SCIENCE TECHNOLOGY INDUSTRY

S T I

TAX INCENTIVES FOR RESEARCH AND DEVELOPMENT: TRENDS AND ISSUES

OECD

FOREWORD

An increasing number of OECD governments are offering special fiscal incentives to business to increase spending on research and development (R&D), largely because R&D and innovation are considered key to productivity and growth performance. Many OECD governments are redesigning their R&D tax incentives to make them more effective. This study compares the design features and generosity of R&D tax incentives across OECD countries. In general, the choice of R&D tax measures depends on country-level variables such as overall innovation performance and the nature of corporate tax systems.

This study was prepared by the OECD Secretariat with substantial analytical input from Jacek Warda of The Conference Board of Canada. It is a joint product of three OECD Committees: the Committee on Industry and Business Environment (CIBE), the Committee for Scientific and Technological Policy (CSTP), and the Committee on Fiscal Affairs (CFA). It benefited from discussions at a Joint Roundtable held on 6 June 2002 and from extensive comments from OECD country delegations.

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SUMMARY

Given the contribution of research and development (R&D) to productivity growth, economic performance and the achievement of social objectives, it is generally agreed that governments have a role in encouraging appropriate R&D levels and expenditures. With regard to business R&D, national factors largely determine whether countries prefer tax incentives, subsidies, patent rights or other instruments to increase research investments. The choice of R&D tax incentives will depend on country-level variables such as overall innovation performance, perceived market failures in R&D, industrial structure, size of firms and the nature of corporate tax systems. Some OECD countries (*e.g.* Sweden, Finland) neither subsidise nor extend preferential tax treatment to business R&D although these countries have high levels of private R&D expenditures. Other countries (*e.g.* New Zealand) prefer R&D subsidies over taxes to steer research to particular goals and avoid jeopardising the neutrality of the tax system. Countries such as France, the United States and the United Kingdom use a combination of subsidies and tax incentives to stimulate private R&D investments.

Depending on national circumstances, R&D tax incentives can be an effective instrument for inducing a certain degree of private sector research. Studies show that, depending on their design, tax incentives can increase private research spending by an amount equal to the loss in tax revenue on average. Most studies also find that social returns to such R&D far outweigh private returns. However, the effectiveness of fiscal incentives to R&D depends very much on the design of tax measures relative to policy objectives. OECD countries can learn from each other with regard to what works best to achieve various policy goals in considering the following design aspects:

- *Administration* -- certainty in R&D tax reliefs allows long-term corporate planning, while streamlined forms and procedures and information programmes can enhance the accessibility of R&D tax provisions;

- *Form of tax incentive* -- R&D tax allowances and R&D tax credits tend to have differential effects on large and small firms and on R&D decision-making;

- *R&D volume or increment* -- applying the tax incentive to the volume of R&D spending or to the increase over a previous year has different administrative and financial implications;

- *Targeted incentives* -- popular targets for R&D tax incentives are small firms and co-operative public/private research to achieve greater spillover effects;

- *Definition of R&D* -- tax incentives can be directed to basic research, applied R&D, etc. depending on the research gap being addressed;

- *Avoidance provisions* -- special provisions can prevent firms from avoiding taxes by claiming unwarranted R&D tax relief; and

- *Foreign firm eligibility* -- R&D tax rules can influence the attraction of countries as locales for multinational research as well as the benefits accruing to the sponsoring government.

INTRODUCTION

Both economic theory and empirical analysis underline the key role of research and development (R&D) in economic growth. R&D -- which may take the form of basic research, applied research or experimental development -- comprises "creative work undertaken on a systematic basis to increase the stock of knowledge... and the use of this stock of knowledge to devise new applications" (OECD, 1994). R&D produces technology -- a form of knowledge that is used to enhance the productivity of the factors of production -- to spur economic growth, address societal concerns such as health and environment, and ultimately improve living standards. However, the processes by which technology is created and diffused in an economy and the role of governments is not well understood.

In theory, long-term economic growth is driven by the accumulation of knowledge-based factors of production -- such as R&D and human capital -- which prevent the marginal return to physical capital from falling below profitable levels. Empirical analysis affirms that R&D increases multi-factor productivity (OECD, 2001*b*). Cross-country comparisons show that increases in private, public and foreign R&D all contribute to increases in MFP. OECD countries where business expenditure on R&D relative to GDP increased most from the 1980s to the 1990s had the largest increases in MFP growth. There is a link between the conduct of R&D and the ability of countries, sectors and firms to identify and adapt new technologies. In large countries, R&D helps increase the rate of innovation, while in smaller countries, R&D may primarily facilitate the transfer of technology from abroad. Country studies suggest that a 1% increase in the stock of R&D leads on average to a rise in output between 0.05-0.15% (OECD, 2001*a*).

The R&D intensity of countries and their growth performance tends to be correlated with the share of research financed by business (OECD, 2001*a*). Yet, market failures generally cause enterprises to underinvest in research. Due to spillovers and other externalities, the private rate of return to R&D investments is lower than the social rate of return. Econometric studies find that social rates of return to R&D can be up to five times higher than private rates of return (Salter *et. al*., 2000). Technology is not fully appropriable in a market economy, since once produced, it can diffuse widely and be used by other firms. This is due to spillovers which exist between different R&D projects in the public and private sectors, between firms operating in the same industry, between different industries, and between countries.

Asymmetric information and imperfect competition are the market flaws that lead to gaps in R&D expenditures. Because private R&D rapidly becomes a public good, firms are prevented from recouping all the benefits of their investments. Market incentives alone are insufficient to produce an adequate supply of R&D, making it crucial for governments to stimulate private R&D spending. As with any investment decision, R&D is not undertaken by firms unless there is an opportunity for profit. By changing the relative costs of research investments -- through subsidies, taxes, trade or other policies -- governments can influence the generation of research and knowledge for economic growth.

ROLE OF FISCAL INCENTIVES FOR R&D

Numerous factors influence the level of business research expenditures in a country, including economic and industrial structure (*e.g.* the share of high-technology, defence or aerospace sectors); the number of large firms and the average size of enterprises; the availability of technical personnel and an adequate science and technology (S&T) infrastructure; the extent of international openness and links to the world economy; the level of government expenditures on basic research; the channels between public and private research efforts; the extent of intellectual property protection, etc. The relative role of these factors in determining a country's R&D profile or innovation performance is complex. A main purpose of the ongoing DSTI project on *Growth Follow-up: Micro-Policies for Growth and Productivity* is to examine how combinations of policies affect various performance variables, including those related to R&D and innovation.

Governments are one factor in this spectrum of influences. The basic and applied research which governments fund and conduct through public laboratories and universities is itself an influence on the level of private research (Guellec and van Pottelsberghe, 2000). Due to recognised market failures, governments use a range of mechanisms to further stimulate business R&D, including research partnerships with the private sector, direct funding of private R&D, and fiscal incentives. The choice of approach -- government research efforts, partnerships, direct support to business R&D, market-based incentives, etc. -- depends largely on the national context.

The direct funding of industry research -- through supports or subsidies -- has the advantage of allowing governments to retain control over the nature of R&D conducted. Subsidies ensure that industry helps address important public missions -- such as defence, health care or energy development -- or areas where significant gaps exist between public and private returns to R&D. Moreover, government funding of business R&D has a positive effect on business-financed R&D, particularly in enhancing the capacity of firms to digest the knowledge generated through public research. But this effect is only observed up to a certain threshold of government R&D financing (Guellec and van Pottelsberghe, 1999).

However, direct financing of industry R&D leaves governments open to criticisms of picking winners and losers – in terms of both the topics that receive attention and the individual firms that receive government funds. Government financing can displace private R&D investments and distort market competition. Although R&D subsidies are sometimes favoured over fiscal incentives due to their greater transparency, such supports can incur lock-in effects and be extremely difficult to phase out.

Fiscal incentives to R&D have a different set of advantages and disadvantages. These measures generally provide a tax credit or allowance for some portion of business R&D expenditures. By reducing the cost of R&D, fiscal reliefs raise the net present value of prospective research projects. However, the place of incentives targeted to research must be examined within the context of the overall tax system of a country and its objectives. The value to firms of R&D tax incentive programmes is strongly influenced by overall corporate tax rates. Enterprises in many countries would prefer general tax relief or lowering of corporate taxes rather than targeted incentives to certain types of investments such as R&D. New Zealand, for example, has opted for R&D grants to industry rather than tax incentives largely to retain the neutrality of its tax system. In addition, taxes on individual income, inheritance, etc. can influence personal wealth creation and the likelihood to invest in businesses as well as R&D. Some countries, *e.g.* Canada, provide tax incentives to individuals who perform R&D.

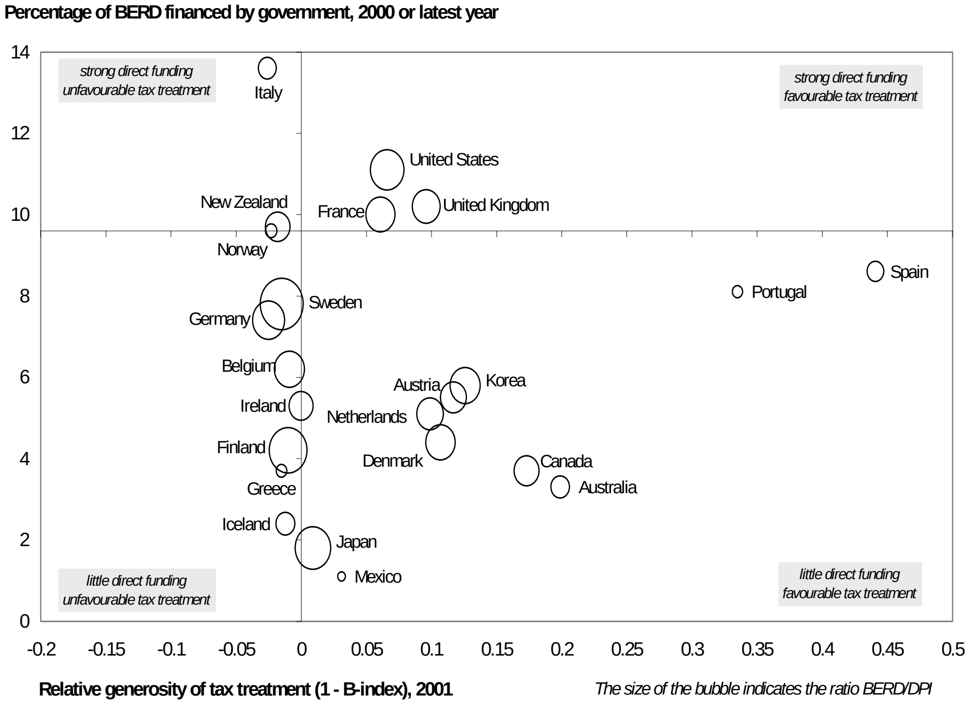
Fiscal measures allow markets -- rather than governments -- to determine the allocation of R&D investments across sectors, firms and projects. They can provide a general boost to business R&D in reducing research costs for a large population of firms, or can be targeted. Tax reliefs can be important for stimulating research in small and medium-sized enterprises (SMEs) as well as larger companies. If properly designed, they can have lower administrative costs for government agencies than other types of programmes or supports, although tax incentives can be extremely costly in terms of budget expenditures. The United Kingdom, for example, has argued that fiscal incentives to both large and small firms are needed to supplement government grants in order to correct prominent market failures in R&D investments.

Unlike direct funding of business R&D, tax-based mechanisms do not typically allow governments to direct business R&D into areas with high social returns (*e.g.*, technological fields with significant spillovers or basic research). Because tax incentives are taken against earnings, they may be more likely to favour R&D projects that will generate greater profits in the near-term rather than longer-term exploratory projects and investments in research infrastructure. In addition, weaker spillover benefits to other firms and industries can be expected from tax incentives in comparison to R&D directly financed by governments.

The mix of direct financing and tax incentives for business R&D varies considerably across OECD countries (**Figure 1**). For example, with regard to large manufacturing firms, France, the United States and the United Kingdom both directly fund R&D and offer favourable tax treatment. Italy and New Zealand finance business R&D, but do not have preferential tax treatment. In contrast, Spain, Portugal, Canada and Australia have generous fiscal incentives but less direct government funding.

Subsidies and tax incentives are but two factors influencing private R&D which is dependent on complex business decisions and numerous variables in the economic environment. For example, Sweden and Finland have high private R&D expenditures despite the fact that they have neither substantial direct nor indirect funding. Their substantial private R&D spending is partly explained by an industrial structure focusing on highly-skilled, human-capital intensive production. These countries also have among the lowest statutory tax rates on business income (28% and 29%, respectively) within the OECD area. It is doubtful that tax incentives can compensate for a lack of "enabling conditions" in countries with low levels of R&D spending.

Figure 1. Direct and indirect government funding of business R&D



Notes: B-Index = before-tax income needed to break even on one dollar of R&D outlay; BERD = business expenditures on research and development ; DPI = business value-added. *Source*: OECD.

DESIGN OF FISCAL INCENTIVES FOR R&D

An increasing number of OECD governments -- now numbering 18 -- are introducing special fiscal incentives to business R&D. In addition, several countries have modified their existing R&D tax measures to increase their effectiveness in achieving policy goals. Fiscal incentives for R&D usually take one of three forms: *i) tax deferrals*, which are reliefs in the form of a delay in payment of a tax, *e.g.* depreciation allowances; *ii) tax allowances* or extra amounts over current business expenses deducted from gross income to arrive at taxable income; and *iii) tax credits* or amounts deducted from tax liability. The fiscal incentives now in place in the OECD vary widely in their form and other features of their design.

Some general trends can be identified. More countries are introducing R&D tax credits rather than allowances. With regard to the latter, countries are basing allowances on a combination of the level of expenditures and their increment (*e.g.* Australia, Austria, Hungary). With the addition of Norway in 2002, there is a continuing tendency to favour small firms in R&D tax provisions, although the United Kingdom is now extending its R&D tax reliefs to larger enterprises. In the past two years, Australia, Hungary, Norway, Portugal, Spain and the United Kingdom significantly improved the attractiveness of their R&D tax systems. Countries such as Iceland, Japan, New Zealand and the United States are studying ways to enhance the tax treatment of R&D, while the Netherlands is reviewing ways to improve the effectiveness of the R&D tax incentive. At the same time, Ireland's R&D tax allowance ceased in respect of relevant expenditure commencing after June 1999 in accordance with a sunset clause. In Belgium, the *High Council for Finance to the Federal Minister of Finance* recommended in 2001 that the R&D tax allowance be phased out to increase the neutrality of the tax system (OECD, 2002*b*).

Current and capital expenditures

R&D investments can be separated into *i) current expenditures*, which include the wages and salaries of research personnel and the cost of materials, and *ii) capital expenditures*, which include the cost of equipment and facilities. All OECD countries allow for current expenditures on R&D to be deducted from income in the year they are incurred as a form of business expense. Many countries have the same provisions for other forms of current expenditure (*e.g.* training, advertising). Canada also allows tax credits on either actual overhead or an allowance for overheads based on a percentage of the salary or wages paid to research personnel. Such expensing is a form of accelerated depreciation (and some say a generous subsidy), since current R&D expenditures may generate income in the future as well as the present. It is estimated that close to 90% of each R&D dollar is spent on "current" expenses, the remainder representing capital expenditures or fixed assets (Hall, 1995).

With regard to capital expenditures for R&D, some countries allow these to be written off in the year they are incurred, while others require that they (or some fraction thereof) be depreciated over their economic life. Other things being equal, the net-of-tax cost of R&D is lower in those countries that allow an immediate or accelerated write-off of expenditures on R&D equipment and facilities. While 10 OECD countries allow accelerated depreciation for R&D equipment expenditures, five provide an immediate 100% write-off (Canada, Denmark, Ireland, Spain and the United Kingdom) (**Table 1**). Canada also allows a partial credit for equipment used more than half the time for R&D. Switzerland, which has normal depreciation of capital expenditures, allows deductions for contracted future costs of R&D carried out by third parties, limited to 10% of taxable profits or CHF 1 million, whichever is lower.

A smaller number of countries provide for accelerated depreciation for buildings used for R&D, with three providing an immediate 100% write-off (Denmark, Ireland, United Kingdom). For example, the UK *Research and Development Allowance* allows plant, machinery and buildings used in R&D to be immediately written off against profits (for all size firms). Countries also differ as to what types of expenditures are used as the basis for further R&D tax credits or allowances. Some countries (*e.g.* Canada) provide R&D tax credits based on current expenses plus an allowance for overhead, while other countries include equipment and facilities in the expense base (**Annex Table 3**).

Table 1. Accelerated depreciation for R&D capital assets, 2001/2002

Country	Machinery and equipment	Buildings
Belgium	3 years	
Canada	100%	
Denmark (basic research only)	100%	100%
Greece	3 years	12.5 years
Ireland	100%	100%
Mexico	35% slm	
Netherlands	5 years	
Portugal	4 years	
Spain	100%	
United Kingdom	100%	100%

Source: Warda (2002).

Allowances and credits

Over time, tax credits for R&D expenditures have become more popular than tax allowances. There are now 11 OECD countries offering R&D tax credits, while 7 offer R&D tax allowances (**Table 2**). Both reduce the after-tax cost of R&D conducted by enterprises. Tax allowances allow firms investing in R&D to deduct more from their taxable income than they actually spend on R&D. Tax credits are a specified percentage of R&D expenditures which are applied against payable income tax. An allowance is a deduction from taxable income, while a credit is a deduction against final tax liability. There are two other distinctions between allowances and credits: *i)* the value of a tax allowance depends on the corporate income tax rate, while a tax credit does not; and *ii)* unused tax allowances may be carried forward to offset future tax under normal loss carryforward provisions, while the carryforward of unused tax credits requires the creation of a special pool to track unused credits.

Table 2. R&D tax incentives, 2001/2002

	Level of R&D	Increment of R&D	Combination of level and Increment
R&D tax credits	Canada Italy Korea Netherlands Norway	France Japan Korea Mexico United States	Portugal Spain
R&D allowances	Belgium Denmark United Kingdom		Australia Austria Hungary

Source: Warda (2002).

Provisions applying to R&D tax allowances or credits vary considerably, including the rates, the amount of any floors or caps, carry-over provisions, and whether they are taxable or not. For example, the rate of tax allowances varies from 13.5% in Belgium to 125% in the United Kingdom. Of the countries which offer credits or allowances on taxable income, about three-fourths impose limits on the annual amounts that can be claimed by the firm. There are two types of limits: a cap (floor or ceiling) on the absolute amount of R&D that can be claimed; or a cap on the maximum amount of the tax incentive that can be deducted. These tax provisions also vary as to whether the amounts gained are themselves taxable or not. The majority of OECD countries with R&D tax credits give the taxpayer the full value of the tax credit, while two countries – Canada and the United States – tax their tax credits.

Some OECD countries allow tax credits to be claimed against tax in future years under tax credit carry-forward rules. Allowing the tax credit to be carried-over increases its value to firms incurring losses in a given year, particularly smaller companies that are unable to make a current tax claim or tax credit due to insufficient taxable income. In 2001, Australia introduced a new R&D tax offset for small companies which allows tax-loss companies to obtain a rebate equivalent to the R&D tax allowance when their tax liabilities are assessed. Canada also refunds unused R&D tax credits to smaller Canadian-controlled private corporations (CCPCs). For both CCPCs and other Canadian corporations, unused tax credits can be carried back three years or carried forward 10 years.

Levels and increments

Tax credits and tax allowances come in three main forms depending on whether they are based on: *i)* the level of R&D expenditures in a given year; *ii)* the increment of R&D expenditures or *iii)* a combination of level and increment. More OECD countries now apply their tax incentives in terms of the volume of R&D spending rather than incremental annual spending (**Table 2**). A disadvantage of volume-based incentives is that they not only subsidise new R&D but also support the R&D a firm would have done anyway. Incremental incentives can help address the problem of windfall gains, but also confront the difficulty of defining a base period or base level of R&D to determine the increment or increase.

With regard to tax allowances, a level or volume-based allowance permits a firm spending one dollar on R&D to deduct $\$(1+w)$ (where $w>0$) from its taxable income for the year in which the expenditure occurs. In the case of an incremental allowance, a firm is allowed to deduct some fraction, w, of the increase, if any, in its R&D expenditures over a specified base period. With regard to tax credits, a level or volume-based tax credit provides a direct reduction of a firm’s tax liability equal to some fraction, c, of its annual R&D spending. An incremental tax credit is based on the nominal change in a firm’s R&D spending over a base period.

Several methods, which have various advantages and disadvantages, have been used in countries for defining the base period for calculating incremental increases in research expenditures (Bloom *et.al*., 2001):

- *Rolling-average base* -- the base period defined as a rolling average of firm-level expenditure on R&D in some number of preceding years (*e.g.* Austria, France)

- *Fixed-base* -- the base period defined as the firm-level of R&D undertaken in a specific year which is then updated each year by inflation.

- *Sales-based* -- the base period as a ratio of R&D to a firm's sales, *i.e.* a firm can claim a tax credit whenever its R&D expenditures constitute a higher percentage of sales than in the year the base was fixed (*e.g.* United States).

Several countries are introducing R&D tax allowances and credits based on a combination of level and increment. For the increment, both Australia and Austria are relying on a rolling-average base. In 2001, for example, Australia added a 175% premium tax allowance rewarding incremental research expenditures to its existing 125% tax allowance on eligible R&D expenditures. To be eligible for the premium rate on the additional investments, companies must increase their R&D expenditure during the year above a base level determined by their average claim history over the previous three years. In its tax reform of 2000, Austria introduced provisions whereby companies can deduct 25% of their R&D investments from their profits as well as an additional 10% (*i.e*. 35% in total) of R&D investments that are above the average of the preceding three years. In 2001, Hungary increased its R&D tax incentive from 8% to 20% on the level of expenditures and from 30% to 50% on incremental expenditures. Korea offers both a level-based and an incremental R&D tax credit, but these two credits are available only for SMEs and mutually exclusive so the firm can claim only one.

Targeted incentives

There is a tendency for countries to offer R&D tax incentives or give more generous tax relief to particular targets in order to further policy goals such as assisting small, innovative firms or encouraging joint public-private research (**Table 3**).

Table 3. Targeted R&D tax provisions, 2001/2002

Country	Firm size	Type of research	Activity
Belgium	SME		
Canada	SME		
Denmark		Basic research	
Italy	SME		
Japan	SME	Basic research	Collaboration
Korea	SME		R&D facilities
Netherlands	SME		
Norway	SME		Collaboration
Spain			Collaboration
United Kingdom	SME		Collaboration

Notes: Blank spaces indicate no targeting in these areas.
Source: Warda (2002)

Since most business R&D expenditures are carried out by large firms, countries may target their tax incentives to smaller firms who are less likely to make these investments due to financial, technical, information-related and other constraints. Italy and the United Kingdom have had R&D tax credits only for small firms, although the United Kingdom will now extend tax relief to larger enterprises (but at a less preferential rate). In 2002, Norway introduced an SME tax credit for R&D, which includes external purchases of R&D services (from universities and public research institutes) as well as research conducted by the firm itself. Other countries have more generous R&D tax provisions for small firms than for larger enterprises (*e.g*. Canada, Japan, Korea, the Netherlands).

Stimulating more collaborative research between industry and public research institutions/universities is another goal adopted by countries in the design of the R&D tax incentives. Japan, Norway, Spain and the United Kingdom have more generous tax relief for industry R&D projects contracted to universities and public research institutes. For example, the UK tax credit for all companies introduced in April 2002 is provided for companies conducting rather than financing R&D, except where projects are carried out in collaboration with universities or research organisations. Canada provides tax credits to companies that make payments to approved research institutes or universities for research that relates to the business of the company. Japan, Canada and Denmark give tax incentives for basic research conducted by the private sector, while Korea is attempting to increase investment in R&D facilities.

Federal and sub-federal

In addition to national R&D tax incentives, a growing number of provinces and states in federal countries such as Canada and the United States are introducing their own R&D tax reliefs. At present in Canada, eight out of ten provinces and one territory (the Yukon) provide their own sub-federal R&D tax incentives. In the United States, most states offer some form of R&D tax relief. It is expected that, in these and other countries, and particularly those with federal systems, the existence of R&D tax incentives at various tiers of government may increase as a reflection of increasing competition among regions to attract knowledge-based investment. The combination of federal and sub-federal tax reliefs for R&D expenditures can also greatly reduce the cost of business research.

COMPARATIVE GENEROSITY OF FISCAL INCENTIVES TO R&D

Taking into account various design features, the relative generosity of R&D tax incentives differs significantly across OECD countries. A "*B-index formula*" is used here to compare the relative importance of R&D tax support across national tax jurisdictions (**Box 1**). The value of the *B-index* is based on the before-tax income required to break even on one dollar of R&D outlay and takes into account corporate income tax rates, R&D tax credits, special R&D allowances from taxable income, and depreciation of capital assets (machinery, equipment and buildings) used in R&D (**Annex Tables 2 and 3**).

While a useful analytical and comparative tool, the *B-index* is based on a number of methodological assumptions. As a rough measure of the relative support for private sector investment in R&D delivered through a tax system, it attempts to show the impact of taxes on private sector decisions to invest in research. The *B-index* is the present value of before-tax income necessary to cover the initial cost of R&D investment and to pay corporate income taxes so that it becomes profitable to perform research activities. Algebraically, the *B-index* is equal to the after-tax cost of an expenditure of one USD on R&D divided by one minus the corporate income tax rate.

The relative generosity of R&D tax provisions has been calculated for large and small firms in the manufacturing sector of most OECD countries for the years 2001/2002 (Warda, 2002). According to this indicator (one minus the *B-index*), Spain, Portugal, Australia and Canada have the most generous fiscal incentives among OECD countries for R&D conducted by *large firms.* Germany, Italy, New Zealand, Norway, Greece, Sweden, Iceland, Finland and Switzerland offer lesser R&D tax incentives for large firms (**Figure 2**). Overall, there has been a marked increase in generosity since 1999 in the R&D tax treatment by OECD countries, in particular in the large company category. Thirteen OECD countries increased the benefits provided by their R&D tax provisions in this period (**Annex Table 1**).

Concerning research by *small firms*, Italy, Spain, the Netherlands, Portugal, Canada, Norway and Australia are relatively more generous than other OECD countries in terms of R&D tax incentives (**Figure 3)**. A comparison of

R&D tax treatment in 1999 and 2001/2002 for the small company category shows modest increases in generosity in R&D tax treatment. Approximately ten OECD countries enhanced their provisions with regard to small firms, while the others had a decrease in generosity or no change in their R&D tax reliefs (**Annex Table 1**).

Box 1: The B-Index Formula

The first step in calculating the B-index is to determine the numerator - the present value of the after-tax cost (ATC) of a one dollar (USD 1) expenditure on R&D. The next step is to determine the present value of the before-tax income required to cover the present value of a one dollar outlay on R&D expenditures and to pay the applicable taxes. Thus, the generic formula for the B-index is as follows:

B = (1 - uz)/(1 - u) Where:

(1 - uz) = after-tax cost per dollar of R&D expenditure

z = present value of d

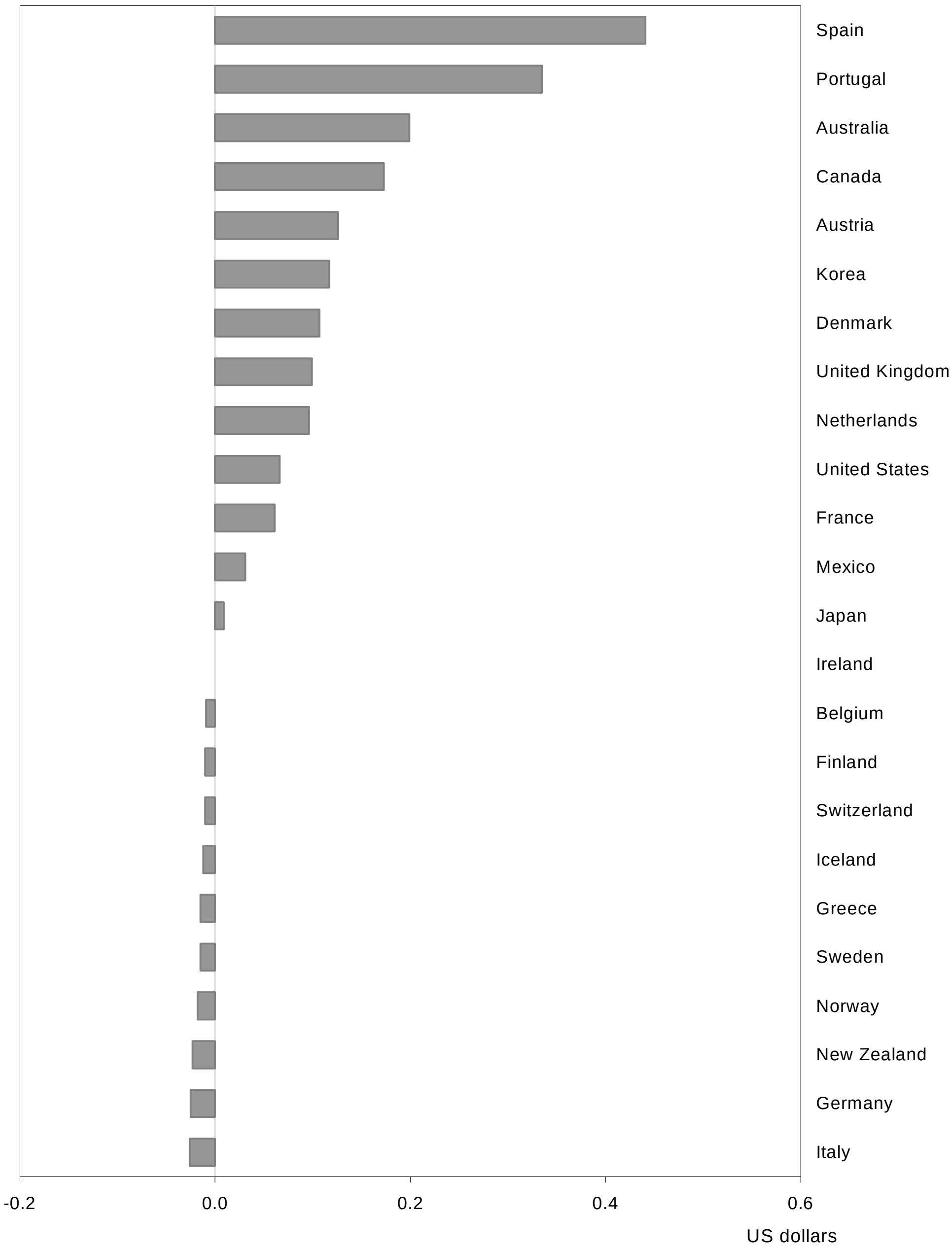
u = corporate income tax rate.

The B-index is calculated with 90% current expenditures and 10% capital expenditures for all countries. In Figures 2 and 3, the comparisons, which estimate the generosity of R&D tax provisions, are presented as one minus the B-index.

In a world in which there are no taxes (*u* = 0), the value of the B-index will be 1. A firm would never find it profitable to undertake a project for which the present value of project-related income was less than the present value of project costs. No project with a benefit-cost ratio of less than 1 would be undertaken. In a world where taxes exist, however, the value of the B-index can still be 1, provided that all R& D expenditures are fully deductible in a current year (*z* = 1) and are taxed at the same rate. For example, if *u* = 50% then B = (1 - 0.5)/(1 - 0.5) = 1. The B-index will vary from 1 only when R&D expenditures are not fully deductible (*z*<1) or are more than fully deductible (z > 1), and/or where there exist allowances or tax credits for R&D that reduce the after-tax cost of an R&D project (that is, the after-tax cost of one dollar of expenditure on R&D).

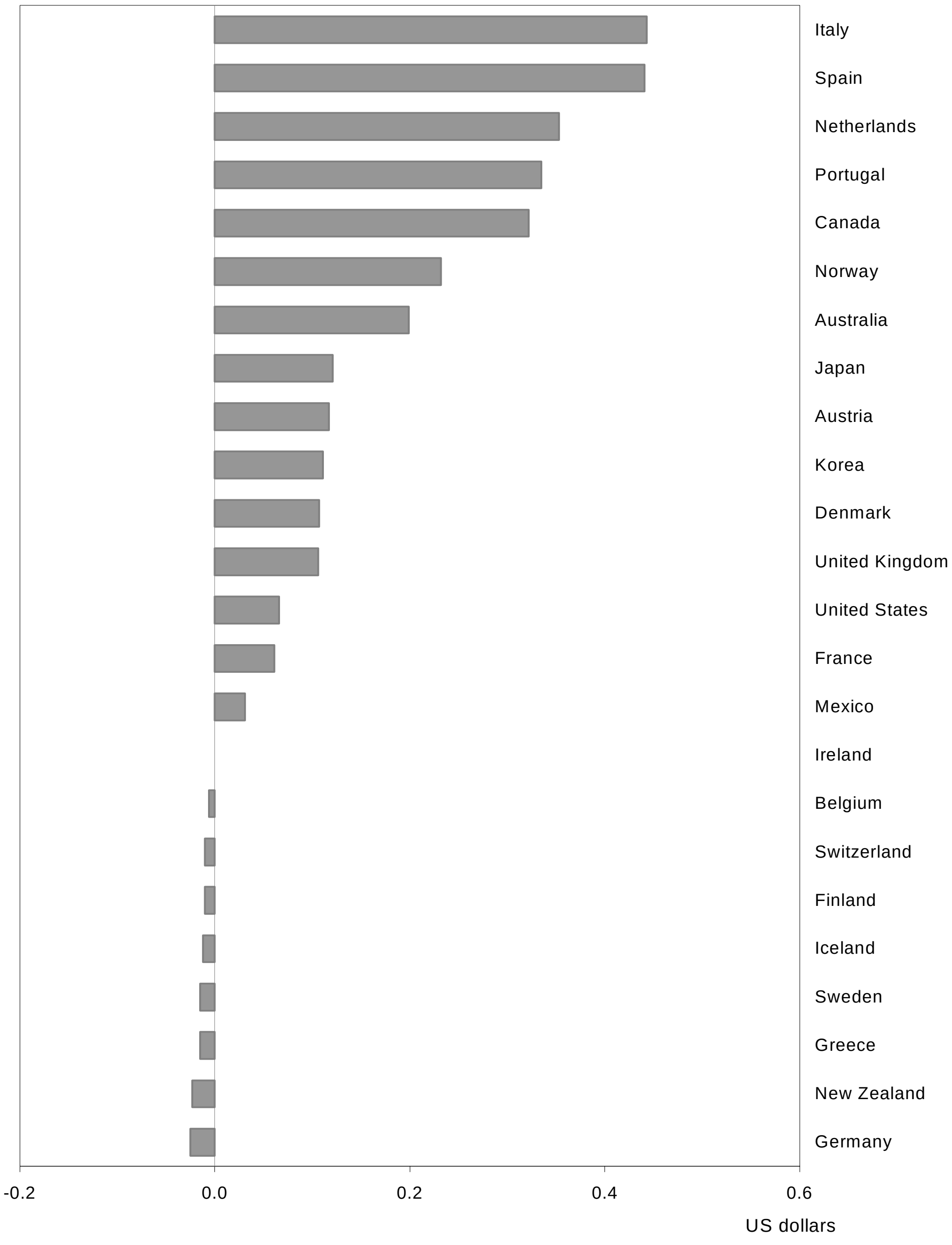
Source: Warda, 2001.

Figure 2. R&D Tax Treatment of Large Firms, 2001/2002



Note: Comparative R&D tax incentives calculated as one minus the B-index.
Source: Warda (2002).

Figure 3. R&D Tax Treatment of Small Firms, 2001/2002



Note: Comparative R&D tax incentives calculated as one minus the B-index.
Source: Warda (2002).

COSTS AND BENEFITS OF FISCAL INCENTIVES FOR R&D

Fiscal incentives to business R&D can incur substantial costs to governments related to associated administrative costs and intended and unintended tax revenue losses. Previous studies indicate that in some OECD countries (*e.g.* Australia, Canada), the cost to government of R&D tax incentives exceeds direct government funding of business R&D (**Table 4**). However, in larger economies (*e.g.* France, Japan, the United States) greater amounts of support are provided to business R&D through direct financing than through tax incentives. Estimates indicate that in Canada in 1995, R&D tax credits were equivalent to about 13% of industry R&D expenditures. In the United States in contrast (in 1999), R&D tax incentives represented less than 1.6% of industry R&D spending.

Table 4. Direct versus indirect financing of business R&D in select OECD countries

(millions of 1995 PPP dollars)

Country	Cost to government of tax credits	Direct government funding of business R&D	Industry R&D expenditures
Australia (1997)	138	84	3 233
Canada (1995)	685	441	5 143
France (1997)	376	1 778	14 159
Japan (1997)	202	828	65 173
Netherlands (1997)	207	210	3 269
United States (1999)	2 393	23 595	152 617

Source: OECD (2002*d*).

With regard to benefits, many studies show a correlation between R&D tax incentives and increases in private research spending within individual countries. Although it is difficult to relate heightened R&D intensity directly to fiscal measures, it appears that, on average, tax incentives can increase private research spending by an amount equal to the loss in tax revenue. An examination of panel data on tax changes and R&D spending in nine OECD countries over a nineteen-year period (1979-97) found that a 10% decrease in the cost of R&D through tax incentives stimulated just over a 1% increase in the level of R&D in the short-run and just under a 10% rise in R&D in the long-run (Bloom *et. al*., 2000). A Canadian study found that each dollar of tax revenue foregone through tax incentives generated CD 1.38 in additional business research spending and concluded that the federal R&D tax incentive is cost-effective in stimulating additional R&D (Finance Canada, 1998). A review of country studies of the effectiveness of R&D tax credits reported similar findings (Hall and Van Reenen, 2000) (**Table 5**).

Table 5. Effectiveness of R&D Tax Credits

Study	Estimated elasticity of R&D to tax credit	Period of analysis	Country
Australian Bureau of Industry Economics (1993)	–1.0	1984 - 94	Australia
McFetridge and Warda (1983)	–0.6	1962 - 82	Canada
Mansfield and Switzer (1985)	–0.04 to –0.18	1980 - 83	Canada
Bernstein (1986)	–0.13	1981 - 88	Canada
Bernstein (1998)	–0.14 (short-run) –0.3 (long-run)	1964 - 92	Canada
Mansfield (1986)	–0.35	1981 - 83	United States
Berger (1983)	–1.0 to –1.5	1981 - 88	United States
Baily and Lawrence (1987, 1992)	–0.75	1981 - 89	United States
Hall (1993)	–1.0 to –1.5	1981 - 91	United States
McCutchen (1993)	–0.28 to –10?	1982 - 85	United States
Hines (1993)	–1.2 to –1.6	1984 - 89	United States
Nadiri and Mamuneas (1996)	–0.95 to –1.0	1956 - 88	United States
Bloom, Griffith and Van Reenen (1999)	–0.16 (short-run) –1.1 (long-run)	1979 - 94	G7 and Australia

Source: Hall and Van Reenen (2000).

Closer examination of R&D tax incentives shows more nuanced effects. In Europe, tax incentives were not seen as influential in encouraging established non-R&D performing firms to begin investing in R&D (European Commission, 2000). Interviews with company executives in the United States indicated that tax incentives do not influence overall corporate R&D strategies, but act more as financial instruments that operate at the level of general budget considerations (OTA, 1995). However, a Canadian survey found that the federal R&D tax credit was more important in the amount of research conducted by firms than government R&D grants or contracts (Finance Canada, 1998).

In designing effective R&D tax incentives, it is important to note past trends in industry take-up. Studies indicate that R&D tax incentives are used mostly by large manufacturing firms in sectors such as electronics, telecommunications and chemicals. According to a US study, large manufacturing firms, particularly those with rapidly increasing R&D expenditures, claimed 70% of the value of the R&D tax credit in any given year (NIST, 1998). In Australia, evaluation of its R&D Tax Concession in 1999-2000 showed that the top three areas of research conducted by users of the tax incentives were general engineering and ICT-related fields (OECD, 2002*b*). The Canadian evaluation found that firms with a greater percentage of new product or process R&D and which had research results subject to intellectual property protection tended to be more responsive to the tax incentives (Finance Canada, 1998).

CONCLUSIONS

It is generally accepted that business research and development has significant positive externalities in terms of technical and economic spillovers. R&D is a key factor in enhancing innovative performance and productivity as well as long-term economic growth. However, national R&D spending is influenced by a broad range of factors. The decision to support private R&D through direct financing and/or tax incentives are decisions to be taken by governments within the context of their political and economic systems. The design of R&D tax reliefs will also depend on the general configuration of the tax system and the particular policy goals being pursued. The following are design aspects for consideration and discussion.

Administration -- OECD country experience and empirical studies highlight a number of administrative recommendations for the implementation of R&D tax incentives. Clarity, consistency and predictability are essential to assist enterprises in making R&D investment decisions partly on the basis of tax incentives. There is need for a clear definition of what constitutes research and development costs qualifying for the tax incentive. Certainty in R&D tax reliefs allows corporate planning over the longer-term; evaluations show that R&D tax incentives are more effective when provided over a longer period. Overly complex schemes -- or those which change frequently -- will act as a deterrent to R&D investments.

Information programmes help increase awareness and understanding of the availability of R&D tax incentives on the part of a large population of firms. Providing public seminars, increasing the availability of staff to answer telephone enquiries, undertaking partnerships with industry associations, and making greater use of Internet sites can assist in increasing the transparency and accessibility of R&D tax incentives. Governments should also take into account the compliance costs of submitting tax credit claims, which can be particularly burdensome for smaller firms. Canada found that compliance costs for small firms equalled 15% of the value of the R&D tax credit compared to 5.5% for larger firms (Finance Canada, 1998). Governments can simplify and streamline forms and processes as well as develop advisory programmes for first-time and smaller claimants of R&D tax incentives.

Tax credit vs. tax allowance -- In general, the preference of an enterprise for a tax credit or a tax allowance depends on the effective marginal tax rate of the firm. For large firms, both R&D tax credits and allowances can lower their overall tax liability. Smaller firms -- which may not have significant tax liabilities -- may benefit more from tax allowances, which lower their taxable income. However, some countries, *e.g.* Canada, remedy this by making R&D tax credits refundable and thus of use to smaller firms without taxable income. R&D tax allowances are a type of super deduction which is not directly offset against R&D expenditures. Thus, some firms argue that R&D tax credits have greater effects on R&D decision-making than allowances since the credit is applied directly into the R&D budget of a firm. Credits are therefore more visible to those responsible for research spending within a company and more likely to encourage additional R&D investments.

Increment vs. level -- There are various pros and cons associated with basing tax reliefs on either the volume of R&D spending or incremental R&D spending. Volume-based schemes tend to be simpler for both companies and governments. Large firms which conduct a large quantity of R&D tend to prefer the level-based approach. They contend that incremental schemes do not take into account the cyclical nature of research which follows business and product cycles, and that companies should not have to maintain an upward curve in their R&D budgets even if not appropriate for their business at a given time. Incremental schemes can frustrate the ability of larger firms to factor the benefits of tax incentives into long-term R&D plans as well as penalise heavy R&D spenders for their existing high levels of research expenditures. On the other hand, level-based R&D tax incentives are extremely expensive for governments and can give windfall profits to companies for R&D they would conduct anyway.

Although more complex to design and administer, incremental R&D tax schemes may better target additional, new research and that by small firms. Studies show that incremental R&D tax schemes can be better value for money, provided the base period is defined to avoid perverse incentives to firms. Incremental approaches can cause distortions in enterprise behaviour in order to maximise access to tax credits. This can be partly overcome by using a fixed-based system or a firm's all-time maximum R&D expenditure as a base. (Bloom *et.al*., 2001). Other studies indicate that tax credits based on incremental spending have a sharper incentive effect and tend to give better stimulants for companies to increase R&D expenditures at the margin (Brean and Leonard, 1998).

Targeted incentives -- R&D tax incentives available for all size firms can encourage increased investments in all types of companies, sectors and research (basic, applied, developmental). However, in general schemes, most R&D tax benefits tend to be claimed by larger enterprises who conduct the lion's share of research. Tax measures aimed at small firms are unlikely to have a significant effect on aggregate investment spending, but may encourage innovative expenditures at the margin. Provisions for carrying-forward such credits also assist smaller enterprises, since in early years they may not be sufficiently profitable to take advantage of the tax incentive.

In addition to small firms, research contracted to or conducted with public research institutions and universities is an increasingly popular target for R&D tax schemes. More R&D tax provisions are attempting to encourage certain types of research investments, *e.g.* collaborative research, basic research, R&D facilities. Countries are also considering targeting R&D tax incentives to *i)* new firms of all sizes -- who would tend to be more innovative and less profitable than other enterprises, *ii)* firms in specific industrial sectors which may be underinvesting in R&D, and *iii)* particular fields of research (*e.g.* information and communications technology (ICT), biotechnology).

Definition of qualifying R&D -- There are questions as to what types of R&D should benefit from tax incentives, which will determine the generosity and the expense to governments of the tax relief. Most countries define R&D for tax purposes more restrictively than the OECD Frascati Manual (OECD, 1994). Some countries direct tax incentives to basic research, while others focus more on R&D that benefits the economy including applied and developmental research. While this can range from blue sky research to applied R&D directed towards a practical aim or product, commercial development without S&T investigation is not considered applicable by most countries. Some firms argue that tax reliefs should be extended to the development end of the R&D process, including technology demonstration and engineering improvements, and not be confined to laboratory-based processes. For example, the very broad definition of R&D recommended by the British aerospace industry for the purpose of tax incentives is:

> *"All activities involving studies, research, generic technologies as well as prototyping and demonstrators, which are designed to maintain or expand knowledge and/or the technology baseline and development of a product and/or process to prove a product, including acceptance testing and certification, prior to any future production." (SBAC, 2002)*

Possible tax avoidance or evasion -- A continuing concern related to R&D tax incentives is the possibility for tax evasion or avoidance by companies, *e.g.* when non-R&D spending is claimed under a tax credit or other incentive. Germany is one OECD country which abolished its R&D tax credit in the mid-1990s due to problems with abuse. Several countries have adopted anti-fragmentation provisions to prevent companies from artificially splitting up entities to take advantage of premium rates or special allowances for smaller enterprises. Countries such as Australia have mandatory grouping rules for companies applying for R&D tax reliefs. Other countries have adopted special provisions or rules for separating incremental R&D expenditures from normal annual spending. In general, there are provisions which countries can implement to prevent firms from avoiding or evading taxes by claiming unwarranted R&D tax relief.

International considerations -- OECD countries differ on their rules regarding the eligibility of foreign companies for local R&D tax incentives. Among the eligibility requirements in OECD countries are the following:

- *location provisions* -- R&D must be carried out in the country that provides the tax incentive;

- *national content provisions* -- there must be a certain amount of national content associated with the R&D (*e.g.* research staff, equipment);

- *exploitation provisions* -- the results of R&D must be exploited to the benefit of the country providing the tax incentive; and

- *IPR provisions* -- the intellectual property rights (IPR) resulting from the R&D are owned by the country providing the tax incentive.

For example, Canada and the United States maintain provisions that the R&D must be performed in the country to be eligible for tax incentives. However, expenses incurred by national firms or foreign subsidiaries on R&D projects performed outside the country (*e.g.* salaries, travel costs of researchers) are not eligible. Other countries extend incentives to their enterprises which conduct R&D in foreign jurisdictions. Australia has both national content and exploitation provisions: key research staff must be Australian nationals and the benefits from R&D must be applied within Australia.

The place of R&D tax reliefs within overall corporate tax systems can also play a role in locational decisions of multinationals. An Irish survey in 1998 showed that decisions to locate R&D functions in Ireland, especially by multinational enterprises, are adversely affected by low corporate tax rates; most firms prefer to incur R&D costs where they can be offset against higher taxes (OECD, 2002*b*). Through such provisions, R&D tax incentives can act as incentives or disincentives to international investment. At a time when many countries are concerned about the "*hollowing-out*" of their research base, any factors affecting the globalisation of increasingly-mobile R&D facilities and personnel are important.

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ANNEX: DETAILED TABLES

Annex Table 1. Comparing the value of B-indexes over time

(manufacturing companies, by country)

Country	Large company 1999-2000	Large company 2001-2002	Change	Small company 1999-2000	Small company 2001-2002	Change
Australia	0.890	0.801	↑↑	0.890	0.801	↑↑
Austria	0.878	0.875	↑	0.878	0.875	↑
Belgium	1.012	1.009	↑	1.008	1.006	↑
Canada	0.827	0.827	↔	0.678	0.678	↔
Denmark	0.871	0.893	↓	0.871	0.893	↓
Finland	1.009	1.010	↓	1.009	1.010	↓
France	0.915	0.939	↓	0.915	0.939	↓
Germany	1.041	1.025	↑	1.041	1.025	↑
Greece	1.015	1.015	↔	1.015	1.015	↔
Iceland	1.028	1.012	↑	1.028	1.012	↑
Ireland	0.937	1.0	↓	0.937	1.0	↓
Italy	1.027	1.026	↑	0.552	0.557	↓
Japan	0.981	0.991	↓	0.937	0.879	↑
Korea	0.918	0.874	↑	0.837	0.821	↑
Mexico	0.969	0.969	↔	0.969	0.969	↔
Netherlands	0.904	0.901	↑	0.613	0.647	↓
New Zealand	1.131	1.023	↑	1.131	1.023	↑
Norway	1.018	1.018	↔	1.018	0.768	↑↑
Portugal	0.850	0.665	↑↑	0.850	0.665	↑↑
Spain	0.687	0.559	↑↑	0.687	0.559	↑↑
Sweden	1.015	1.015	↔	1.015	1.015	↔
Switzerland	1.011	1.010	↑	1.011	1.010	↑
United Kingdom	1.0	0.904	↑↑	0.888	0.894	↓
United States	0.934	0.934	↔	0.934	0.934	↔

↑ = increase in generosity
↑↑ = significant increase in generosity
↔ = no change
↓ = decrease in generosity
Source: Warda (2002).

Annex Table 2. General R&D tax treatment, 2001-2002

Country	B-index Large/SME	CIT rate Large/SME %	Current deduction %	Depreciation Machinery & equipment	Depreciation Buildings
Australia	0.801	30	100	0	40 years
Austria	0.875	34	100	5 years	25 years
Belgium	1.009/1.006	33.99	100	3 years	20 years
Canada – federal	0.827/0.678	32.12/23.1	100	100%	4%
Denmark – ordinary – basic R&D	 1.015 0.893	 30	 100	 30% 100%	 20 years 100%
Finland	1.010	29	100	25%	20%
France	0.939	34.33	100	40%	20 years
Germany	1.025	38.9	100	30%	4%
Greece	1.015	35	100	3 years	12.5 years
Iceland	1.012	18	100	10 years	50 years
Ireland	1.000	10	100	100%	100%
Italy	1.026/0.557	36	100	10 years	33 years
Japan	0.991/0.879	42/35	100	18%	50 years
Korea	0.874/0.821	29.7/16.5	100	5 years	5-20 years
Mexico	0.969	35	100	35% slm	20 years
Netherlands	0.901/0.647	34.5	100	5 years	25 years
New Zealand	1.023	33	100	22%	4%
Norway	1.018/0.768	28	100	20%	5%
Portugal	0.665	32	100	4 years	20 years
Spain	0.559	35	100	100%	33 years
Sweden	1.015	28	100	30%	25 years
Switzerland (Zurich)	1.010	24.5	100	40%	8%
United Kingdom	0.904/0.888	30/19	100	100%	100%
United States – federal	0.934	35	100	5-year MACRS property	39-year property

Source: Warda (2002).

Annex Table 3. Special R&D tax incentives, 2001-2002

Country[1]	Rate on level	Rate on increment	Base for increment[2]	Expense base[3]	Deducted from TI or CIT[4]	Taxable	Special treatment of SMEs
Australia	125%	175%	3 yrs	C, ME	TI	Yes	Offset
Austria							
-capital allowance	115%			ME,B	TI	Yes	
-special allowance	125%	35%	3 yrs	C	TI	Yes	
Belgium	13.5%			ME, B	TI	Yes	18.5%
Canada – federal	20%			C, ME	CIT	Yes	35%; refund
Denmark							
-basic research	125%			C, ME, B	TI	Yes	
France		40%	2 yrs	C, MEA, B	CIT	No	Refund
Italy – SME	30%			C, ME, B	CIT	No	Yes
Japan							
– regular		15%	3 yrs	C, MEA	CIT	No	
– small business	10%			C, ME	CIT	No	Alternative
– basic technology	5%			ME	CIT	No	
– co-op R&D	6%			C, ME, B	CIT	No	
Korea							
– SME *	15%	50%		C	CIT	No	
– large firm		50%	4 yrs	C	CIT	No	
– facilities	10%			ME	CIT	No	
Mexico		20%	3 yrs	C	CIT	No	
Netherlands	13%			Salaries	CIT	No	40%
– inv. Deduct				ME, B	TI	Yes	13%
Norway							
– SME	20%			C	TI	Yes	

…/…

Annex Table 3. Special R&D tax incentives, 2001-2002 (cont.)

Country[1]	Rate on level	Rate on increment	Base for increment[2]	Expense base[3]	Deducted from TI or CIT[4]	Taxable	Special treatment of SMEs
Portugal	20%	50%	2 yrs	C	CIT	No	
Spain							
– Tax credit	30%	40%	2 yrs	C	CIT	No	
– Capital R&D	10%			ME	CIT	No	
United Kingdom							
– SME	150%			C	TI	Yes	
– Large	125%			C	TI	Yes	
United States – fed.		20%	Max. 50% of C	C	**CIT**	Yes	Start-up credit base

1. Other OECD countries do not have tax credits or taxable income allowances.

2. Average over specified number of years.
3. C = current; ME = machinery; B = buildings. 4. CIT = corporate income tax; TI = taxable income.
* Two Korean R&D tax credits for SMEs are mutually exclusive so the firm can claim only one.

Source: Warda (2002).