ENCOURAGING INDUSTRIAL R & D

- *How R&D translates into wealth*
- *How effective are tax credits on R&D?*

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POSTnotes are intended to give Members an overview of issues arising from science and technology. Members can obtain further details from the PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (extension 2840).

There is a wide consensus that research and development (R&D) contribute to innovation and economic competitiveness, and some countries use the tax system to encourage industry to increase the amount of R&D it supports. In the UK, there is continued debate how far such measures are effective in increasing industrial R&D, and creating more wealth.

This note summarises the current debate and recent academic findings on the efficacy of fiscal measures to encourage industrial R&D.

BACKGROUND

Most countries allow companies to deduct from taxable income their R&D expenditures, but additional fiscal measures are used in some countries (e.g. Australia, Canada, France, Japan, USA) to encourage industrial R&D. This is justified by economists because R&D has some of the attributes of a public good (see **Box 1**) so that the 'market' can tempt companies to be 'free-riders' on the back of others' R&D, and industrial R&D will thus be below the optimal level for society at large. By reducing the 'cost' of R&D, governments can encourage a level of domestic R&D which maximises the potential for wealth creation, while reducing incentives for companies to site R&D abroad.

Proposals to introduce some form of tax credit for R&D in the UK have been under discussion for many years, especially following the introduction of a scheme in the USA in 1981. In 1987, the Treasury and Inland Revenue reviewed fiscal incentives for R&D spending and the experience of other countries, and concluded that reducing the 'price' of R&D through special fiscal incentives did have the expected effect of increasing the amount carried out by firms, but the amount of R&D increase was only around half the amount of tax foregone, the balance going to swell companies' cash flow.

These conclusions have been cited by Ministers in support of decisions not to adopt R&D tax credits in the UK. However, recent academic studies of the first 10 years experience in the USA (up to 1991) now suggest that the increase in corporate R&D exceeded the tax foregone, substantially changing perceptions of the scheme's cost-effectiveness. The House of Lords Science and Technology Committee had already (in 1991) supported tax credits for UK research, and the more recent evidence also persuaded the Commons Science and Technology Committee[1] that the time had come for a *"..major re-examination of the case for fiscal incentives for investment in R&D..."*.

Box 1
INDUSTRIAL R&D - PRIVATE PROPERTY OR PUBLIC GOOD?

The debate on the pros and cons of fiscal incentives for R&D derives from the argument that the market economy is incapable of generating an optimal level and composition of R&D because of problems in appropriating the benefits. This market failure flows from the inevitable 'leakage' of the fruits of R&D from the company funding the work to other companies, into the knowledge base of the country concerned, and ultimately to other countries. This leakage can be substantial. Thus a company which develops a new production process ultimately helps all those using that process; a company which develops a new technology for one application may open the door for different applications by other companies. Companies which fund basic research at universities contribute to the world's body of knowledge with only limited opportunity to benefit preferentially from it, while innovations improving quality of life (e.g. environmental protection, enhanced health) often benefit society much more than the company.

In economists' terms, this means that there are significant positive "externalities" which the market mechanism cannot take into account in setting the 'right' level of R&D. In other words, the basic rate of return perceived by the company is lower than the rate from the wider viewpoint of society - the 'social' rate of return. Since the company pays all the costs of the research while only reaping some of the benefit, the amount of research dictated by the market will be sub-optimal from society's viewpoint.

There are two ways of helping research to reach the 'right' levels. One increases the supply by government funding extra R&D (e.g. by grants); the other reduces the 'costs' of research (e.g. by providing extra tax relief or other rebates on R&D expenditures).

The Government response (September 1994) did not accept the Committee's findings and reiterated the previous position based on the 1987 Treasury analysis, i.e. that tax credits were inefficient and ineffective and would distort commercial investment decisions. In the debate on the Committee's report however (October 24,1994), Members from all parties raised the more recent US evidence and the Minister for Science undertook to look again at this issue.

R&D AND WEALTH CREATION

At the level of whole economies, studying the factors which have led to the sustained growth in productivity this century leads economists to conclude that the primary agent of economic growth is not labour or capital inputs, but **technical change**. It is thus very important to understand how technical changes come

1. The Routes Through Which the Science Base is Translated into Innovative and Competitive Technology. First Report Session 1993-4.

about and how far they depend on the level of R&D. Economists have researched this question for many years, tackling it from a number of angles.

R&D clearly contribute to developing new or higher quality products, to improving production processes (better quality, lower cost etc.), but also create wholly new technologies and markets (information and communications technologies being good examples). However there are clearly many other factors at work in the innovation process which affect economic competitiveness (e.g. design, marketing, management, organisational ability, quality control), so that the size of the R&D effort is only one of a number of factors involved. In exploring the importance of R&D, the differences between publicly-funded and industrial R&D also need to be taken into account. Publicly-funded R&D creates the knowledge base and supplies the trained personnel without which much applied R&D of industry would not be possible. On the other hand, the chances of R&D leading to a short-term application in a product or process are clearly much greater in industry.

Studies by economists follow two broad approaches - case studies which trace back important technical developments to their R&D origins and work out a rate of return on the original investment, and wider 'econometric' studies which try and disentangle the various reasons for different performance levels between countries and/or industrial sectors. The many case studies are broadly consistent, suggesting that R&D generates returns on the original expenditure of 20-60% across a range of industries and timescales.

Looking at the underlying causes of improved productivity, some economists have concluded that the **level of business R&D** is the single most important factor in explaining the performance of OECD countries. A recent comprehensive study (**Box 2**) found that both domestic and foreign R&D contributed to productivity growth. Small countries relied more on importing the results of foreign R&D, but the G7 countries benefited most from their own R&D. The typical rates of return at a national level were considerably higher than those enjoyed by individual companies, suggesting that the benefits to the nation as a whole may be at least double those appropriated by the firms paying for the R&D.

The above work is not without its critics. Case studies have been criticised for assuming that innovation (technical change) is wholly derived from R&D, when as already pointed out, successful innovation requires additional skills and knowledge. Assigning all the benefits to the original R&D thus overestimates its rewards. On the other hand, in that many technical breakthroughs are rapidly exploited by others, or their productivity gains feed through into general industry, the wider benefits at later stages can be substantial and are not captured by the case studies. On the whole, many observers see these effects as somewhat compensating for each other so that the overall conclusions on the benefits of R&D are reasonably robust. Reviews carried out for the Office of Science and Technology (OST) in 1993 reflected the above and concluded that both public and private R&D are a very good investment in terms of the return earned.

Box 2 THE ECONOMIC GAINS FROM R&D

The Commons Science and Technology Committee based its calculations on work by a number of economists, but a key part was the research by Coe and Helpman of the Centre for Economic Policy Research which examined the links between R&D and productivity gains in OECD countries from 1970-90. This concluded that an increase in business R&D increases total factor productivity (TFP - the output for a given input of labour and capital), with a response (elasticity) which was related to the total 'stock' of R&D from domestic and foreign sources. The rate of return on industrial R&D was over 100% at the national level. In the larger (G7) countries, domestic R&D had a much greater effect on TFP than foreign R&D, which suggests that despite the international flows of knowledge, there remains a substantial competitive advantage to each G7 country from its own R&D.

The elasticity for domestic R&D was found to be 0.233 - i.e. for every increase of 1% in the stock of R&D, TFP increases by 0.233%. If this applied while business R&D increased from the UK's current level of 1.36% of GDP(£8B) to 1.8% after five years, the Committee estimated that the resulting improvement in TFP would increase GDP by 0.8%, worth £5B p.a.

HOW MIGHT R&D TAX CREDITS WORK?

Although the typical rates of return on R&D investment may appear very good, companies still may not invest to the optimum level for their markets for the reasons outlined in Box 1. Companies will then be less innovative[2] than they could be and fewer benefits in terms of wealth created flow to society through R&D. There is thus at least a *prima facie* case for governments to seek to remedy these market shortcomings, and such thinking has persuaded several countries to favour R&D expenditures through tax credits which reduce the cost of research.

The most studied is the USA's system, although other countries (particularly Australia and Canada) are much more generous (**Table 1**). The USA rules have varied since the law was introduced in 1981, but currently allow a credit against tax of 20% of the R&D expenditure over a base level. The base level used to be the average of the previous 3 years' R&D expenditure, but this had the effect of always eroding the incentive for future years, and in 1990, this was changed to the average of 1984-8 R&D expenditure adjusted for current sales value. Credits have a 3-year carry-back and 15-year carry-forward provision.

2. Companies may lose out in two ways. Firstly because they miss out on discoveries or inventions they would have made themselves; secondly because they may lack the competence to make the most of others' scientific work.

Table 1 KEY ELEMENTS OF SOME TAX CREDIT SCHEMES ABROAD

Country	Rate of Credit[1]	R&D Eligible
Australia	50%	All R&D expenditure
Canada	20-35%	All R&D expenditure
(Quebec offers separate tax credits of up to 50% of R&D spend)		
France	50%	Increase over average last 2yrs
Japan	20%	Increase over previous highest R&D spend
USA	20%	Increase relative to average of 1984-8 R&D spend adjusted for sales volume.

1. Over and above the usual 100% allowance against taxable income.

Evaluations of this scheme around the time of the Treasury's review suggested limited effectiveness during the first 5 years. But the scheme's performance up to 1991 has recently been evaluated in more detail. Bronwyn Hall of the University of California looked at the R&D spend for around 1000 companies responsible for some 85% of US industrial R&D. More detailed data were available than for earlier studies, and the results suggested that for an annual tax foregone of ~$1B, R&D expenditure had increased by some $1-2B. In terms of price 'elasticity', a reduction in the cost of R&D by 5% led to an increase of 10-15% in the amount of R&D funded some 2-3 years later.

The study indicates that the limited impact detected in studies of the first 5 years of the scheme arose from:

- the inevitable delay while companies adapted their decisions to new stimuli;
- uncertainty over the 'temporary' scheme's future;
- the initial rules were such that for many companies there was little or no incentive to increase R&D.

ISSUES

The proportions of GDP spent on R&D in G7 countries are shown in **Figures 1 and 2** for Government funded R&D and Business Enterprise R&D (BERD) respectively. The UK is in fourth position on publicly-funded research, and a major theme of the 1993 White Paper on Science and Technology was to refocus this to the overall ends of wealth creation and the quality of life. With regard to BERD, UK expenditure is fifth out of the seven (Figure 2), and if the key indicator is taken as the amount of BERD actually financed by industry (as opposed to Government), the UK (0.94% in 1991) is below the levels of Japan (2.12), Germany (1.5), USA (1.37), France (1.01) though ahead of Italy (0.6) and Canada (0.57). UK Government policy recognises the importance of increasing industry's priority for R&D, and the Department of Trade and Industry (DTI) has instituted through its Innovation Unit, a number of measures to 'persuade' industry of the benefits of placing a higher priority on innovation and R&D.

One of these is to encourage fuller disclosure of corporate R&D (a new accounting standard for R&D was introduced in 1989), and publish an annual R&D 'scoreboard'. The latest R&D scoreboard show that 13 UK companies are in the world's top 200 companies for

Figure 1 GOVERNMENT FUNDED R&D IN G7 COUNTRIES

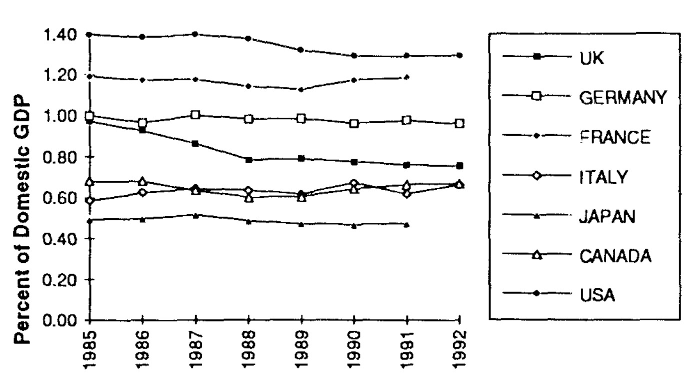
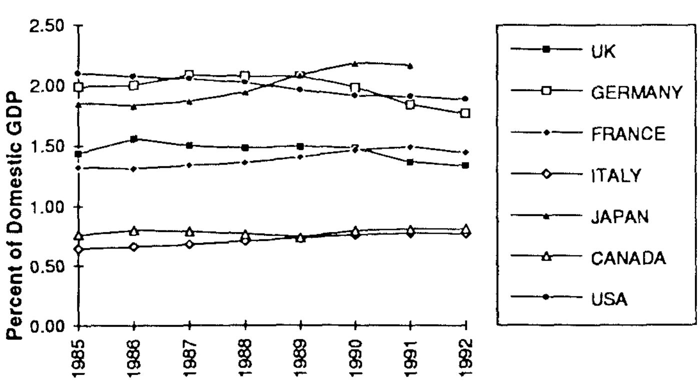


Figure 2 BUSINESS ENTERPRISE R&D IN G7 COUNTRIES



R&D (**Table 2**) - compared with France (17) and Germany (10). Amounts of industrial R&D in 1993 were 9% higher than the previous year (a larger rise than in most other OECD countries). However, these 13 companies accounted for two thirds of all R&D spending by listed companies in the UK, leaving many companies and sectors with much weaker performance.

A patchy picture in the UK has also been found in work by the Economic and Social Research Council (ESRC) on the role of R&D and innovation in industry. This found *inter alia*, that many companies' R&D activities are very small and often do not employ technically qualified staff. At the same time, high-tech research-based start-up companies have a **lower** failure rate than other start-ups, and companies with technically qualified directors are more successful.

The signals from the UK are thus mixed and can support different views. Some point to the fact that UK BERD increased faster than other OECD countries in 1993 as indicating that UK industry is recognising the importance of R&D, and that it is better to aim for the lowest general level of corporate taxation rather than introduce tax incentives which may distort commercial decisions. Others see the increase as merely reflecting cyclical factors and not affecting the underlying position wherein UK industry continues to operate at a sub-optimal level of R&D, thereby continuing to miss wealth-creating opportunities.

The Institute of Fiscal Studies (IFS) and others however point out that one of the most significant effects of tax

Table 2 UK FIRMS IN WORLD TOP 200 FOR R&D EXPENDITURE

Company	1993 R&D (£M)	Ranking	Company	1993 R&D (£M)	Ranking
Glaxo	739	42	Rolls Royce	253	102
SmithKline Beecham	575	58	British Petroleum	237	106
Shell	529	59	BT	233	108
Unilever	518	61	ICI	177	139
Zeneca	490	63	British Aerospace	168	147
General Electric	398	74	Reuters	110	186
Wellcome	325	81			

credits may be to distort the **siting decisions for** R&D. Canada in general and Quebec in particular have very favourable tax credits and have attracted substantial pharmaceutical and chemical R&D from overseas. Such facilities are key to the long-term future of companies (more so even than HQ and production plant), and thus such decisions can be particularly advantageous (or damaging to the loser) in the longer term.

UK corporate R&D is already conducted abroad to a greater degree than some other countries (40% vs 10% for the USA), and some in industry are concerned at the effect of the relative disadvantage of the UK's lack of tax credits. R&D is increasingly mobile, and a more attractive cost structure could well lead to more being retained or returned to the UK. There is thus much support in research-intensive industries for the UK to adopt measures to remove any relative financial disadvantage to siting in the UK. This is a particular concern of the Chemical Industries Association.

The OST is charged with looking again at the issue of tax credits, and will no doubt address the main objections voiced in the Treasury's 1987 analysis that only half the amount foregone appeared to be translated into increased R&D, that there was an incentive to 'reclassify' other expenditures as R&D, and that companies not paying tax would receive no incentive.

How do these objections look today? The US research results suggest that after the system had been improved to provide a consistent incentive, the increase in R&D resulting is now much larger than suggested in the 1987 review. Also, while attempts to exploit the system have been encountered, thorough audits led to only small amounts of claims being disallowed, suggesting that adequate precision in definitions combined with enforcement can avoid significant distortions in the system. The problem of some firms gaining more than others cannot be entirely solved, but the 3-year back-claim and 15 year roll-forward provisions increase the number of companies potentially benefiting, while other countries' schemes allow direct payments where the tax credit cannot be utilised.

However, disagreement remains over the extent of benefits likely to flow from a change in UK policy. The Commons Science and Technology Committee calculated (Box 2) that an increase in UK industrial R&D from 1.36% of GDP now (£8B) to 1.8% GDP after five years would feed through to an increase of 0.8% in GDP worth £5B. On this basis, the tax revenue from the increased GDP would soon exceed the tax loss from the tax credit. Some economists however question the reliability of the assumed link between BERD and productivity, and it is also unclear what level of incentive would be needed to achieve the increase in BERD envisaged. One assumption could be that UK R&D would respond to changes in the costs of R&D in the same way as in the USA. In this case, tax incentives would have to reduce the costs of UK corporate R&D by ~8-9% on average to generate the increase in UK BERD in the Committee's calculations. This would require a more generous tax credit scheme than applied in the USA, possibly closer to that of Canada.

Moreover, the IFS point out that tax credits cannot be seen in isolation, and tax treatment of royalties and corporation tax rates are equally if not more important. These broader questions were examined in 1993/4 by the former Advisory Council on Science and Technology (ACOST), which identified several aspects of the tax system which discouraged innovation - apart from the specific question of R&D tax credits. ACOST reported that rules on advanced Corporation Tax could make it financially advantageous for UK companies to site their corporate R&D activities abroad, and the Government introduced a foreign income dividends payments scheme to address this in the 1993 Budget[3]. However, economists see some residual distortions remaining, and ACOST also called for **a broader definition of qualifying expenditure under the Scientific Research Allowance** so that businesses could claim all the costs of R&D, as well as a 100% first year allowance for purchases of intellectual property. Very recently, the Lords Science and Technology Committee warned that the Inland Revenue should be careful not to inadvertently create incentives to place R&D outside of the UK.

In view of the impacts that tax credits may have on siting decisions, the IFS and others argue that any policy on tax credits for R&D would be better developed through the EU rather than as national questions potentially leading to escalating tax rivalry. Such a co-ordinated policy could be seen as a common measure to encourage technological competitiveness for the Union as a whole, just as the Commission already administers the R&D Framework Programmes to the same general end. Indeed, some in industry argue that the groundwork in collaborative R&D laid by the Fourth Framework Programme (worth some £9.6 B over the next 4 years) could be more effectively exploited if allied with EU-wide provision of R&D tax credits.

3. Oher measures such as the Enterprise Investment Scheme and the Venture Capital Trust have been introduced to encourage innovation.