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Tax Incentives: Issue and Evidence

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Résumé / Abstract

Cet article fait le point sur l'utilité des incitations fiscales à la recherche-développement: le pourquoi, le comment, le pour et le contre de ces incitations, leur efficacité et l'existence de solutions alternatives.

This paper discusses the issue of R&D tax incentives: why these incentives?, what are their modalities?, their pros and cons?, are they effective? and are there alternatives to R&D tax incentives?

Mots Clés : Recherche-développement, incitations fiscales

Keywords: Research and development, tax incentives

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1 Why should government intervene?

Research and development (R&D) is considered as a basic ingredient to economic growth. A country grows not only if it sets aside resources to invest in plant and equipment, but also if it cuts on consumption and physical investment in order to invest in knowledge. Under perfect knowledge, R&D should be driven so far as to equate at the margin the social cost and the social benefit.

A certain number of reasons can explain why firms do not perform the first-best amount of R&D:

- Firms may be constrained in the amount of funds available to finance new research projects or the completion of existing projects. The asymmetric information between research performers and lenders of funds leads to a suboptimal solution. Firms know the innovation potential but are afraid to reveal it to banks or other lenders of funds, because knowledge is non-rival and only partially excludable. Banks may take the information and run away with it. But, in the absence of goodwill, reputation, or collateral, banks are unwilling to lend funds in the absence of more information about the profitability of the innovation.

- Firms often complain that it is difficult to find qualified engineers, scientists, researchers. Because of a lack of qualified people they have to shelve research projects or execute them somewhere else.

- Firms may be discouraged to invest in knowledge if the benefits it generates are taxed away.

- Knowledge may leak away and be exploited by other firms. The stronger the competition, the greater the danger of seeing the benefits of R&D eaten up by competitors.

The amount of R&D undertaken by private firms is also insufficient from the government's perspective if R&D creates positive externalities in the form of new ideas, new applications, new combinations of inputs. As firms do not take these external effects into account, they do too little R&D from a social point of view. By decreasing the cost of doing R&D, government can induce the first-best amount of R&D (it is like a negative Pigouvian tax). For this argument to be powerful, however, one must assume that government knows by how much it can reduce R&D cost by various tax incentives, by how much firms respond to changes in the user cost of R&D (in other words what is the schedule of the marginal private benefit of R&D), and finally what is the magnitude of the R&D spillovers (i.e. where the social marginal benefit schedule of R&D lies with respect to the private marginal benefit schedule).[1]

In many countries, government feels that it has to help high-tech firms in the national interest or for reasons of national prestige. In economic terms, this could be rationalized in terms of the creation of a comparative advantage in knowledge (Grossman and Helpman (1991)) or in terms of strategic competition (Brander and Spencer(1983)).

2 How can government intervene: various tax incentives

Many countries have adopted various forms of fiscal incentives for R&D. For a description of those measures and a cross-country comparison, the reader is referred to Warda (1996, 1997), OTA (1995), Bloom *et al* (1998) and Griffith *et al.* (1995). For a discussion and a comparison of the effectiveness of various measures, the following classification is useful:

- Measures which support a portion of the level of the expenses
  - immediate write-off or expensing
  - tax credits proportional to the level of R&D (possibly with minima, maxima, sliding scales)
- Measures which support a portion of the increment of R&D
  - tax credits proportional to the incremental R&D expenditures over a defined base (possibly with minima, maxima, sliding scales)
- Measures intended to remove ceilings in the effective use of tax incentives
  - refundability of unused tax credits

[1]For a more formal presentation of the argument, see McFetridge and Warda (1983), pp. 22-25.

  - carryback and carryforward of unused tax credits
  - flowthrough mechanisms, i.e. transfer of unused tax credits to an eligible third party

- Focus on specific types of R&D
  - depending on R&D function: environment, health, defense, agriculture, information
  - depending on R&D performer: university, small and medium entreprises (SME), regional support, R&D conducted abroad

- Differential treatment of parts of R&D expenses: labor, buildings, equipment

- Permanent nature vs year-to-year overhauls of the fiscal incentive system.

3 How else can government intervene?

Decreasing the tax of doing R&D through tax incentives is just one of many ways in which government can influence firms' R&D spending. Another channel would be subsidies. Subsidies are more focused than R&D tax incentives, they can be directed towards specific projects with potentially a high social rate of return. But, on the other hand, there is a greater danger that policy makers use the subsidies for other reasons than innovation, be it regional policy, fight against unemployment, or simply pork-barreling, and that they collaborate with the innovator for rent-seeking purposes. There is also the difficulty to pick a winner. Government does not necessarily know more than entrepreneurs about the future of technology. There is the strong argument that entrepreneurs are sufficiently motivated by the prospects of profits and losses to make the right choices. Another indirect way to support part of the R&D cost is through government research contracts, especially if they are recurrent and on a long-term basis.

A non-pecuniary way to promote R&D is by creating the right environment. This can be done in a number of ways:

- By allowing R&D cooperations, governments can let firms share the costs and the risks of doing R&D and let them internalize some of the R&D externalities. There is a risk though that R&D cooperation creates monopoly rents and discourages innovation.

- To fight the disincentive arising from externalities, governments could strengthen the patent protection. Numerous studies on the power of patents as a mechanism of appropriability show that it does not rank very high compared to other means such as trade secrecy, first leader advantage, except in a few industries such as pharmaceuticals where the patented object can be clearly defined and defended against claims of infringement.

- Some very basic, costly, risky, non-appropriable R&D can be financed and performed in government laboratories (e.g. as regards defense, health, environmental protection).

- Goverments can encourage the creation of venture capital, specifically conceived for R&D projects.

- Efforts can be made to establish and finance centers of higher learning, so as to provide the country with an appropriately skilled workforce. Measures can be taken to attract foreign human capital (e.g. easing immigration or lowering personal income taxation).

In conclusion, R&D tax incentives are just one of many tools by which governments can influence the amount of R&D undertaken on the territory of their jurisdiction. It is a relatively simple, non-discriminatory, self-selecting process. But, is it effective in stimulating R&D?

4 How to evaluate the effectiveness of R&D tax incentives?

The ideal way to assess the effectiveness of R&D tax incentives would be to do a proper cost-benefit analysis: evaluate in comparable terms (in constant dollars, present value terms) the costs and the benefits for the government to support R&D via tax incentives. Such a computation requires a lot of information, which is not always available: the readiness of firms to engage in R&D with and without tax incentives, the social rate of return of the additional R&D, the forgone opportunities of alternative uses of government funds allocated to support R&D (e.g. for enjoyment of the arts, care of the sick, the homeless and the elderly, a lowering of income tax rates, etc.), the cost of running the policy (auditors, tax officers), the costs for the firms to apply for tax credits (paying lawyers, accountants),...

The alternative route followed in the literature is to compute the additional amount of R&D that is generated by a marginal increase in foregone tax revenues ("the bang for a buck"). If for one dollar of forgone tax revenues, one additional dollar of R&D is forthcoming from the private sector, the tax policy is considered to be efficient. If less than one dollar of R&D is executed, the goverment would be wiser to conduct the R&D itself. To put it differently, does the private sector partially substitute government funding for private funding of R&D? Notice that this analysis completely ignores the differential rate of return of tax-stimulated R&D as compared to privately funded R&D. To evaluate the additional R&D, the most common approach is to compute the effect of a tax incentive on the cost of R&D (i.e. the elasticity of the user cost of R&D w/t a change in a tax measure) and to multiply it by the estimated elasticity of the demand for R&D w/t a change in the user cost. An accurate calculation would take into account the substitution and complementarity effects between R&D and the other inputs. For example, by increasing the relative price of physical capital to the price of R&D capital, R&D tax incentives decrease physical capital investment and thereby slow down R&D, if physical capital and R&D capital are complements. It would also take into account the spillovers effets (R&D induced in sector j because of a R&D-stimulating tax change in sector i), the scale effects (more R&D yields profits which increases output, which in turn increases R&D), and the strategic effects (other countries might retaliate by increasing their domestic tax-incentives to attract high-tech firms). A proper calculation would discount future R&D outlays and government expenses. Dagenais et al. (1997) and Mohnen et al. (1997) compare the different time paths of R&D expenditures to the different time paths of foregone tax revenues. What a tax incentive costs to the government can be taken from statistical records if they are accessible. Alternatively, it can be calculated by the decrease in the cost of holding R&D, which approximates a subsidy to R&D.

Two difficulties have to be faced. The first is to get good estimates of price elasticities, i.e. to use the right specification of firm behavior in order to infer their responsiveness to R&D tax incentives. Do firms follow a static or a dynamic planning? How do they form expectations? What is the technology determining factor demand? What are the relevant prices and other variables that influence R&D decisions? Should R&D be treated as a stock or as a flow? The second sensitive issue for a proper evaluation of additional R&D forthcoming from a tax change is the correct computation of the B-index (including the whole gammut of available measures and possible ceilings in the use of tax credits). The B-index introduced by McFetridge and Warda (1983) is defined as the ratio of the net cost of a dollar spent on R&D, after all quantifiable tax incentives have been accounted for, to the net income from one dollar of revenue.

5 Overall effectiveness of R&D tax incentives

A first way to evaluate the effectiveness of R&D tax incentives is to compare the R&D expenditures before and after changes in tax incentives to R&D. Cordes (1988) mentions some studies which show that R&D increased in the United States after the passage of the Economic Recovery Tax Act of 1981 and the Tax Equity and Fiscal Responsibility Act of 1982 and continued to be strong despite the economic recession. In a similar vein, Grégoire (1995) and Lebeau (1996), examined a sample of Quebec firms which accounted for over 75% of the province's R&D effort and noticed that after 1986 (when provincial R&D tax credits were introduced in Quebec) the value of R&D increased much more than the tax credits given to Quebec companies during this period. They observed an increase of over 100% in the number of small and medium-sized firms performing R&D in Quebec between 1986 and 1992, but they also noticed an eleven percent decrease among large companies performing R&D. Finally, they found a lengthening of the time horizon of research projects and a growth in R&D from foreign sources. Anecdotes of this kind suggest that firms are responsive to R&D tax credits. Clearly, as informative as such evidence might be, it does not allow to attribute the credit for the increase in R&D entirely to tax incentives. The effects of other pertinent variables must be netted out, such as other economic policies, the evolution of the business cycle, the anticipation of future tax policy reversals. As Cordes (1988) notes, another potential upward bias in these figures is due to a reclassification of activities as R&D expenditures.

Another avenue consists in surveying firms. Mansfield and Switzer (1985) conducted a survey of 55 Canadian companies. The composition of their sample was representative of the set of all Canadian firms performing R&D. The results revealed that R&D generated by tax incentives did not amount to more than 40% of the lost tax revenue. An econometric regression of R&D expenditures, where the exogenous variables contain dummies identifying different fiscal periods, confirm the results of these surveys. These results were qualified by the a survey of the Conference Board of Canada (Warda and Zieminski (1995)), which revealed that the R&D tax credit constitutes an important source of funds for smaller firms. The Australian study by the Bureau of Industry Economics (1993) revealed that only 17% of Australian R&D was performed in response to tax incentives, which implies an incremental growth of research between \$0.60 and \$1.00 per dollar of tax expenditure. McFetridge (1995) mentions a study by the Inland Revenue in Britain which concluded that industrial R&D spending increased roughly by half the tax revenue foregone. These results show that the effect of R&D tax incentives on R&D are considerably more modest.

The third approach to the evaluation of R&D tax incentives consists in estimating the relationship between R&D and tax incentives by econometric methods. Baily and Lawrence (1992), Hines (1993), and Hall (1993) regress R&D expenditures on a number of explanatory variables, among which the effective price of R&D which varies with tax incentives. This type of specification is not founded on a structural model and ignores the knowledge stock aspect of R&D. Bernstein (1986), Hines (1993), Mamuneas-Nadiri (1993), Shah (1994), Dagenais et al. (1997) and Mohnen et al. (1997) specify a demand equation for the stock of R&D that depends on fiscal parameters through the user cost of capital. Bloom *et al.* (1998) specify an error correction model. Whichever approach is adopted, it is important to clearly distinguish between price elasticities relating to stocks and those relating to flows of R&D.

Table 1 summarizes the empirical studies on the effectiveness of tax incentives to R&D[2]. The first thing to notice is that flow elasticities are generally greater that stock elasticities. Baily and Lawrence (1992) report a short-term elasticity of -0.95, Hines (1993) finds -1.6 with a flow model but only -1.2 with a stock model, and Hall (1993) has elasticities between -0.8 and -1.5 in the short run and between -2.0 and -2.7 in the long run.[3] In contrast, with stock models, Bernstein (1986) finds elasticities of -0.13 in the short run and of -0.32 in the long run, and Dagenais et al. (1997) -0.07

[2]Some additional empirical studies on the effectiveness of R & D tax incentives are mentioned in Office of Technology Assessment (1995) and in a recent updated survey by Hall and van Reenen (1999).

[3]Hall (1993) presents a stock model but favours the results obtained from a flow model.

and -1.09 respectively. In the long run, the flow elasticities and the stock elasticities are equal, since the flow is proportional to the stock. But in the short run, gross investment in R&D equals net investment plus replacement investment. The elasticity is thus a weighted sum of the elasticities of the two types of investment. It is quite likely that net investment is more responsive to tax changes than replacement investment, because replacement investment occurs even without tax incentives.[4]. This could explain why in the short run the flow elasticity is greater than the stock elasticity. The stock elasticities reported above are consistent with previous studies.[5] Bloom *et al.* (1998) use an error-correction model, which yields both long-run and short-run elasticities. They obtain elasticities (-0.16 in the short run and -1.1 in the long run) which are in line with a stock model although they pertain to flows of R&D.

The second thing to notice is the high price-elasticity (-1.0) obtained by Mamuneas and Nadiri (1995) with a stock model. However, they only consider the privately funded portion of R&D. It is normal that R&D funded by private sources is more sensitive to tax changes than total R&D, including R&D financed by government grants, which should be ineligible to tax credits. To the extent that the previously mentioned studies do not separate out privately financed and publicly financed R&D, their estimates have a

[4]Let I, ΔR, R represent respectively R&D gross investment, R&D net investment and the stock of R&D. Thus I = ΔR + δR, where δ is the R&D depreciation rate. Then we have $\partial \ln I/\partial \ln p = \partial \ln I/\partial \ln c$, where p and c are respectively the price and the user cost of R&D, c being a fraction of p. We also have

$\partial \ln I/\partial \ln c = (\Delta\mathrm{R}/\mathrm{I})\partial \ln \Delta\mathrm{R}/\partial \ln c + (\delta\mathrm{R}/\mathrm{I})\partial \ln \delta\mathrm{R}/\partial \ln c$.

We argue that $\partial \ln \Delta\mathrm{R}/\partial \ln c \geq \partial \ln(\delta\mathrm{R})/\partial \ln c$.

[5]The first studies to estimate a demand elasticity for the stock of R & D with respect to its user cost were based on an ad hoc dynamic specification with distributed lags. Goldberg (1979) estimated -0.39 for the short-term elasticity and -0.92 for the long-term elasticity on panel data from American manufacturing industries. Nadiri (1980) found an elasticity of -0.16 in the short term and -1.0 in the long term for the entire U.S. manufacturing sector. Some subsequent studies used dynamic models of factor demand based on the notion of adjustment cost. Cardani and Mohnen (1984) and Mohnen, Nadiri and Prucha (1986) estimated the own-price elasticity of R & D from time-series on manufacturing in five countries of the G-7. Their estimates were between -0.04 and -0.10 in the short run (defined as the first stage of the adjustment process) and between -0.25 and -0.55 in the long run. Nadiri and Prucha (1990) arrived at short-term elasticities of -0.03 and long-term elasticities of -0.12 for the Bell company in the United States. Using panel data on firms, Bernstein and Nadiri (1995) derived long-term elasticities between -0.43 and -0.50 estimated separately for four research-intensive U.S. industries.

downward bias.

Regarding the evaluation of additional research generated per dollar of tax expenditure, results are mixed. Eisner, Albert and Sullivan (1983) emphasized that few firms were able to take advantage of tax credits for incremental research in the U.S. because they were not in a taxable position. Actually, in some cases, the effect was even perverse: firms which invested when they were not in a taxable position to benefit from tax incentives were penalized in the following years because of having increased their reference base. The authors further failed to find a significant effect of incremental R&D tax credit on R&D expenditures. Mansfield and Switzer's survey (1985) on Canadian firms found that for each tax dollar forgone on R&D tax incentives only $0.40 in additional R&D was generated. Also on Canadian firms, Bernstein (1986) calculated that a forgone dollar of tax revenue generates $0.80 of new R&D, if output is maintained constant, and between $1.05 and $1.70 if the spillover impact of output on R&D is considered. Dagenais et al. (1997) use a different procedure to compare additional R&D expenditures and foregone tax revenues, but their end-result is pretty much consistent with Bernstein's (1986). They obtain $0.97 additional R&D per dollar of tax foregone from a one percent increase in the rate of the federal R&D tax credit. Using the same procedure as Bernstein's (1986), the General Accounting Office (1989) estimates that the stimulating effect in the U.S. is only $0.35, whereas Manuneas and Nadiri (1993) report a figure of $0.95.

The figures might be higher for industry data than for firm data. Shah (1994) on Canadian industry data, reports a figure of 1.8, although he estimates a short-run price elasticity of R&D of the same order of magnitude as Bernstein's (1986). Mohnen *et al*'s (1997) preliminary results are in the order of 1.2 to 1.5 with Canadian industry data. The difference in results with firm and with industry data could be explained by the higher elasticity of R&D to tax incentives for small firms and new R&D starters, which are usually underrepresented in firm panel data, such as Compustat's.

The three studies reporting higher results are Berger (1993), Hall (1993) and Hines (1993). Berger (1992) included among the explanatory variables of R&D spending a dichotomous variable taking the value one if there was a usable tax credit to R&D and zero otherwise. He concluded from a panel regression of 231 U.S. firms over the period 1975 to 1989 that incremental R&D tax credits induced $1.74 additional R&D spending per dollar of forgone tax revenue during the period 1982-1985. This is a rough approach, as it makes no allowance for differences in the level of credits between firms. Hall

(1993) evaluated the additional R&D per dollar of tax revenues forgone at 2.0. Her higher results could be due to the modeling of R&D flows, as discussed above. Hines (1993) arrived at \$1.20 to \$1.90, but it should be borne in mind that he simulated a particular tax experiment: the introduction of a 100% expensing of R&D expenditures for American firms as opposed to the deductibility prorated to domestic sales.

6 The differential effect of various tax incentives

In comparing results from different studies one should be careful about the particular tax incentive under investigation. Different incentive policies may yield different results. The American and French studies have largely focused on tax credits for incremental research. This measure is less powerful than for instance R&D expensing. Cordes (1989) calculates that the introduction of the 25 percent incremental R&D tax credit in the United States decreases the user cost of R&D by no more than 4.2 percent. Bernstein (1985) calculates that a 1 percent increase in the incremental R&D tax credit rate decreases the user cost of R&D by 0.06 percent. Mamuneas and Nadiri (1995) report that a change in the rate of expensing has a ten times larger effect on cost than a change in the incremental R&D tax credit. Dagenais et al (1997) evaluate the elasticity of the effective price of research with respect to a change in the rate of credit to incremental research to only -0.01. The growth in R&D in response to incremental R&D tax credits is small, because it has a minimal effect on the user cost of R&D. The reason is that an increase of R&D in one period decreases the eligibility to receive further tax incentives in the following periods. Yet, if additional R&D is compared to the fiscal revenue loss, the ratio looks impressive. Dagenais et al (1997) report that a one percent increase in the rate of incremental R&D tax credit stimulates \$4.00 in extra R&D per dollar of government expenditure! It makes sense since the goverment carries only a fraction of the additional R&D expenses. Cordes (1989) reports from his analysis that a permanent 25 percent incremental R&D tax credit could contribute to somewhere between 35 cents and 93 cents in additional R&D per dollar of foregone tax revenues.

The effective rate of R&D tax incentives can be smaller than the official rates indicate. This point was already raised by Eisner *et al.* (1984). Altshuler (1988) notes that in 1984 almost half of all U.S. firms could not fully offset their tax credits. Dagenais *et al.* (1997) report that the B-index of tax incentives for the Canadian firms in their sample ranges from 0.5 to 1.8. A large part of this variation derives from ceilings on the use of tax incentives unique to each firm. For 20% of the observations on firms performing R&D, these expenditures could not be entirely expensed for lack of immediate taxable profit. In only 11% of the observations, tax credits could not be entirely claimed in the year in which the R&D was performed. For 22% of the observations on R&D performers, tax credits for incremental research could not be claimed. But despite these ceilings, they compute that the additional R&D from a one percent increase in the federal R&D tax credit is 0.97 for all firms in the sample and 1.04 if only firms without ceilings are considered. The various measures introduced by the Canadian government to remove any obstacles to the use of tax incentives (carryback, carryforward, reimbursement) seem to achieve their goal. Provincial tax credits which are reimbursable, i.e. not subject to any ceiling, yield \$1.09 in additional R&D per dollar of tax expenditure.

The final fiscal parameter appearing in the effective price of research is the corporate income tax rate. On the one hand, a lower rate has the effect of diminishing government support for R&D. It increases the effective price of R&D since firms can deduct less for R&D expenditures. On the other hand, a lower rate increases after-tax income and hence lowers the income required to recover the R&D expenses. It that sense it decreases the effective price of R&D. In general, the second effect dominates. Moreover, a decline in the corporate tax rate allows the government to save money on recurring R&D. Thus, we may even find a growth in the level of R&D concurrent with a decline in government outlays. It would, however, be unwise to recommend such a policy if the only goal is to stimulate R&D, because of the numerous other effects it would have on the economy. The research tax credit has the advantage to be a more targeted method of stimulating R&D.

R&D incentives can bear on the level of R&D expenditures or on their increment with respect to a reference base. If they bear only on the level, they carry a tax burden. Suppose the government raises the R&D tax credit from 10% to 20%. New R&D will be forthcoming on which the governement will apply the 20% tax credit. But on any R&D conducted anyway regardless of the announcement of the tax change, the government will now have to pay a 20% instead of a 10% tax credit. The tax transfer amounts to more than 80% of government support for R&D in Dagenais *et al.* (1997). The inefficiency of tax credits has also been illustrated in the case of Australia, where a study by the Bureau of Industry Economics (1993) reported that 83% of R&D eligible for tax incentives would have been performed in any case. The study evaluates the economic cost (the marginal excess burden of taxation) in Australia at close to 25% of the cost of the program. If the only support to research consisted of tax credits to incremental research, the tax transfer would disappear, as the government would only be paying a fraction of the new research and not subsidizing recurring R&D.

7 Other aspects of R&D tax incentives

- R&D support can attract footloose high-tech companies. The studies by Hines (1994) and Bloom *et al.* (1998) show that firms are not insensitive to tax considerations in decisions to locate their R&D facilities. Some governments have used such policies, be it for matters of national prestige or in the hope of building a human capital and a cluster of advanced technology firms. However, the trap here is that governments may be lead into a prisoner's dilemma game, if each tries to attract foreign investors by means of R&D tax incentives without considering other governments' reactions. Each one might end up worse off, siphoning money out of the tax payers pocket to the benefit of R&D performing multinational firms.

- The existing evidence about the effectiveness of R&D tax incentives, although it is mixed, seems to tilt towards the conclusion that they are not terribly effective in stimulating more R&D than the amount of tax revenues foregone. But, given that R&D has a high social rate of return, paying for more R&D, even if the additional R&D is totally supported by the government, might make economic sense. One virtue of the tax incentives policy is that it lets the private sector decide on the allocation of funds and lets it foot part of the bill. Too much R&D support via tax incentives might lead to research projects with a low rate of return, unprofitable without the tax support. But, if the social rate of return is the argument, then why apply the same tax parameters for all research projects? Some are more likely to have a higher rate of return than others, and should thus be given more support.

- The present system of tax incentives by the sheer size of the R&D

programs supports more the big firms than the small firms, even if small firms are given higher rates of R&D tax credits. Big firms, to the extent that they actually spend more on R&D, have a higher incentive to apply for R&D tax credits because it earns them more cash than small firms. Some firms, especially small and new ones, do not bother to apply: too much trouble, lack of experience, fear to reveal information and to have the tax authorities mingle in their business. [6]In contrast, for big, established firms, R&D tax credits are a source of extra cash. It is not certain that it will affect the decision on certain projects, but since it pays something, why not apply for it?

- The main virtue of the tax incentive system is to provide a climate of support for R&D. Therefore, it helps if the tax laws are stable and not subject to continuous revisions. If taxes are considered to be an effective means of supporting R&D, they should be reliable. If they are temporary, the may disturb optimal decision-making. Projects might just be undertaken to benefit from temporary tax incentives. It would also help if ceilings in the use of tax credits were virtually eliminated.[7] Another possible tax distortion has to do with the fact that in the absence of tax credits, different research plans would be undertaken, or investment instead of research, or research spending would follow a different time-schedule (e.g. to get the maximum out of incremental R&D tax credits, it is optimal to have periods of heavy spending, followed by periods of no spending). A final source of tax distortion has to do with the definition of R&D. Firms may be lead to accounting tricks to reshuffle items under the cover of R&D (although this could be monitored) whereas other important stages in the innovation process, such as monitoring, are not included under the heading of R&D, according

[6]Gunz et al. (1996) suggest that the procedures for claiming R & D related tax credits generally do not cost firms more that 0.7% of the amounts claimed. These weigh much more heavily on small firms, however, where the corresponding figure is about 15%.

[7]Cordes (1989), for the U.S., concluded that "85 to 90 percent of the tax subsidy provided by the R&D credit in 1981 and 72 to 80 percent of the subsidy provided in 1982 was extended to firms who were ultimately able to use it fully". A report by the Canadian Department of Finance (1983) found that in 1980 firms that accounted for 71 percent of industrial R&D expenditures could not utilize 60 percent of the R&D tax credits. Things have improved in Canada. The study by Dagenais et al. (1997) concluded that few of the Canadian firms in their sample were unable to use the R&D tax incentives given the carry forward, carryback and reimbursement provisions available in Canada.

to the tax definition.

8 Conclusion

The system of R&D tax incentives is one way of encouraging research and development. From the empirical evidence, we may conclude that it does not generate much R&D beyond the tax expenditure. It is conceived to help financing R&D projects and to generate the socially optimal amount of R&D. But it only partially fulfills these two objectives: it mainly finances big R&D spenders and it does not focus on R&D projects with high social rates of return. It contains a certain amount of tax transfer and hence of indirect R&D subsidy, especially if it builds on R&D-level-based tax credits. The virtue of it is to let the market choose the projects and to reduce bureaucratic decision making. Some bureaucratic burden remains, but it is perceived to be relatively small.

What really matters, though, is not the amount of R&D generated per se, but the social return from the additional R&D. In the absence of any financing constraint, support is justified when the social return sufficiently exceeds the private return, given a project's R&D cost. This in turn implies that government must seek expert opinion on the social returns of R&D projects, which is costly, time-consuming, and subjective. Alternatively, government could define priority areas where the social rate of return of R&D is supposed to be high (health, environmental protection, defense,...). If support comes in the form of level-based R&D tax credits, the tax transfer and the excess tax burden have to be included in the social cost of R&D when deciding on priority areas. If support comes in the form of incremental R&D tax credits, the base on which the increment is defined must be fixed. Otherwise, the elasticity of R&D with respect to the rate of incremental R&D tax credit is low and renders the policy costly to be effective, because the rate would have to be set sufficiently high to induce the required R&D response. With a sliding base, any R&D increase limits temporarily the potential to receive future tax credits. The base could be revised but not in a way that recipients could foresee.

If we want to avoid picking winners on the basis of not well comprehended social returns to R&D, unless the electorate states clearly its preference for a particular type of research (e.g. medical research, pollution abatement,...) we should perhaps give more weight to the second argument in favour of R&D

tax incentives: the financing problem. The problem of not having or of not getting the means to finance R&D is quite different from the problem of having the means but not engaging in an R&D project, presumably because its expected net return is negative. In a way, the financing problem is an easier one to tackle. One way is to subsidize firms on the basis of grant applications to be examined by experts. But this gets us back to the subsidy program. A more general tax incentive program would be geared and limited to a class of firms more likely to face financing constraints such as small, starting, and non R&D performing firms. Here the incremental moving base R&D tax credit policy would be appropriate because it precisely helps irregular R&D performers (see Corbel (1994)), who are not penalized by a moving base. If the eligible recipients are small R&D performers, the issue of tax transfer is not very severe and hence level-based R&D tax credit can also be used. Also a combination of level-based and increment-based tax incentives could be adopted.

Whatever policy is adopted, any obstacles to the use of tax incentives are counterproductive and should be avoided by any means (sliding base for incremental R&D, carryback and carry forward provisions, reimbursement of unused tax credits,...). It would also help to follow a consistent tax concessions policy, to make it a permanent reliable feature in the business environment. The R&D subsidies and R&D tax incentives programs could complement each other. Finally, there is something to be said to the argument of harmonization of the tax policies towards R&D in the OECD countries, so that competition relies on prices and quality and not on tax policies, unless social preferences differ across regions/countries regarding such matters as health, security, and environmental protection.

A challenging question is whether there is no better way to handle the aymmetric information, moral hazard, inappropriability, lack of funding, and lack of human capital problems that an innovator faces at the different stages of the innovation process than handing out some cash to whomever declares doing some R&D.

Table 1: Representative empirical studies on the effectiveness of tax incentives to R&D

Authors	Data	price elast. of R&D[a]	R&D/$tax	Cost to govt.	Approach
Mansfield & Switzer (1985)	Canada firms survey	Survey responses	0.4	observed	flow
Bernstein (1986)	Canada firms panel	−0.13 (ST) −0.32 (LT)	0.8	elast: cost/ fisc. param.	stock
Dagenais, Mohnen Therrien (1997)	Canada firms panel	−0.07 (ST) −1.09 (LT)	0.97	individually simulated	stock
Baily & Lawrence (1992)	United States industries time-series	−0.95 (ST)			flow
Hines (1993)	United States firms panel	−1.2 (stock) −1.6 (flow)	1.2 (stock) 1.9 (flow)	individually simulated	stock flow
Hall (1993)	United States firms panel	−0.8 to −1.5 (ST) −2.0 to −2.7 (LT)	2.0	individually simulated	flow
Mamuneas Nadiri (1993)	United States industries panel	−0.9 to −1.0 (ST)	0.95	elast: cost/ fisc. param.	stock
Berger (1993)	United States firms panel	dichotomous variables	1.74	observed	flow
Asmussen Berriot (1993)	France firms	R&D w/t increm. R&D tax credit elast. = 0.013	0.26	observed	flow
Bureau of Ind. Economics (1993)	Australia Enterprises Survey	Survey responses	0,6 to 1,0	observed	flow
Bloom, Griffith and van Reenen (1998)	Panel of 8 countries aggregates	−0.16 (ST) −1.10 (LT)			flow

ST = short-term | LT = long-term

a. Price or user cost elasticities

Table borrowed from Dagenais-Mohnen-Therrien (1997)

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