Tax policies affecting R&D: an international comparison

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Abstract:
As more and more emphasis is being given to the role of government in supporting innovation-related activity, a clearer understanding of the historical intent of R&D-related tax policies (by far the most common mechanism for support of R&D) and of the effectiveness of these policies appears warranted. The purpose of this paper is threefold. First, it provides an overview of the history of R&D-related tax policies, both in the USA and in twenty-two other industrial countries Second, it reviews the extant empirical evidence on the effectiveness of R&D tax credits. And third, it offers a critique of R&D tax policies per se.

Article:
1. A history of R&D-related tax policies 1.1. The US experience[1]
Historically, a number of elements of the Internal Revenue Code have acted as incentives for R&D. Under Section 174 of this code, businesses have, since 1954, been able to deduct allowable current-year research and experimental (R&E) expenditures[2] or to amortize those expenditures over a period of not less than five years.[3] While R&E is clearly important to the innovation process, it is difficult to separate the marginal contribution of R&E from the effects of other inputs such as management structure, quality control, marketing strategy, and the level of employee creativity. Additional benefits have also existed for some time in the form of deductions for contributions to educational and scientific organizations operating in the public interest,[4] and in the form of exemptions for the income of such organizations if they are operated in the public interest.[5]

In recent years most attention has focused on an additional incentive — the R&E tax credit. Originally created as part of the Economic Recovery Tax Act of 1981 (ERTA),[6] it granted a 25% tax credit for each dollar of qualified R&E expenditures in excess of the average amount spent during the previous three years (or 50% of current year expenditures if greater).[7] Because of limitations on the definition of qualified R&E expenditures, only about 70% of total company-financed R&D qualified for the credit under the 1981 law. [4].

Several changes in the R&E tax credit have been made since its inception in 1981.[8] The Tax Reform Act of 1986 reduced the R&E tax credit rate to 20% and narrowed the definition of qualified research in order to emphasize the discovery and experimentation stages of the innovation process.[9,10] I" In 1988, the Technical and Miscellaneous Revenue Act (TAMRA) reduced the allowable deductions under the 1954 law (Section 174) by an amount equal to 50% of the R&E tax credit. This change effectively reduced the maximum effective R&E credit rate to 16.6% [6, 8]. Finally, the Revenue Reconciliation Act of 1989 made several adjustments in the definition of the base and increased the deduction disallowance noted above to 100% of the R&E tax credit, thus reducing the maximum effective rate for the R&E tax credit to 13.2%.

Closely connected to the R&E tax credit is the accelerated cost recovery system (ACRS) for capital expenditure first established by ERTA but later amended by the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA). Though its impact will depend on a variety of firm-specific factors, in general the ACRS will tend to shift firms toward greater reliance on capital in their conduct of R&E projects. In contrast, the R&E tax credit applies to the non-capital portion of R&D and therefore should have a greater impact on labor-intensive R&E. To some extent, at least, these two subsidies for R&E may each cancel the other's tendency to misallocate resources. However, net biases will most likely continue to exist.

1.2. Experiences of other countries[11]

Neither Brazil, China, Denmark, Hong Kong, Ireland, Italy, South Africa, Switzerland, nor the United Kingdom, among others, have tax credits or special allowances for R&D. Most of these countries, however, do permit R&D spending to be expensed, and most have carry-forward provisions. Hong Kong and the UK permit capital outlays to be expensed as well. Tax incentives for R&D were proposed in the UK in 1988 but were rejected on the basis of cost effectiveness [13].

For about a decade, beginning in the mid-1960s, Australia offered grants for up to 50% of total R&D. In 1985, tax concessions were granted for R&D whereby allowable R&D could be expensed at the rate of 150% (to decrease to 125% in 1993 and to 100% in 1995), and capital could be expensed at a 100% rate [14].

The Belgian Income Tax Code does not contain *per se* incentives for R&D. Rather, the 1984 Recovery Law allows the distribution of profits from an innovative company (defined in the law) to be exempt from corporate tax for 10 years (up to stated maximum amounts). Also. companies are permitted to deduct as an expense an additional BEF100 000 per year for each additional employee used in scientific research.

In Canada, there have been intermittent tax policies to encourage R&D spending.[12] Between 1962 and 1966, 50% of the difference between current R&D and 1961 R&D was deductible. Beginning in 1967, a grants program was also initiated which remained in effect until 1977. Approximately, Can$2 million was allocated to private R&D firms in 1967 and as much as $46 million was allocated in 1976. In 1977, the R&D tax credit was restored. It began at rates between 5 and 10%, and was increased in 1978 to 10% for larger firms and 25% for smaller firms. In Canada, the tax credits have been based on levels of spending rather than on incremental expenditures (as in Japan and the USA). Also, in 1978 a tax allowance was initiated in order to stimulate capital expenditures. In 1984, this allowance program was terminated and the R&D spending tax credit was increased to, in general, 20%.

France has a cash grants program to encourage R&D spending, but this does not operate through the tax system. Job creating grants are equal to 15- 20% of up to FFr25 000 for each job created. In 1982, the French government adopted a direct R&D assistance program as part of its broader industrial policy, focusing specifically on what was referred to as the six industries of the future: bioengineering, marine industries, robotics, electronic office equipment, consumer electronics, and alternative energy technologies. In 1983, with the passage of the Finance Act, the government established a tax credit program equal to 25% of the increase in company-financed R&D over the previous year. Beginning in 1990, this credit was raised to 50% of the difference between current R&D spending and the average of real R&D spending over the previous two years. The maximum credit is FFr5 million per year. France is the only country with an incremental tax credit program based in real rather than nominal terms.

The Federal Republic of Germany used to have a tax credit program for investments in R&D equipment through which firms, in addition to regular depreciation, were permitted (under the Income Tax Act and the Income Ordnance Act) to depreciate the cost of R&D equipment by an additional 10-40% in the year acquired. There was also an investment grant program for R&D assets equal to 20% of the first DM500 000 and 7.5% for the balance of the asset costs. This latter program, which had a major impact on the development of the steel, mining and energy industries, expired on 31 December 1989. Germany does not currently have an R&D tax credit program, and there is no information to suggest that one will soon be proposed.

There are six areas of preferential tax treatment for R&D in Japan [18, 191: (1) an accelerated depreciation system for R&D machinery (which began in 1952) and for the development of new technology (which began in 1958); (2) tax deductions on experimental research expenditures (which began in 1966); (3) special deductions on foreign technology transactions (which began in 1956); (4) reduction in withholding tax on fees for the use of foreign technology (which began in 1953); (5) tariff exemptions for imported new machinery (which began in 1951); and (6) an R&D tax credit. The R&D spending tax credit rate is 20% for increases in R&D over the largest amount in any one previous year since 1966. up to a maximum of 10% of the corporation's tax liability. Also, tax credit is given for 7% of the cost of acquiring R&D capital in fundamental technologies. The maximum tax credit in a given year is equal to 15% of the corporation's tax liabilities for that year.

The Income Tax Act in the Netherlands does not deal specifically with R&D expenditures. Special investment allowances, up to 18% of cost, are permitted for technical capital. Companies can also obtain from the government subsidies for portions of the salary cost of employees engaged in specific research activities. This Innovation Stimulation Scheme (INSTIR) was introduced in 1984 and phased down in 1989. Today. only 30% of R&D labor expenses (to a maximum off 150 000 over a six month period) is eligible for the subsidy program.

In Singapore, the Income Tax Act permits R&D expenditures and capital to be expensed. Qualifying expenditures exceeding S$1 million per year may be doubled when calculating these deductions.

Spain's 1990 General Budget Law permits a tax credit for 15% of intangible R&D expenditures (defined as product development costs) and 30% of the acquisition value of fixed R&D capital.

In Sweden, an R&D tax allowance was initiated in 1973. Partially incremental in nature, it equals 10% of a firm's R&D expenditure plus 20% of the increase in R&D spending over the previous year's level. Company-financed R&D expenditures include 5/3 of R&D salaries plus contracted work. Salaries are defined as R&D-related if more than 50% of a worker's time was so devoted. This allowance differs from a tax credit. The Swedish tax allowance is deducted from pre-tax income. In 1981, a change was initiated to make the allowance more incremental in nature. It equalled 5% of current R&D and 30% of the incremental increase. Also, salaries were classified as R&D-based only on a 25% time qualification, and the salary multiple was raised from 5/3 to 5/2.

In Taiwan, the Statute for Encouragement of Investment permits a 20% tax credit for current R&D in excess of either the highest amount in any one of the last five years or 0.5% of current revenues. The maximum tax credit is 50% of the current year's liabilities, but unused portions may be carried forward.

While Norway does not have a tax-based incentive system to encourage R&D. it does permit firms to take R&D deductions now while planning for future R&D. These funds are contributed to a research reserve. The South Korean program is similar. Up to 20% of taxable income may be deposited in a technological reserve so that deductions may occur before the actual research begins.

2. The empirical evidence

In general, there have been no systematic empirical evaluations of the international programs described above. The four exceptions are the USA, Canada, Sweden and Japan. The following two sections summarize the empirical evidence on the effectiveness (viewed in terms of stimulating R&D) of direct tax incentives toward R&D in those four countries. Although there are, in concept, indirect effects on R&D through other tax policies (as discussed above with regard to R&D investments), there have not been any empirical studies of this issue.

2.1. Studies of the USA

The empirical evidence on the effectiveness of the R&E tax credit is mixed. There is general agreement that R&D spending did increase in the post-1981 period, but there is disagreement as to whether this increase actually began before the tax credit went into effect; or, if it was induced by the tax credit, by how much. Obviously, there is also disagreement about the net cost of the program.

A number of researchers employed time series analyses to estimate the 1981 tax credit's initial impact on company-financed R&D spending. There are four notable studies of this type. Each relied on historical R&D-

related data as the basis for formulating a forecast of post-1980 R&D spending. Forecasted R&D spending was then compared to actual R&D spending. When actual spending exceeded the forecasted amount, it was presumed that the R&E tax credit had a positive causal impact.

Using this time series methodology, Baily *et al.* [20] found that R&D spending was, on average, 7.3% greater in 1982-1983 in twelve R&D-intensive manufacturing industries than would have been predicted from historical data. Likewise, Mansfield [21] found that actual firm-level R&D spending exceeded projected R&D spending in six R&D-intensive manufacturing industries by an average of 10% in 1981 and 23% in 1982. Brown's [22] aggregate study reached a similar conclusion, reporting that the 1981 R&E credit was responsible for a 25% increase in R&D spending by 1984. Most recently, Cordes [23] reanalyzed this issue using aggregate data and found that actual R&D spending exceeded forecasted R&D spending by 8.7% in 1981, 17-4% in 1982, 25-5% in 1983 and 26.8% in 1984. Cordes did not claim from this increasing trend that the credit was becoming more effective over time.

These four time series studies are somewhat at odds with several related microeconomic investigations. For example, Mansfield [21], using survey data from 110 manufacturing firms, found that the tax credit induced only a modest increase in company-financed R&D spending — between 0.1 and 0.6% in 1981, between 0.4 and 1.5% in 1982, and between 0.6 and 1.8% in 1983. Mansfield noted that these estimates may approximate the expected long-run impact from the credit. He also noted that one reasonable estimate of the effective tax credit is 6%.[13] Hence, if the price elasticity of the demand for R&D is 0.3, then a 1.8% annual increase in R&D appears to be reasonable. In a related review article [25], Mansfield notes that others have found that the credit had only a modest impact on R&D spending of between 0.4 and 0.8% per year [26].

Eisner *et al.* [24, 27], using multiple data sources and a microeconomic methodology, also found very little impact from the 1981 credit on R&D spending. In fact, they present rather detailed evidence that the surge in qualified R&D in 1981 was nearly offset by a decrease in non-qualified R&D. They admit, however, that this offset could either be a credit-induced substitution or a redefinition issue.

Cordes [23] attempted to reconcile the varying conclusions drawn from the time series analyses and the microeconomic studies. He notes, first, that the time series analyses may yield upwardly biased estimates if, in fact, firms are reclassifying activities as R&D.[14] Second, Cordes notes that, as with any time series extrapolation, it is extremely difficult to attribute a structural change to one particular factor when many things are changing over time as well as across industry. Hence, the upward shift in aggregate R&D spending may have begun even before the 1981 credit went into effect. Finally, he observes that the long-run behavior response to the credit may be measured most correctly using the price elasticity of demand for R&D. And, as mentioned above, Mansfield [21] and Baily *et al.* [20] found the response, so measured, to be relatively small.

Just as there are varying opinions as to the effect of the 1981 tax credit on increasing company-financed R&D, there are varying opinions as to the cost of the tax credit. According to Mansfield [25], his survey information from US, Canadian and Swedish firms is quite similar — the ratio of tax-credit-induced R&D to foregone government revenue is in the range of 0.3-0.4. The US General Accounting Office [4] estimated similarly that the 1981 tax credit stimulated between $1 billion and $2-5 billion of additional R&D between 1981 and 1985 at a cost of $7 billion. In other words, the credit stimulated between 15 cents and 36 cents of additional R&D spending per dollar of foregone tax revenue [6].

In comparison, the Baily, Lawrence and DRI calculations [20] include not only the direct revenue loss from the credit but also the potential revenue gains from additional taxes. They estimate that by 1991, the 1981 tax credit would result, in a worst case scenario, in a $200 million revenue loss and, in a best case scenario, in a $4-2 billion net revenue gain. Similarly, Cordes [23] reports that he found (in his earlier National Science Foundation-sponsored study) that if the 1981 tax credit were made permanent, it may have a stimulating effect of between 35 cents and 93 cents of additional R&D per each $1 of revenue loss.

Finally, the Bush Administration estimated [4] that if the tax credit were made permanent at 20%, beginning in 1991, revenue losses would be $0-5 billion in 1991, $0-9 billion in 1992 and $1-1 billion in 1993.

2.2. Studies of other countries

The most detailed studies of R&D tax incentives outside the USA relate to Canada, Sweden and Japan.

2.2.1. Canada

As described in section 1.2, Canada has used various tax policies, including tax credit and tax allowance programs, to encourage R&D spending. Mansfield and Switzer [17] estimated the extent to which the tax credit and tax allowance program increased company-financed R&D between 1980 and 1983. Based on survey information from 55 major R&D-intensive corporations, they concluded that the R&D tax credit increased company-financed R&D only by about 2% per year. The research allowance accounted for about an additional 1%. These increases translated to about Can$50 million in 1982.

Finally, as will be the case with almost any R&D tax credit, redefining occurred in Canada as it did in the United States. Reported R&D increased by about 14% for this reason between 1977 and 1987.

2.2.2. Sweden

As noted above, Sweden has employed some form of incremental R&D tax allowance program since 1973. Based on survey data from 40 major R&D-intensive companies, Mansfield [21] found that the R&D tax allowance increased company-financed R&D between 0.4 and 1.6% in 1981 and between 0.3 and 1.9% in 1983. Redefining accounted for about a 13% increase in company-financed R&D after 1973.

2.2.3. Japan

Goto and Wakasugi [18] report that Japan's preferential R&D tax treatment described above had, at most, an effect of increasing R&D by 1% in 1980 (last data reported). The effect of direct subsidies was nearly twice as large. However, unlike across-the-board tax credits, Japan's subsidy program is highly focused toward advanced technology fields and toward energy.

3. Summary and critique

By means of summary, a brief description of the tax credits toward R&D in the various countries discussed above, along with other special assistance policies, is categorized in Table 1; if not explicitly noted as an incremental credit, the credit is based on the annual level of R&D. All the countries mentioned above are listed in the table even if they have no specific tax policies toward R&D. The remainder of this section is devoted to a critique of the US tax credit.

According to the 1981 House Report 4242, the purpose of the R&E tax credit was "to reverse [a] decline in research spending by industry" and "to overcome the reluctance of many ongoing companies to bear the significant costs of staffing and supplies, and certain equipment expenses such as computer charges, which must be incurred to initiate or expand research programs in trade or business" [6]. It is not surprising that the Reagan administration was concerned about declining R&D, especially when productivity growth had been declining since the mid-1960s [28].

However, efforts to increase R&D spending may not have been the correct policy target variable. First, tax incentives hold little promise for distinguishing between the total level of R&D expenditures and the portion which are successful (i.e. that actually lead to an innovation).[15] Second, not all categories of qualified R&D spending have the same measured impact on productivity growth. If one adheres to the traditional National Science Foundation data reporting categories of basic research, applied research, and development, then incremental basic research should be targeted, instead of applied research or development. Mansfield [30] and Link [29] have verified this correlation.[16] Or, using alternative terminology, if productivity growth and global competitiveness are the ultimate policy objectives, then perhaps investments in infratechnology should have been singled out rather than company-financed R&D [3, 32]. Finally — and this point applies not only as a criticism toward the R&E tax credit, in general, but also to any narrowly-focused innovation policy — R&D is only one input into a firm's innovation process.

TABLE I. Summary of tax policies affecting R&D

Country	R&D tax credit	Special assistance
Australia		150% expensing of R&D
		R&D grants
Belgium		R&D personnel subsidy
Brazil		Exemptions from profit taxes
Canada	20% incremental	
China		
Denmark		
Federal Republic of Germany		Investment grants
		Tax credit for R&D equipment
France	50% incremental	R&D grants to selected industries
Hong Kong		
Ireland		
Italy		
Japan	20% incremental	Trade policies beneficial to R&D equipment
Netherlands		Subsidy for R&D labor and capital
Norway		Expense against future R&D
Singapore		200% expensing of R&D
South Africa		
South Korea		Expense against future R&D
Spain	15% on R&D	
	30% on R&D equipment	
Sweden	30% incremental	Subsidy on R&D salaries
Switzerland		
Taiwan	20% incremental	
UK		
USA	20% incremental on R&E	
	20% on basic research	

Increasingly, technology-based firms are be-coming concerned about the effective use of technical knowledge originating outside the firm. Such externally-produced technical knowledge comes from universities, state-based science and technology centers, cooperative R&D programs, joint ventures, consortia and federal laboratories. Firms look toward an effective mix of external and internal technical knowledge as a strategic response to shortening life cycles and increasing global competition [3, 33j. In other words, technology-based firms strive toward developing what may be referred to as an optimal 'technical information portfolio.

Theoretically, innovation policy should be aimed at increasing the efficiency of the entire technical information portfolio of firms. However, as might be expected, the administrative mechanisms with which to accomplish this are too cumbersome. While R&D tax credits do have the potential advantage of avoiding bureaucratic entanglements, they affect portfolios differently. True, tax credits do lower the price of conducting R&D. This was noticed in the studies summarized above that relied on a price elasticity of demand for R&D in order to quantify the impact of the 1981 tax credit. But many have serious reservations about the accuracy with which these elasticities were estimated. Certainly, they cannot be determined without a full understanding of firms' technical information portfolios — and those portfolios probably change over time as do a firm's competitors.[17]

Notes

1 More extensive reviews are in refs [1-3].

2 This expensing option is limited to R&E expenditures and not expenditures for R&D applications or capital assets necessary for the conduct of R&E activities. Capital expenditures are partly recovered through depreciation allowances applicable to any depreciable property.

3 This deferral option was intended to benefit small, newer firms that have little or no taxable income during their early years.

4 Section 170(a) of the Internal Revenue Code. Deductions are limited to 50% of adjusted gross income for individuals, and to 5% of taxable income for corporations.

5 Section 501(a-c) of the Internal Revenue Code. To qualify for the exemption, the organization must conduct scientific research and the results of that research must be published in a form that is available to the interested public. The research performed may take place under a contract or agreement in which the sponsor of the

research has the right to obtain ownership or control of any patents, copyrights, processes or formulae resulting from such research.

6 ERTA also allowed for a faster depreciation of R&E assets, a two-year suspension of the requirement that US multinational firms allocate some of their domestic R&E expenses against income from foreign sources (Treasury Regulation 1.861-8), and an increase in the deduction for contributions of newly manufactured research equipment to universities.

7 Qualified expenditures include company-financed expenditures for R&E wages and supplies, 65% of the amount paid for contracted research, and 65% of corporate grants to universities and scientific research organizations for basic research. To be allowable, R&E expenses must be paid during the taxable year and must pertain to the carrying on of a trade or business. Hence, the credit is not available to start-up companies, certain joint ventures, or to existing firms in new lines of
business. Expenses not pertaining to development of potentially marketable goods and services fail to qualify, as do research expenditures paid prior to commencing a trade or business. Thus, wages for laboratory scientists and engineers and their immediate supervisors qualify, but wages for general administrative personnel or other auxiliary personnel do not. Also, research done outside the USA was excluded from the operable definition.

8 The remainder of this section draws from refs [4-7].

9 According to ref. [8], the 25% rate (coupled with corporate income tax rates) resulted in a 9.3% savings in the cost of R&E expenses that qualified under the law. With the fall in the credit rate to 20% (coupled with a lowering of corporate income tax rates). that savings fell to 6.7% in 1987 and to 6.1% in 1988.

I0 An additional tax credit, the Basic Research Credit, was also created to encourage corporate support of university-based and nonprofit-based basic research. Because the rate for this credit is 20%, it provides a greater tax advantage than does the conduct of basic research in-house under the R&E tax credit, *ceteris paribus.*

11 This section draws from refs [9-12].

12 This section draws from refs [10, 15-17].

13 Eisner *et al.* [24] and the US General Accounting Office [4] estimate the effective rate to be closer to 4%.

14 Interestingly, Mansfield [21] reports, from his sample of manufacturing firms, that measured R&D increased by about 4% between 1982 and 1983 due to such redefining.

15 We know that firm size is not a prerequisite for success in R&D beyond a modest threshold level [29], and that larger firms. generally those with corporate assets greater than $250 million, took greater advantage of the R&D tax credit than did smaller firms [4, 27j.

16 Along this line, Bozeman and Link [I, 2] proposed a tax credit for cooperative research investments (cooperative research occurs at the basic end of the R&D spectrum). Link and Bauer's [31] econometric analyses demonstrate the productivity growth increases associated with cooperative research endeavors.

17 As Leyden and Link [3] have shown, a change in the level of company-financed R&D changes the probability of receiving federally-financed R&D. A change in the level of federally-financed R&D changes the nature of the company-based R&D program. The nature of such a synergism is critical to any evaluation of a change of the price of one element within the portfolio.

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