

Higher Education

Meeting International Business Demand

An Interim Report on R&D Issues

Richard Brown and Philip Ternouth



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Foreword

The Council for Industry and Higher Education (CIHE) is undertaking a major project to gain business views on the international competitiveness of UK higher education as evidenced by their investment and purchasing decisions. The study will also gain insights into how those decisions are made and whether the process of decision making is changing. We launched the study at our Council meeting in May 2005 and subsequently issued a report *International Competitiveness: setting the scene*, that summarised the discussion at that meeting.

The project has the involvement of HM Treasury, the DTI/OST and the DfES. It is being funded by the four UK higher education funding councils, Universities UK and the Higher Education Careers Services Unit (HECSU), and we greatly appreciate their support. The full terms of reference are on the CIHE website: www.cihe-uk.com. The study develops the report from Richard Lambert which provided a general survey of the interactions between businesses and universities with a focus on knowledge transfer. We are probing deeper into how businesses make their decisions and what might persuade them to purchase and invest more with UK universities. We are assembling business views from semi-structured interviews with senior staff in the Research and HR functions and then with the CEOs or equivalents of a wide range of businesses that have a significant presence in the UK.

We would welcome guidance in particular on:

- whether we have identified the most relevant data on the research relationship;
- whether we have drawn the right conclusions or raised the right issues for debate;
- what else we should be probing to understand what lies behind the data we have so far identified;
- the specific issues we have raised in the report.

The feedback will inform the round of interviews we still have to make and the conclusions and recommendations we will draw in our final report.

Acknowledgements

Two of our Trustees Richard Greenhalgh (recent Chairman Unilever UK and Chairman of Templeton College Oxford) and James Ross (recent Chairman National Grid and Chairman of the Leadership Foundation for Higher Education) are working with us on interviewing CEOs and we are very grateful for their high level perspectives. We much appreciate the provision of some data from the DTI/OST (especially Mike Needham and Julie Tam) and Universities UK (notably Dan Rieser) and the views of the project Advisory Group whose names are listed in the Annex. Much of the information was assembled by our research assistant Christine Dela Cruz. However, we take responsibility for the interpretation and conclusions drawn.

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Background

The UK has one of the best higher education systems in the world with a consistency of quality provision that is probably second to none. One of the key messages that we constantly hear in our discussions with senior business people (those in charge of graduate recruitment, HR, heads of research/chief scientists as well as CEOs and their equivalents) is that the UK produces some of the best graduates and some of the best research anywhere. But they need more of this high quality. If the UK does not supply it then the brand leaders will purchase it and invest in it elsewhere; and in a world marketplace with a range of high quality provision, including in the Far East where it is particularly competitively priced, international businesses have a wide range of purchasing and investment options.

Businesses that are less able to tap this international excellence do not have this luxury. They are more dependent on what is available locally. If that is not of high quality then they will suffer and the rest of the UK with them.

While there is much that the UK must do to increase the capabilities and aspirations of the millions of people of all ages who remain at worst functionally illiterate or at best have a limited ability to add significant value to organisations, we have no doubt that the vitality of the economy and society rests on adding ever greater value to the goods and services traded internationally. This applies as much to the tourism and hospitality sectors, to healthcare, fashion and the wholesale and retail industries as it does to financial services, engineering, design and digital media. Wealth and wellbeing in our society rests on the global competitiveness of an ever widening range of businesses. All of these increasingly depend on higher education for quality graduates, sometimes leading edge research and often problem solving and knowledge sharing. Without more high quality people than our competitors with relevant capabilities and experience to drive the economy up the value chain, to develop and apply leading edge knowledge, processes and practices and to start and then succeed in growing innovative enterprises, the UK will fail economically and the living standards and quality of life of everyone will suffer.

Maintaining and enhancing the quality of what UK higher education can offer should therefore be of concern to everyone. It is at the heart of our study.

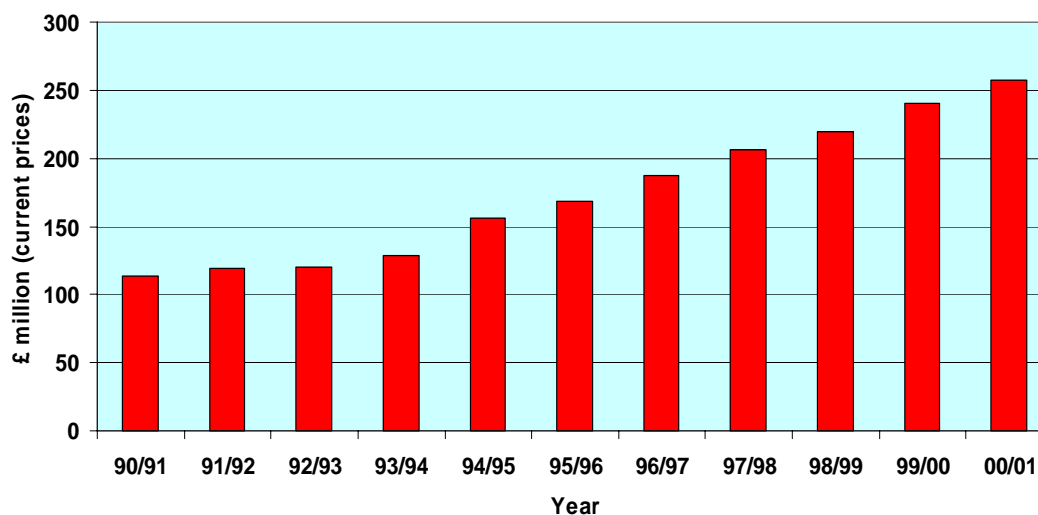
This interim report is very much work in progress. It is also focused purely on issues relating to research. It sets the background just to that part of our study by illustrating at the aggregate level the results of the many decisions that businesses take. Where possible we offer a brief commentary on the data and raise some general questions and issues. This early focus on research issues may appear to give a distorted view either of the role of higher education or of our study. However, the full report will not only offer business views on their investments in R&D and knowledge exchange but also on their "purchasing" decisions of the graduates they recruit and the development of staff at all levels (including the top team). It is at the graduate interface where businesses and universities come most into contact. Businesses have stressed to us that it is the quality of staff at all levels that is the most important determinant of their competitiveness.

We are focusing only on the research interface in this report as we feel that there are a range of underlying factors in the research relationship that have not been considered adequately in previous studies and yet might help to explain what we are being told by business leaders. They may set some bounds to the Government's aspirations for businesses to spend more of their research budgets with UK higher education institutions. Equally they support the reinforcement of excellence which is a constant theme in our discussions with business leaders.

Trends in Business Investment in UK Universities

The Lambert Report noted the rising trend of business investment in university research.

Figure 1: UK Industry Expenditure on Research Grants and Contracts in UK Universities



Source: Office of Science and Technology (2003) based on data from HESA

This reflected a wider move worldwide on the part of businesses to undertake research in universities¹ particularly following the down-scaling of corporate laboratories.²

Figure 2: Percentage of R&D Outsourced to Universities in EU (OECD)

Year	Percentage
1981	0.7
1990	2.0
1999	2.5

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By 2000/01 there were some 157,600 researchers in the UK, of whom 31% were in higher education. Although the total number of researchers was less than in Germany or France, the growth rate in the UK was faster than in these countries, reflecting in part the increased numbers in higher education.³

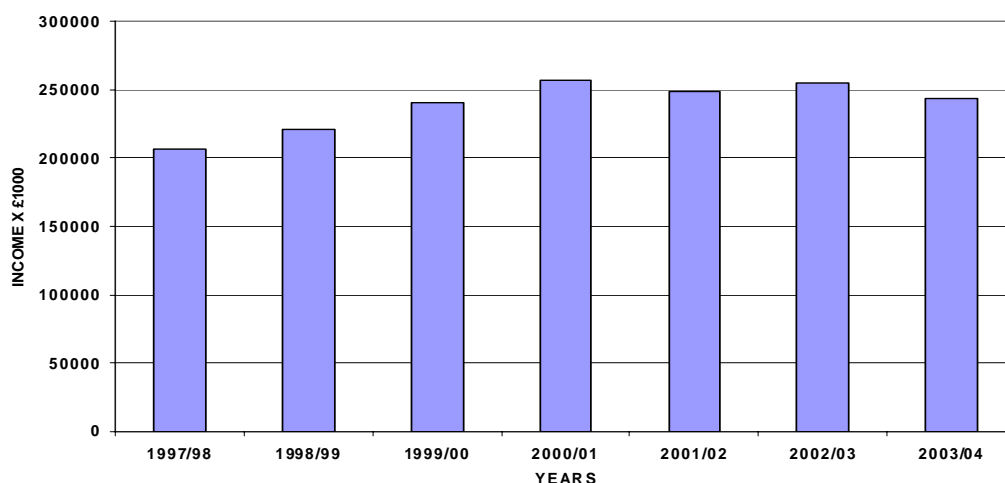
However, Richard Lambert only reported on the trends to 2000. Since then the R&D investment by UK-based businesses in British universities has remained broadly static (and declining in real terms).

¹ We use the term "universities" throughout as shorthand for all universities and colleges that undertake higher education teaching, research and knowledge exchange.

² We have been told for example that probably no semi-conductor business world-wide now has the capability to explore the underlying solid state physics on the scale of MIT which also has the ability to integrate cross-functional teams for this pre-competitive fundamental research.

³ For a general comparison of EU trends, see "Towards a European Research Area: Science, Technology & Innovation; Key Figures 2003-04", European Commission.

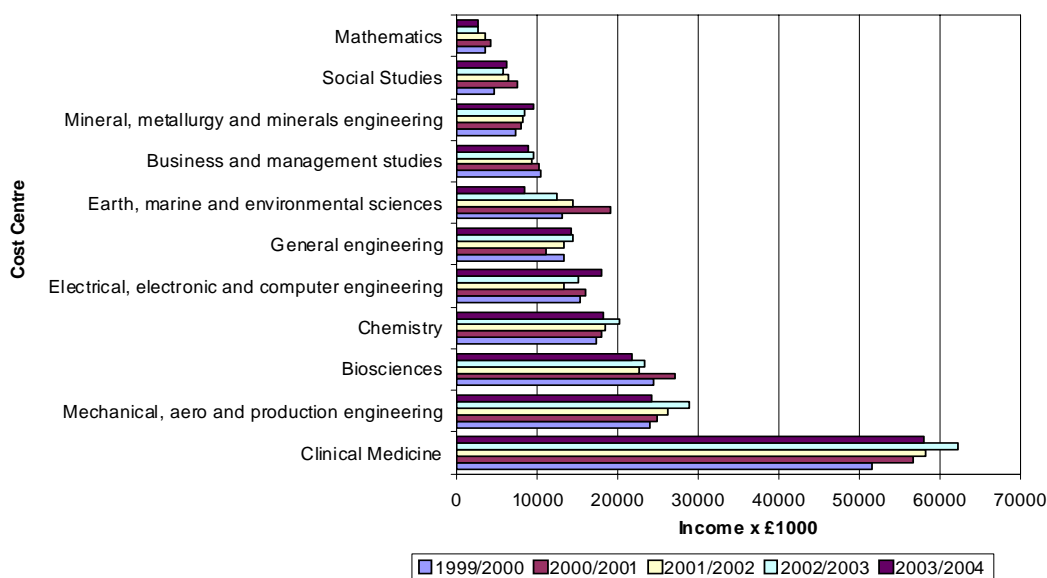
Figure 3: Research Income from UK industry (1997 – 2004)



Source: HESA FSR 1997 – 2004

While the position varies by business sector, the trends are broadly similar with only the engineering disciplines and chemistry maintaining fairly steady business funding. We comment later on the significance of clinical medicine, the longer term trends in this particularly important area and whether 2002/3 might have been a peak year for university funding.

Figure 4: Research Income from UK business cost centres 1999/2004

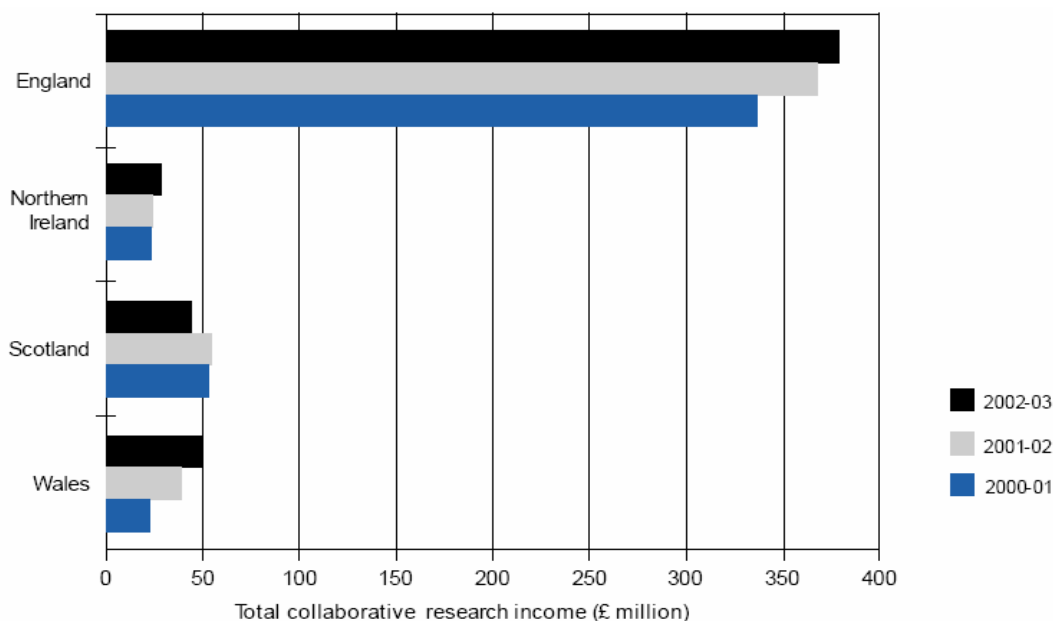


Source: HESA FSR 1999 – 2004

Across the nations of the UK it would appear from Figure 5 HE-BCI data that overall business investment in universities in Scotland may have declined and in universities in England and Wales increased.⁴ We note later the relationship between business structure and overall R&D spend, and it may be that the limited capacity of Scotland's business to undertake or absorb R&D restricts their collaboration with universities which must therefore look further afield.

⁴ There are difficulties in comparing information collected from HESA university records with that from the HE-BCI sample survey of universities. While we are mainly interested in trends, we should still issue a health warning on the HE-BCI survey.

Figure 5: Income from formal collaborative research (in real terms*)

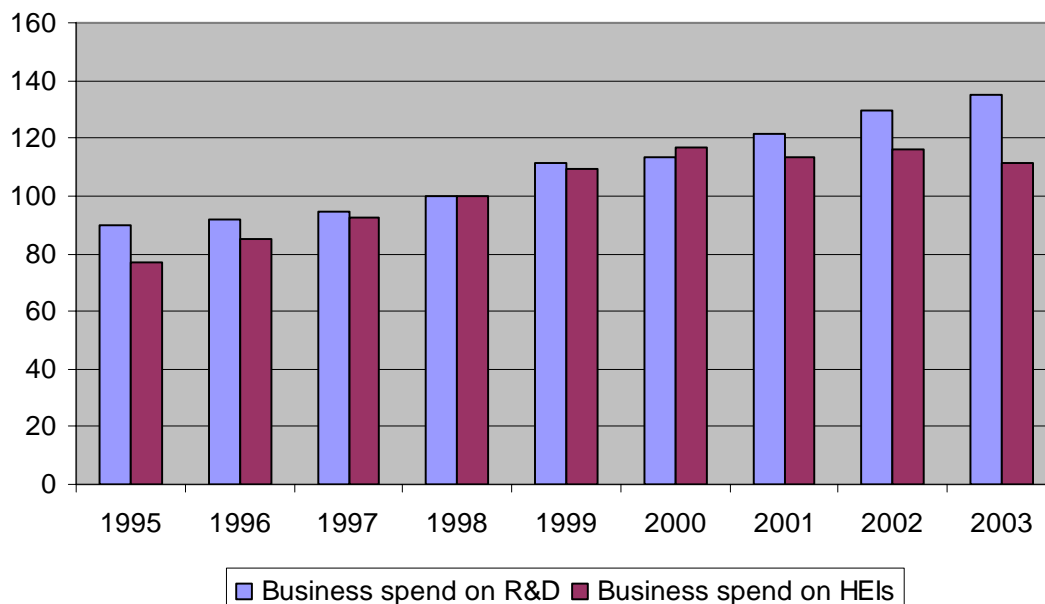


* 2000-01 and 2001-02 have been adjusted to 2002-03 prices.

Source: HE-BCI Survey 2002 - 2003

In terms of market share, UK universities increased their share of business R&D spent in the UK in the 1980s and '90s but did not manage to maintain this increase into the 21st century. The OECD data suggests a change trend in business spend in universities as a percentage of their total spend from around 2000. Businesses spent some 1.67% of their R&D with universities in 1985, 2.39% in 1990, 2.51% in 1995, 2.99% in 2000 and 2.81% in 2002 (OECD Science and Technology Statistics).

Figure 6: Business Spend on R&D v Business R&D Spend with Universities

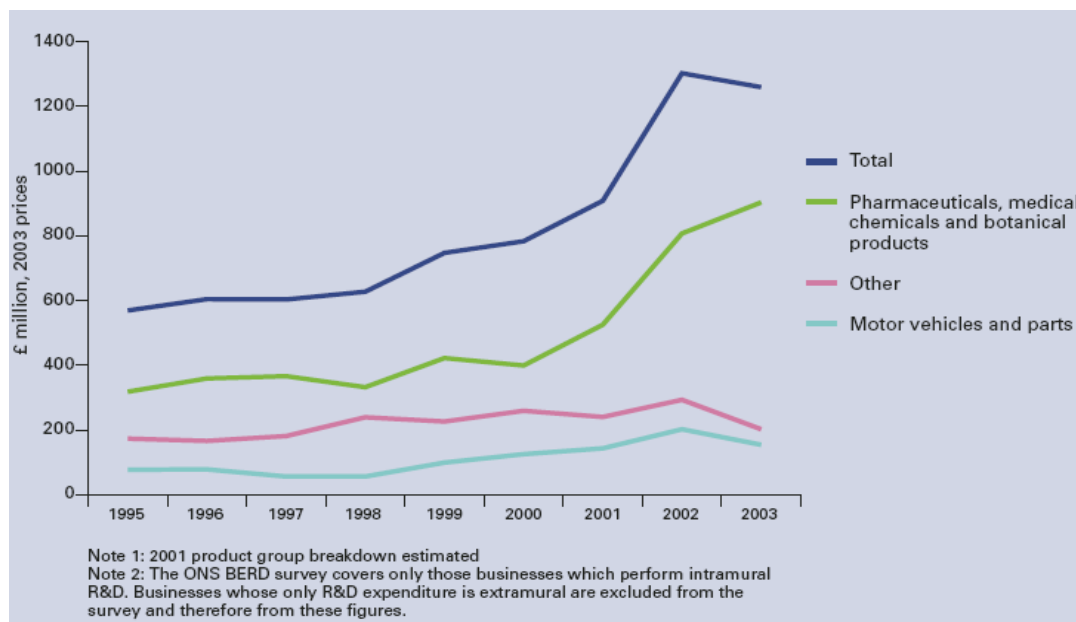


Nominal amounts of business spend and amount spent in universities indexed with a base year of 1998.

Source: HESA and ONS Gross Domestic Expenditure on R&D, March 2005

Perhaps the main reason for this stall in market share is, so we have been told, that UK businesses are increasing the amounts they spend overseas on near market research which is less likely to be undertaken in universities. This is particularly the case in the all-important pharmaceutical industry.

Figure 7: UK business-funded but overseas-performed R&D: by product group, real terms, 1995–2003

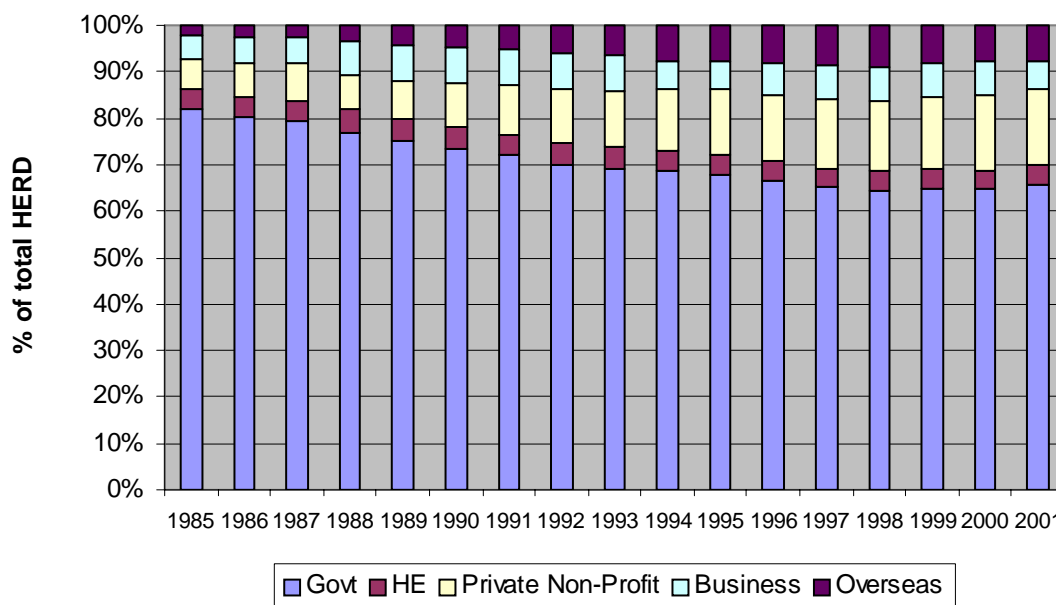


Source: Figure 22, 'R&D intensive businesses in the UK', March 2005, DTI Economics Paper No.11

The EU Commission has suggested that there is a general movement of business R&D offshore across the EU. This has led the EU Commission to suggest that expenditure on R&D within the EU will only rise on present trends from 1.93% of GDP in 2003 to 2.2% in 2010, well short of the ambitious target of 3% set at Lisbon. By comparison R&D in China is increasing at double digit rates from 1.31% in 2003 partly on the back of inward investment and could overtake that in the EU by 2010. (FT 10th October)

While the proportion of R&D funds from UK based businesses has been static (revenues have been generally increasing), universities have increased the amount of R&D secured from overseas and from non-profit organisations. Some have told us this increase in overseas incomes includes funding from overseas businesses.

Figure 8: Source of HE R&D funding in UK

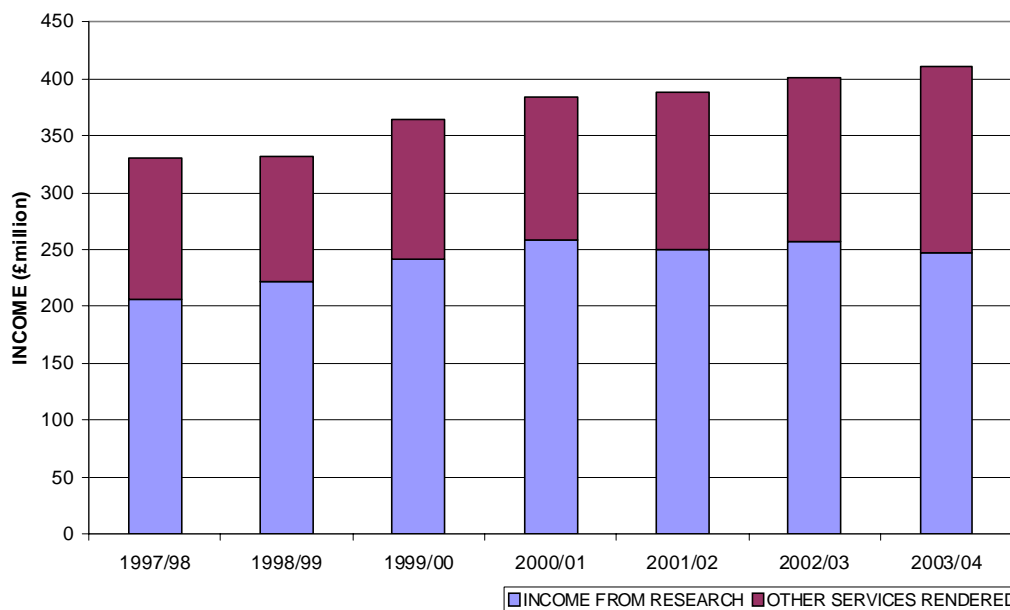


Source: OECD Science and Technology Statistics, R&D Statistics

A pilot analysis is being undertaken for us by a major research focused university to identify the specific amount of R&D from overseas and by key sectors. Other universities may then help us with this analysis.

UK universities have also increased their business income from sources other than R&D such as consultancy and CPD. This is consistent with the policy trends to encourage a wider spectrum of knowledge transfer mechanisms and partners and towards increased patenting, licensing and consultancy which can complement joint or contract research.

Figure 9: Higher Education Income from the UK Industry and Commerce



Source: HESA FSR 1997-2004

What underlies these trends?

What factors underlie and might explain the trends noted above? In particular why has the proportion of R&D spent by businesses with universities held fairly constant when their total spend has been increasing?

The globalisation of R&D

The increase in business R&D investment overseas by UK and other EU businesses is evidence of the increasing globalisation of business investment that we are identifying in our study. Multinational businesses seek world class research wherever that may be found. The UK undoubtedly has such research and this has been confirmed by the range of companies we are interviewing as well as by the evidence in these charts. Globalisation is being driven by a trend that we have identified across many businesses to centralize their decisions on major R&D investments.

Businesses have told us that their R&D investment decisions are influenced by a range of factors:

- the nature of the research to be undertaken;
- proximity to customers and key markets;
- where they have existing investments and infrastructure;
- the quality of the science and research base relevant to their operations;
- the availability of quality staff;
- general Government fiscal and tax policies towards businesses and individuals.

It is not our purpose to explore each of these factors in detail. But we comment in this interim report on the first two as they set limits on what the UK and UK universities might reasonably aim to capture. (Indeed since there is little the Government or universities can do about the first three factors, we hope our study will be useful in reinforcing the importance of actions on the last three over which the Government does have some control.)

The nature of research

We postulate that there are various forms of research on a spectrum from horizon scanning to application development:

- **horizon scanning**; what is happening out there that might impact on our business in 10-20 or more years time? These might be changes in the age structure of our target population, in energy supply and price patterns, in nano-technology or in a development in another industry that could fundamentally affect the need for our product or service (self-cleaning glass for a manufacturer of window cleaning products for example); universities can help an organisation perform this role if they have multidisciplinary teams and are well connected internationally;
- **fundamental research**; research into basic physics or chemistry that can affect molecular structure or how molecules behave over a turbine blade or can create a vacuum without moving parts. This is classic university territory and strategic relationships can be formed with world-class professors and their associated team; pre-competitive research may be with a consortia of businesses;
- **core research**; the proprietary research that is core to the unique capability of a business. This might be researching the therapeutic potential of their compound libraries, or mathematical modelling for a financial futures or hedge-fund business. This will rarely be contracted out as it is at the heart of the added value of the business; however, in some case this may merge into:
- **problem solving outside the core competencies**; these will arise throughout the life of a project or may be generic; there will always be more problems than funds available and universities are prime targets to undertake this work under flexible or problem specific contracts; the quality/price balance and speed of response will determine the successful bidder where a general framework contract is not in place;
- **applications/near market development**; these encompass the evolution of software, fashion, design with customers in the so-called creative industries; application of a design to suit a particular new market; clinical trials of drugs focused on particular strains of diseases. We comment in more detail on this category below.

For our full report we will develop this typology with help from the CIHE R&D Group (chaired by Sir Tom McKillop) and the CBI's ICARG. We would welcome comments and suggestions from others on how this typology might be improved to better inform all parties on what determines where research is undertaken and where universities might best focus their efforts. Some businesses for example have mentioned the significance of universities forming collaborative Centres of Excellence in strategic areas and for businesses to work with such centres through an IP framework and with a supply chain of SMEs.

The companies we have so far interviewed have shown us figures that suggest that the majority of the R&D they have undertaken is application, near market or clinical research ("experimental development" under Frascati definitions). One major engineering business, for example, spends some 75% of its research budget on product development and nearly a half of its university spend is short term contract driven by the need to find solutions to individual technical problems. Multinationals are driven increasingly to undertake such research in their major markets where they are close to their customers and to changing customer needs. In the past this has required a major presence in the USA. In the future it will require a presence in such increasingly sophisticated major markets as China and India. We have therefore been told and have seen evidence that an increasing proportion of this research will be undertaken overseas. The extent to which this will happen will vary by business sector and be influenced to some extent by the relative strengths of the intellectual environment, absorptive capability of the country and the relative price. But the UK and UK universities may struggle to maintain the current volume of this particular type of research.

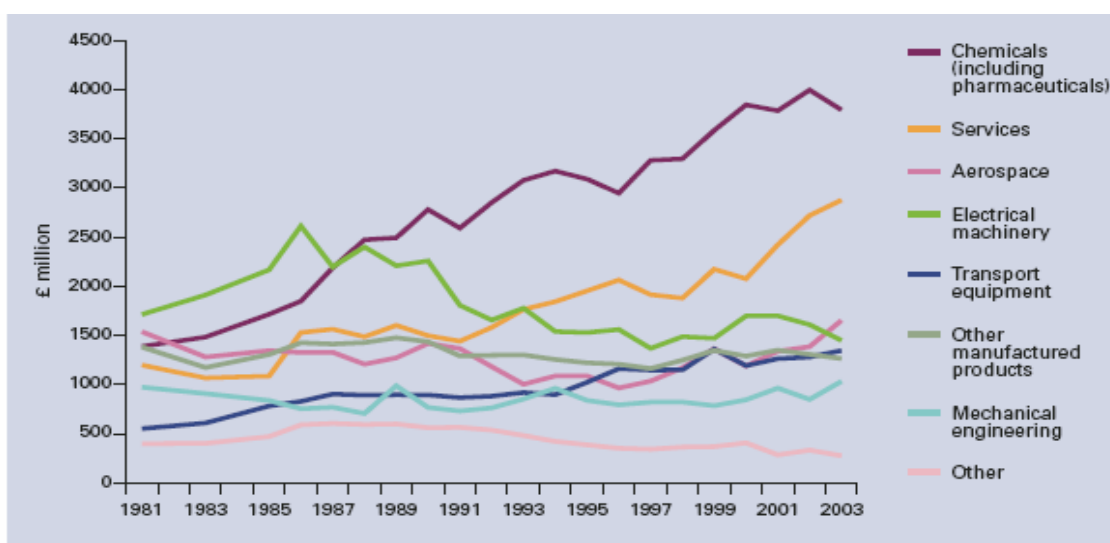
We have also been told that the UK market is not large enough to capture a significant counterbalancing volume of application or clinical research from overseas companies. For example, it has only 3% of the worldwide market for prescription drugs. If there was greater coherence in the purchasing policies of major public customers across the EU then the potential purchasing power of Europe could be maximized and more near market research might be undertaken. In the important pharmaceutical sector, we have been told that a lack of flexibility and tendency towards conservatism in the acceptance of new drugs by the NHS is limiting the attractiveness of this market despite the apparent high NHS spend on research and drug purchase (though at .11% of GDP this is dwarfed by the .25% of GDP spent in the USA).

UK universities are especially vulnerable because their income from businesses perhaps not surprisingly reflects the overall pattern of business spend on R&D with its heavy concentration on pharmaceuticals.

In fundamental and core research the strength of the UK's science base and the particular capabilities of world-class research teams in our universities makes the UK an internationally competitive location. The size of the market is not such a powerful consideration for pharmaceutical companies for the location of this core research – hence the presence of important laboratories by the three major players Pfizer, GSK and Astra Zeneca. However some businesses will invest for political reasons in order to gain influence in their major world markets and thus invest in universities irrespective of the strength of the science base. Through this investment they can grow the science and the graduates and researchers they need and invest in ways that are both politically acceptable and make for good corporate citizenship (some investments in Russia and China might fall into this category). The converse is also true: that some businesses may not invest where there is good science if it does not advance their wider political and market strategies (Switzerland being an example).

Understanding what drives decision making is particularly important in the pharmaceutical industry given that it accounts for such a large share of the R&D undertaken in the UK. The following chart shows the skewed distribution of business R&D with some 50 per cent being undertaken in pharmaceuticals. Aerospace and defence also continues to account for another significant proportion while that spent by the services sector (and recorded as having been spent – an issue we will return to) is rising strongly.

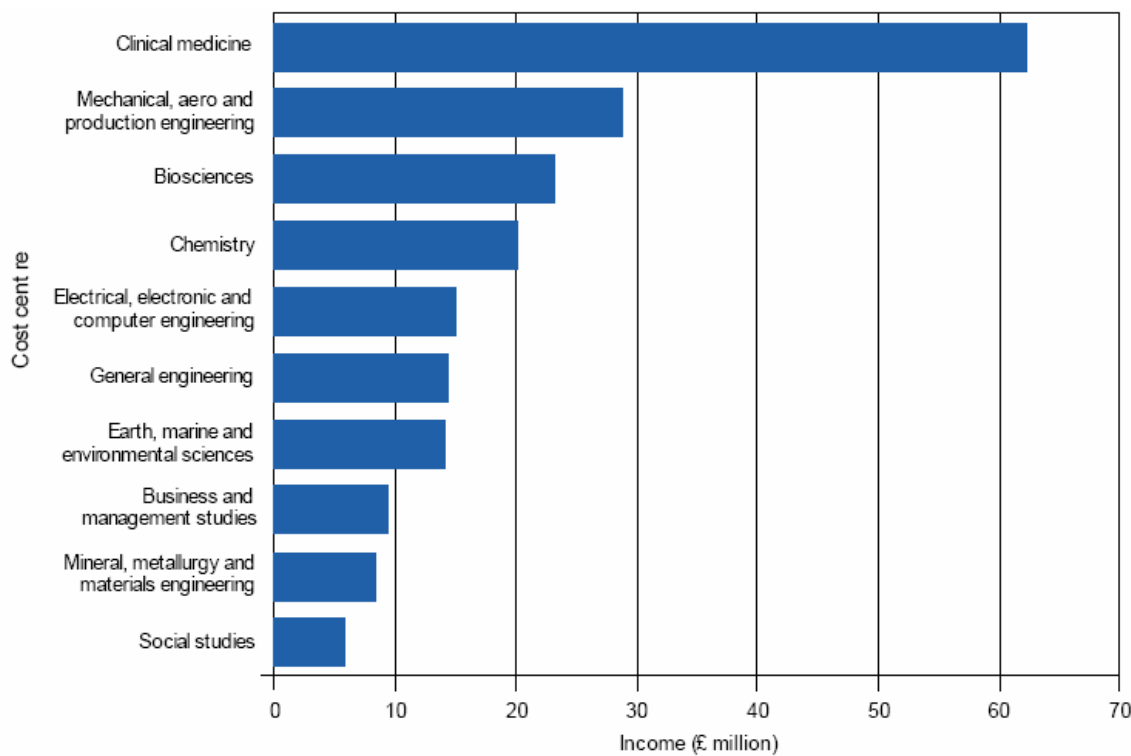
Figure 10: Real terms UK business R& by broad product groups (£ million)



Source: Figure 7, 'R&D intensive businesses in the UK', March 2005, DTI Economics Paper No. 11

It is perhaps not surprising that, as we saw earlier, university research income from businesses reflects this pattern.

Figure 11: Research income from UK industry (by selected cost centres)



Source: HESA FSR 2002-2003

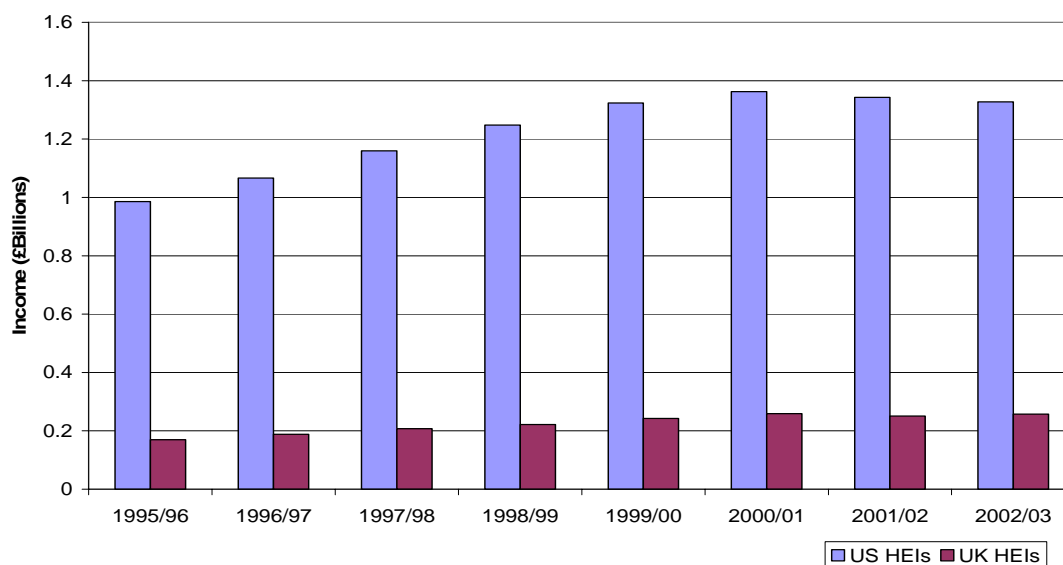
We need better to appreciate the sensitivity of the future location of clinical research and indeed other near market research to the growth of the major markets of the world and how much of this research might reasonably be maintained by the UK in general and UK universities in particular. The Government's 10 Year Science and Innovation investment framework sets as one aim: "maintaining or growing R&D in sectors where the UK is strong". But further analysis is needed on the realistic opportunities based on the type of segmentation of research that we have suggested and a detailed knowledge on the market drivers and resulting sourcing intentions of multinational businesses.

Does R&D tend towards an equilibrium?

Some of the businesses we have seen have suggested that their overall spend on R&D is set by the Board as a percentage of sales or income. The amount will vary by business sector. From this amount a percentage (perhaps in the range of 3-5% of total R&D expenditure) may be spent with universities. The amount will vary depending on the nature of the relationships. Thus expenditure via strategic relationships will tend to be preserved irrespective of annual sales. However research related to problem solving is easier to reduce if sales and profits are threatened and it is easier and often preferable to cut external rather than internal research for obvious reasons.

The relationship with sales turnover and the focus on problem solving suggests that the amount of fundamental and problem-solving research spent with universities could relate to the economic cycle (or at least the cycle relevant to a particular industry sector). The similar pattern of business spend in UK and US universities over recent years might support this hypothesis. Both flattened during the economic slow down of recent years.

Figure 12: University Research Income from Industry UK & USA



Source: HESA and NSF data

Where business spend with universities is short-term and problem related, then perhaps it is vulnerable to being considered a marginal activity by businesses. If this hypothesis is right, then increasing the R&D spent by existing businesses with universities as a percentage of turnover will be difficult. However some businesses have told us they intend to increase the amount of fundamental or problem solving research they will outsource and there is every opportunity for UK universities to capture at least some of this if their research is world class. Businesses search for what is world best as the globalization effect on world market share leaves little room for the second best. Government investment plays a key role in helping universities achieve this through focusing its research funding on centres of excellence. Business spend cannot substitute for basic capacity building.

Another implication of the relationship of university research to business turnover is that as UK universities apply full economic costing, then (so we have been told) the volume of research undertaken in UK universities will fall. We are investigating this claim further. The danger is that if the search for best value for money shifts away from some UK universities to overseas universities or research institutes, then once new relationships are established and value for money is secured, further work could migrate to that new source. Some businesses have told us that the quality of research and of the research facilities in China and India can now be at least as good as in the UK and that a complacency on the part of UK universities would be misplaced.

The relative ease of doing deals

Another factor that determines where research is undertaken is the relative ease of doing deals. We have been told that UK universities are generally receptive to approaches from businesses (whereas in the USA there is more of a climate of suspicion), that the IPR climate is more realistic (whereas again in the USA the Bayh-Dole approach can inhibit partnerships)⁵ and that UK academics can take a realistic view on where the value is added and the total costs and effort involved in bringing an idea to market.

Equally some have said that in the recent past, UK universities were increasingly under pressure to earn income from their research and that the climate on IPR in the UK has also made it more difficult for

⁵ Bayh-Dole is generally held to have had a positive impact on the exploitation of federally funded research. It allows Universities to claim title to research outcomes which have been derived wholly or in part from such federal funding, and makes them accountable for the exploitation. However this right to claim title and direct exploitation exists even when the proportion of federal funding compared with business funding is small and has led to the view in business that such research can be "tainted" and their rights restricted. This may in turn restrict the amount of collaborative research compared with contracted research in which business funds fully overhead costs to try to avoid such "tainting".

businesses to do deals. We have been told that the research administration offices of some universities remain a block to cooperation between academics and businesses and that some of them have unrealistic assumptions and expectations on the income generating potential of their IPR. Again we will investigate these different views.

For their part, universities may view it as easier and more profitable to undertake projects with Research Council funding (this may be especially true in the future as the Research Councils move to full overhead cost recovery). It has been suggested to us that they consider that the esteem and rewards attached to success in the Research Assessment Exercise (RAE) far outweigh that from working with businesses. If articles in peer reviewed academic journals score more highly than research with businesses, the former will tend to be preferred. Although vice-chancellors say that public funded research does not crowd out private funded research, that there is no capacity constraint on the research undertaken and they would never turn away additional funding from businesses, nevertheless it would not be surprising if academics focused on the research and the output from that research that will maximise their score in the RAE and their prestige in their own communities. We would welcome in particular the views of academics on this issue.

Businesses have suggested to us that the widening of the criteria for RAE 2008 and the recruitment of a relatively few business people may not be sufficient to change priorities or the perceptions as to what will produce high scores in this next round. Is there a disjuncture between the needs of the UK for research that will contribute to wealth creation and a research assessment procedure that understandably has wider aims? Future formulaic funding may want to reward and incentivise research that is recognised as excellent by businesses - perhaps on the basis of evidence of business co-funding that research.

The Opportunities for Increasing the Amount of Business Research

If, as we have postulated, there may a relationship between the amount that is spent by businesses in general on R&D and the amount that they spend with external bodies such as universities on fundamental and problem solving research in particular, then the opportunities for UK universities rest on:

- UK based businesses increasing their expenditure on fundamental and problem solving research;
- universities capturing a larger share of the external business R&D expenditure; and/or
- universities capturing R&D expenditure from businesses not based in the UK.

Overall business expenditure on R&D

Economics Paper 11 from the Treasury and DTI shows that those UK-based companies that do operate in industries with high levels of R&D tend to invest on a par with their competitors in other countries. It also shows that "lower levels of R&D by UK business appear to be largely due to the fact that many of our most successful companies operate in markets where R&D is a less important input". Obvious examples are the financial services industry, consultancy and retail. Hence it is not inevitable that UK business has to increase its spend on R&D to a significant extent in order that the UK will remain internationally competitive.

The greater amounts spent by businesses in Germany and France and the USA as a percentage of their GDP may simply reflect the greater role of manufacturing in their economies. The International R&D Scoreboard shows that the US is strongly represented in the three big R&D intensive sectors of industry: pharmaceuticals, IT hardware and software. This is a key factor behind the 4.5% of sales that US companies spend on R&D. Europe is relatively weak in IT and related fields while Asia currently lacks a strong pharmaceutical sector.

Equally the effectiveness of R&D spent can be as important as the overall volume. A survey by Booz Allen of the world's top 1,000 corporate R&D spenders found that while the companies at the bottom

10% of R&D intensity significantly underperformed, the top 10% enjoyed no consistent performance differences compared with those that spend rather less. R&D is an input not a measure of efficiency or effectiveness and "R&D productivity is the real challenge for global innovation" (FT November 2005). Achieving this relies on having the right quality people.

The available statistics may also hide almost as much as they illuminate. An increasingly service based economy does not imply an absence of R&D. Application research is certainly undertaken in the financial and business consultancy sectors. There is research in investment banking for example on mathematical modelling for risk analysis, derivative and hedge fund operations and on the application of IT. But most of this type of research will not count as R&D under Frascati definitions,⁶ not qualify for R&D tax credits and almost certainly not be reported in annual accounts. Therefore it does not officially exist. In fact, so we have been told, it is undertaken in house. While sometimes relevant PhDs might be hired, rarely would the research be contracted out to universities as it is core to the international competitiveness of the business (see the definitions suggested above).

Given the importance of the financial services and business consultancy sector in the UK economy the extent of the R&D captured may be seriously understated. In the USA service sector R&D accounted for 39% of total R&D in 2001 (up from just 5% in the 1980s) – though the DTI has suggested that "up to a third of all US service sector R&D could in fact be directed at manufacturing purposes" (Economic Paper 11). Different reporting and measurement may be the reason why it does not figure so highly in UK statistics – though Figure 10 above shows how it has been rising strongly in recent years. One of our Trustees, Rob Margetts, is investigating further the extent of R&D in the financial services sector and we are sharing information.

The same understatement of R&D is possibly also true in the retail and food sectors and, most significantly, in the fastest growing sectors of the UK economy - the "creative industries". These encompass fashion, music, art, design, software and digital media. Here the R&D is the development, application and adaptation of processes and products to meet fast changing customer needs. A wide range of universities and specialist colleges engage in this R&D through close partnership with businesses. Indeed often the distinctions between the academic and the entrepreneur, the student and the practitioner, even the department and the commercial organisation are difficult to distinguish. Yet these industries which account for more than 8% of GDP and employ some 2 million people undertake a range of R&D that is almost entirely unreported or captured in official statistics. Industries such as digital media and animation have arisen without apparently hardly any R&D being undertaken according to those statistics. We do not know the extent of R&D in the creative industries and do not even know how to measure it. Unsurprisingly we cannot capture the importance of universities in that process. It may be that an element of the growing university income from businesses classified as "consultancy" is in fact disguised "development" R&D.⁷

This gap in our understanding is particularly significant given that the future of the UK lies increasingly in continuous innovation and the development of creative, enterprising individuals and organisations. The organizations in these creative sectors also symbolise the multidisciplinary fusion of ideas which our study suggests is one of the great distinguishing assets of the best UK universities and of the best UK graduates.

While it is not the purpose of this interim report to make recommendations, we commend the AHRC discussion document "Unweaving the Rainbow: research, innovation and risk in a creative economy"

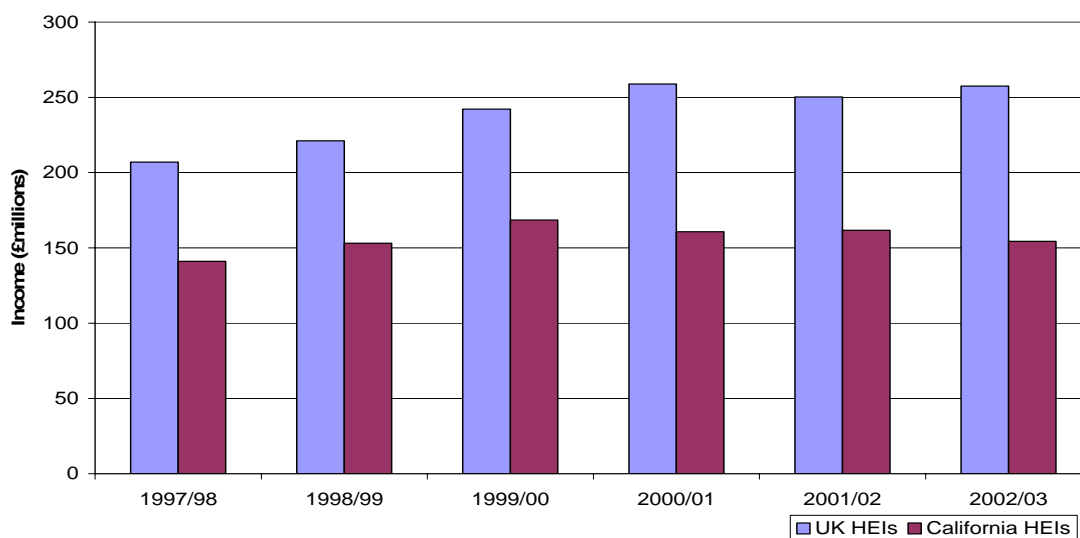
⁶ There are wider problems with using a definition of research that implies a linear process when the reality is that iteration and close interplay with clients is more common even in such areas as engineering. The full extent of R&D in the UK may well not be captured because of definitional problems. Equally the apparent percentage of R&D undertaken by UK-based companies may decline for reporting reasons. As multinationals establish substantial footprints in China and India, they will tend to report their activities accordingly. Tax rates, tax rebates and financial grants may influence and distort these reporting policies. But unless there are considerable tax advantages in reporting R&D in the UK (e.g. if the current tax credits for R&D were to become markedly more attractive, vis Australia and Canada) then we would expect to see research being reported in the country where it occurs rather than in the UK accounts.

⁷ A project in which the CIHE is a funder is identifying how universities can help those in the creative industries develop entrepreneurship. Examples of joint R&D work will also be identified.

which we have placed on our website, and consider that such R&D should be eligible for R&D tax credits and the support available under CASE and the DTI business support schemes such as KTP.

If the UK may be spending more on R&D than is recognised and maybe a not inappropriate amount given the structure of its increasingly service oriented economy, UK universities may also be doing well. Comparing the UK and California (which has a similar population to England and a GDP not much different from the UK) suggests that UK universities are capturing a greater amount of business R&D funding than their Californian peers.

Figure 13: Higher Education Institutions Research Income from Industry – UK and California



Source: HESA and NSF data; \$ to £ at annual exchange rates

The relatively modest overall funding of university research by businesses in the US may perversely reflect the reliance of US universities on Federal funding since such funds carry with them implications under the Bayh Dole Act of Federal rights to exploitation with which businesses do not want to become contaminated. Equally the figures may hide the non-contractual basis of so much US interaction between individuals. There is also much suspicion of university research being over influenced by big business and this attitude contrasts with an emerging range of examples of joint public and private funding in the UK which we will note in our final report.

We do not want to overplay the success of UK universities. The different structures for undertaking research in different countries also affect the relative share of business R&D captured by universities. The UK is virtually alone in placing so much research funding through universities. In France (e.g. CNRS Labs), Germany (Max Planck and Fraunhofer Institutes) and many other countries there are major research centres. China and Russia have followed this model with their Academies of Sciences laboratories, and China has about 100 of these - BP contracts with them rather than direct with for example Tsinghua. We have been told that being outside universities, they are more able to undertake both fundamental and applied research. In the USA there are major labs and those of the US Department of Energy for example have a combined annual turnover of several billion dollars. Hence we might expect the business percentage spent with universities to be higher in the UK given the absence of such major laboratories.

The focus of the UK's national research effort in universities raises wider questions on what Government wants from such research and about the role of the privatized national research laboratories (NPL, DERA, AEA, BREL, etc) and those such as the Cavendish Laboratory in working with businesses on fundamental and applied research. It is beyond the scope of our work to investigate this. But the Government may want to consider how far the structure of the UK research base is likely to support business focused research. Many businesses have stressed to us that university research cannot substitute for business research.

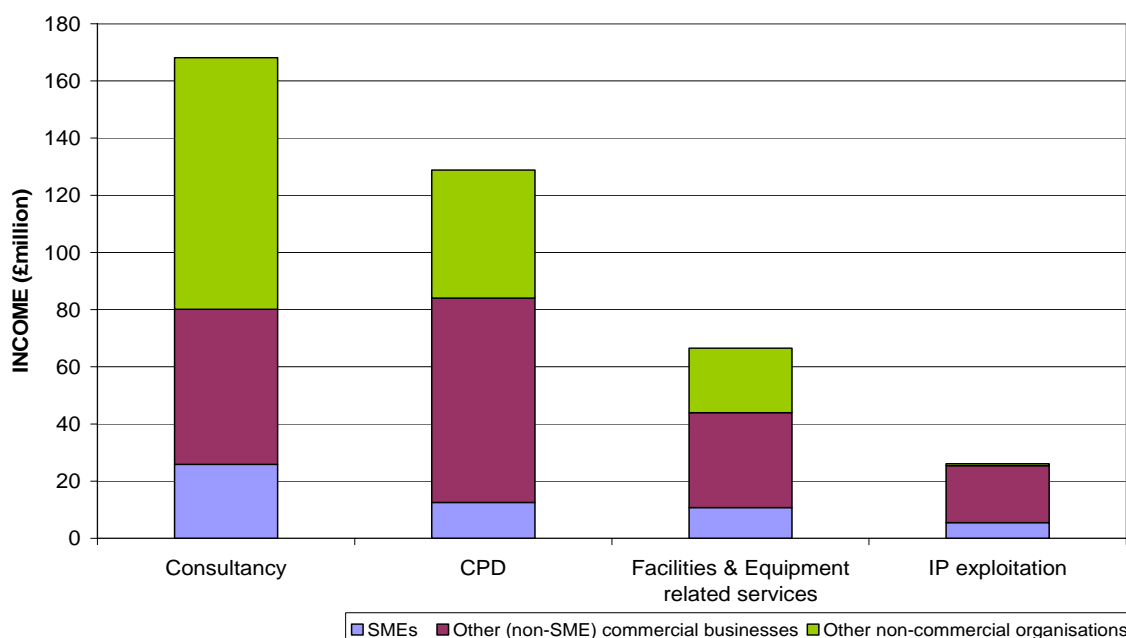
Given that those UK businesses that are most likely to invest in research are already doing so at an internationally competitive level and appear to be investing more pro-rata in universities than is the case in the US in general and California in particular, then where might additional research from UK based businesses be found to offset the probable move of more applications and clinical research to the major markets of the world?

Capturing R&D from new UK sources

If the quantum of R&D carried out in the UK and in UK universities may be under-reported partly for the reasons noted above, then the market and opportunities for engaging in that research may be greater than currently assumed. Equally there are opportunities amongst smaller and medium sized enterprises (SMEs). Richard Lambert proposed a number of actions to help such businesses interact more with universities. The subsequent development of IPR Protocols (and the explanation of their use on the CIHE website that links to the DTI site where they reside) is one useful development. Increasing the professional capability of RDAs (through their Science and Industry Councils and using earmarked funding which they have received from the OST) as well as the increase in the Higher Education Innovation Fund (HEIF) will all help.

Universities already have a range of income generating relationships with SMEs and it has been put to us that universities can act as “windows on the world” for small higher technology driven businesses and other organisations wanting to move up the value chain. One of the strengths of our universities is their international presence and their membership of a range of networks.

Figure 14: Higher Education Business Income from Sources other than R&D



Source: HEB-CI Survey 2002-2003

However, SMEs need to have the strategic awareness, planning capacity and absorptive capability both to realise what is needed and then assess what is offered. They also need the staff to implement the higher value strategy and associated projects. To do this they will increasingly need to recruit and deploy graduates who have the knowledge and business skills and the enterprise and innovative ability to transform those organisations. It was, in the view of many people we have interviewed, a weakness of the Lambert report that so little attention was given to the development and deployment of graduates and to the role of higher education in upskilling the existing workforce. We agree that most knowledge is transferred through the movement of people and particularly graduates. Our final report will focus very much on the development of graduates and how far they meet the needs of the businesses we have seen.

We are becoming aware of a range of other measures that the Government and even some regulatory bodies are introducing that will incentivise universities to work closer with businesses. We will list these in our final report.

Other opportunities for universities

If some business sectors of the UK economy have R&D strengths and linkages with universities that largely go unrecognised, some other sectors have weaknesses that are at odds with the strengths of UK universities. An analysis comparing international excellence in university research as measured by the RAE with the structure of UK business might suggest areas where universities could strengthen the innovative base of the UK. This assumes that there is a correlation between RAE scores as measured largely by academic peers and excellence as recognised by businesses. This may be a bold assumption especially given the focus of business on application research. An earlier analysis by the CIHE has suggested that while there is indeed a correlation, there are also areas where excellence in the eyes of business is not well correlated with excellence as viewed by academics – maybe it would be surprising if it was.

Work is needed better to analyse the source of the business investment into universities including the amounts from overseas. This may help determine whether UK universities have centres of world class excellence as recognised by businesses in sectors where the UK is relatively weak industrially. The embedding of research by world-class IT companies such as Microsoft, Hitachi and Toshiba in Cambridge laboratories suggests that there are indeed areas where overseas businesses recognise and benefit from UK university strengths. Such an analysis could be the basis for achieving the Government's aims (as set out in the 10 year Science and Innovation Investment Framework) of:

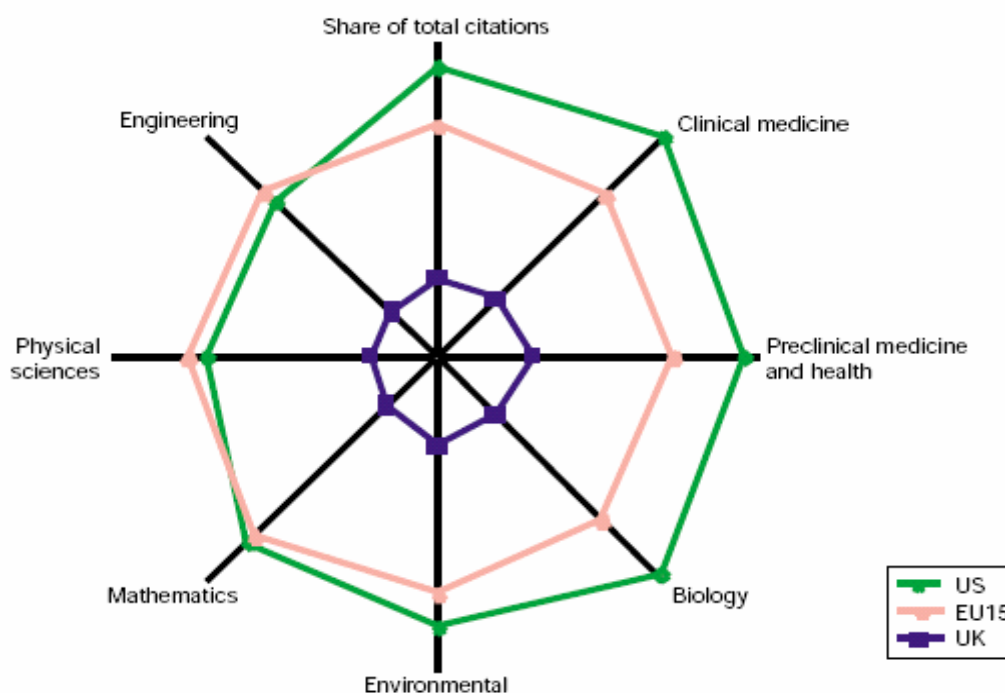
- “attracting R&D in from multi-nationals;
- increasing R&D intensity in firms or sectors that are lagging behind their peers;”

as well as the existing and more traditional focus on universities for

- “developing new R&D intensive sectors through the creation and growth of R&D intensive SMEs”

The evidence on citations (at least at the aggregate level) when compared with that on R&D business spend and university income by UK business sector noted earlier (Figures 10 & 11), suggests that UK universities have a much broader base of internationally recognised and used research than the distribution of business spend on R&D might suggest. If true, this would reinforce the message that there are opportunities for universities to market their capabilities better to businesses both in the UK and overseas to both raise the R&D intensity of UK based companies and generate additional income for the university.

Figure 15: Disciplinary strengths in the US, EU-15 and UK



Source: OST Analysis

There may be opportunities for the UK to redevelop a UK industrial research capability on the back of the expertise that exists in the university sector. An example might be in energy where, post-privatisation, the UK lost much of its industrial R&D capability in transmission and distribution (and even the ability to develop certain graduates as there is evidently no course in nuclear engineering anywhere in the UK). However, research capabilities still exist at Strathclyde and Manchester and are being redeveloped at Imperial College. There are also university R&D strengths in transport and no doubt other areas that might usefully be identified for UK businesses.

It is beyond the scope of this project to investigate this issue further. But we and the DTI would welcome pointers as to how best to identify research excellence that would support UK business and take forward the Government's policies.

Some Conclusions

First, we do not know how much business R&D is being undertaken in the UK. Official data understates the extent partly because it focuses on standard Frascati definitions. We do not know the effectiveness of the R&D undertaken relative to other countries and cannot be certain how much R&D we should be undertaking for an economy with our sectoral distribution of businesses.

Second, the traditional Frascati definitions of research that were appropriate to science and engineering are increasingly inappropriate to an economy where the services and creative sectors are significant players. The supposedly linear progression from fundamental to applied research with relatively clear delineations assumed under Frascati has changed to a process where business related R&D is the result of an interplay of ideas and practices between the client and the researcher.

Third, while orthodoxy points to research suggesting a correlation between R&D in science and engineering on the one hand and successful economic performance on the other, this refers to a time when manufacturing was more important in the economy. We do not know if this is true of an economy based more around services, processes and the creative industries. Equally the Government should not neglect such sectors as tourism, hospitality and healthcare just because they appear to be less knowledge and research based. These businesses are still important drivers of economic growth and

wealth creation and of sustainable jobs – provided they can recruit graduates who have the appropriate skills and range of experiences that are needed (we will comment on this in our final report). They are exposed to international competition and are part of the internationally traded sector (the focus of our study). They need to be internationally competitive.

Fourth, we should not overplay the financial significance of the research interface between business and universities. The R&D performed within business (BERD) in 2002 was some £13,100 million; the R&D performed within higher education institutions (HERD) was some £4,413 million (ONS data). The business R&D performed in HEIs was just some £250 million (1.9% of the former and 5.7% of the latter). The main interface is through the interaction of people. It is also through the recruitment and deployment of graduates that most higher education knowledge is transferred into organisations. Our full report will therefore have much to say on the purchasing and investment decisions that businesses make in this area.

Fifth, there would appear to be limits as to how much R&D international businesses are likely to place with universities in the UK or elsewhere. The amounts they do spend will to varying degrees be affected by the type of research that is being undertaken (and in particular how much is “core” and “near market” as opposed to “fundamental” or “project related”). We have postulated that it may also be affected by the economic cycle. UK universities appear by international standards to be capturing a good share of what is available and globalization pressures will influence how far they are able to maintain their share.

Sixth, in particular there could be a gradual move of application and clinical research off-shore. It will require substantial efforts to replace that with near market R&D from other sectors and from smaller businesses. Capturing additional R&D from SMEs may be of a different order and require different marketing approaches and different skills on the part of universities and their interface units. It will also require an increase in the absorptive capacity of those SMEs – notably through the recruitment and deployment of business savvy graduates. This will be a theme of our substantive report.

Seventh, if smaller businesses are to be engaged, then the Government will want to consider whether just providing more funding via the supply-side is an appropriate response to a largely demand-side problem. Many smaller businesses need relatively simple problems solved rather than high technology transferred. The CIHE had already urged the Government to learn from the experience of the US Small Business Innovation Research (SBIR) programme. This is a means whereby federal agencies spending more than \$100m pa on R&D direct a small percentage (e.g. 2.5%) of this via competitive calls to small businesses. Because the majority of this work must be carried out directly by the company, it stimulates the recruitment of SET graduates, grows the innovative and absorptive capacity of the business and thus its ability to interact with universities. The Chancellor's 2005 Budget mandated the UK public sector to adopt a similar stance, but we have heard that its implementation is decidedly patchy.

Finally, most knowledge is transferred through the interchange of people. Government funding (such as HEIF) will want to recognise and encourage this rather than overfocus on rewarding financial transactions in technologies. It will also want to encourage and reward those partnerships that have business not just academic members and see that funding is available to train practitioners in the value of partnerships and appropriate patterns of behaviour. A range of models for facilitating partnerships will be needed and our study will identify some good practice examples and seek to draw general conclusions. A continuation of existing trends and existing Government measures may not ensure that UK R&D and the proportion undertaken by universities will increase.

Annex

List of Advisory Group Members

Mr Richard Brown	CIHE (CEO)
Mr Richard Greenhalgh	CIHE (Chair)
Mr James Ross	CIHE (Trustee)
Mr Philip Ternouth	CIHE (R & D)
Ms Jane Artess	HECSU
Ms Ilona Blue	HM Treasury
Dr Linda Bradley	DELNI
Dr Roger Carter	HEFCW
Prof David Gani	Scottish Funding Council
Dr Graeme Reid	OST
Prof David Rhind	Universities UK
Patrick Robinson	DTI
Dr Rama Thirunamachandran	HEFCE
Sir Alan Wilson	DFES

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CIHE PUBLICATIONS

Workforce Development and Progression to Higher Education: The California Experience

Workforce development is economic development. What can we learn from the experiences of California in encouraging student progression and employer engagement?

Helen Connor & Madeleine King (£5) (CIHE & Aimhigher, November 2005) ISBN 1 874223 54 8

Ethics Matters: Managing Ethical Issues in Higher Education

Co-produced with the Institute of Business Ethics (IBE), this is a practical guide designed to help UK universities and colleges address ethical issues across their organisations. It sets out to raise questions, encourage debate and make suggestions on how higher education institutions might develop their own approach to ethical matters. (£25) (CIHE & IBE, October 2005) ISBN 1 874223 51 3

Workforce Development and Higher Education

This report summarises responses to our February consultation on Work Based Learning and proposes that the Government, higher education and business should seize the opportunities presented.

Helen Connor (£5) (CIHE, September 2005) ISBN 1 874223 53 X

International Competitiveness: Setting the Scene

Introductory paper to the CIHE's project seeking business views on the international competitiveness of UK higher education. This report summaries the May 2005 Council meeting that launched this project. (£5) (CIHE, July 2005) ISBN 1 874223 52 1

Fishing for Talent from a Wider Pool

The CIHE and IES have together produced this report that investigates trends and dilemmas in corporate graduate recruitment. The executive summary and the report of the web audit are available for download from our website, but the full report can be ordered from the IES website at £35. (£35) (CIHE & IES, March 2005) ISBN 1 851843 50 7

Student Employability Profiles: An Employer's Guide

The CIHE with Graduate Prospects commissioned this guide to raise awareness amongst employers of the employability skills that are developed through the study of a wide range of academic subjects. This information helps employers better to understand the skills developed in specific disciplines so they can help recruit from a wider pool of graduates.

Bianca Kubler & Peter Forbes (£3) (CIHE & Graduate Prospects, March 2005) ISBN 1 874223 49 1

The Value of Higher Education

A guide for students and their advisers on the value of higher education and what businesses look for in the graduates they recruit. This document was written with support from CIHE and UCAS, in association with Prospects. Available electronically from UCAS and CIHE websites and in hard copy from UCAS.

Vikki Pickering (Free – website) (CIHE & UCAS, March 2005)

Higher Education: More Than a Degree

This consultation at St George's House in January 2005 on the student experience of higher education follows our consultation in March 2004 on higher education as both a public and a private good. (£5) (CIHE, March 2005) ISBN 1 874223 50 5

The Business of Knowledge Transfer

With reference in particular to US Institutions, this report stresses the wide range of university knowledge transfer relationships and the need for appropriately wide metrics against which to evaluate performance. *Philip Ternouth* (£5) (CIHE, October 2004) ISBN: 1 874223 47 5

Higher Education Leadership and Fundraising

Summarises the Council discussion with the US fundraising guru John Glier on how US institutions have secured funding. (Free – website only) (CIHE, June 2004) ISBN 1 874223 46 7

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