briefing notes

IFS

BACKGROUND FACTS AND COMMENTS ON "SUPPORTING GROWTH IN INNOVATION: ENHANCING THE R & D TAX CREDIT"

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THE INSTITUTE FOR FISCAL STUDIES
Briefing Note No. 68

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November 2005

1. Executive Summary

On 25 October 2005 IFS and HM Treasury hosted a round table discussion that brought together practitioners from business, tax professionals, academics and policy makers from HM Treasury, HMRC and DTI to consider the proposals put forward in the discussion document "Supporting growth in innovation: enhancing the R&D tax credit" published by HM Treasury, DTI and HM Revenue and Customs in July 2005. This IFS briefing note provides some background facts and comments related to the issues raised in the discussion document, and a final section summarises the discussion that took place at the round table.

Businesses located in the UK spend around 1.2% of GDP on research and development (R&D). This figure is less than the US (1.9%), Germany (1.8%) and France (1.4%) and has declined slightly over the past decade. These trends are seen not only in R&D figures but also in other indicators of innovation such as patenting statistics, and have been a cause for government concern. The discussion document raises questions about whether government policy should and can do more to stimulate private sector R&D spending, particularly with respect to broader or more targeted application of the existing R&D tax reliefs.

In considering this question it is useful to have some background on R&D in the UK and R&D by UK firms. We start by laying out some key facts about which industries and firms carry out R&D in the UK and how these compare to the US, France and Germany. We then comment on two topics raised in the discussion document - R&D by emerging firms and internationally mobile R&D.

The main facts that we present are as follows:

1.1 Low R&D intensity in the UK relative to other countries is not mainly due to the industrial mix of the UK's economy. The main reason is low R&D intensity *within* a few manufacturing industries.

1.2 There is some evidence that lower UK R&D intensity is due to a smaller proportion of firms in the UK carrying out any R&D at all. Firms in the UK that do R&D are on average as R&D intensive as firms that do R&D in other countries.

The authors are grateful to Robert Chote, Nicholas Dee and Helen Simpson for valuable comments. This work was funded by the Gatsby Charitable Foundation. Any errors are the responsibility of the authors.

1.3 UK R&D is becoming increasingly internationalised, both in terms of foreign multinationals performing R&D in the UK, and UK firms performing R&D abroad. The US is the most important partner country in both cases.

1.4 Small and medium sized enterprises (SMEs) perform a relatively small share of all R&D in the UK, probably less than 10%. The top 100 R&D-doers in the UK account for 78% of all R&D in the UK.

1.5 Service sector R&D has grown very rapidly in the UK in recent years. More than half of this growth was accounted for by the computer services industry. Innovation in many large service sectors does not take the form of formal R&D.

Our main comments on the topics raised in the discussion document are as follows:

Targeting emerging firms

1.6 Any rationale for targeting additional government support at emerging innovative firms should be based on evidence that these firms are particularly constrained by the inability to protect their intellectual property and/or by the inability to obtain external financing.

1.7 Any rationale for targeting support on a particular group of firms should also be set against the potential costs of introducing additional complexity or uncertainty to the tax system.

1.8 The most recent evidence suggests that firms do not perceive financing, high costs or appropriability problems to be more significant barriers to innovation in the UK than in the US. This suggests that R&D tax credits may not directly address the main reasons for the faster growth of successful new firms in the US than the UK.

Internationally mobile R&D

1.9 While cost is an important determinant of international R&D location decisions, recent survey evidence suggests that other factors such as access to skilled labour and proximity to markets are more important.

1.10 There may be a trade-off between encouraging the location of R&D in the UK and supporting the performance of UK-owned firms. Evidence suggests that R&D performed in the US by UK firms provides access to new technologies that benefit the firms' UK operations.

1.11 There is some evidence that tax competition for footloose R&D may be a zero-sum game, with a fixed amount of R&D shifting between different locations.

Other issues

1.12 Finally, a key issue is the supply of scientists and engineers to conduct R&D, and the increasing mobility of researchers. There is some evidence that the UK has experienced a net outflow of patenting scientists over the past two decades.

In the rest of this note we discuss all of these points in turn. A final section summarises the discussion at the round table.

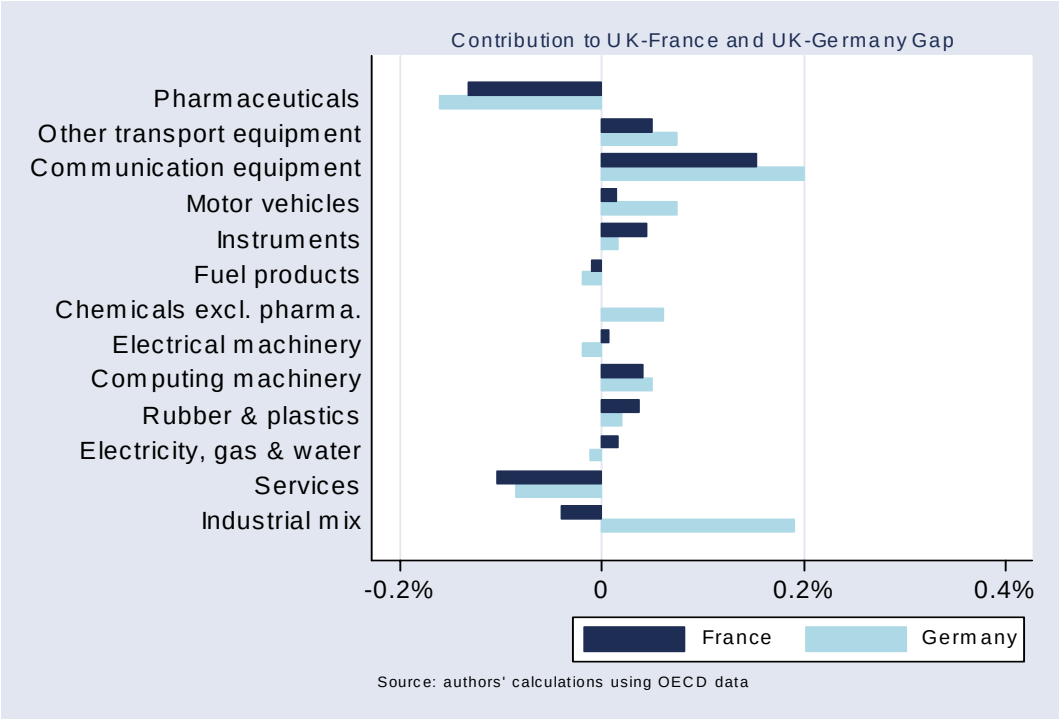
2. R&D in the UK: what are the facts?

2.1 Is low UK R&D due to the UK's industrial mix?

The discussion document states that *"the UK economy has developed to become concentrated in sectors that are not traditionally R&D intensive"* (paragraph 5.5), and that this is one of the main reasons for the UK's relatively low overall R&D intensity. In fact, the most comparable international data published by the OECD suggest that this is not the main story – in general the UK has low R&D intensity *within* industries, although industrial mix does explain some of the UK-Germany gap.

The usual comparison is made with the US. This generally shows that industrial mix is not important in explaining the UK's relatively low R&D intensity. However, a number of data problems mean that this comparison is not reliable.[1] Figure 1 shows the composition of the UK's R&D intensity gap with France and Germany. The total gap of 0.13% of GDP with France and 0.46% of GDP with Germany is decomposed into the contribution of different R&D intensities *within* industries and differences in industrial mix. The UK's industrial mix does explain part of the difference with Germany (nearly half), mainly due to the UK's smaller motor vehicles industry (which has a high R&D intensity on average) and larger service sector (which has a low R&D intensity). However, compared to France the UK's industrial mix acts slightly in the UK's favour.

Figure 1: Contribution to UK gap in BERD intensity (% of GDP), 1999



Source: Abramovsky, Harrison and Simpson (2004), "Increasing innovative activity in the UK? Where now for government support for innovation and technology transfer?", IFS Briefing Note No. 53

[1] For example, R&D by some large manufacturers in the US is allocated to the service sector because their main US activity is wholesale and retail. Dell Computers is an example of this.

Overall the UK's lower R&D intensity is mostly accounted for by lower R&D intensity *within* a few key manufacturing sectors, including communication equipment, transport equipment and computing machinery. This is partly counteracted by the UK's higher R&D intensity within pharmaceuticals and services.

How do these facts relate to the statement in the discussion document that industrial mix is important in explaining the UK's R&D performance relative to other countries? The evidence cited in the document is based on the DTI's 'R&D Scoreboard' and 'Value Added Scoreboard', which classify firms according to their country of ownership.[2] In contrast, the analysis presented above is based on R&D that is geographically located in the UK. These can be quite different, as discussed below. The latter (R&D located in the UK) has traditionally been the focus of Government concern, and is more relevant to a discussion of the role of the R&D tax credits.

The DTI research correctly identifies that, outside of Pharmaceuticals, Aerospace and Defence, *large UK owned firms* are more likely to be concentrated in sectors with low average R&D intensity, such as financial services and the extractive industries. In addition, compared to France and Germany, the largest UK owned firms are less well represented in sectors such as motor vehicles, IT, software and electronics. The two sets of results can be reconciled by the presence of more foreign-owned firms and/or more small and medium sized firms in these sectors in the UK. This increases the denominator of R&D intensity (value added) but not the numerator (R&D by large UK-owned firms).

From a policy perspective it is not obvious whether we should be more concerned about R&D performed by UK-owned firms or R&D performed in the UK. As mentioned above, the latter has normally been the main focus of policy, but we discuss below several reasons why the former may also be of interest.

2.2 Do firms in the UK have lower innovation intensity or are there fewer innovative firms?

The analysis presented by DTI and HM Treasury suggests that, compared to French and German firms in the same sectors, large UK-owned firms do not have lower R&D intensity than one would expect. Instead, there are fewer UK firms that do R&D, especially in the sectors mentioned above.

Evidence from the Third Community Innovation Survey (CIS3) provides some support for the hypothesis that innovative firms in the UK do not have a lower innovation intensity than firms in other countries, but that a smaller proportion of firms in the UK are innovative. The first line of Table 1 shows the proportion of manufacturing firms in each country that reported introducing a product and/or process innovation during the 1998-2000 period. The proportion in the UK is lower than in France and especially Germany.[3] This pattern is similar within individual high-tech sectors, although the UK

[2] The analysis is based on information presented in "R&D Intensive Businesses in the UK", DTI Economics paper no. 11, March 2005

[3] There are some concerns over the representativeness of the national samples. In particular the response rate in Germany (and to a lesser extent the UK) was quite low so the sample may be biased towards innovative firms.

performs particularly poorly relative to the other countries in the machinery and electrical sectors.

Table 1: Innovative activity in manufacturing, 1998-2000

	France	Germany	Spain	UK
Product and/or process innovators	41%	60%	35%	34%
New products as a % of sales, product innovators	19%	45%	32%	30%
% of innovators with cooperation agreements with the research base	19%	13%	8%	14%

Source: Abramovsky, Harrison and Simpson (2004), "Increasing innovative activity in the UK? Where now for government support for innovation and technology transfer?", IFS Briefing Note No. 53; data from the 3rd Community Innovation Survey

However, the second and third rows of Table 1 show that, conditional on being an innovator, UK firms have comparable levels of innovation intensities as innovators in the other countries, as measured by the percentage of sales that are due to new products, and the percentage of firms that have cooperation agreements with the research base. Other evidence that supports the idea that fewer UK firms engage in R&D is given in Bond, Harhoff and Van Reenen (2003).[4]

2.3 Footloose R&D: the importance of multinationals in the UK

Multinational firms, both UK and foreign-owned, form an important part of UK based R&D. Table 2 shows the proportion of R&D located in the UK that is performed by purely domestic firms and by domestic and foreign multinationals, broken down across five broad sectors. Multinationals perform more than 75% of all business R&D expenditure in the UK, and foreign multinationals perform around one-third. In 'mechanical engineering & electrical machinery' foreign multinationals perform nearly half of all UK R&D - there are not very many large UK multinationals doing R&D in these sectors.

Which countries account for most of the foreign R&D in the UK? Figures from the ONS suggest that US-owned multinationals perform more than half of foreign R&D, and account for an increasing proportion, rising from 13% of all UK R&D in 1999 to 25% in 2003. The next largest country by ownership is France, with French multinationals accounting for 8% of all UK R&D in 2003.[5]

[4] Bond, S, D. Harhoff and J Van Reenen (2003) "Investment, R&D and financial constraints in Britain and Germany", October 2003, 55 pp., IFS Working Papers, W99/05

[5] "Research and Development in UK Businesses, 2003", ONS, January 2005

Table 2: Proportion of UK R&D performed by multinationals, 2000

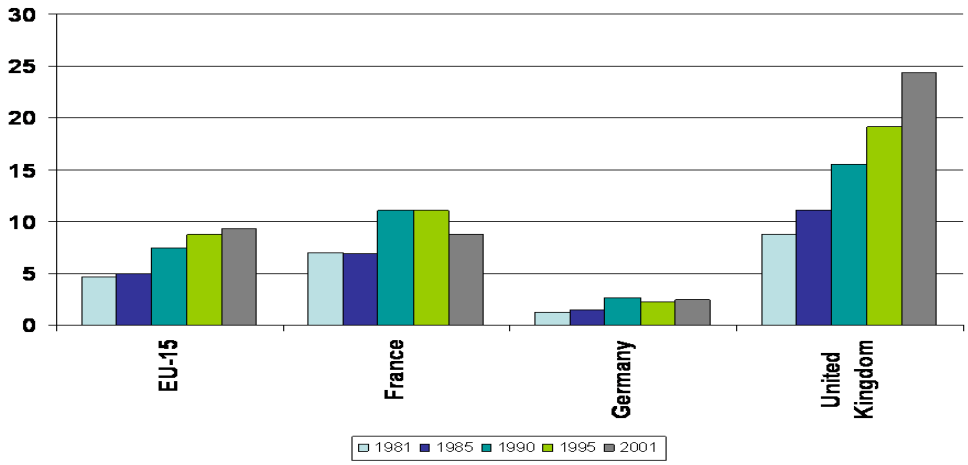
R&D product group	R&D (£bn)	Domestic firms	Multinational firms	
			UK	Foreign
Pharmaceuticals & Chemicals	*3.42*	16%	52%	32%
Mechanical Engineering & Electrical Machinery	*2.36*	16%	36%	48%
Transport equipment & Aerospace	*1.85*	10%	52%	38%
Other manufacturing	*1.08*	42%	38%	21%
Services	*2.25*	39%	43%	17%

Source: Griffith, Redding and Simpson (2005) "Foreign ownership and productivity: new evidence from the service sector and the R&D lab" *Oxford Review of Economic Policy* 20: 3, 440-456.

2.4 R&D is becoming more mobile

R&D, as with other activities, is becoming increasingly mobile across countries. This is not a new trend, but there is some suggestion that the pace of change has accelerated recently, at least for some countries. The recent World Investment Report emphasise increasing cross-border investments in R&D, particularly in developing countries. [6] Data from the OECD show that this internationalisation is more pronounced for the UK than for other G5 or EU countries. Figure 2 shows the amount of UK based R&D that is financed from abroad, mainly through the activities of foreign multinationals. In 1981 less than 10% of UK based R&D was financed from abroad. By 2001 it had reached nearly 25%, substantially higher than in France, Germany or the EU-15 on average.

Figure 2: The share of R&D financed from abroad



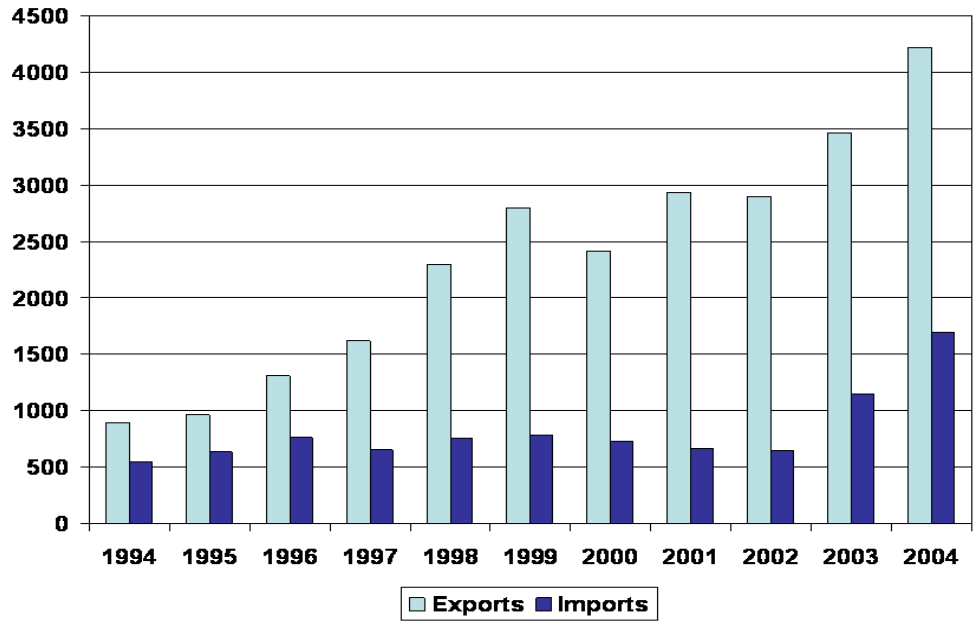
Source: OECD Main Science and Technology Indicators, 2004

[6] "Transnational Corporations and the Internationalization of R&D", WIR05, UNCTAD

Another way to see the increasing internationalisation of R&D is to look at trade in R&D. There are a number of difficulties with measuring trade in intangible goods such as R&D. Nonetheless, looking at trends over time should contain some information (if these difficulties have remained relatively similar over time). Trade in R&D is based around the transfer of intellectual property rights. For example, if a US multinational performs R&D in the UK, and then transfers the intellectual property rights to its parent firm in the US, this should be counted as an export of R&D from the UK to the US.

Figure 3 shows the value in millions of pounds of exports from and imports of R&D into the UK. These show that the UK has a substantial and growing trade surplus (exports minus imports). This is in line with Figure 2, foreign firms carry out R&D in the UK and export it for use elsewhere in the world.

Figure 3: Exports and Imports of R&D, by year (millions of pounds)



Source: Table 3.9 in Chapter 3: Trade in services, The Pink Book, ONS, 2005.

2.5 Which countries do we export R&D to and import it from?

The largest UK trading partner in R&D is the US. This is probably largely accounted for by US firms owning R&D labs in the UK. The UK also has a trade surplus with some other European countries. Table 3 shows the five countries with which the UK had the largest trade surplus and largest deficit in 2003. A few points are striking about this Table. The first is that we have a substantial trade surplus with other G5 countries.[7] The second is that the size of the trade deficits are very small. While much attention has been placed on increased offshoring of R&D to countries such as India and China, these still represent a very small part of total trade in R&D.

Table 3: Trade in Research and Development, 2003 (millions of pounds)

	Export	Import	Trade Balance
US	1609	293	1316
Japan	528	45	483
Switzerland	279	34	245
Belgium and Luxembourg	209	18	190
Germany	246	139	107
Poland	3	4	-1
India	1	5	-4
China	2	8	-6
Philippines	11	47	-36
Sweden	73	332	-258

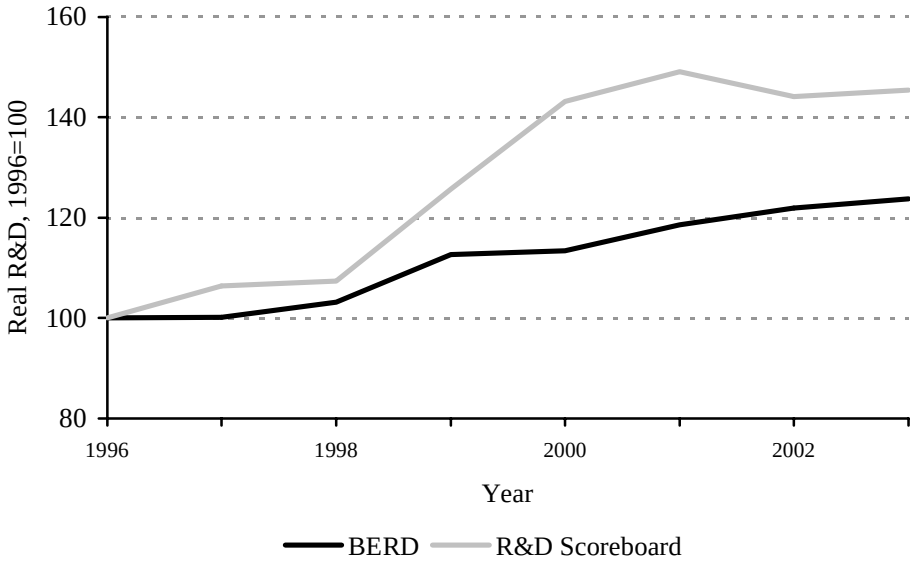
Source: Table B2, UK Trade in Services, ONS, 2003

2.6 What if we look at UK plc? Do UK firms do R&D abroad?

UK multinationals also do an increasing amount of R&D abroad. To give a rough idea, Figure 4 compares the trends in the total amount of R&D performed by business in the UK (from the ONS Business Enterprise R&D Survey) with the trend in the total amount of R&D reported in the DTI's R&D Scoreboard, which includes R&D performed abroad by UK firms. The two data sources are not exactly comparable, and so the series have been rebased to equal 100 in 1996. The Figure suggests that the amount of R&D performed abroad by UK firms increased significantly between 1998 and 2000. This may be related to the wave of international mergers and acquisitions that took place over this period. The evidence presented by the DTI and HM Treasury also suggests that R&D performed overseas, but funded by UK firms, grew faster over this period than R&D performed in the UK.

[7] One puzzle is that, as we explain in Section 2.6 below, UK firms perform about the same amount of R&D in the US as US firms perform in the UK. It is not clear whether the fact that the UK has a trade surplus in R&D with the US is a result of measurement issues or whether it represents the true picture of flows of intellectual property between the two countries.

Figure 4: UK R&D levels, BERD and R&D Scoreboard, 1996-2003



Notes: values have been deflated by the GDP deflator and re-based to equal 100 in 1996.
Sources: ONS; DTI, R&D Scoreboard (1997 to 2004)

The US is a major recipient of this investment. According to the US Bureau of Economic Analysis, UK majority-owned firms carried out $5bn of R&D in the US in 2000, equivalent to about 28% of all the R&D performed in the UK.[8] The equivalent percentages for French and German firms are much lower, at 10% and 16% of the R&D performed in France and Germany respectively.

2.7 How much R&D is performed by small and medium sized enterprises?

ONS figures show that enterprises with 0-249 employees carry out 26% of all business R&D in the UK. However, many of these may be part of larger groups, and so do not count as SMEs for the purpose of the R&D tax credits. After attempting to control for this by using historic information on past ownership, the ONS estimate that SMEs perform only 3% of R&D. The ONS state that this estimate should be treated with caution, and indeed it does appear to be surprisingly low. For example, in 2002-03 the SME R&D tax credit provided £225m of tax relief on an estimated £1.2bn of R&D expenditure.[9] This corresponds to about 9% of all business R&D in the UK, but includes R&D subcontracted by SMEs to large firms or non-profit organisations. In any case, SMEs account for a relatively small percentage of total R&D.

An alternative way to examine this is to look at the proportion of UK R&D accounted for by the largest R&D doers. ONS figures show that the top 20 R&D-doing enterprise groups accounted for 55% of all business R&D performed in the UK in 2003, while the top 100 accounted for 78%.

[8] Source: U.S. Bureau of Economic Analysis, U.S. Department of Commerce, Survey of Foreign Direct Investment in the United States, http://www.bea.gov/bea/di/di1fdiop.htm

[9] Source: HMRC

Chart 5.1 in the discussion document shows that R&D expenditure performed in UK businesses with 0-249 employees has grown much faster since 2000 than R&D expenditure performed in larger businesses. However, as discussed above, many of these businesses with 0-249 employees do not count as SMEs for the purposes of the R&D tax credits. Another reason for the increase in R&D performed by smaller businesses could be an increasing tendency for larger firms to outsource R&D rather than perform it in house.

2.8 What are the trends in service sector R&D?

Service sectors make up over 70% of economic activity in the UK and therefore play an important part of any aggregate picture. In general, service sectors have much lower R&D intensity than manufacturing. However, there is great diversity within the service sector, with sectors such as computer services performing an increasing amount of R&D, while the wholesale and retail sectors hardly do any R&D at all.

In addition, innovative activities in some service industries may not come under the heading of formal R&D. For example, the introduction of information technology and new working practices in the wholesale and retail sector is thought to have contributed significantly to productivity growth, but does not show up in the R&D statistics. These considerations are particularly important since the sectors that make up the largest proportion of the UK's productivity gap with the US are wholesale, retail and financial services.[10] Formal R&D is not likely to be a major determinant of productivity in these sectors, and so the R&D tax credits have limited relevance for them.

As discussed above, the UK has a relatively high level of R&D intensity in services compared to France and Germany. The services sectors in the UK that do the most R&D are 'computer and related activities' (46% of all service sector R&D) and 'post and telecommunications' (23%). There is also a significant amount of R&D performed in 'research and development services' (16%) that is not allocated to any particular product group.

Service sector R&D grew by 53% in real terms in the five years between 1998 and 2003, going from 16% of all business R&D to 21%. Over half of this growth was accounted for by the 'computer and related activities' sector. These trends are similar to those found by the DTI and HM Treasury analysis of the R&D Scoreboard data. While some of this growth in service sector R&D certainly represents a real shift in activity, some of it is probably due to re-labelling of activity that would previously have been allocated to the manufacturing sector, as well as increased outsourcing of R&D that is not allocated to any particular product group. As discussed above, these types of issues make international comparisons of trends in service sector R&D very difficult.

[10] See Griffith, Harrison, Haskel and Sako (2003), "The UK productivity gap and the importance of the service sectors", AIM Briefing Note

3. Emerging firms

The discussion document states that *"the strongest immediate case is for giving additional support to growing innovative firms"* (Paragraph 5.22). In this section we briefly consider the possible rationales for targeting emerging winners, and whether it would be possible to do so within the existing system. We then discuss some recent cross-country evidence on the growth and innovation activity of small firms.

3.1 What are the rationales for targeting emerging firms?

The main economic rationales for government support for R&D in businesses are that businesses do not always capture the full returns from their R&D (the 'spillovers' rationale) and that information constraints may result in a shortage of external finance for businesses investing in risky R&D, especially for SMEs (the 'credit constraints' rationale). R&D tax credits are a form of government support that allows businesses to maintain decision making over which R&D projects to pursue, on the basis that businesses are likely to have better information about potential payoffs than governments.

In this context, any rationale for giving additional support through R&D tax credits to 'growing innovative firms' should be based on the hypothesis that they are particularly constrained by the inability to protect their intellectual property and/or by an inability to access external finance.

An additional consideration could be that the returns to government support may be higher in firms that have a greater ability to make use of it, for whatever reason. The fact that a firm is growing and innovative may demonstrate that it is able to generate higher returns to government support than firms that are neither growing nor innovative. However, this signal is also given to private sources of finance and support, and the government is unlikely to have better information as to which firms are able to generate the best returns than the private sector.

The issue then returns to whether 'growing innovative firms' are more affected by the spillovers and/or the credit constraints rationale for intervention than other firms in a way that prevents the private sector from directing resources towards high-return activities. We investigate some empirical evidence on this point below. If it turns out that 'growing innovative firms' are not more significantly constrained by these factors, it may be that policy is better directed at increasing the proportion of firms that are innovative, rather than focusing support on firms that are already innovative.

Any rationale for additional support should also be set against the potential costs of introducing unnecessary complexity, uncertainty and distortions to the tax system. These may affect the choice of activity and legal form by businesses in ways that are not determined by genuine economic considerations.

3.2 Targeting emerging firms within the existing system

The discussion document states that *"the Government invites early views on whether it is possible to target effectively additional support to the emerging firms within the tax credit system, without compromising the basic market-driven premise"* (Paragraph 5.30)

Targeting specific groups of firms is likely to introduce considerable complexity and distortions into the existing system. It is worth noting that an *incremental* credit would

focus a larger proportion of government support on firms with growing R&D expenditure than the current volume based credit. However, an incremental credit could have other unintended consequences and would be more complex than the current system.[11] Given that R&D investment decisions are taken using a long time horizon, there is also a considerable premium on maintaining stability and certainty in the design of R&D tax credits.

The discussion document also suggests that it may be easier to target SMEs more generally. There are several reasons why SMEs may be more affected by both the spillovers and the credit constraints rationales for government support for R&D. However, the current system is already more generous to SMEs due to the higher rate of the SME R&D tax credit and its repayable aspect.

3.3 Cross country evidence on the growth and innovation activity of small firms

In this section we briefly consider recent cross-country evidence on the growth and innovation activity of small firms. Evidence produced for the World Bank suggests that, while entry and exit rates are fairly similar across industrial countries, the post-entry growth of surviving firms differs markedly.[12] In particular, conditional on surviving for seven years after entry, manufacturing firms in the UK have grown on average significantly faster than firms in France or Germany, but only two-thirds as fast as firms in the US. Entrants in the US are on average smaller relative to incumbent firms than in the UK, are more likely to exit early on, but then grow rapidly if they do survive. These patterns are consistent with higher levels of experimentation and more rapid sorting between successful and unsuccessful entrants in the US, although the larger US domestic market may also be an important factor.

These results also raise the possibility that there may be higher barriers to the growth of small firms in the UK (and especially France and Germany) than in the US. However, the fact that surviving small firms tend to grow faster in the US than in the UK does not necessarily imply that firms in the UK face higher barriers to growth, and in particular barriers related to innovation. Survey evidence suggests that growth is not always a business goal of small businesses, so we need to examine the extent to which businesses are in fact constrained.

A study by the Cambridge-MIT Institute provides the only recent comparable evidence on the innovation activity of firms in the UK and the US.[13] Table 4 shows preliminary evidence from this study on the extent to which firms report barriers to innovation activity, focusing on three potential barriers that are related to the economic rationales for R&D tax credits. The results are based on a matched sample of 1900 UK and US firms with fewer than 1000 employees. For each potential barrier listed, the table shows the percentage of firms in each country rating it as very significant or crucial.

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[11] For further discussion in the UK policy context see Bloom, Griffith and Klemm (2001), "Issues in the design and implementation of an R&D tax credit for the UK", IFS Briefing Note No. 15.

[12] "Microeconomic evidence of Creative Destruction in Industrial and Developing Countries", by Eric Bartelsman, John Haltiwanger and Stefano Scarpetta, World Bank Working Paper No. WPS 3464

[13] Andy Cosh, Alan Hughes and Richard Lester, International Innovation Benchmarking Study, Cambridge-MIT Institute. These results are preliminary and reproduced by kind permission of the authors.

Table 4: Barriers to innovation in the UK and US: % of firms rating factor as very significant or crucial

	UK	US
Lack of appropriate sources of finance	24.1	33.4 **
Innovation costs too high	23.9	25.9
Innovation too easy to copy	16.6	20.3 **

Notes: ** indicates that the two values are stastically significantly different.
Source: Andy Cosh, Alan Hughes and Richard Lester, International Innovation Benchmarking study, Cambridge-MIT Institute. These results are preliminary.

The most striking result is that a higher proportion of firms in the US report that each of the potential barriers to innovation are very significant or crucial for them. The difference is statistically significant for two of them. It is important to note that this does not necessarily imply that these barriers to innovation are in fact more severe in the US, since a firm may report that a barrier is not important simply because it does not *want* to innovate, or because other factors are more important in preventing it from innovating. However, these results do provide some indication that the types of barriers to innovation that might be addressed by R&D tax credits are not particularly important in explaining the innovation performance of firms in the UK compared to the US.

4. The Internationalisation of R&D

The discussion document recognises the importance of attracting R&D by multinationals into the UK if the government is to meet the 2.5% target it has set itself (see paragraphs 3.7-3.9). In section 2 we showed that the UK is already the recipient of a large amount of foreign R&D investment and that UK firms perform an increasing amount of R&D overseas. In this section we highlight the main determinants of where firms locate R&D. We point out that there may be costs to encouraging UK firms to relocate R&D from abroad back into the UK, for example if those investments were facilitating the transfer of new leading edge technologies into the UK. We then consider the issues related to tax competition - if R&D tax credits are mainly leading firms to relocate R&D around the globe, but not increase the total amount of R&D, then this may not be a sustainable strategy.

4.1 What determines where firms locate R&D?

A recent survey of R&D managers conducted by the Economist Intelligence Unit indicates that access to skilled labour is the most important factor determining R&D location decisions, followed by proximity to markets, and costs.[14] Traditionally the economics literature has emphasised two main reasons for locating R&D overseas – the adoption of products and services to local markets and access to cutting edge technologies. The latter is thought to be growing in importance, and the discussion document highlights the importance of maintaining a strong science base. Preliminary research by IFS researchers suggests that in some sectors such as pharmaceuticals, foreign R&D in the UK is disproportionately located near to top quality research departments.[15]

There is also evidence that cost is an important determinant of R&D location decisions. R&D tax credits are one way that policy can encourage footloose R&D to relocate to the UK, by reducing the cost of R&D. In doing this, an overriding issue that has been emphasised in the literature (for example in Bronwyn Hall's work) is the importance of simplicity and certainty in design. Below we discuss various issues relating to tax competition and R&D.

4.2 Technology transfer and technology sourcing

As highlighted in the discussion document, and in work by the OECD and others, multinational firms play an important role in productivity growth, in both home and host countries. One important way in which they do this is by transferring new technologies and best practices between countries. What is important to emphasise is that the flows of information go both ways – UK multinationals operating abroad access new ideas and technologies and can transmit these back to the UK. This is often referred to as technology sourcing. The business literature has emphasised the importance of technology sourcing as a method of gaining access to foreign knowledge. Firms can tap into leading edge knowledge by setting up R&D labs abroad, close to clusters of innovative activity, and use this knowledge to improve productivity in their home operations.

[14] "Scattering the seeds of invention: the globalisation of research and development", Economist Intelligence Unit, September 2004

[15] Abramovsky, Harrison and Simpson (2005), "University research and the location of R&D", IFS mimeo

Recent work has examined whether technology sourcing in the US had a beneficial impact on UK firms during the 1990s.[16] The findings suggest that UK firms with R&D activity located in the US benefited more from US R&D 'spillovers' than firms that were not located there. In fact, growth in US R&D was associated with an average 5% increase in productivity over the decade for UK firms, with the majority of the benefits accruing to firms with R&D located in the US. This compares to an average 6% increase in productivity due to their own R&D activity.

This evidence suggests that there may be a trade off between encouraging the location of R&D activity in the UK and gaining access to cutting edge technologies. Support for domestic R&D activity is justified by spillover benefits to other UK-based economic activity. But the foreign R&D activity of UK multinationals, especially in the US as the world leader in many areas of technology, is also likely to benefit the UK by increasing the productivity of UK firms.

4.3 Tax competition: a zero sum game?

One potential concern about using tax credits as a policy instrument to attract R&D to the UK is whether it leads to increasing costs, if other countries respond and engage in a process of tax competition.

As we saw above, a rising share of UK R&D is funded from abroad and UK firms are undertaking more of their R&D overseas. Using an international panel of industries, Bloom and Griffith (2001) show that R&D in one country responds to a change in its price in another "competitor" country.[17] This suggests that UK R&D tax credits could play a role in determining whether increasingly footloose R&D locates in the UK or moves overseas. However, they also show that there is a positive relationship between the amount of R&D conducted in one country and the tax price of conducting R&D in its major FDI partners. This suggests that at least part of the explanation for the mobility of R&D could be the increasing generosity of tax subsidies to R&D that are on offer in many countries.

Recent work across US States finds similar results – for every dollar of R&D that one State attracts this reduces R&D done in another State by roughly a dollar, resulting in a zero-sum competition for mobile R&D. [18]

[16] Rachel Griffith, Rupert Harrison, and John Van Reenen "How special is the special relationship? Using the impact of US R&D spillovers on UK forms as a test of technology sourcing", IFS Working Paper, W04/32

[17] Nick Bloom and Rachel Griffith (2001) "The Internationalisation of R&D" *Fiscal Studies* 22: 3, 337-355, 2001

[18] Wilson (2005) "Beggar thy Neighbor? The In-State vs. Out-of-State Impact of In-State R&D Tax Credits" *Federal Reserve Bank of San Francisco, mimeo*

5. Other issues

Finally, a key issue is the availability of scientists and engineers to conduct R&D, and the increasing mobility of researchers. Recent (and preliminary) work by Manuel Trajtenberg using patents data shows that there has been far greater 'brain drain' out of the UK than other countries. Brain drain is defined as scientists who are listed as inventors on a patent at least once in the UK and are then observed patenting in another country (patents give the address of each inventor). Using a sample of patents from the US Patent office during the 1980s and 1990s Trajtenberg's data show that the US experienced a substantial net inflow of patenting scientists, while the UK experienced a substantial net outflow, as shown in Table 5 below. The implications of these results for policy are not immediately obvious, but they raise questions about the UK's ability to capture the benefits from its science base, and merit further consideration.

Table 5: Flows of scientists between countries

	To						
From	US	Japan	Germany	France	***UK***	Other	Total
US	0	808	657	265	***1602***	3940	7272
Japan	908	0	115	22	***49***	150	1244
Germany	731	122	0	95	***38***	715	1701
France	329	20	83	0	***48***	185	665
UK	***2077***	***41***	***51***	***66***	***0***	***574***	***2809***
Other	3996	123	645	217	***444***	0	5425
Total	8041	1114	1551	665	***2181***	5564	20769
Net	**769**	**-130**	**-150**	**0**	***-628***	**139**	

Source: http://emlab.berkeley.edu/users/bhhall/others/TrajtenbergOct1904slides.pdf

6. Summary of the round table discussion

On 25 October 2005 IFS and HM Treasury hosted a round table discussion that brought together practitioners from business, tax professionals, academics and policy makers from HM Treasury, HMRC and DTI to consider the proposals put forward in the discussion document "Supporting growth in innovation: enhancing the R&D tax credit" published by HM Treasury, DTI and HM Revenue and Customs in July 2005

The discussion centred around three main topics - whether a focus on targeting emerging firms was the right approach, attracting internationally mobile R&D, and service sector R&D.

6.1 Targeting emerging firms

One of the key questions raised by the discussion document was whether a focus on targeting emerging firms was the right approach for policy.

Overall, participants felt that this was a very difficult question and no real consensus or definitive answers were arrived at. Two separate aspects of this issue were identified - the practicalities of claiming the credit for small and growing firms and the question of whether targeting emerging firms was like "picking winners" and whether this was an appropriate policy objective.

There was some discussion of how the R&D tax credits work in practice for SMEs. Several participants welcomed the improvements to the definition of R&D and guidelines for SMEs. Tax practitioners said that applying for the R&D tax credits was a learning process for small firms, and that in many cases the tax credits provided incentives to identify R&D activity that they had not previously regarded as R&D. This was possibly a good side effect. However, a number of difficulties remained, including issues around uncertainty in the value of the credit a firm would actually receive, delays in decisions and receiving the credit and the fact that a large proportion of expenditure was not eligible for relief. Everyone agreed that the repayability of the credit was a good feature that worked well and made a substantial difference to small firms. Some participants with experience of venture capital said that the R&D tax credits often helped secure access to third round funding.

Participants from HM Treasury stressed that they were not interested in 'picking winners' and that any changes to the policy would be within the existing market-based framework. While some participants said they agreed with targeting 'winners' they did not specify how they would do it, and many participants thought that targeting emerging firms would introduce unnecessary distortions, and that R&D tax credits should be as neutral as possible across firms. One particular difficulty that was highlighted was how to define "emerging firms".

It was widely recognised that targeting non-innovators was important. One idea raised was to provide more generous relief for first-time claimants.

6.2 Internationally mobile R&D

A key issue raised in the discussion document is the ability of the UK to attract internationally mobile R&D.

It was generally agreed that there are many different factors affecting the location of R&D labs, and that they differ depending on the specific projects or industries they are

associated with. In some cases, innovation is bought from suppliers and in other cases is done within the firm. In all cases, information and communication technologies are considered to have changed significantly the ability to fragment the R&D process across countries and firms, making close proximity of colleagues less important.

In general, business practitioners pointed out that a “strong environment” is essential to attract investment in R&D. Factors considered to be important included a strong research base, sound financial institutions, a rigorous education system, robust regulation, good infrastructure, and an attractive environment for internationally mobile scientists. The availability of specific technologies, skills or markets also affects location decisions, as well as friendly product market regulation for the relevant product. In addition, the “reputational capital” that a country has in specific research fields is important in attracting and maintaining R&D investment. Specific factors like animal rights protests are relevant for industries such as pharmaceuticals. The cost of doing R&D is also relevant; hence R&D tax credits and other pecuniary incentives affect firms’ decisions to locate R&D labs in a particular country. Several participants considered that tax competition was to some extent a zero-sum game. Some also thought that there was an element of ‘fashion’ in locating R&D in countries such as China, and that the UK would benefit from creating a similar ‘buzz’.

The simplicity of the UK R&D tax credits and the fact that they are volume based were considered as very positive features. However, a large part of what business consider as R&D expenditure does not qualify for the R&D tax credits; for example, overhead costs, capital expenditure, subcontracting R&D and other ancillary services. It was pointed out that, for many businesses, other features of the tax system were probably more important, particularly the headline corporate tax rate on income flows resulting from R&D.

6.3 Service sector R&D

Services are a large (and growing) part of the economy and thus will be an important part of the aggregate picture, even if most service sectors are not very R&D intensive.

Several participants stressed that services are very different to manufacturing industries. It was pointed out that, in economic terms, the IT-enabled service sector (firms using technology but not generating it) is much more important than the IT sector (firms that generate new technology). Innovation in the IT-enabled service sectors is more associated with the introduction and modification of processes. Thus, innovation and the creation of value added are related to the adoption and adaptation of technologies rather than to the introduction of new technologies. Innovation is likely to occur along the entire value chain in services.

There were some specific concerns about the claim process being more difficult in specific or newer industries such as software. Some participants suggested considering the Canadian system as an example in which there are industry-specific government consultants that assist firms in the claiming process. Others did not support this suggestion, instead they favoured industry-specific guidance on what constitutes R&D.