

In response, the Omnibus Budget Reconciliation Act of 1989 changed the method for calculating the base amount. The new method used a fixed R&D intensity (R&D/sales), calculated as the average for the period 1984–1988 (0.03 for younger companies). This intensity ratio is multiplied by the average sales for the four years preceding the year when the claim for the credit is made to determine the base level. While this method eliminated an explicit R&D base creep, it substituted an indirect one through a sales-driven adjustment to the base level. Firms experiencing sales growth now pay a price in the form of the same base creep that was the target of reform. This method can be especially severe for small, fast-growing R&D-intensive firms who are realizing rapidly increasing sales from previously successful innovations. Thus, at least to a degree, the base-creep problem was shifted from one subset of R&D-intensive firms to another. Only if sales do not grow would an incremental increase in R&D receive the maximum subsidy over that project's lifetime, but such a firm would likely not be in business very long and certainly would not produce the cash flow growth needed to fund successive increases in R&D spending.

Fourth, small firms can be disadvantaged in several additional ways. In new industries like biotechnology, companies can operate at a loss for many years. Sustaining R&D expenditures through long development periods often forces financing options that require these firms to give up major shares of equity. Because the tax credit is not refundable, it provides no support for these firms, thereby contributing to the undesirable financing arrangements.

Moreover, by being less diversified, small firms can experience a substantial jump in R&D investment in a single year. Such instances are common when a major R&D project reaches the development stage, which requires much larger amounts of R&D spending than earlier phases of the R&D cycle. In such situations, a firm may not be able to take full advantage of the tax credit because qualified research expenditures are limited to 200 percent of the calculated base amount of R&D. That is, the increase from which the credit is calculated can never be more than the base amount, so that a 100-percent increase in qualified research expenditures above the calculated base in a particular year is the maximum amount (increment) to which the credit can be applied. A firm with a 200-percent increase above its base amount of R&D would therefore only realize a 10-percent tax credit on the total increase. Therefore, small firms, even when profitable, can be penalized by the current structure of the credit.

Fifth, the amount of the tax credit received is partially offset by the requirement to reduce the standard business expense deduction for qualified research expenditures by the amount of the credit (Treasury Regulation Sect. 1.41-4(c)(2)). In effect, this reduces the value of the credit by a company's marginal tax rate. Such an "adjusted" credit is the true value of the tax incentive, which is considerably lower than the nominal rate.

5 International comparisons

The problems with the structure of the US R&E tax credit become more pressing as globalization results in a constantly growing number and variety of R&D tax incentives in other economies. Thus, the relative effectiveness of US tax policy is increasingly important

Most countries allow a tax benefit (a credit or immediate expensing) for the capital costs associated with R&D. However, capital costs account for only about 10–13% of total R&D costs, which minimizes the impact of such tax incentives (Hall and Van Reenen 2000). All countries allow R&D operating costs to be expensed.

Any differential impacts of tax incentives across countries should be due, therefore, to differences in either tax credits or deductions greater than 100% of qualified R&D expenditures. Table 1 compares the growth in industry-funded R&D with the existence of various tax incentives beyond the conventional business expense deduction (i.e., incremental credits, flat credits, and "super deductions" of more than 100%) for a number of relatively R&D-intensive economies over the first two decades since the enactment of the US R&E tax credit in 1981.

To the extent that tax preferences for R&D affect the user cost of risk capital, they can influence decisions by companies with respect to location of R&D facilities and operations. Billings (2003) estimated the effect of tax incentives by relating the average rate of growth in R&D spending relative to the comparable rate of growth in the United States for seven industries across 11 other countries over a 10-year period (1991–2000). This approach provided 458 industry years of data after eliminating industries in countries with incomplete time series or outliers. Industry years with tax-based incentives had an average annual increase in industry R&D spending of 9.61% compared to 2.24% average annual growth for years without tax-based incentives. Thus, the average growth rate for industry years with a tax incentive is more than four times that average growth rate for industry rates without such an incentive.

Table 1 Percent change in industry-funded R&D, 1981–2001

Country	Percent change	R&D tax incentive
Australia	733.9	125% super deduction plus a 175% incremental deduction
Finland	510.8	None
Sweden	286.7	None
Canada	240.9	Flat 20% credit
United States	201.4	20% incremental credit
Japan	165.7	Flat 10% credit (15% for small firms)
France	138.8	Incremental credit of 50%
Germany	97.1	None
United Kingdom	53.6	None[a]

Source: OECD

[a] In 2002, the UK instituted a super deduction of 125% (150% for SMEs); unlike the US credit, this "credit" is refundable for net-loss years

Based on a “user cost of R&D” index developed by Bloom et al (2002), Canada and Australia have the most generous tax treatment of R&D. As shown in Table 1, these two countries rank first and fourth in terms of growth in industry-funded R&D in the two decades since the US R&E tax credit was implemented. However, the two economies with the second and third largest growth rates for industry-funded R&D over this time period, Finland and Sweden, provide no tax incentive beyond the common business expense deduction. Moreover, Canada and Australia do not use an incremental tax credit. Canada has a 20% flat tax credit and Australia uses a 125 percent deduction for R&D expenses (effectively a flat credit) plus a larger deduction for R&D increases. In fact, a survey of 25 industrialized economies by Hall and Van Reenen (2000) found that only six relied on an incremental tax credit.

Of course, these averages do not reveal potential differences in R&D investment impact from the specific details of individual countries’ tax incentives. To this end, Billings also estimated the average “effective tax credit” (equivalent flat tax credit rate above normal business deductions for R&D) for 20 US multinational companies in seven economies. As shown in Fig. 1, the United States ranks near the bottom. Only France was estimated to have a lower effective R&D tax incentive.

France’s low estimated tax subsidy provides a good example of the need for thorough analysis of tax policies. Simply stating the apparently generous 50% incremental credit (along with a number of other incentives) conveys the impression that France is an attractive location for corporate R&D based on relative user costs. France even touts their tax incentives as a marketing strategy aimed at multinational companies. However, the total credit in any one-year is limited to 6.1 million euros (approximately $8 million). Because the 20 companies used in Billings’ simulated tax incentive calculations have large R&D budgets, this limitation greatly reduces the calculated effective tax subsidy for these companies.

In summary, although Table 1 does not indicate a strong correlation between tax incentives in general and growth in R&D spending at the national level, available industry-level analysis shows a strong positive impact, at least for an average company and some “average” tax benefit. However, more detailed examination of individual country tax

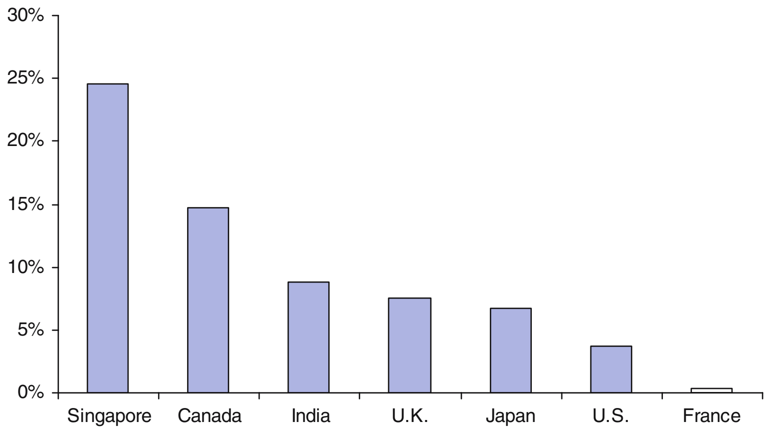

Fig. 1 Estimated average realized equivalent flat R&D tax credit for 20 US Multinationals in seven countries. *Source*: Billings (2003, Table 3, Panel B)

incentives reveals that the actual incentive is frequently considerably less than what the common superficial description suggests. Further analysis also shows that R&D tax incentives have differential effects across individual companies based on factors such as company size, profitability, and pattern of R&D or sales growth. The dominant use of a flat credit or its equivalent among countries at least hints that this form of tax incentive may have greater impact.

6 The R&E tax credit's role in federal R&D policy

The rationale for using a tax-based subsidy to stimulate R&D is the fact that this mechanism provides a market-oriented response by leaving the decision of the composition of a company's R&D portfolio up to corporate decision makers. However, if the intent of the credit has been to shift industry R&D portfolios toward longer-term, higher-risk research, any such effect, if it exists at all, has been quite weak. In fact, Fig. 2 indicates the opposite trend is occurring. Development expenditures, which are focused on shorter-term applied R&D objectives, dominate the growth of industry R&D spending in the US economy over the past three decades.

One possibility is that the increase in development expenditures has been due, in part at least, to the existence of the credit. That is, instead of shifting the composition of R&D, the result may have been the stimulation of more of the type of R&D that industry was already doing. Sufficiently strong flat tax incentives can have such an effect, as previously indicated by data from other countries. However, interviews of industry R&D managers for an OTA study indicated little impact of any type on decision making from the U.S. credit. Therefore, this policy mechanism "represents more of a financial tool than a technology tool" (Office of Technology Assessment 1995). As a result, the credit is of primary interest to corporations' tax accountants. In fact, in a 1996 Industrial Research Institute R&D

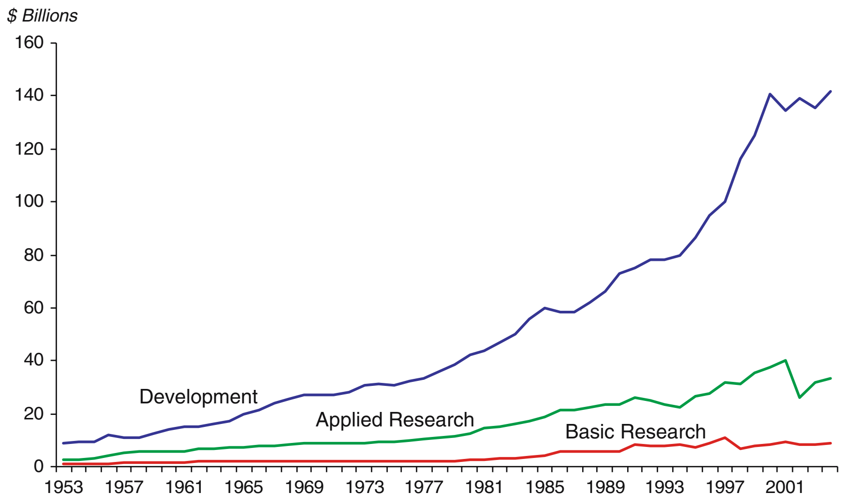

Fig. 2 Composition of industry-funded R&D by major phase, 1953–2004 in real (2000) dollars. *Source*: National Science Board, 2006

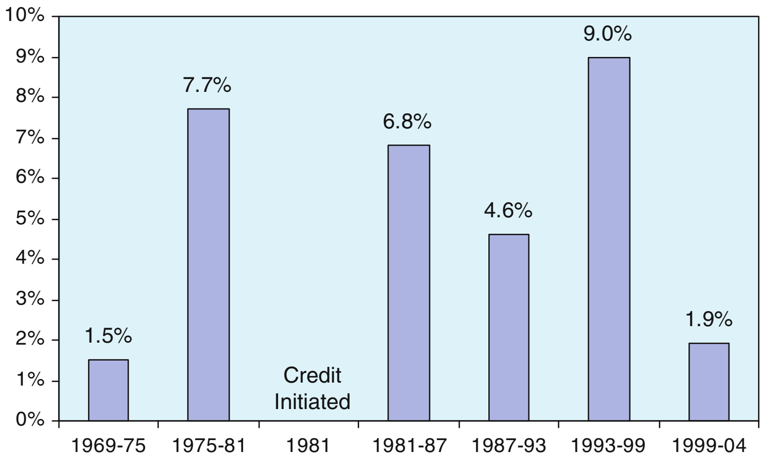

Fig. 3 Average annual growth in industry-funded R&D before and after initiation of the R&E tax credit. *Source*: National Science Board, 2006. The last interval is five years

spending survey, 55% of responding companies indicated that the credit was "not at all" influential even in establishing the *level* of their companies' R&D investment.[2]

That the R&E tax credit seems to have had little measurable effect at the national economy level is also apparent when industry R&D spending is divided into six-year intervals, two intervals before and three after the implementation of the credit in 1981. Using such intervals, Fig. 3 shows that not only did the credit show no discernable leverage on industry R&D, the reverse trend seems to have occurred. The period 1969–1975 had a relatively low average annual growth rate, while the next interval that immediately preceded the initiation of the tax credit had a much higher average annual rate of increase. Then, for the six-year period immediately following the credit's implementation, the average growth rate dropped slightly and then declined more substantially in the next interval before finally showing above-average growth in the information technology investment binge of the last half of the 1990s. The credit not withstanding, the growth rate for industry-funded R&D then dropped precipitously in the first half of this decade.

In summary, given the strategic nature of R&D, company investment decisions are made largely on the perceived need for new products, processes, and services to meet competition and achieve growth in market share. The increased foreign competition over the past three decades has forced US industry to focus more on shorter-term applied R&D. This compositional shift is in response to increased risk faced by all companies for all types of R&D, thereby pushing corporate spending forward in the R&D cycle. The current tax credit is not large enough to have much effect at all on R&D, and it is certainly not capable of being efficiently designed to reverse the compositional shift.

Thus, the various indicators presented here imply a need to carefully examine tax policy's potential for leveraging industry R&D. If a decision is made to continue with a tax credit (or super deduction), the current credit will have to be redesigned.

[2] An accurate assessment of the credit's impact requires data on company-level R&D investment and the motivations for such investment. Only one study reviewed in the GAO report (1996) actually interviewed company R&D managers (Mansfield 1986) and this study found little impact of the credit on R&D portfolio composition.

7 Reforming the tax credit

As described above, the current R&E tax credit suffers from several problems:

(1) The credit is incremental, which limits the benefit for a new R&D project largely to the project's first few years, thereby favoring shorter-term projects;
(2) The credit is targeted, which places uniquely large administrative costs on the Treasury to manage this tax expenditure;
(3) The formula for calculating the credit is complex and, more important, reduces its value to many firms.
(4) The credit's net effect is too small to achieve a policy goal of significantly increasing industry R&D.

Tax incentives are most effective when leakages to non-targeted investment can be minimized and boundary conditions are relatively simple so as to avoid expensive government management efforts. These requirements are typically met when the scope of the target economic activity is broad in that it covers most or all of a particular category of investment (i.e., all R&D) and when the policy objective is to increase the current pattern of investment (i.e., the same composition of R&D).

Thus, a preferred approach would be to substitute a flat tax credit or a super deduction, which would apply to all legitimate R&D. Such a mechanism would have a continuous and larger cost-reducing impact on R&D and would be less burdensome to administer. Most important, such a tax incentive would increase all applied R&D to some extent, leaving targeted long-term, high-risk R&D support to direct funding programs where leakages to research already supported by industry can be kept to a minimum.

The cost of a flat tax expenditure would likely be greater than the current incremental credit. However, if analysis shows that the rate of return is higher from R&D than from alternative investments, which available evidence suggests (Tassey 2007), then the policy conclusion is that not enough investment funds are flowing into R&D and incentives (in the most efficient form) are required.

It should be noted that it is possible to conceive of ways to overcome management problems associated with targeted tax incentives, such as those currently being encountered by the Treasury in implementing the current R&E tax credit. If the credit is targeted at a research mechanism associated with a particular type of R&D where significant under investment has been identified, then the research mechanism becomes the eligibility criterion rather than the type of R&D. For example, Bozeman and Link (1984, 1985) proposed a tax credit for collaborative research on the assumption that companies typically collaborate for more radical technology research where the required complementary research assets often do not reside within individual firms. Under current law, companies only file notification of collaborative research under the National Cooperative Research Act (1984) when they fear antitrust concerns will be raised. As no antitrust action has been taken for such activity, few firms file. However, if firms were required to file under the NCRA to receive a tax credit for collaborative research, then a large database would be established that would allow assessment of the nature of the research being conducted and, therefore, a determination of the accuracy of the targeted tax credit.

8 Conclusion

The policy analysis capability and relevant data sets are not available to accurately assess the need for and the optimal structure of tax incentives for R&D. The result is that the US

R&E tax credit has been "temporary" for 25 years and has exhibited modest impact at best. Moreover, its form and targeted impact seem to be inappropriate for the stated objectives.

To have a significant impact, a tax incentive should be focused on stimulating the amount of industry-funded R&D, as opposed to attempting to adjust the composition of such spending. Underinvestment problems at specific phases of the R&D cycle or for elements of industrial technologies with strong public good content (i.e., those with infrastructure character) can be addressed more effectively in most cases with direct government funding.

As currently structured, the US R&E tax credit probably has had at most a minor and transitory effect on industry R&D spending. Given the limitations of incremental tax credits, consideration should be given to a substantial flat tax credit that would significantly lower the cost of R&D year over year. The four countries with the fastest growing industry-funded R&D either use the equivalent of a flat credit or no tax incentive. Of these four, the two without a tax incentive, Finland and Sweden, have relied to a relatively greater extent on government-funded R&D implemented through various partnership arrangements with industry.[3]

However, tax policy and direct government funding have distinctly different and complementary roles (Tassey 2007). In particular, tax policy is not appropriate for adjusting the composition of industry R&D, but it has a role in increasing the amount of such investment. The reverse is the case for direct funding of technology research. Therefore, the policy imperative is to fix the substantial set of problems besetting the current R&E tax credit, so it can achieve the needed and appropriate impact of increasing the overall R&D intensity of the US economy.

References

Billings, B. A. (2003). Are US tax incentives for corporate R&D likely to motivate American firms to perform research abroad? *Tax Executive, 7–8*, 291–315.

Bloom, N., Griffith, R., & Van Reenen, J. (2002). Do tax credits work? evidence from a panel of countries, 1979–1997. *Journal of Public Economics, 85*, 1–31.

Bozeman, B., & Link, A. (1984). Tax incentives for R&D: A critical evaluation. *Research Policy, 13*, 21–31.

Bozeman, B., & Link, A. (1985). Public support for private R&D: The case of the research tax credit. *Journal of Policy Analysis and Management,* 4, 370–382.

General Accounting Office. (1996). *Tax policy and administration* (GAO/GGD-96–43). Washington, DC.

Hall, B. (1993). R&D tax policy during the 1980s: Success or failure? In J. Poterba (Ed.), *Tax policy and the economy* (Vol. 7). Cambridge, MA: MIT Press.

Hall, B., & Van Reenen, J. (2000). How effective are fiscal incentives for R&D? A review of the evidence. *Research Policy,* 29, 449–469.

Herman, T. (2001). Treasury to reserve Clinton-Era rules on research credits. *Wall Street Journal, 243* (December 2), A2.

Mansfield, E. (1986). The R&D tax credit and other technology policy issues. *American Economic Review, 76*, 190–194.

Moris, F. (2005). The research and experimentation tax credit in the 1990s *InfoBrief* (NSF 05–316), National Science Foundation, Division of Science Resources Statistics.

National Science Board. (2006). *Science and Engineering Indicators 2004* (NSB 06–1). National Science Foundation.

Office of Technology Assessment. (1995). *Innovation and Commercialization of Emerging Technology*. Washington, DC: US Government Printing Office.

[3] These two countries have the second and third highest ratios of government R&D funding to GDP (OECD, *Main Science and Technology Indicators*, Vol. 2006/1).

Sawyer, A. (2004). Potential implications of providing tax incentives for research and development in NZ. Report for the Royal Society of New Zealand (February).

Surrey, S. (1969). Tax incentives: Conceptual criteria for identification and comparison with direct government expenditures. In *Proceedings of the Tax Institute of America*, pp. 20–21.

Tassey, G. (1996). Choosing government R&D policies: Tax incentives vs. direct funding. *Review of Industrial Organization, 11*, 579–600.

Tassey, G. (2007). *The technology imperative*. London: Edward Elgar.