

## CHAPTER 4

# University-Industry Links and U.K. Science and Innovation Policy

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In the United Kingdom, as elsewhere in the industrial and developing world, more attention is being paid to the role that universities can play in supporting innovative performance and productivity growth. The U.K. Science and Innovation Investment Framework for 2004 to 2014 is based on the proposition that

Harnessing innovation in Britain is key to improving the country's future wealth creation prospects . . . [Britain] must invest more strongly than in the past in its knowledge base and translate this knowledge more effectively into business and public service innovation. Securing the growth and continued excellence of the U.K.'s

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public science and research base will provide the platform for successful innovation by business and public services. (Her Majesty's Treasury, DTI, and DfES 2004, 5)

The notion that the translation of science into business innovation is ineffective has deep roots:



[T]he small band of British scientific men have made revolutionary discoveries in science; but yet the chief fruits of their work have been reaped by businesses in Germany and other countries, where industry and science have been in close touch with one another. (Marshall 1923, 101–2, fn 1).

A problem that is so deep rooted as to be an issue during two periods a hundred years apart is unlikely to have an easy or straightforward policy solution. This chapter assesses the nature of university-industry links in the United Kingdom and outlines the current policy approach. The comparator in this respect is the United States, the current role model for U.K. policy in this area. The nature of that role model is often misinterpreted. One aspect of the role, namely that connected with licensing, patenting, and high-tech entrepreneurial spinoffs, is overemphasized. Other aspects—the differentiated role of U.S. universities, technology absorption by key user sectors such as retailing and wholesaling, and the important support role of public expenditure and procurement policy—are neglected (Hughes 2003). This chapter attempts to demonstrate the full range of university-industry interactions in the two countries. It also attempts to place those links in perspective within the range of sources of knowledge for business innovation. A brief overview of relevant U.K. policy locates university-industry links within the overall policy framework for innovation and science, engineering, and technology (SET). A key to developing successful policy is to integrate existing and potential policy levers as much as develop new initiatives; there is a potential role for more effective use of public procurement in this area.

### **The Diverse Nature of University-Industry Relationships**

Despite abundant evidence testifying to the diverse nature of university-industry relations, current discussions on innovation policy tend to focus on those few directly concerned with commercialization (patenting, licensing, and spinoffs). It is useful, therefore, to map out the range of actual interactions.

At least four potentially separable kinds of interactions work at the university-industry interface (Lester 2005). First is the basic university role of educating people and providing suitably qualified human capital for the business sector. Second is the role that research activity plays in increasing the stock of codified knowledge that may have useful or commercial elements. Third is a role in problem solving in relation to specifically articulated business needs. Fourth is a group of what one might term *public space functions*. These functions are relatively neglected but distinctive features of the role of universities in the economic and intellectual systems of nations. They include a wide range of mechanisms for interaction between the university staff and the business community. They range from informal social interactions to specially convened meetings and conferences, centers that promote entrepreneurship and entrepreneurship activities, and exchange of personnel, including through internships. Each of these public space functions promotes a range of activities between the business community and the university sector. They may lead to the transfer not only of codified but also of tacit knowledge and to the establishment of relationships that may in addition feed back into the other three roles.

It is also important to recognize the different elements that individual universities stress. These elements may reflect a university's particular mission as well as the economic circumstances of the university's locality or region and the role it chooses to play in relation to them. In a recent international collaborative study of regional patterns of university interactions, the Local Innovation Systems Project at the Massachusetts Institute of Technology (MIT) developed a useful typology for the ways in which different dimensions of activity may develop and be most appropriate to different local economic development pathways (Lester 2005).

One pathway focuses on the creation of new industries. The most important interactions occur in circumstances that emphasize leading-edge science and engineering research, aggressive technology licensing policies, and promotion or assistance of entrepreneurial businesses. Such circumstances may also lead to great emphasis on participation in standard setting and other activities that promote the rapid diffusion of particular technologies.

A second pathway emphasizes the role of universities, where the regional development strategy is focused on importing or transplanting industries, for instance, into formerly declining localities. In those circumstances, curricula that are responsive to the needs of the transplanted or imported industries (and associated education and human resources

developments) might receive more emphasis, as might technical assistance for the emerging subcontracting and supplying industries that those industries may require.

A third pathway emphasizes building bridges. To the extent that the local development strategy involves diversifying from existing strengths to new technological ones, the university role may emphasize making bridges between otherwise disconnected actors in the local system. It can also focus on filling structural holes in the networks of activity and creating new industrial identities.

A fourth pathway may apply where existing industries are upgrading. In these circumstances, problem solving and the use of faculty for consulting and contract research may assume significance. Associated activities include those designed to upgrade the skills of the educated labor force and those concerned with global best practices for scanning foresight exercises and developing user-supplier forums.

The first key point here is that the variety of interrelationships allows a rich set of interaction patterns. There is no one true way. Although regional patterns are emphasized here, the nature of the relationships varies sectorally. The second key point is that in each industry or region, universities will be only one among many sources of knowledge inputs. Their potential influence must be seen in this wider systems context.

### **University-Industry Links: A U.S.-U.K. Comparison**

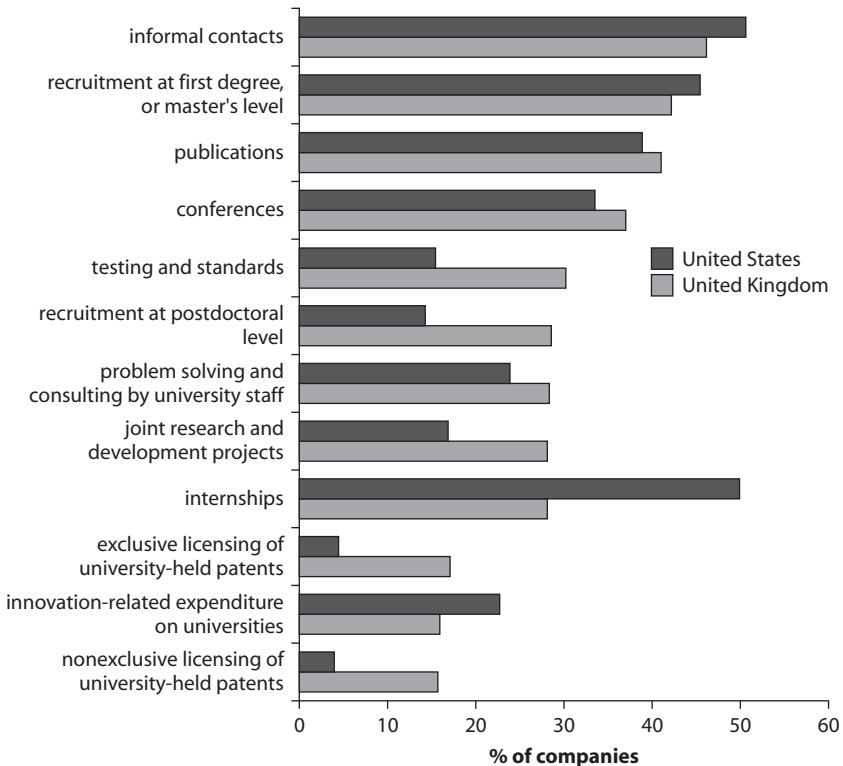
A recent survey by the Centre for Business Research (CBR) at the University of Cambridge, United Kingdom, and the Industrial Performance Center (IPC) at MIT indicates the variety of mechanisms by which university activity may affect innovative performance in industry. The survey benchmarked innovation activity in the two economies (Cosh, Hughes, and Lester 2006). The only survey to date that compares the U.K. and the U.S. systems, it provides the most recent data available for both countries.

The survey was carried out from March to November 2004 by telephone. Response rates were about 19 percent in the United States and about 18 percent in the United Kingdom. In 2005, a top-up survey was carried out by mail for the largest firms in both countries. The survey instrument contains about 200 questions and generates about 300 variables per firm. The final sample consisted of 2,129 U.K. firms and 1,540 U.S. firms. The results reported here relate to a sample of 2,298 businesses: 1,149 from each country matched by size, sector, and age. This

sample makes it possible to compare the countries without adjusting for differences in the size, sector, or age of businesses.

The survey inquired about interactions that contributed to innovative activity. The responses are summarized in figure 4.1. They show a similar pattern of interaction in the two countries. In both countries, businesses report engaging with universities through a very broad range of mechanisms. Informal contacts are most frequently cited, followed by what may be regarded as conventional interactions involving recruiting graduates, using publications, and attending conferences. Licensing and patenting are among the least frequently cited interactions that contribute to innovative activity across the matched sample. Strikingly, with a few exceptions such as internships, U.K. firms report such interactions more frequently. There is little here to suggest that, with those exceptions, the

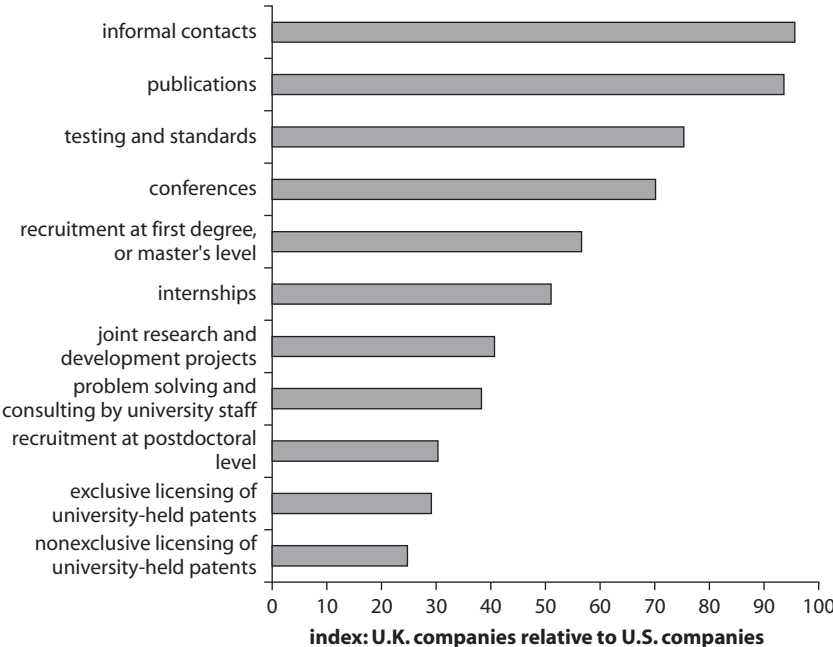
**Figure 4.1. University-Industry Interaction Contributing to Innovation**



frequency of interaction is below par in the United Kingdom or that particular policy attention is required to increase it.

In addition to asking whether a particular type of interaction occurred, the survey asked about the importance attached to that interaction. Here it is useful to look at the relative results in the two countries. In figure 4.2, a score of more than 100 on the horizontal axis means the relevant interaction is rated as important relatively more frequently in the United Kingdom than in the United States. The first point that emerges clearly is that, whereas U.K. businesses more frequently report taking part in most types of interaction, it is the U.S. companies that more frequently rate their interactions as highly important for their innovative activities (that is, the relative score is less than 100). U.S. companies more frequently place high importance on the admittedly infrequent licensing interaction, as well as on joint research and development (R&D) and problem solving and on postdoctoral and graduate recruitment and internships. The last two are also quite high-frequency interactions, and the U.S. firms are also much more likely to use internships than are the

**Figure 4.2. University-Industry Interactions Regarded as Highly Important for Innovation**



Source: Cosh, Hughes, and Lester 2006.

U.K. firms. The differences between the two countries are less marked for the much more frequent activities of informal contacts and publications. Further evidence for the view that the depth and quality of relationships distinguishes the United Kingdom from the United States is the separate finding from the survey that U.S. businesses are more likely to make innovation-related expenditures to support their university links (Cosh, Hughes, and Lester 2006).

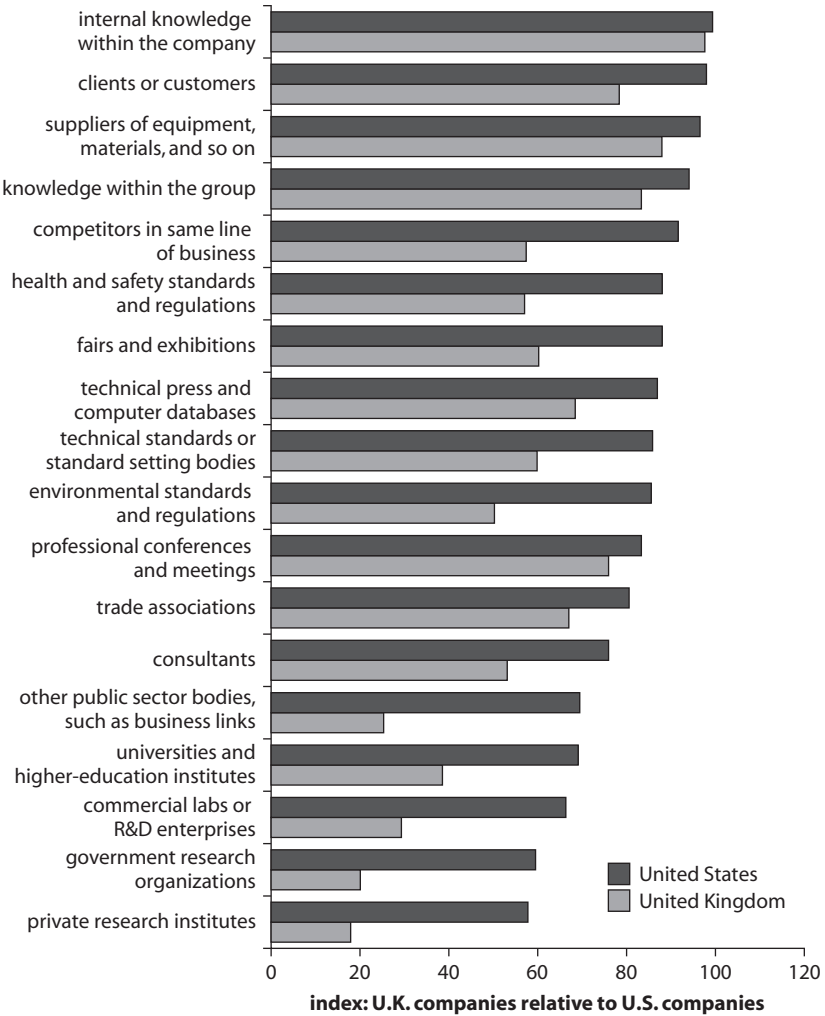
The patterns revealed in figures 4.1 and 4.2 suggest that, in terms of the frequency of interactions, far more is at stake than licensing, spinoffs, and R&D. Equally, the relatively high importance that the U.S. firms place on all university interactions and particularly on licensing, joint R&D, and problem solving suggests a need to address the quality of these relationships.

In thinking about the relative weight to give university-industry interactions in the promotion of innovation and productivity, we must look at the context of those interactions—the broader system of business interactions related to innovation. The CBR and IPC survey therefore asked businesses about their overall sources of knowledge for innovation. The results, summarized in figures 4.3 and 4.4, present the frequency of use of various sources of knowledge for innovation in the two countries and the relative importance attached to each source by U.K. businesses as compared with U.S. businesses.

Figure 4.3 shows that in both countries universities are ranked very low in frequency of use. Customers, suppliers, competitors, and internal organizational knowledge are the dominant sources of knowledge for innovation. In all cases, the U.K. businesses claimed to be more frequent users of external sources than did the U.S. businesses. However, figure 4.4 shows that, as with university interactions, the U.S. companies more frequently placed more importance on external knowledge sources than did the U.K. businesses. For all but three sources (competitors, in-house knowledge, and clients or customers), U.S. companies were more likely to rate sources as highly important than the U.K. companies. This finding was particularly true for the public sector, university, and private research institute sources, even though these sources were used somewhat less frequently.

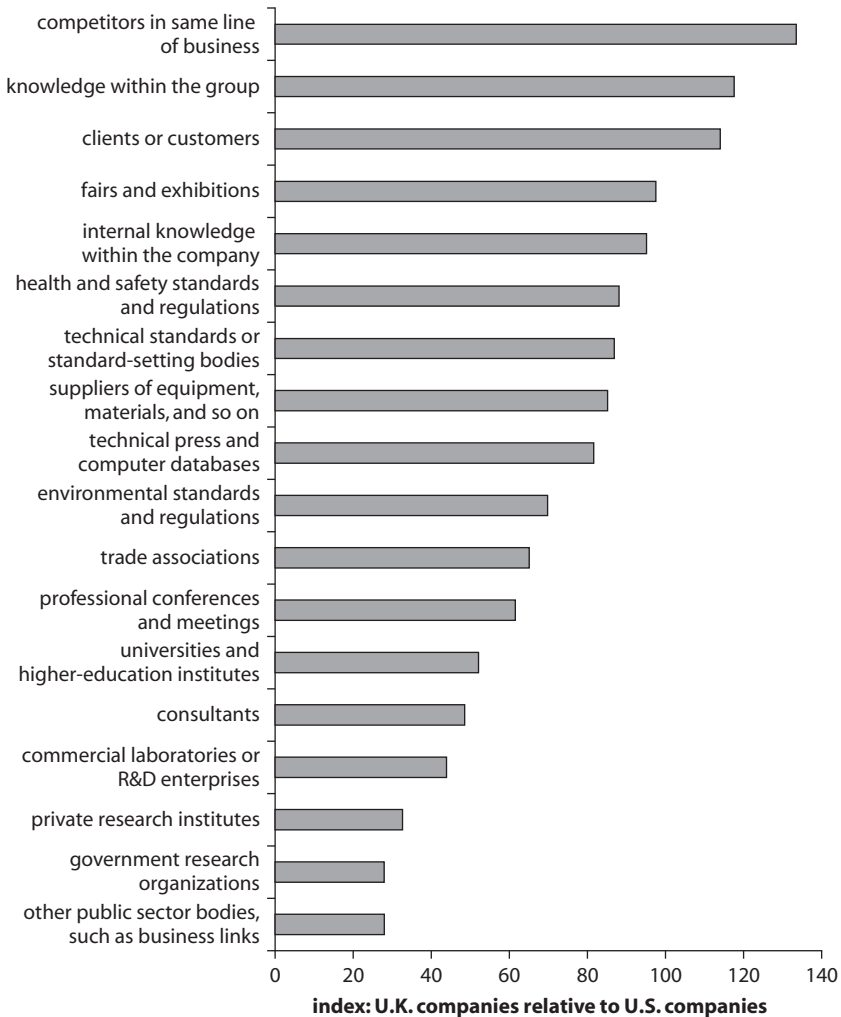
In general, these findings imply that although the use of external sources appears to be more important in the United Kingdom, the value or importance placed on those relationships is higher in the United States. The implication is that U.S. firms give greater importance to open innovation system sources that are outside the immediate industrial context.

**Figure 4.3. Use of Sources of Knowledge for Innovation**



Source: Cosh, Hughes, and Lester 2006.

Further analysis of the survey data looked at variations in the importance attached to particular university interactions and to the frequency of use of sources across size classes. It shows that the U.S. firms in all size classes appear more likely to rate universities highly as sources of knowledge. However, it also shows that the smaller U.K. firms lag most behind U.S. counterparts in attributing significant importance to univer-

**Figure 4.4. Sources of Knowledge for Innovation Regarded as Highly Important by Users of That Source**

Source: Cosh, Hughes, and Lester 2006.

sities as a source of innovation-related knowledge (Cosh, Hughes, and Lester 2006).

This brief overview of some key findings of the CBR and IPC survey has a number of implications for policy. In both countries, innovation-related interactions between universities and businesses are a small part

of the overall innovation system and must be seen in that light. This is not to deny that for some sectors such links may be significant. Rather it is to emphasize the need to craft university-focused innovation policy with close attention to the full set of relevant interactions. A second implication arises from the observed relative depth of—and degree of importance attached to—such interactions in the United States. If the United States is to be the policy role model, then attention should be paid to raising the quality of interactions in the United Kingdom rather than increasing their incidence. Finally, it appears that in the United Kingdom smaller businesses are less likely to be involved in and place importance on university interactions. These findings and the importance of focusing beyond spinoffs and licensing confirm the qualitative arguments made in the recent innovation policy review carried out by Richard Lambert (Her Majesty's Treasury 2003).

The main conclusions of the Lambert review relevant to this chapter were that the principal challenge to the effective exchange of knowledge between U.K. businesses and universities lies in raising the demand by business for quality research from all sources—including universities. The report argued that there was a case for making greater business inputs into university courses and curricula in the United Kingdom. It also made a strong plea for shifting R&D support policy to promote interactions between universities and smaller firms.

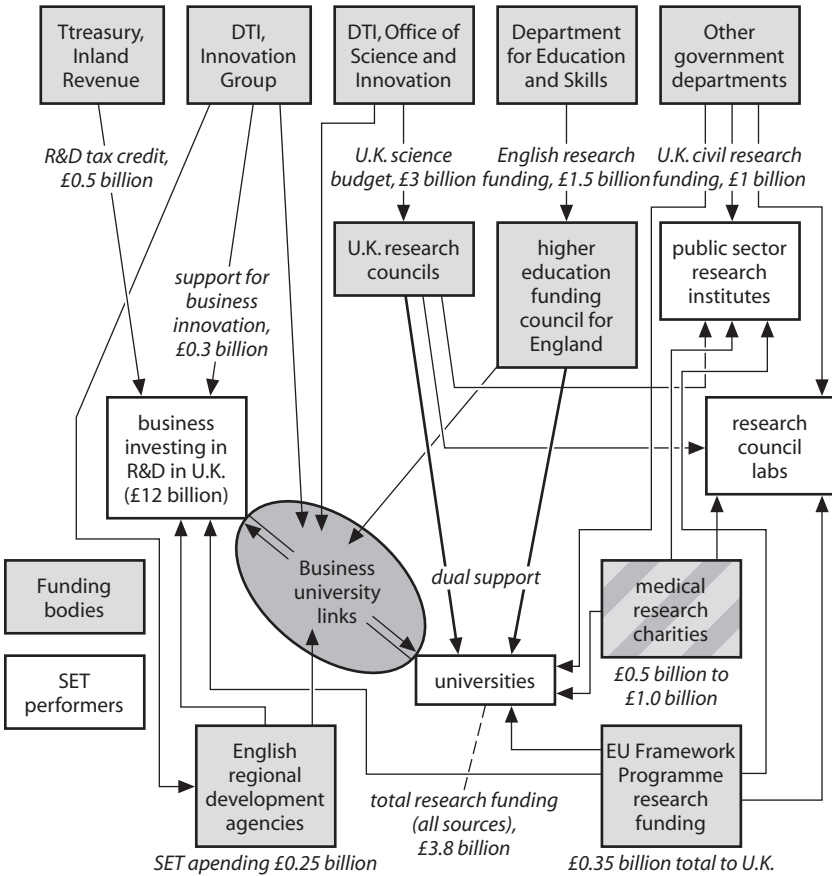
### **U.K. SET Policy and University-Industry Links: A System Overview**

For an understanding of the nature of policy intervention in university-industry links in the United Kingdom, it is useful to set them in the context of overall science policy and of the U.K. R&D system. To avoid complications of detail that arise when considering the nature of policy in the devolved national administrations, the analysis shown in figure 4.5 is for England alone.<sup>1</sup> Figure 4.5 provides a schematic overview of the public organizations and the major charitable organizations that fund SET activity and the organizations that carry it out. Funders are shown in the shaded boxes, along with indications of the scale of funding levels in 2002. SET performers in the public and private sectors are shown in

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<sup>1</sup> I am very grateful to Daniel Storey of Her Majesty's Treasury for this diagrammatic exposition. In 2006, the Office for Science and Technology was renamed the Office of Science and Innovation. Its new name is used in the diagram.

**Figure 4.5. Funding and Performing SET in the United Kingdom: University-Industry Links in Context**



Source:  Majesty's Treasury 2005.

unshaded boxes; they cover the business sector, universities, public sector research institutes, and the U.K. Research Council laboratories.

There are many actual and potential, direct and indirect policy influences on university-business links. The most important route is through the dual support system. It provides core university funding through two mechanisms, which, along with charitable funding of medical research, account for about £3 billion of the total expenditure on university research funding (about £3.8 billion). The first mechanism is direct block grants from the Department for Education and Skills through the Higher

Education Funding Council for England. These grants support research activity with allocations that are linked to university size and performance in a periodic research assessment exercise. The extent to which the funds are linked to university-business activities is essentially a matter for individual universities. The second leg of the dual funding system is provided by the Office for Science and Innovation through the seven U.K. research councils,<sup>2</sup> which allocate project- or program-specific funds to universities, research council labs, and public sector research institutes on the basis of scientific peer review of competing bids. The extent of specific university-business interaction here depends on council policy initiatives related to the award process.

Government policy concern about the extent to which this dual flow of funds was too dominated by scientific peer review and too little connected to business uses has led to periodic attempts to address both problems (for example, HEFCE 2003a, 2003b). It has also led to a series of initiatives, such as the Higher Education Innovation Fund (HEIF), designed to provide resources to develop a so-called third leg of university funding. The initiatives are based on encouraging entrepreneurial spinoffs and raising income from commercialization activities such as licensing and patenting. They are discussed in more detail in the next section.

In addition to those primary funding sources, universities attract research funding on a smaller scale from the Department of Trade and Industry (DTI) to support innovation activity and from the nine regional development agencies (which are funded by the DTI). Universities also compete for funds under a variety of European Union programs. Those funding routes are frequently linked to schemes designed to promote specific national or regional university interactions or to promote research collaboration across Europe. Of £3.8 billion in university research funding, about £300 million comes directly from the business sector.

Businesses carry out about £12 billion per year in R&D. The main direct policy support here comes from the R&D tax credit (worth about £500 million a year) and from a range of business support programs delivered regionally or nationally by DTI. Such programs were worth about £300 million in 2004/05. They are discussed further later.

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<sup>2</sup> The seven councils are the Economic and Social Research Council, Engineering and Physical Sciences Research Council, Arts and Humanities Research Council, Particle Physics and Astronomy Research Council, Biotechnology and Biological Sciences Research Council, Medical Research Council, and Council for the Central Laboratory of the Research Councils.

Civil public sector expenditure on R&D shown in figure 4.5 (amounting to about £1.8 billion) was augmented by about £500 million of defense-related public sector R&D (not shown). Only about £400 million of this combined total was channeled through higher education or research council institutions. The rest was either conducted inside the relevant department (about £900 million) or in the U.K. business sector (about £900 million) with a small balance carried out overseas. The effect that publicly procured R&D could have on university-industry links from the business demand-pull side is thus considerable. For instance, an element of this procurement could be used to promote knowledge-based firms linked to the science base. This underdeveloped aspect of U.K. innovation policy is discussed further in the next section.

The complexity of the system poses obvious problems of coordination. In developing SET policy and university-business links, the U.K. government has, therefore, developed a long-term program designed to strengthen the science base, rationalize business support policy, raise the overall R&D effort, and strengthen commercialization activity and university links.

### **Science and Innovation Investment Framework for 2004 to 2014**

The investment framework for science and innovation sets a target of raising total U.K. R&D from 1.9 percent of GDP to 2.5 percent of GDP by 2014. The broad structure is shown in table 4.1. The year-on-year growth of public science spending was 10 percent from 2003/04 to 2005/06. The commitment in the science and innovation framework is that the level of public spending on the science base will grow faster than the rate of growth of GDP over the framework period, rising from 0.7 percent to 0.8 percent of GDP. To reach the 2.5 percent target nationally by 2014 clearly requires a substantial matching investment by the private sector, which must raise its R&D from 1.2 percent to 1.7 percent—in a period of stagnant or declining levels of private sector R&D. The share of overall private sector R&D in GDP fell from 1.4 percent in 1985 to 1.2 percent in 2002. R&D in the private sector is also heavily concentrated; only a handful of large U.K. firms in a few sectors have intensive R&D expenditures (DTI 2005). The pharmaceutical and aerospace sectors account for 23 percent and 10 percent of private sector R&D, respectively.

There is little sign that the target will be met by the large R&D spenders. Moreover, R&D is internationally mobile. Increasing attention has therefore focused on the potential role of newer, technologically based

**Table 4.1. The 10-Year Science and Innovation Framework R&D Target**

| <i>Type of investment</i> | <i>R&amp;D investment as percentage of GDP</i> |             |
|---------------------------|--|-------------|
|                           | <i>2004</i>                                    | <i>2014</i> |
| Science base              | 0.4  | 0.5         |
| Other government R&D      | 0.3  | 0.3         |
| Private sector            | 1.2  | 1.7         |
| Total                     | 1.9  | 2.5         |

*Source:* Her Majesty's Treasury, DTI, and DFES 2004.

small and medium enterprises (SMEs) in filling the void. There is, however, an order of magnitude problem. Data on independent SME R&D are subject to considerable margins of error, but even generous estimates suggest that the total is only between £400 million and £600 million—a minor fraction of the £12 billion spent by the private sector in 2004/05.

Whatever the likelihood of meeting the target, doing so may be far less important than other aspects of the framework. First, R&D is an input, and what matters for commercialization is how effectively it is converted into output. Second, that conversion requires major complementary investments in design, marketing, and human capital developments (Cox 2005), effective access by business to the full range of knowledge sources described earlier, and the design of a public space architecture to enable universities to play their parts across the full range of interactions identified earlier (Lester and Piore 2004).

It is worthwhile to highlight a few of the more important policy related elements of the innovation and investment framework here. First, in relation to university spending in particular, the investment framework for science and innovation makes a basic commitment to the full economic costing of university research projects. This commitment is an important element in maintaining a sustainable science base because it prevents the undercosting of projects and the cross-subsidization of them from other sources of university income—typically at the cost of essential overhead infrastructure. Second, in relation to third-leg funding, there has been a realignment of the HEIF and a rationalization of the DTI innovation support policies (or *products*, as they are now known). Third, a Technology Strategy Board has been introduced to play a key intermediary role between science and technology projects with market potential and the business sector.

In its realigned third phase, HEIF will involve approximately £240 million in funding to higher education institutions from August 2006 to

July 2008. The intent is to promote activities in the university sector of direct and indirect economic benefit to the United Kingdom. The fund is designed to support knowledge-transfer activities that are unlikely to generate large net income for universities and, therefore, are not attractive investment propositions for the universities. It is a national scheme that encourages bids with regional involvement, to foster connections between the university sector and regional economies. The scheme avoids a problem that many newly introduced schemes face: a lack of sustainable human capital to support them. It does so by allocating new funds under phase 3 of HEIF on a formulaic and predictable basis. More predictable funding should allow the recruitment and retention of skilled staff members. A small amount of the funding is reserved for a competitive allocation. This portion is designed to encourage new and innovative approaches and to encourage collaborative activities across higher education institutions, so as to get economy of scale gains from knowledge-transfer activities and to capitalize on best practices. These changes are designed to encourage an increased degree of quality and depth in university-industry relations, which the CBR and IPC survey suggests is required.

Before the introduction of the science and innovation investment framework, the DTI innovation support program was characterized by a plethora of schemes and products with varying or ill-defined objectives and different modes of operation and delivery. As a result of an innovation review (DTI 2003) carried out before the development of the framework, the DTI innovation products have been rationalized into three. First is the grant for R&D, which used to be called the SMART (Small Firms Merit Award for Research and Technology) program. It provides about £30 million per year to support SME funding for innovation activities in the early development stages before commercialization. This product is therefore a continuation of a very successful scheme that has operated effectively for many years (Cox, Hughes, and Spires 2002) and is part of the useful underlying support system for SME R&D activity that is linked to early-stage commercialization from the science base.

The second DTI innovation product is the Knowledge Transfer Network. This product supports the formation of groups of knowledge-transfer organizations, which were formerly known as *Faraday Partnerships*. They are intended to strengthen the relationship between sector-based businesses and universities that specialize in relevant technologies. They develop pooled sources of knowledge on technology development and foster collaboration between business partners and universities on a national rather than a regional scale. This activity includes, among other things, a range

of metrology and related issues and the creation of standards for effective network activity. The product is designed to help address the tailoring of specific university-industry relationships to sector needs as well as the encouragement of an open system in the connections between the relevant partners in the sectoral framework. There is a clear and unresolved tension between this national sector-based approach and the various attempts to develop a regional focus in university-industry links.

The third central product is based on Knowledge Transfer Partnerships. This program, formerly known as the Teaching Company Scheme, is worth £20 million per year. It is a substantial scheme with about 1,000 projects under way; the projects partner universities with firms to resolve particular technology-based projects. It too is an important initiative; it links the university base, through human capital relations and internships, with individual firms wishing to solve particular problems. This scheme relates directly to that dimension of university-industry links identified in the survey results that emphasizes customized, problem-solving, contract research. It also has a successful track record (SQW Limited 2002).

Taken as a whole, these products address a number of potential problems highlighted earlier. They have been in place for some time, and the commitment of resources remains stable. Notwithstanding their merits, it would appear that additional effort must come from a more focused commitment to these products as part of the overall technology strategy embedded in the long-term framework.

A new addition to the architecture that is designed to enhance inputs from the science base is the Technology Strategy Board (TSB). It is designed to play a key role in the selection of priority areas for innovation support expenditures, through the DTI Collaborative Research and Development project program (TSB 2006). About £250 million will have been committed by TSB by 2006, with the amount rising in subsequent years. The board largely consists of members from the private business sector, including the venture capital community. Its role is to encourage the development of technology emerging from the science base that is closest to market possibilities, through collaborative bids for funding. Those market possibilities are to be chosen with a view to the likely scale of potential markets available globally in which the United Kingdom has potential for augmenting or developing world-class competitive capacity. The initial program activities focus on seven key areas: electronics and photonics, advanced materials, information and communications technology, bioscience and health care, sustainable production and consumption, emerging energy technologies, and design engineering in advanced

manufacturing (TSB 2006). The board represents an important new initiative in terms of focusing expenditure in relatively key areas from a combined business and technology perspective.

The size of the budgets committed in these areas is substantial in public policy terms. Their impact on the inputs from the science base by SMEs could, however, be considerably enhanced if public sector extramural R&D could be used more effectively. The opportunity to enlist those expenditures to harness technologies from the science base has been relatively neglected in the United Kingdom, compared with successful schemes using public procurement measures in the United States such as the Small Business Innovation Research (SBIR) Program (Connell 2004, 2006).<sup>3</sup> Attempts in the United Kingdom to develop a similar program have so far failed to generate significant results. The reasons are closely related to two key factors. First, the extent to which opportunities are available is intermittent, and the terms on which they are accessible are relatively opaque. Second, in the past, a strong element of cofunding has been required in obtaining U.K. public sector procurement support. This situation is in contrast to that in the United States, where full cost contracts are awarded.

The potential benefits of extending and making this scheme more effective in the United Kingdom are twofold. First, the amount of funding potentially available to mobilize technologies from tertiary-level institutions would be substantially enhanced. Second and more significant, the contract nature of the relationship helps develop reputation and competence in the early stages of start-up. The existence of a contract, as opposed to a grant, both helps formalize the development of early-stage businesses and makes those businesses more attractive propositions when they seek funding for further development from the financial sector and other sources (Connell 2004, 2006).

This potential role for public procurement, which was relatively neglected in the original Science and Innovation Investment Framework report, has been given more emphasis in the follow-up program (Her Majesty's Treasury and others 2006). Thus, in the 2004 and 2005 budgets, moves were taken to make it mandatory for government departments and agencies to place 2.5 percent of their extramural R&D contracts with SMEs through the Small Business Research Initiative (SBRI), as well as to develop a new National Health Service research strategy to

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<sup>3</sup> For more information about the SBIR Program, see [http://patapsco.nist.gov/ts\\_sbir/](http://patapsco.nist.gov/ts_sbir/).

attract business-related R&D on health (Her Majesty's Treasury and others 2006). It is too soon to evaluate these latest proposed changes. The first change implies buying about £50 million of government research from smaller firms.<sup>4</sup> It still faces concerns about how effective delivery will be in practice, given the lack of effective, simple procedures and the lack of coordination in the delivery of the initiative compared with the U.S. SBIR Program (Connell 2006).

## Conclusions

University-industry links and their potential role in innovation must be seen as part of a complex system. These links are only one of the sources of knowledge from which businesses derive information on technologies relevant to their production processes and competitive positions. In the development of university-industry links, it is important to recognize the distinctive public space that universities can provide and not focus only on issues relevant to licensing, spinoffs, and R&D expenditure.

Insofar as the United States is seen as a role model for the United Kingdom, it appears that within those university-industry relationships that do exist, it is not their number but their depth and quality that are the most significant difference. These differences appear to be exacerbated for smaller firms, suggesting that policy on these links should attempt to ameliorate weaknesses in quality and improve access for smaller firms. The range of patterns of these interactions is very broad and likely to vary systematically across sectors. Therefore, policies need to cater to the specific requirements of different sectors. In a regional context, they need to be nested in specific regional development strategies. In the small, open economy of the United Kingdom, the tension between promoting national sector-based schemes and regional schemes requires careful management.

This brief overview of the SET policy system in the United Kingdom highlights the complexity of the system and the diversity of actual and potential intervention routes. Effective policy intervention in connection with university-industry relationships requires an overall holistic view of this policy framework. It also requires a long-term perspective, to enable a degree of predictability in the functioning of the system. The 10-year framework for investment in science and technology for 2004 to 2014


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<sup>4</sup> See <http://www.sbri.org.uk/aboutus.php> for the details.

is clearly a welcome step in providing a long-term perspective within which to work. A number of elements in the framework make a positive contribution to university-industry relationships. A central problem for the framework is the likelihood that the private sector component of the R&D target will not be met, given the structural features of R&D spending in the United Kingdom. However, the target is one of the less important aspects of the framework. Instead, those aspects that concentrate on developing the quality of university-industry relationships and the flow of knowledge to business are likely to be most fruitful in the longer run. In a review of the elements of policy that address these aspects, the underexploited potential of public procurement for small high-technology businesses stands out.

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