

INCREASING INNOVATIVE ACTIVITY IN THE UK?
WHERE NOW FOR GOVERNMENT SUPPORT FOR
INNOVATION AND TECHNOLOGY TRANSFER?

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1. Introduction

In this Briefing Note, we present new evidence on the UK's innovative performance and provide a summary of government business support programmes aimed at fostering innovative activity and technology transfer. Following recent reviews of policy in this area, there remain a number of such schemes in operation. We discuss the rationales for each, including the extent to which they overlap, and suggest some ways in which evidence on take-up and on effectiveness might be used to guide any future policy changes in this area.

Our main conclusions are:

- Business R&D intensity is lower in the UK than in the US, France and Germany. Most of the gap with France and Germany is due to lower UK R&D intensity in several manufacturing industries. In contrast, *higher* UK R&D intensity in the service sector contributes to a reduction in the gap with both countries. Service sector R&D has grown particularly fast in the UK in recent years.
- Innovative firms in the UK, France and Germany are equally likely to collaborate with, or source information for their innovative activities from, research institutions. However, firms in the UK are less likely to be innovative in the first place.
- The UK has a wide range of policies to encourage innovative activity and technology transfer, and frequent changes have been made to schemes in recent years. A number of the schemes aim to address the same underlying market failures. This suggests a need to evaluate

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whether having multiple schemes is the most effective way of addressing these market failures, given the possibility of excessive administrative burdens.

The Department of Trade and Industry (DTI) has identified the need for improved evaluation of the economic impact of business support schemes.² Our evidence suggests that evaluations used to guide future policy changes should examine three main issues:

- the extent to which schemes overlap in achieving the same objectives;
- whether schemes affect firms' decisions to become innovative (in addition to increasing innovation activity by firms that are already innovative);
- the extent to which policies are tailored to the needs of firms in the service sector.

Policy background

Expenditure on research and development (R&D) activity in European countries lags behind that in the US. Gross expenditure on R&D in the US comprised 2.8% of gross domestic product (GDP) in 2001, compared with 2.0% in the EU15 countries. With this in mind, the Barcelona European Council in March 2002 set an explicit target for R&D expenditure in the European Union to reach 3% of GDP by 2010, with two-thirds of that R&D expenditure to be financed by the private sector. The UK government has also set a target of increasing expenditure on R&D in the UK to 2.5% of GDP by 2014 from 1.9% in 2001.

The UK government recently commissioned two reviews into innovation policy: the Lambert Review of Business–University Collaboration³ and the DTI Innovation Review.⁴ (Brief details of the reviews are given in Annex A.) Following these, the 2004 Budget announced measures building on the recommendations of the Lambert Review, including changes to the Higher Education Innovation Fund to provide funding for universities for technology transfer activities. Other recent policy changes include expanding the breadth of activities that qualify for the R&D tax credits, changes to the tax treatment of Scientific Research Organisations, and the recasting of DTI business support products in the area of innovation.

²See DTI, *Business Support Solutions: A New Approach to Business Support*, March 2004, www.dti.gov.uk/bss/product_guide.pdf.

³*Lambert Review of Business–University Collaboration: Final Report*, December 2003, www.hm-treasury.gov.uk/media/EA556/lambert_review_final_450.pdf.

⁴DTI, *Innovation Report – Competing in the Global Economy: The Innovation Challenge*, December 2003, www.dti.gov.uk/innovationreport/.

At the time of the 2004 Spending Review, the government announced an increase in public spending on science over the period to 2007–08 and published details of its 10-year framework for science and innovation.⁵ This set out a series of goals in terms of public and private sector R&D activity, interactions between business and the publicly funded research base, and improvements in skills. The DTI has also committed to a Public Service Agreement (PSA) target for the period 2005–08 to:

Improve the relative international performance of the UK research base and increase the overall innovation performance of the UK economy, making continued progress to 2008, including through effective knowledge transfer amongst universities, research institutions and business.⁶

2. International comparisons of innovative activity

Is the UK not fulfilling its innovative potential? HM Treasury and the DTI have recently proposed a set of indicators to be used to benchmark the UK's innovation performance against other countries.⁷ While it is hard to say what the optimal level of innovative activity in the UK might be, such comparisons can point out areas in which the UK may be underperforming. However, it is important to note that differences between countries may also arise for structural reasons that do not merit policy attention. Here, we present new evidence on some of these comparative performance measures to shed light on where the UK's 'innovation gap' might lie.

Business expenditure on R&D (BERD)

As discussed in the DTI Innovation Review, the level of business expenditure on R&D as a proportion of GDP is low in the UK compared with the US, Germany and France.⁸ It is interesting to examine the extent to which cross-country differences in R&D intensity are driven by differences in economies' sectoral composition or by differences across countries in the intensity with which R&D is carried out within sectors. In other words, is R&D intensity lower in the UK because activity is more concentrated in sectors that have naturally low R&D intensity or because R&D intensity is

⁵HM Treasury, DTI and DfES, *Science and Innovation Investment Framework 2004–2014*, July 2004, www.hm-treasury.gov.uk/spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm.

⁶For details of the DTI's PSA targets, see www.dti.gov.uk/psa_target.html.

⁷DTI and HM Treasury, *Benchmarking UK Productivity Performance*, March 2004, www.hm-treasury.gov.uk/media/97626/productivitychs.pdf.

⁸See also R. Griffith and R. Harrison, *Understanding the UK's Poor Technological Performance*, IFS Briefing Note no. 37, June 2003, www.ifs.org.uk/corpact/bn37.pdf.

low within particular sectors of the economy? If it is the latter, we can ask which sectors contribute the most to the UK's low overall R&D intensity.⁹

The government's science and innovation investment framework publication addresses exactly this question for the manufacturing sector, where most R&D is performed, comparing the UK with the US, France and Germany.¹⁰ Below, we present the results of a similar exercise for the whole business sector, including the service sector. Data limitations mean that the results of any comparison with the US would be extremely unreliable, so we only present results comparing the UK with France and Germany. In particular, differences in data collection in the US would result in too much of the gap in R&D intensity between the UK and the US being attributed to higher R&D intensity in the US service sector. While the US appears to have seen rapid increases in R&D intensity in services such as 'wholesale and retail' over the late 1990s, much of this is due to mis-allocation of R&D performed by manufacturing firms.¹¹

Our results are presented in Figure 1. The overall gaps in business R&D intensity between France and Germany and the UK were 0.13% and 0.46% of GDP respectively in 1999. In both countries, the largest contributor to the gap was lower UK R&D intensity in 'communication equipment', with a partially offsetting effect from higher UK R&D intensity in 'pharmaceuticals'. These results for the manufacturing sector correspond closely with those in the government's science and innovation investment framework document.

The graph also shows that higher service sector R&D intensity in the UK than in France or Germany acted to reduce the overall gap in R&D intensity with both countries by about 0.1% of GDP. Even though R&D intensity is lower in the service sector than in manufacturing, the large size of the service sector means that small changes in R&D intensity can have significant effects on overall R&D spend. More recent data for the UK show that R&D in the UK service sector grew rapidly between 1999 and 2002, with the result that service sector R&D accounted for over 20% of total UK business R&D in 2002, up from 17% in 1999.¹²

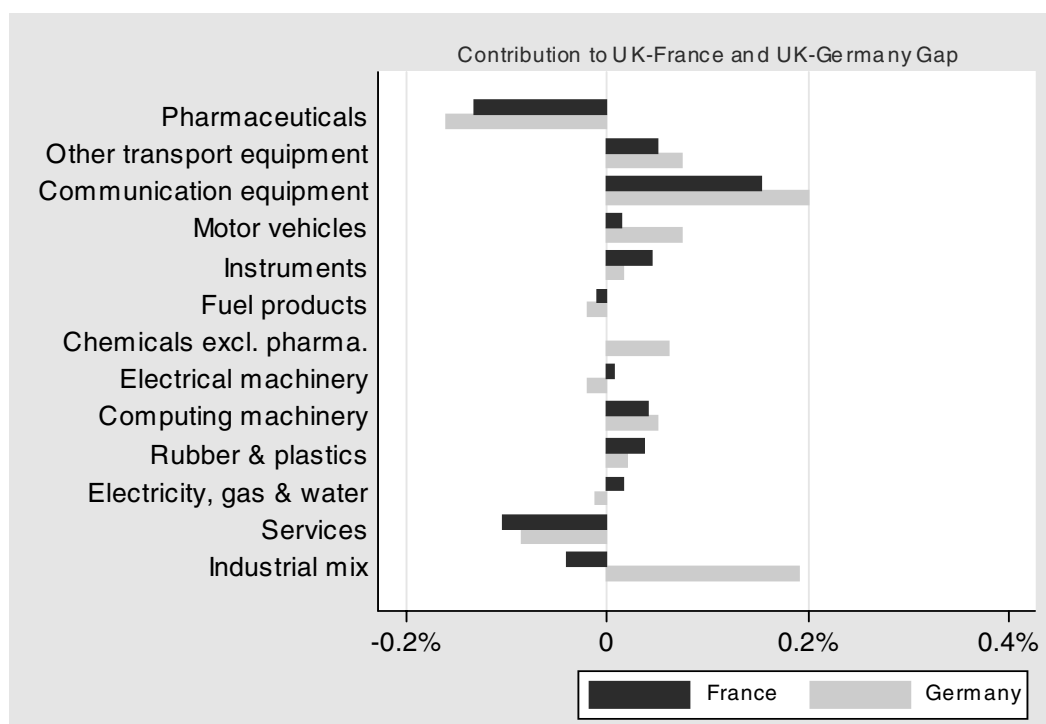
⁹Annex B outlines some potential limitations of this type of thought experiment.

¹⁰See pages 57–59 of HM Treasury, DTI and DfES, *Science and Innovation Investment Framework 2004–2014*, July 2004, www.hm-treasury.gov.uk/spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm.

¹¹See Annex B for further discussion of the US data.

¹²Source: J. Owens, 'Research and experimental development (R&D) statistics 2002', *Economic Trends*, no. 610, pp. 39–63, September 2004, www.statistics.gov.uk/downloads/theme_economy/ET610.pdf.

Figure 1. Contribution to UK–France and UK–Germany gap in BERD intensity (% of GDP), 1999: total gap 0.13% and 0.46% of GDP respectively



Source: Authors' calculations using OECD data.

Finally, the main difference between the UK–France and UK–Germany comparisons is the large positive contribution from a different industrial mix for Germany of almost 0.2% of GDP – almost half of the total UK–Germany gap. This is mainly due to a smaller share of UK value added in motor vehicles (an R&D-intensive sector), but also due to the larger share of UK value added in the service sector, which has low average R&D intensity compared with the manufacturing sector, as discussed above.

Other indicators of innovative activity

An alternative source of internationally comparable information on innovative activity is the EU-wide Community Innovations Survey (CIS). Here, we provide some comparisons from the third survey, which covers the three-year period 1998–2000.¹³ The survey identifies innovative firms as those that answer ‘yes’ to either of the following questions:

- ... did your enterprise introduce any technologically new or significantly improved products (goods or services) which were new to your firm?

¹³For a wider range of comparisons, see L. Abramovsky, J. Jaumandreu, E. Kremp and B. Peters, *National Differences in Innovation Behaviour: Facts and Explanations*, June 2004, www.eco.uc3m.es/IEEF/ieef-cis3.pdf.

- ... did your enterprise introduce any new or significantly improved processes for producing or supplying products (goods or services) which were new to your firm?

We describe firms that answer ‘yes’ to the first question as *product* innovators and those that answer ‘yes’ to the second as *process* innovators. Table 1 shows the percentage of firms in the manufacturing sector that are classified as product and/or process innovators for France, Germany, Spain and the UK. The first section shows that the UK has a lower percentage of innovators than Germany and France. In all four countries, the percentage of firms that are innovators is higher in high-tech manufacturing sectors than in low-tech manufacturing sectors, but within each group the general cross-country pattern remains.

Table 1. Indicators of innovative activity from the third Community Innovations Survey

	<i>France</i>	<i>Germany</i>	<i>Spain</i>	<i>UK</i>
Percentage of innovators (product and/or process), manufacturing population, 1998–2000				
<i>High-tech sectors</i>	56%	70%	46%	44%
<i>Low-tech sectors</i>	35%	55%	32%	30%
Total manufacturing	41%	60%	35%	34%
Percentage of innovative sales in total sales, manufacturing population of product innovators, 1998–2000				
<i>High-tech sectors</i>	23%	52%	38%	38%
<i>Low-tech sectors</i>	11%	30%	24%	21%
Total manufacturing	19%	45%	32%	30%

Notes: Calculations are weighted to be representative of the relevant population in each country. Population for the first section of the table is the total manufacturing sector. Population for the second section is product innovators in the manufacturing sector. Populations are for firms with 10 or more employees (20 or more in France). *High-tech sectors*: transport equipment, chemicals, machinery and equipment, and electrical. *Low-tech sectors*: food, beverages and tobacco, textiles and leather, wood and paper, rubber and plastic products, non-metallic mineral products, metallic products, recycling, and manufacturing not classified elsewhere.

Source: Authors’ calculations using CIS 3.

Firms identified as product innovators answer a further question on the proportion of total sales that are due to new products or services. This provides a guide to the importance of the innovation and how the market values the firm’s innovative activity. The lower half of the table illustrates that the UK compares more favourably on this indicator in manufacturing industries, although it still lags behind Germany. This provides some indication that, while a smaller percentage of firms are product innovators in the UK than in France and Germany, those that do introduce new products benefit to a similar extent.

Collaboration and technology transfer

In light of the recent focus on business–university collaboration and technology transfer, we look at two indicators derived from the CIS of the extent to which innovative firms (product and/or process innovators) interact with the research base. Here, we also include information for innovative firms in the service sector. The first section of Table 2 shows the percentage of innovators that had formal cooperation agreements on innovative activities with the ‘research base’, defined to include commercial laboratories and R&D enterprises, universities and higher education institutions, and government and private non-profit research institutes. Across all four countries, the proportion of innovative firms undertaking such agreements is higher in the manufacturing sector than in services and is highest among innovative firms in high-tech manufacturing industries. Looking across countries, the UK has a higher percentage of innovative firms undertaking such agreements than Germany and Spain, although lower than France.

Table 2. Business–university interaction: evidence from the third Community Innovations Survey

	<i>France</i>	<i>Germany</i>	<i>Spain</i>	<i>UK</i>
Percentage of innovators with cooperation agreements with the research base, population of innovators (product and/or process), 1998–2000				
<i>High-tech manufacturing sectors</i>	25%	21%	14%	20%
<i>Low-tech manufacturing sectors</i>	16%	8%	6%	11%
Manufacturing	19%	13%	8%	14%
Services	9%	8%	7%	9%
Total	16%	10%	8%	12%
Percentage of innovators sourcing information from institutional sources, population of innovators (product and/or process), 1998–2000				
<i>High-tech manufacturing sectors</i>	52%	56%	41%	55%
<i>Low-tech manufacturing sectors</i>	36%	35%	27%	38%
Manufacturing	42%	43%	31%	45%
Services	34%	35%	28%	35%
Total	39%	39%	30%	40%

Notes: Calculations are weighted to be representative of the population of innovative firms in each country (product and/or process innovators). Populations are for innovative firms with 10 or more employees (20 or more in the manufacturing sector in France). High-tech and low-tech manufacturing sectors are described in the Notes to Table 1. Source: Authors’ calculations using CIS 3.

The second indicator looks at where firms sourced information for their technological innovation activities. In the lower section of Table 2, we show the percentage of innovative firms that sourced information from ‘institutional sources’, defined to include universities and higher education institutes, and government and private sector non-profit research institutes. The table shows the UK to be on a par with France and Germany on this measure.

These two measures indicate that innovative firms in the UK engage in roughly the same amount of collaborative research and technology transfer from research institutions as innovative firms in France or Germany. The key difference across countries appears to be in the first indicator in Table 1: whether or not firms are innovators in the first place. On this measure, the UK looks similar to Spain and performs worse than France and Germany.

An important question therefore is why firms in the UK are less likely to be innovative. Is it because specific market failures are more prevalent in the UK, or is it because government policy is not affecting this margin – the decision to engage in innovative activity – to the same extent in the UK as in other countries? It is possible that both reasons play a role. Work by Bond, Harhoff and Van Reenen, which compares investment in R&D by British and German firms, suggests that financing constraints may be more prevalent in the UK and that they mainly affect a firm's decision to engage in R&D rather than the amount of R&D investment they undertake if they are R&D active.¹⁴

It is difficult to make definitive statements about the role of government policy in explaining the lower proportion of innovating firms in the UK. A recent study of the effects of R&D subsidies in Spain found that, even though most subsidies went to firms that would have performed R&D anyway, almost half of the total increase in R&D expenditure as a result of the subsidies was due to an increase in the number of (mainly small) firms performing any R&D at all.¹⁵

Using the CIS, we can compare across countries the proportion of innovators in manufacturing sectors that received public financial support (for example, a grant) for innovation activities. The proportion is significantly lower in the UK, at just over 13%, than in France, Germany and Spain, where it is roughly 30%. Again, we should bear in mind that this is only for innovative firms, which make up a smaller proportion of all firms in the UK than in France and Germany, as shown in Table 1. Thus the percentage of *all* firms that received public financial support for innovation activities is almost certainly even lower in the UK relative to France and Germany. However, it is important to stress that, from these types of figures, it is not possible to tell whether public programmes have been effective in inducing firms to become innovative or whether innovative firms are more likely to be aware of, or receive, such support.

¹⁴S. Bond, D. Harhoff and J. Van Reenen, 'Investment, R&D and financial constraints in Britain and Germany', IFS Working Paper no. 99/5, updated October 2003, www.ifs.org.uk/workingpapers/bhvr26.pdf.

¹⁵X. Gonzalez, J. Jaumandreu and C. Pazo, 'Barriers to innovation and subsidy effectiveness', *RAND Journal of Economics*, forthcoming.

Next, we briefly consider potential rationales for government intervention to increase the amount of innovative activity in the economy. In the rest of the Briefing Note, we then consider in more detail the types of public financial support available in the UK and suggest some evaluation questions that might be useful in shaping future policy changes in this area.

3. What market failures might rationalise intervention?

Policy-makers increasingly recognise the importance of solid economic rationales for intervention to be successful in increasing the amount of innovative activity in the economy.¹⁶ In practice, establishing a solid reason for intervention involves two steps. The first consists of identifying a reason why the market does not provide sufficient incentives for individuals and firms to undertake the ‘optimal’ amount of innovative activity from society’s point of view. The second step involves demonstrating how government intervention can correct this at sufficiently low administrative and compliance cost.

It is sometimes argued that a narrow definition of market failure along these lines is too simplistic to capture the potential role of government in supporting innovation. Innovation is said to be such a complex process, involving so many networks of different actors, that correcting individual market failures may have small or perverse effects unless the system is considered as a whole. However, while it is clearly true that innovation is a complex process, this ‘systems failure’ approach often provides few clear guidelines for intervention. Indeed, almost any intervention may appear to be justified by appealing to a systemic failure. For this reason, we take a broad view of potential market failures as our framework for evaluating rationales for intervention. In practice, this is also the approach most often taken by policy-makers.

Most potential and actual economic rationales for intervention in innovation on the basis of market failure fall into three broad categories. The first category is based upon the idea that innovators may find it difficult to appropriate all the returns from their innovations. As a result, their incentives to innovate are reduced below the optimal level. We call this the ‘spillover’ rationale for intervention. The second category stems from the difficulties groups of individuals or firms encounter in acting collectively towards some common goal. These difficulties may result in otherwise productive projects not being undertaken. We call this the ‘coordination failure’ rationale for intervention. Finally, the third category comes under the heading of ‘information failures’. These arise where differences in the information available to different parties prevent transactions from taking

¹⁶See, for example, Annex F of DTI Economics Paper no. 7, *Competing in the Global Economy: The Innovation Challenge*, November 2003, www.dti.gov.uk/economics/economics_paper7.pdf.

place that would have taken place if both parties had had access to the same information. Information failures are often cited in the context of firms' attempts to find external sources of finance for risky projects, but there are many other examples. The different rationales for intervention each suggest different potential policy interventions. We discuss these below.

Spillovers

The spillover rationale suggests that government intervention to lower the private cost of innovation to the innovator may raise innovative activity towards the optimal level. Ways that government might do this include R&D tax credits and grants for R&D. We should also note that the patent system addresses the issue of spillovers by guaranteeing innovators the rights to the profits from their innovations for a certain period of time. However, not all innovations are easy to patent, and the system is inevitably imperfect at preventing imitation. Another way that innovators may solve the spillover problem is by collaborating with other innovators and sharing the returns from the project. In economic terms, they 'internalise' the 'externality' within the group.

Coordination failures

The coordination failure rationale suggests a range of different interventions. For example, several parties might find it difficult to commit themselves to collaborating on a research project that involves a large fixed cost, even though they all expect the project to be profitable. This is more likely to be the case if the project involves sunk investments in capital whose use is specific to the project. Government intervention might be beneficial in this case by subsidising the fixed costs of the project or by underwriting the risk involved in the fixed cost. We should note that coordination failures may also result in too much innovative activity from society's point of view. For example, if several firms are competing to perfect and patent the same invention, they may overinvest in R&D by duplicating each other's research. Coordinated activity in this case might result in a smaller amount of innovation expenditure being used more efficiently. Of course, there may be anti-competitive implications from this type of collaborative activity that might in turn have detrimental effects.

Information failures

Finally, the information failure rationale can be interpreted in several ways. The simplest implication is that the provision of information by government may often be beneficial. For example, a firm may not be aware of the existence of potential research partners or of a particular technology. Of course, firms should, in principle, be willing to pay for the provision of potentially beneficial information, but this may not be a relevant consideration when they don't know that the information exists (i.e. it is an 'unknown unknown'!). In other cases, it may be beneficial for government to provide a system of standards and/or accreditation in order to overcome

information failures. The case of information failures that may lead to credit constraints is discussed in Section 4.

The relative importance of these different rationales is likely to vary across firms and industries according to a number of factors, including the nature of the specific innovative process, the extent to which patents and other mechanisms allow innovators to appropriate any profits from innovation, and the degree of product market competition.¹⁷ Nevertheless, these fundamental sources of market failure should drive the design of effective policy.

4. Current policies and their rationales

Specific policies towards innovation and technology transfer operate within a larger context of government interventions that affect the rate at which new technologies are invented and diffuse through the economy. These include the education system (particularly but not exclusively higher education), direct government support for R&D in universities and government laboratories, the patent system, competition policy and many other aspects of regulation. We will only discuss this broader context in so far as it directly affects the specific policies we are considering. In addition, we will not focus on the recently introduced R&D tax credits, even though their cost is greater than any of the individual policies we consider.¹⁸ However, since the R&D tax credits are principally designed to address the issue of spillovers arising from R&D, we will discuss how their introduction may necessitate a re-evaluation of the rationales for other government schemes that aim to address similar issues.

The schemes

We focus on largely DTI-funded schemes aimed at increasing R&D activity and technology transfer. We restrict our attention to policies that do not target a single specific industry or technology. A brief summary of each of the schemes we consider is given in Box 1. Much of the available information refers to the schemes in operation before the introduction of the DTI's new business support products; however, where appropriate, we illustrate the correspondences between the old schemes and the new ones.

¹⁷For an interesting discussion, see S. Martin and J. Scott, 'The nature of innovation market failure and the design of public support for innovation', University of Copenhagen mimeo, 1999.

¹⁸For information on the design and effectiveness of R&D tax credits, see, for example, N. Bloom, R. Griffith and A. Klemm, *Issues in the Design and Implementation of an R&D Tax Credit for UK Firms*, IFS Briefing Note no. 15, January 2001, www.ifs.org.uk/innovation/bn15.pdf and N. Bloom, R. Griffith and J. Van Reenen, 'Do R&D tax credits work? Evidence from an international panel of countries 1979–97', *Journal of Public Economics*, 2002, vol. 85, pp. 1–31.

Box 1. Innovation programmes

Grant for Research and Development (www.dti.gov.uk/r-d/). This scheme provides grants to small and medium-sized enterprises (SMEs) for both research and development projects. The size of grant available varies with the type of project undertaken. The Grant for Research and Development scheme is one of the few grant schemes in the EU not to require collaboration in order to get funding. It replaced the **Smart** scheme in 2003. The Smart scheme had previously subsumed the SPUR, SMART and Regional Innovation Grant schemes. A related grant-based scheme is the **Grant for Investigating an Innovative Idea**, which reimburses consultancy advice.

Collaborative Research & Development (www.dti.gov.uk/crd/) and **LINK** (www.ost.gov.uk/link). The new Collaborative Research & Development product builds on the LINK scheme in providing support for research partnerships between UK industry and the research base, but also includes funding for business-to-business collaborations and nearer-market research. The LINK scheme dates back to 1986 and provides support for pre-commercial collaborative research between businesses and research institutions. Research consortia need to comprise at least one industrial partner and at least one research institution – for example, a university. Individual programmes within the scheme focus on particular pre-market areas with the potential for commercial exploitation. Government or the Research Councils provide up to 75% of eligible costs, depending on whether the project involves far- or near-to-market research. LINK is open to companies of all sizes, although SME participation is strongly encouraged.

Knowledge Transfer Partnerships (KTP) (www.ktponline.org.uk/). Knowledge Transfer Partnerships provide financial support for collaborative projects between businesses and individuals from public or private research organisations, higher education institutions (HEIs) or further education (FE) colleges, where a graduate undertakes a research placement at the firm. The grant is paid to the HEI, research organisation or FE college, and the company contributes funding for the placement. Staff from the company and from the research partner jointly supervise the graduate and the project. In 2003, the scheme superseded the **Teaching Companies Scheme**, which originated in 1975.

Knowledge Transfer Networks (www.dti.gov.uk/ktn/) and **Faraday Partnerships** (www.faradaypartnerships.org.uk/). The new Knowledge Transfer Networks product provides grants to set up networks in specific technology areas and appears to supersede the Faraday Partnerships scheme. Faraday Partnerships were introduced in 1997 and provided grant funding for consortia of institutions and organisations (universities, trade associations and businesses), to promote research, technology transfer and the commercial exploitation of science and technology. Funding comprised two parts: a grant from the DTI or other government department of up to £400,000 per year for at least three years to operate the Partnership; and a ring-fenced grant of £1 million from one or more Research Councils or a government department for specific research projects.

Higher Education Innovation Fund (HEIF). The HEIF was established in 2000 as an umbrella under which to consolidate policies pertaining to the improvement of higher education funding, industry–academia collaboration, and support for commercialisation of university research. These policies include the University Challenge Scheme and Science Enterprise Challenge. The government is to expand the HEIF into a permanent ‘third stream’ of income for HEIs, focused on knowledge transfer. The HEIF will provide £187 million for knowledge transfer activities over 2004–05 and 2005–06.

Table 3 shows how the costs of these schemes compare with relevant projected DTI budgets for 2004–05. For comparison, the table also shows the projected Office of Science and Technology (OST) expenditure on science, most of which is accounted for by the Research Councils, as well as HM Treasury’s estimated cost of the R&D tax credits. It is clear from the table that the total costs of any of the individual schemes are small compared with total government support for knowledge transfer and innovation, or indeed the cost of the R&D tax credits and other forms of business support.

Table 3. Relevant DTI and OST budgets

<i>Area</i>	<i>Specific scheme</i>	<i>Budget for 2004–05</i>
DTI: knowledge transfer and innovation		
Knowledge transfer		£150.6m
	<i>KTP</i>	£18.0m
	<i>LINK</i>	£19.3m ^a
	<i>Faraday Partnerships</i>	£9.4m ^a
Exploitation of the science base		£80.0m
	<i>HEIF</i>	£60.3m
Technical infrastructure ^b		£77.7m
DTI: finance for investment^c		
		£152.1m
	<i>Grant for R&D</i>	£26.0m
DTI: improving business performance^d		
DTI: enterprise^e		
DTI: strengthening regional economies		
OST expenditure on science^f		
Cost of R&D tax credits^g		
		£430m

^aFigures for 2003–04. Total government expenditure on LINK in 2002–03 was £43m.

^bLargest component is the National Measurement Scheme.

^cExcluding Aerospace Launch Investment. Largest component is the Enterprise Fund.

^dLargest components are Business Links and the Small Business Service.

^eLargest component is the Phoenix Fund.

^fMainly Research Councils expenditure.

^gEstimated cost in 2003–04 according to Chapter A of HM Treasury, *Financial Statement and Budget Report 2004*.

Sources: *DTI Departmental Report 2004*, www.dti.gov.uk/expenditureplan/report2004; Chapter A of HM Treasury, *Financial Statement and Budget Report 2004*, March 2004, www.hm-treasury.gov.uk/media/1/1AFE2/bud04_cha_190.pdf; Annex F of DTI Economics Paper no. 7, *Competing in the Global Economy: The Innovation Challenge*, November 2003, www.dti.gov.uk/economics/economics_paper7.pdf.

The number of participants varies considerably with the scheme. As of January 2004, there were 899 Knowledge Transfer Partnerships, roughly 80% of which involved SMEs. There are 24 established Faraday Partnerships, involving about 1,700 firms and 400 university research teams.¹⁹ About 2,400 firms, mostly SMEs, and about 200 research base

¹⁹Source: *DTI Departmental Report 2004*, www.dti.gov.uk/expenditureplan/report2004.

institutions have been involved in 75 LINK programmes since the launch of LINK in 1986.²⁰ There were 1,314 Smart awards for R&D over the period 1999–2001.²¹ As a comparison, there were 4,296 claims for the SME R&D tax credit in the single fiscal year 2002–03.²² It would be interesting to know the proportion of firms that participated in more than one scheme, although there is little data publicly available.

The Community Innovations Survey can be used to look at the proportion of businesses in receipt of any form of government support for innovation (financial or non-financial, from local, national or European government agencies). In Section 2, we noted that innovative firms in the manufacturing sector in the UK were less likely to have received public financial support for innovation than those in France, Germany or Spain. Table 4 shows more detailed information on take-up from the UK survey for both innovative and non-innovative businesses.

Table 4. Percentage of firms that used public support for innovation, 1998–2000

	<i>Any support</i>	<i>Technology development</i>	<i>Technology acquisition</i>
Manufacturing	10.9%	4.5%	2.5%
<i>High-technology sectors</i>	15.3%	6.9%	3.7%
<i>Low-technology sectors</i>	9.0%	3.5%	1.9%
Services and distribution	6.4%	3.0%	1.3%
Total	8.4%	3.7%	1.8%

Notes: Populations are firms with 10 or more employees. High-tech and low-tech manufacturing sectors are described in the Notes to Table 1.

Source: Authors' calculations using CIS 3.

The first column of the table shows the proportion of firms that reported receiving any form of government support for innovation activities, while the second and third columns show the proportions of firms in receipt of support for technology development (such as LINK or Smart) and for technology acquisition (such as KTP). As might be expected, the proportion of firms using such schemes is highest in high-tech manufacturing sectors. Perhaps more surprising is that the proportion of firms in service sectors that say they have received support for technology development or acquisition is similar to that in low-tech manufacturing sectors. We also

²⁰Source: *Strategic Review of LINK Collaborative Research*, Report of the Independent Review Panel, September 2003, www.ost.gov.uk/link/linkreview/linkreviewpanelreport03.pdf.

²¹Source: PACEC, *Evaluation of Smart (including SPUR) 2001: Final Report and Appendices*, DTI Evaluation Report Series no. 3, September 2001, www.dti.gov.uk/about/evaluation/smart.pdf.

²²Source: *Inland Revenue Corporate Tax Statistics*, www.inlandrevenue.gov.uk/stats/corporate_tax/menu.htm.

looked at the extent to which firms said they had received more than one type of support, and found that around half of those that were in receipt of support for technology acquisition also received support for technology development.

Rationales for specific interventions

In Table 5, we classify the schemes by their stated rationales, based upon statements in various DTI publications. An important general point is highlighted by the table, and also emerges from a number of government publications. This is that there are a large number of individual schemes relative to the number of stated rationales. For example, LINK, KTP and Faraday Partnerships all aim to address barriers to communication, collaboration and knowledge transfer between businesses and higher education institutions.²³ These barriers come under the coordination failure and information failure rationales described above. The three schemes are structured in different ways, address different aspects of knowledge transfer and reach businesses through different routes – for example, KTP involves the direct placement of HEI researchers in businesses. But, given the administrative costs of running multiple schemes, it would be interesting to investigate the extent to which the schemes overlap in achieving the same objectives. There is very little evidence on how the schemes interact with each other, and very little official justification of why each should exist independently of the others.

Table 5. The rationales for the schemes

<i>Scheme</i>	<i>Spillovers?</i>	<i>Coordination failures?</i>	<i>Information failures?</i>	<i>Main rationale</i>
Grant for R&D	Yes	No	Yes	Credit constraints
LINK	Yes	Yes	Yes	Barriers to communication
KTP	No	Yes	Yes	Barriers to communication
Faradays	No	Yes	Yes	Barriers to collaboration
HEIF	No	No	Yes	Barriers to commercialisation

Source: Authors' classification of official rationales stated in Annex F of DTI Economics Paper no. 7, *Competing in the Global Economy: The Innovation Challenge*, November 2003, www.dti.gov.uk/economics/economics_paper7.pdf and in *DTI Departmental Report 2004*, www.dti.gov.uk/expenditureplan/report2004.

²³Other government schemes with similar aims include the HEIF, EUREKA and the Public Sector Research Exploitation Fund.

While Box 1 above shows that, over time, there has been some rationalisation of the number of schemes in operation, new ones have been started – for example, the University Challenge Scheme (although this has now been subsumed into the HEIF). The number of schemes that are or have been in operation suggests that a third condition should be added to any rationale for intervention. Not only should there be an identifiable market failure that can be successfully addressed by government intervention, but it must also be shown that this market failure is not already addressed by existing policies and could not be addressed by small alterations to existing policies.

A specific example of the overlap between business support products arises in the case of Grant for R&D. This well-established scheme has two stated rationales. The first is that SMEs would otherwise find it difficult to raise small sums because of the high cost of due diligence.²⁴ Essentially, this stems from a failure of information: potential investors do not have the same information as the SME about the quality of the project and the probability that the project will be successful. In addition, this information is too costly to acquire relative to the small size of the project. The second rationale is based on spillovers arising from the SME's R&D.

Both of these issues are addressed by the SME R&D tax credit, which reduces the cost to firms of their R&D by providing additional tax relief. In particular, the SME tax credit has a repayable aspect, so that SMEs making losses can claim a cash payment from the Inland Revenue equal to 24% of their eligible R&D spending. This significantly reduces the downside risk associated with R&D, and should make it easier for SMEs to access external finance. Inland Revenue statistics show that almost 90% of the financial cost of the SME R&D tax credit is for claims for the repayable credit.²⁵ Figures from an evaluation of Smart in 2001²⁶ show that about 90% of businesses that were awarded Smart R&D grants over the period 1988–98 were engaged in R&D during the last financial year, with the mean R&D expenditure for those engaged in R&D equal to £324,000 and the median equal to £70,000. Although this does not tell us how much R&D expenditure was incurred before or at the time of the award, it suggests that the vast majority of Smart award winners might also, in principle, be

²⁴Annex F of DTI Economics Paper no. 7, *Competing in the Global Economy: The Innovation Challenge*, November 2003, www.dti.gov.uk/economics/economics_paper7.pdf.

²⁵Source: *Inland Revenue Corporate Tax Statistics*, www.inlandrevenue.gov.uk/stats/corporate_tax/menu.htm.

²⁶PACEC, *Evaluation of Smart (including SPUR) 2001: Final Report and Appendices*, DTI Evaluation Report Series no. 3, September 2001, www.dti.gov.uk/about/evaluation/smart.pdf.

eligible for support through the SME R&D tax credit (although, under current rules, Smart recipients cannot also claim the R&D tax credit).

Although there remain some differences between the R&D tax credit and the Grant for R&D scheme – for example, in the timing of payments and the fact that non-incorporated businesses can apply for R&D grants – the rationale for the latter scheme clearly needs to be re-examined in the light of the former.²⁷ Several arguments suggest that the R&D tax credit may be a better way to target R&D in small firms than Grant for R&D. For example, the fact that the costs for investors of evaluating prospective projects are high relative to the size of the projects presumably also applies to government decisions on which schemes to support via Grant for R&D. Indeed, it seems likely that private investors have access to better information and less costly evaluation mechanisms than government. Also, given that the principal rationale for the Grant for R&D scheme is financing constraints, this implies that a system of subsidised or guaranteed loans is a more appropriate policy response than a system of grants.

5. What evidence might help guide future policy changes?

The DTI has outlined the new structure of its business support products in the area of innovation.²⁸ However, the scope of support in this area does not appear to have changed significantly in terms of the types of schemes in operation. On what grounds might any future changes to the design of these policies be decided? The schemes described above have been evaluated to assess their economic benefits and cost-effectiveness.²⁹ While the overarching aim of the policies considered in Section 4 is to increase innovative activity, they operate through a number of different routes. Nevertheless, one key evaluation question applies in all circumstances: ‘Did the policy lead to additional, beneficial activity that would not have taken place in the absence of the policy intervention?’.

The method of addressing this question will vary with the policy under scrutiny. In the case of the Grant for R&D scheme, the question might be framed as ‘Does participation lead firms to carry out economically valuable R&D activity that would not have otherwise taken place?’. A recent

²⁷This is especially true bearing in mind that the total relief given under the SME R&D tax credit is almost 10 times the size of the total grants given under the Grant for R&D scheme.

²⁸See DTI, *Business Support Solutions: A New Approach to Business Support*, March 2004, www.dti.gov.uk/bss/product_guide.pdf.

²⁹For a summary of the findings of some of the evaluation evidence, see Annex F of DTI Economics Paper no. 7, *Competing in the Global Economy: The Innovation Challenge*, November 2003, www.dti.gov.uk/economics/economics_paper7.pdf.

evaluation of the Smart scheme³⁰ addressed this by comparing outcomes for participants with those for unsuccessful applicants. This type of approach can produce valuable information beyond simply asking participants what would have happened had they not received support. Further evaluation questions might include whether the R&D activity undertaken generates social returns additional to the private returns to participants (i.e. spillover effects to other firms) and whether the scheme's effectiveness varies across different types of firms. Answering these questions may also shed light on whether the original rationales for the scheme are indeed valid in practice.

In the discussion in Section 4, we suggested that where policies have overlapping rationales, there is clearly scope for assessing whether the policy objectives can be met with a single scheme or a smaller number of schemes. For example, are some schemes substitutes for each other in delivering the same outcomes, and do they target the same groups of firms? It would be useful to know whether participant firms have used, or have considered using, more than one scheme with similar objectives (for example, LINK, Faraday Partnerships and KTP). The evidence from the CIS presented in Section 4 shows that some firms do use more than one type of support, with half of those participating in technology acquisition schemes also participating in technology development schemes. If schemes do meet similar objectives, it is worth considering their relative cost-effectiveness in case there is scope for rationalising the number of schemes in operation.

In Section 2, we saw that innovative manufacturing firms in the UK, France and Germany are similar in the extent to which they collaborate with and source information from the research base, but that the proportion of manufacturing businesses that are innovative is lower in the UK than in France or Germany. An important policy evaluation question is therefore whether the firms that use support schemes are first-time innovators, or whether the schemes operate at a different margin, increasing innovative effort amongst firms already engaged in innovative activity. Evidence on the extent to which firms receive more than one award over time would also shed light on this: 'Is the pool of participant firms widening over time or is there a set of "usual suspects" that make up the majority of participants?'

A final question is the extent to which policies affect service sector R&D activity. While we might expect the majority of scheme participants to be conducting R&D related to manufacturing activity, as this is where the majority of R&D expenditure is directed, it might be a concern if policies were not effectively addressing any market failures leading to underinvestment in service sector R&D. While R&D intensity in the service

³⁰PACEC, *Evaluation of Smart (including SPUR) 2001: Final Report and Appendices*, DTI Evaluation Report Series no. 3, September 2001, www.dti.gov.uk/about/evaluation/smart.pdf.

sector has increased in recent years, and our evidence in Section 4 showed that the proportion of firms receiving support for innovation in the service sector was not a great deal lower than that in low-tech manufacturing, it would be interesting to examine the effectiveness of innovation policies in the service sector. This would be particularly interesting, given that this sector accounts for the largest component of the UK's productivity gap with the US.³¹ Some starting points might be to look at take-up of the R&D tax credits among firms conducting R&D for the service sector and to examine awareness of public support schemes among such firms.

Annex A. The Lambert Review and the DTI Innovation Review 2003

The Lambert Review of Business–University Collaboration

This Review investigated the extent and benefits of collaboration between businesses and university research departments. The final report made a number of recommendations aimed at both universities and business, and recommendations for greater government support for collaborative activities. Of particular relevance to the topics covered in this Briefing Note, it gave support to two existing schemes – LINK and Knowledge Transfer Partnerships (described in detail in Section 4). However, the report suggested improvements to the marketing of the KTP scheme and also to the marketing of R&D tax credits in order to raise awareness and take-up by business. It made no recommendations for further tax incentives to encourage R&D. The report recommended that government support should be focused more strongly on SMEs. It made a number of recommendations concerning direct public funding for university research, and suggested possible extensions to the LINK scheme and the Higher Education Innovation Fund as ways of allocating funding for business-relevant research. Finally, the report concluded that too much emphasis had been placed on university spin-outs and not enough emphasis on licensing of new technologies to businesses.

The DTI Innovation Review

The terms of reference of the DTI Innovation Review were wide ranging, including an assessment of the UK's relative innovation performance, the identification of areas where market or institutional features inhibit innovation in UK firms, identification and prioritisation of the policy levers that might address the market and institutional failures, and comparison of these with current government policy and support.³² While the Review did consider the rationales for particular support schemes and evidence on their

³¹For a discussion, see R. Griffith, R. Harrison, J. Haskel and M. Sako, *The UK Productivity Gap and the Importance of the Service Sectors*, AIM Briefing Note, December 2003, www.aimresearch.org.

³²See DTI, Innovation Group, *Innovation Review: Terms of Reference*, INNREV/AP/2.

effectiveness,³³ it made very few recommendations for reforms to specific schemes or for the introduction of any new schemes. Instead, it made some more general recommendations – for example, with regard to government procurement, increasing the role of the Small Business Service in advancing knowledge transfer and innovation, and the development of a Technology Strategy.

Annex B. Methodological issues in comparing R&D across countries

We should note some limitations of the kind of R&D decomposition presented in Section 2. First, increasing the amount of R&D performed in an industry is likely to result in an increase in its level of productivity, and, as a result, its share of total value added may rise. Therefore the results should be interpreted simply as a description of a single point in time, rather than as causal explanations of overall R&D intensity. Second, the results of this type of decomposition can be sensitive to the level of aggregation used. The proportion of the gap accounted for by a different industrial mix between countries will generally be larger the lower the level of disaggregation. Finally, there are differences across countries in the way that R&D statistics are collected.

This last issue may be particularly important when comparing the UK and the US. In the UK, R&D is allocated to a sector according to the type of product to which the R&D relates, whereas in the US, R&D is allocated according to the sector of operation of the firm doing the R&D. Any differences are likely to be particularly important in the service sector. For example, a firm that only provides R&D services to manufacturing firms may be allocated to the service sector in the US rather than to the manufacturing industry for which the R&D is being performed. In addition, US manufacturing firms with most of their production facilities located abroad (for example, Dell) may be misleadingly classified in the ‘wholesale and retail’ sector since most of their domestic workforce is engaged in sales and distribution. For these reasons, we do not present a comparison with the US, as the results could be seriously misleading, attributing too much of the UK–US gap in R&D intensity to higher R&D intensity in the US service sector than in the UK service sector.

³³See Annex F of DTI Economics Paper no. 7, *Competing in the Global Economy: The Innovation Challenge*, November 2003, www.dti.gov.uk/economics/economics_paper7.pdf.