The economic impact of research conducted in Russell Group universities

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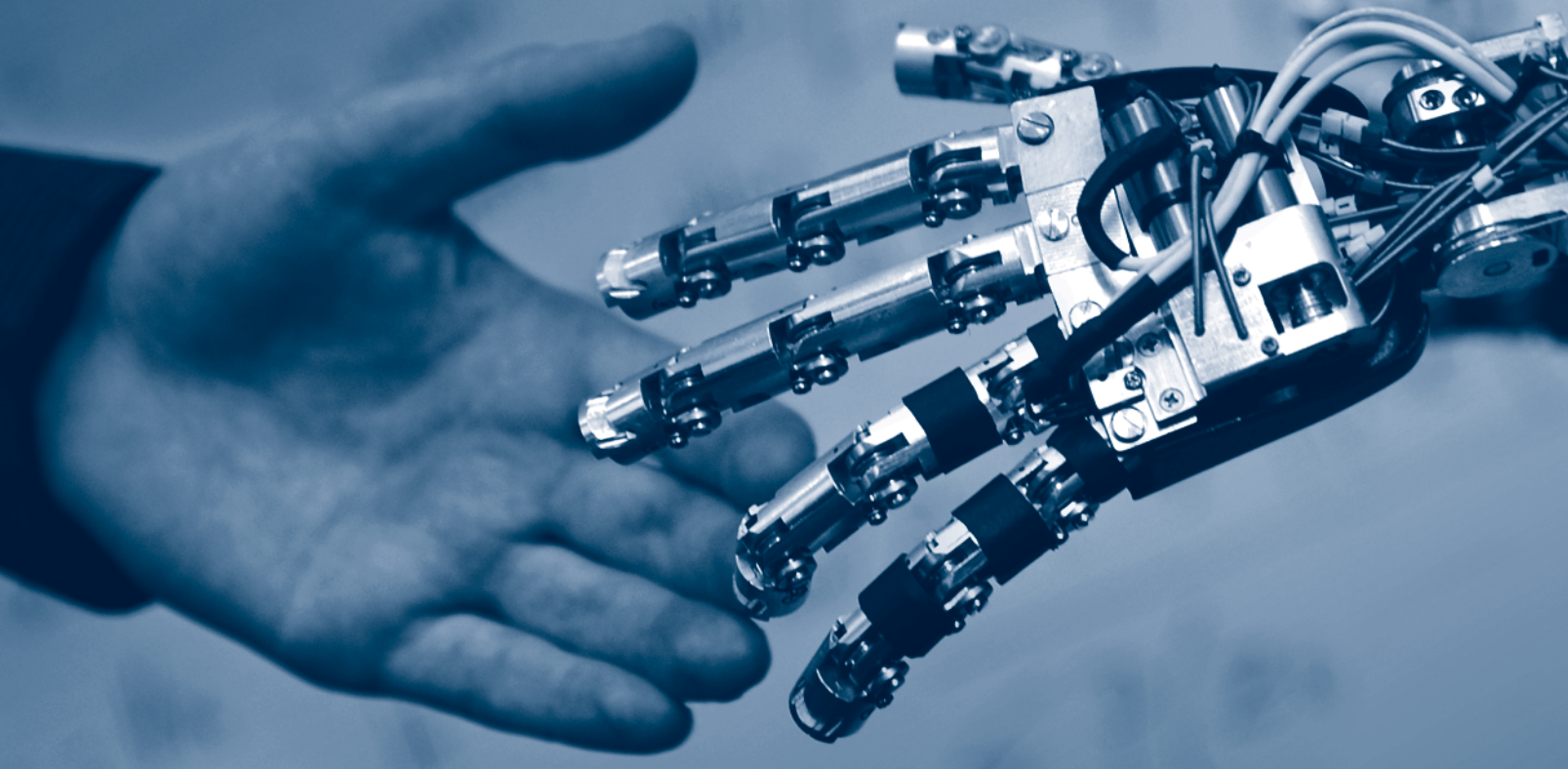

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This report focuses on the benefits of university research to new and existing businesses, and shows how that research serves as a platform for economic growth in the UK. It demonstrates how Russell Group research has brought new knowledge and new perspectives to university-business partnerships, helping businesses to innovate. It has informed the education and training of highly-skilled graduates and postgraduates, giving them the qualities which will be needed by UK businesses to stay ahead of the competition. It has shaped the development of new products and services within UK industry, and helped to improve businesses' strategy, management, and productivity.

In some cases, often when least expected, research within Russell Group institutions has led to truly world-changing discoveries, offering the potential to revolutionise whole areas of healthcare, technologies, or our society. These breakthroughs have sometimes led to substantial revenues for universities and for the UK economy. A sample of such breakthroughs included in this report generated combined wealth of almost £2bn.

This success owes much to investment by businesses themselves, and the UK's unparalleled level of charitable investment in research has made a major contribution to the internationally leading work practised within its higher education institutions. Above all, however, the UK's leadership in research has been founded upon public investment.

This document, building on the activities, insight and experience of Russell Group institutions, shows that public investment in their research has resulted in far-reaching benefits which have been shared by the UK's businesses, the government, and by the taxpayer. It demonstrates that investment in leading research is not a luxury, to be set to one side in times of increased stringency. Instead, it is an indispensible component of the UK's economic competitiveness, and the key to its future growth.

Prof Michael Arthur
Chair of the Russell Group

Dr Wendy Piatt
Director General of the Russell Group

Over many years, the UK has built up a powerful research base, the excellence and productivity of which very few countries can match. A significant proportion of this national research base resides within the university sector and in the Russell Group universities in particular.

This research excellence reflects a strong tradition of research and development within UK industry, and the important work of the charities sector in supporting and funding research. However, it is underpinned by a strong commitment by government to public investment in science and research. Any government invests in research for its potential to have a positive impact on society, and as major beneficiaries of public research funding, Russell Group institutions are committed to optimising the societal benefits of their research. One important aspect of this is benefit to the economy.

This report demonstrates the economic impact of research conducted within Russell Group universities. It focuses in particular on the benefits of university research to new and existing businesses. The full benefits of research are, however, much wider than direct economic impact and include benefits to health, quality of life and culture.

The case studies and data in this report demonstrate how businesses gain competitive advantage through collaborating with universities on research and research-based activities. Working with a university can enable a company, of any size or industry sector, to access the latest knowledge, ideas and research expertise relevant to its business. We present evidence of successful collaborations between university researchers and businesses, including long-term research collaborations, specific projects focused on near-market business problems, and research for improved business processes and efficiency.

University research also plays a vitally important role in the development of the human capital that businesses need for success – "knowledge transfer on legs" as it has been called. Research-led teaching equips graduates with the personal and professional skills that employers need. Postgraduates in particular provide businesses with a highly-skilled and critically important labour force trained in the latest research developments and techniques, able to think creatively and solve complex problems. This report includes examples of universities and businesses working together to optimise the transfer of knowledge between academic research and the economy, through activities focused on graduates and postgraduates.

Many businesses access the research expertise of universities through consultancy aimed at addressing specific business problems. A significant proportion of academics at Russell Group universities engage in consultancy with business and other external organisations. We present examples of how a wide range of different companies have gained practical benefits from the research expertise of universities through this form of engagement. Other examples demonstrate the role played by university research in supporting the provision of continuous professional development to businesses, and in attracting international investment in the UK from global research-intensive companies.

A further very important way in which universities benefit the economy is through the commercial exploitation of research through licences and spin-out companies. Russell Group universities have a strong track record in achieving economic impact through these processes. Based on new data from over 100 case studies collected from our institutions, the latter part of this report looks at how economic benefit is generated from the commercial exploitation of research.

Our case studies show that significant economic impact is derived from the commercialisation of research in a range of different subjects and disciplines, as well as multidisciplinary research. Moreover, professional knowledge transfer staff and processes within universities are critical in ensuring that research results in maximum benefit to the economy. This is an area in which universities have invested significantly in recent years, with good results.

From our analysis of the Russell Group case studies on commercialisation, it is clear that a majority of highly successful licences and spin-out companies have emerged from long-term curiosity-driven research. Moreover, our analysis demonstrates that successful commercialisation requires sustained long-term investment in research, often over many years or even decades.

In some of the commercialisation case studies presented here, the financial returns have been quite spectacular. However, it would be misleading to consider the impact of technology transfer only through its direct and quantifiable economic impact. In many of the cases we have looked at we also found evidence of wider benefits to society resulting from the commercialisation of research.

Whilst this report focuses on the benefits of research to businesses, research is also capable of much wider impacts on society, through positive effects on policy-making, healthcare, the environment, and other quality of life improvements. These wider impacts tend to be more difficult to quantify than impacts on businesses. We will publish a subsequent report which will look at these wider impacts of research.

World-class university research is an invaluable resource supporting the growth of new and existing knowledge-intensive businesses in the UK and worldwide. This report demonstrates the important impact of research on developments in key sectors of the economy such as biotechnology, aerospace, pharmaceuticals, new energies and creative industries. It also demonstrates how research underpins the high-level skills and development of human capital which will be so crucial to the success of businesses in the future.

1.0 The Russell Group of Universities

The UK research base is highly productive and has a global reputation for excellence: with just 1% of the world's population, the UK earns 12% of international citations.[1]

The Russell Group of Universities represents the 20 major research-intensive universities of the UK. These institutions are vibrant and dynamic organisations, actively contributing to their local communities and economies, yet influencing and achieving impact on a truly global scale. By virtue of their size and the quality of their research and teaching, Russell Group universities create and catalyse a hugely diverse range of economic activity which has a major impact on the economy of this country.

The size and scope of Russell Group universities makes them a prominent UK and international industry[2] in their own right:

– they have a total economic output of £22.3bn per annum – equivalent to 40% of the total output for the sector

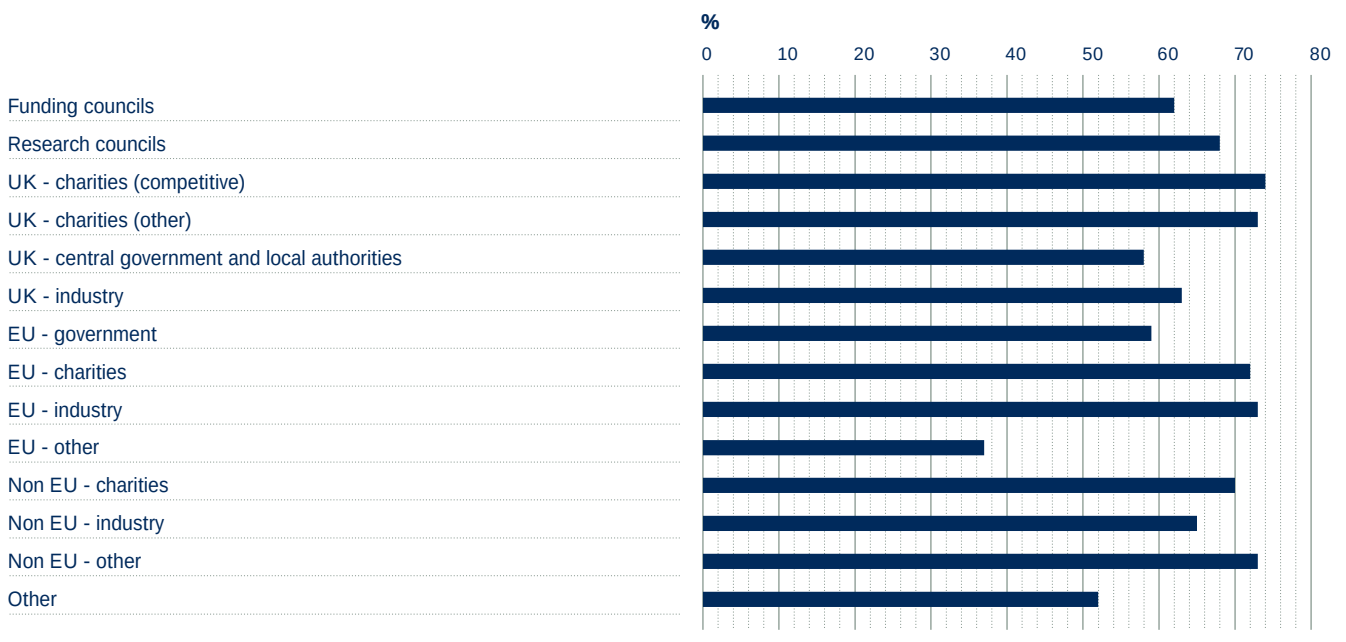
– they are responsible for supporting 243,000 jobs UK-wide – equivalent to 36% of jobs supported by the sector

– they are a major UK export industry, with overseas earnings of over £2bn per annum – 38% of total earnings for the sector.

These institutions represent only 12% of the higher sector by number, but nevertheless account for a significant proportion of the UK's research base, employing 40% of academic staff, and educating 56% of PhD students within the higher education sector. Russell Group universities win the majority of the competitively available research funding from a wide range of sources. Approximately two thirds of research grants and contracts from external funders are won by Russell Group institutions, including 63% of research grants and contracts from UK industry and commerce.[3]

Figure 1 illustrates research income to Russell Group institutions as a proportion of the UK higher education sector totals. The majority of such funding is awarded on a competitive basis, in some cases in competition with other research institutions around the world. This success in competing for funding from multiple public, private and charitable funders reflects the great breadth and depth of research excellence at these institutions.

Figure 1: Investment in Russell Group research as proportion of HE sector total[4]



2.0 Definition of economic impact

This report focuses on the economic impact of the research undertaken within Russell Group universities. We define economic impact as the effects of research on the long-term economic growth[5] and the well-being of the nation, including the benefits to the following groups:

– businesses and other organisations, which benefit from new and improved technologies and skills. Their increased productivity and enhanced ability to offer new goods and services in turn increases the nation's output and GDP

– government, which benefits from increased knowledge to enhance policy making and achieve its desired outcomes

– the general population, which benefits from a better quality of life through consuming new goods and services, and improved policy making.

The impacts on businesses and their ability to offer new goods and services tend to be more easily measured than those on policy and quality of life. For example, the value of a relatively new company can be a proxy measure for the market value of a new technology, which will in turn create new products and services, and contribute to a higher quality of life.

This report focuses predominantly on the benefits to businesses. It explores the extent and nature of the interactions of Russell Group universities with business, and provides new evidence that demonstrates the market value of new technologies arising from research carried out at our institutions.

However, the potential impact of research far exceeds the commercial world, and economic impact also derives from the effects of research on policy-making and society through better healthcare outcomes, improvements to the environment, and many cultural and quality of life benefits. Although many of the case studies in this report illustrate these wider impacts they tend to be more difficult to quantify than impacts on businesses. This is because the effect of research on policy-making and society can be very wide-ranging in nature. We will publish a subsequent report which explores the impact of research on public policy and society more widely, including looking at partnerships with government departments and their agencies and the charitable sector.

3.0 Demonstrating the economic impact of publicly funded research

Russell Group institutions are recognised internationally as leading research universities – a reputation that has been based on a sustained programme of public investment and high level political support for science and research. The Science and Innovation Investment Framework published in 2004 aimed to achieve a substantial overall increase in R&D investment in the UK, rising to 2.5% of GDP by 2014.[6] As a result, public spending on science and research has risen steadily.

Russell Group universities recognise that this significant public investment needs to be justified through evidence of successful translation of research into economic and social benefits for the nation. This report looks at a wide range of cases in which research has led to clear economic impact. It is worth noting that in the vast majority of these examples substantial economic benefits have been generated from "blue skies" or long-term curiosity-driven research projects. This illustrates the importance and value of public investment in research of this kind, as well as projects with more immediate economic potential. Public spending in the UK is entering a period of contraction. The research base needs to demonstrate that investment in science and research continues to be a priority area for public investment. In the current global downturn, the UK needs more than ever to support the businesses able to continue the growth of a knowledge economy.

Case studies throughout this document illustrate the impact which research is having within areas of major economic potential. There are examples from aeronautical engineering, plastic electronics, biotechnology and pharmaceutical development, and low-carbon energy solutions. The case studies also highlight how research is enabling the development of new technologies and processes, to enhance business competitiveness and to improve the skills and capabilities of the workforce.

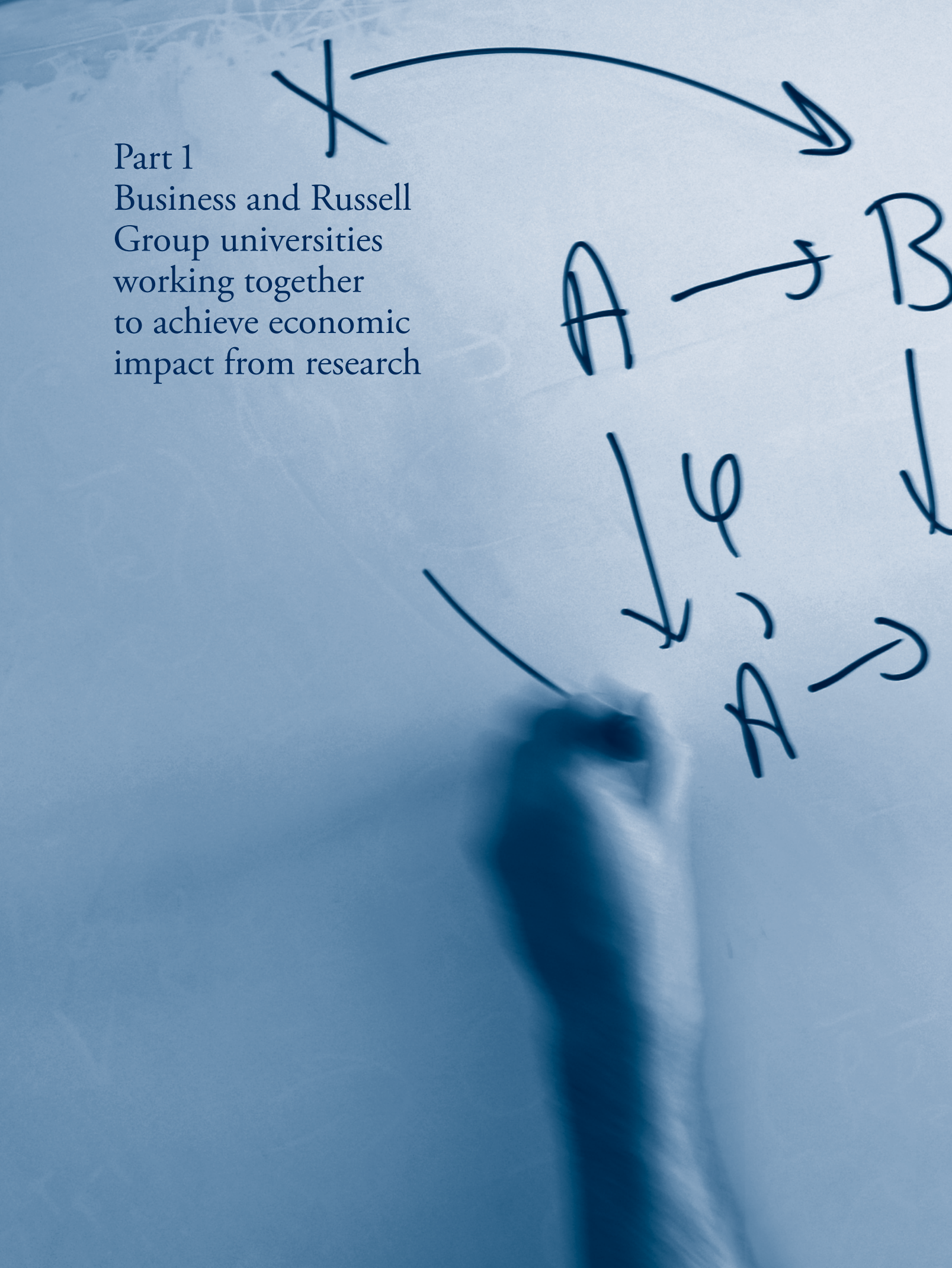
4.0 Structure of this report

In Part 1 of the report we look at the range of different ways businesses and Russell Group universities work together to deliver economic impact, through the training and development of skilled graduates and researchers, via research collaborations, knowledge exchange and commercialisation of research, through contributions to workforce development, and by attracting inward investment to the UK.

In Part 2 we present a new evidence base drawing on over a hundred case studies from Russell Group universities, which demonstrate economic impact through the commercialisation of research. The case studies highlight the economic impact of basic as well as more applied research, and illustrate the commercial potential of interdisciplinary research. We also consider the ways in which universities support the development of economic impact through commercialisation. Through the case studies we have also highlighted the typical timescales from research to economic impact and looked at some of the wider, non-commercial, benefits arising from commercial exploitation of research.

Although we cannot quantify in detail the contribution that Russell Group universities' research has made to the UK economy and society, the evidence provided in this report gives an insight into the very significant returns which follow from the public investment in university research.

Part 1
Business and Russell Group universities working together to achieve economic impact from research



1.0 How university research benefits businesses

World-class academic research underpins the success and competitiveness of many UK businesses. It has been well documented that companies, particularly knowledge-intensive ones, gain competitive advantage from working with universities by:

Access to research expertise. Leading researchers are a source of latest research findings and thinking within the university, but also a source of knowledge about the latest developments nationally and globally.

Access to resources. Businesses benefit directly by access to publicly funded IP. Co-funding research with university partners also enables companies to access leading research talent and to lever public funding, to accelerate the development of an area of research and to pursue more research than the company would be able to afford by itself. There is also considerable evidence that public investment in R&D encourages private sector investment. A strong correlation exists between the volume of public investment in R&D and the volume of private investment in R&D, particularly in the biomedical sciences.[7]

Access to interdisciplinary knowledge and expertise. Increasingly, new opportunities and innovations are likely to arise at the boundaries between traditional research disciplines. Companies are aware of these opportunities and also need to access and utilise the latest research knowledge and findings in an interdisciplinary way. Larger research focused-universities are able to provide these kinds of joined-up solutions.

Access to cutting-edge facilities. In certain areas of research, technologies and facilities are becoming so large, specialist and expensive that companies, particularly smaller or less research-intensive businesses, are unable to justify the capital investment.[8] Universities often host such facilities and can provide access to businesses as well as to other resources such as data and collections.

Research consortia. By partnering with universities, companies are able to collaborate with potential competitors and supply chain partners in early-stage, pre-competitive research.

Proximity. Evidence shows a close association between the performance of R&D intensive firms and their proximity to centres of university research.[9]

Human capital. Numerous studies have shown that businesses use the recruitment of graduates and research staff as a primary way to access the latest research and skills.

Consultancy. Professional consultancy enables businesses to access knowledge, new approaches and skills from within the university sector and address specific business problems.

Case study 1
GSK Clinical Imaging Centre
Imperial College London

Key funding source: GlaxoSmithKline, Imperial College London, Medical Research Council

The GSK-sponsored clinical imaging centre at Imperial College London is a multi-million pound collaboration which has created a world-leading facility drawing on the research expertise of Imperial College.

GlaxoSmithKline committed to a £50m investment in the centre, which officially opened in 2007. Alongside parallel investment from Imperial College and the Medical Research Council, GSK's commitment has equipped the centre with state of the art scanning and imaging facilities, which will enable scientists to improve their understanding of some of the world's most serious diseases, including cancer, cardiovascular disease and neurological disorders. Through improving fundamental understanding of diseases, it will create a platform for the development of new, more effective, treatment and prevention.

Continuing professional development (CPD). Engaging with universities via collaborative projects, consultancy or other means enables employees to gain new skills, techniques and ideas, which can improve company productivity and performance.

Businesses gain these benefits through a wide range of direct and indirect interactions with university research. In the following sections we explain how UK and international companies, both large and small, and Russell Group universities work together to deliver economic impact from research through:

– research collaboration

– human capital

– consultancy

– continuing professional development.

All of these activities ultimately help to boost the reputation of the UK as a location of choice for research and research partnership. Therefore, we will also provide evidence of how Russell Group universities have attracted inward investment from the private sector.

The new knowledge generated by excellent research may be used by companies to inform and improve their own R&D programmes, or stimulate the development of new goods or services. Equally, it may improve business productivity through improved technologies and manufacturing processes, shortening supply chains, improved business processes, management or organisational change. Mansfield *et al* find that 10% of all new products and services developed by companies surveyed could not have been developed, without significant delay, without university research.[10]

A recent study, undertaken by the Advanced Institute of Manufacturing (AIM) for the EPSRC, looked at motivations for commercial engagement with academic research. The report found that access to fundamental understanding and research expertise is one of the most important motivations for industrial collaborators engaging with universities. Amongst surveyed companies, the most frequently cited reason for collaboration with universities was "access to state of the art thinking in science and technology". 57% of companies rated this as a "very important" or "crucial" factor motivating engagement. The ability of universities to undertake exploratory research was the sixth most frequently cited reason for collaboration, with 30% of companies citing this as important or crucial.[11]

Case study 2
Great Western Research
The University of Bristol

A collaboration between the University of Bristol, the universities of Bath and Exeter, and the aerospace manufacturer Airbus UK, is pioneering the development of lighter and stronger aircraft, as well as investing in basic academic research and skills.

The University of Bristol is closely involved in the organisation Great Western Research, which orchestrates research collaborations between business and higher education. One project coordinated by Great Western Research is exploring the potential of "smart materials" – materials which can radically change shape in an electric field. The research involves a partnership between Bristol and the universities of Bath and Exeter, with funding from Airbus UK jointly supporting eight PhD studentships.

The research may have long-term technological potential, with the possibility of faster and more efficient flights, but investigations are at an early stage. Much of the research involves fundamental "blue sky" investigations into the properties of exciting new materials.

Martyn Cantrell, composites engineer and project manager with Airbus for GWR, explained "As it's very blue sky, in terms of potential and products to take to the market, that's not what we are expecting. It's about the idea."

Russell Group universities offer all of these opportunities and resources to the private sector, and seek to work in partnership with businesses both large and small to deliver economic impact. A concentration of excellence in terms of researchers, postgraduates, facilities and interdisciplinary expertise coupled with increasing investment in knowledge transfer processes and more flexible processes for engagement, means that many Russell Group universities are well placed to continue to work in partnership with business to boost the economic competitiveness of the UK.

We are building from a strong base. Data from the 2009 Higher Education Business and Community Interaction Survey show that Russell Group universities are actively engaged in a broad range of partnerships, collaborations and relationships with business and industry, to maximise the potential impact of their research on the economy.

In 2007-08 Russell Group universities:

– secured a total of £244m from the commercial sector for contract research, 66.2% of the total across the UK HE sector

– of this, £229m came from larger companies (68.9% by value of the sector total) and £15m from SMEs (41.1% by value of the sector total)

– accounted for 16 of the top 20 recipients of income for contract research from large companies, and 12 of the top 20 recipients of income from SMEs.

Of course income from research contracts is only a part of the picture. Over the last five years, knowledge transfer revenue at Russell Group universities has increased across a broad range of income streams (Figure 2).

A content analysis of 16 Russell Group universities' strategies for the use of HEIF4 funding showed that, in addition to supporting licensing and spin-out formation:

– 11 were also focused on developing or supporting business partnerships

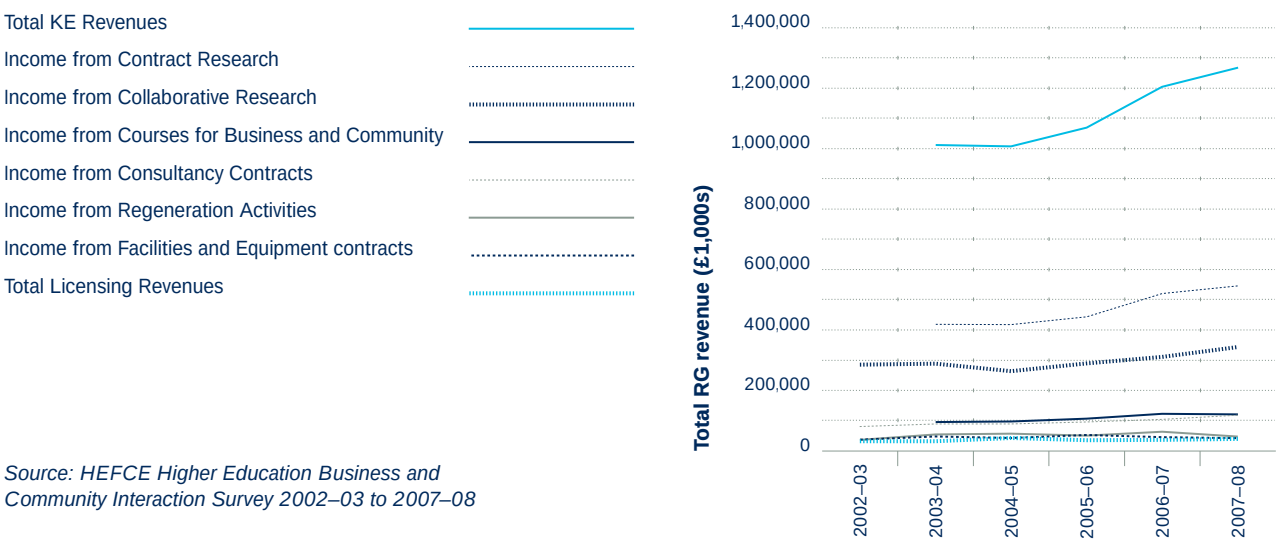
– eight were specifically focused on supporting collaborative research.

2.0 Research collaboration

Russell Group universities and businesses work together on research in many varied ways including via the co-funding, co-design and/or co-production of research, joint research centres, joint chairs and other appointments and research contracts. Such partnerships may be built upon bilateral or multilateral relationships and may involve one or more universities and one or more businesses. They may be short-term and focused on a specific project or piece of research or more strategic, involving a long-term commitment between the university and the company to work together on basic research.

Ultimately the goal of most such collaborations is to develop intellectual property (IP) with commercial potential, now or in the future. Part 2 of this report addresses in detail how research from Russell Group universities has been exploited for commercial benefit via licences, patents and spin-out companies.

Figure 2: Income from knowledge transfer activities within the Russell Group



Source: HEFCE Higher Education Business and Community Interaction Survey 2002–03 to 2007–08

Case study 3
Innovation in financial services
University of Oxford

Key funding source: Man Group plc

The Oxford Man Institute of Quantitative Finance was opened in September 2007. The institute has been established on a model of academic excellence, co-existing with a culture of innovation and commercial engagement in the finance sector.

The result has been the securing of a long-term partnership with Man Group (the world's largest provider of hedge funds), with benefits for both parties: the arrangement will leverage significant commercial investment for the university, while offering its partner direct access to its research and expertise.

Man Group has committed to fund the Institute with a core research grant of £10.45m, and Man Group executives will be seconded to the "laboratory" to pursue research projects of their choosing in relation to quantitative finance. In addition, Man Group is funding an endowed chair of quantitative finance. A framework contract has also been agreed under which academics across the University may provide consultancy in order to further Man's objective of providing innovative products and tailor-made solutions to private and institutional investors.

According to Neil Shephard, Research Director of the Mann Laboratory at the institute:

"Innovative quantitative research is the lifeblood of our industry, and if you want your staff to be genuinely creative then you have to provide them with a stimulating research environment."

Case study 4
The Environmentally-friendly Engine (EFE) project
Universities of Birmingham, Cambridge, Sheffield and Queen's University Belfast

Key funding source: Technology Strategy Board, Rolls Royce plc

The EFE brings together a consortium of industry representatives and major research-intensive universities with the aim of delivering significant improvements in air travel efficiency and environmental impact. Led by Rolls Royce in collaboration with four other industry partners, the project involves the Universities of Birmingham, Cambridge, Oxford, Sheffield, Loughborough and Queen's University Belfast.

The programme began on 1 January 2006 and will run until January 2010, at a total cost of £95m.

As part of a national aerospace strategy for the UK, the project will deliver on environmental goals set for 2020 by the Advisory Council for Aeronautics Research in Europe (ACARE). It will develop new technologies across a broad spectrum of investigation, from basic research to technology validation. In doing so, it will enhance the UK's competitiveness in key aeronautical technologies such as high efficiency turbines, low emission combustion and engine control.

2.1 Long-term strategic research partnerships

Knowledge-intensive and high-tech businesses form strategic, medium to long-term relationships with universities with a focus as much upon enhancing fundamental understanding as working towards a specific commercial application. It is typically larger companies and multinationals in R&D intensive sectors such as pharmaceuticals and aerospace which have been amongst the foremost investors in these kinds of academic research collaborations in the UK.

Russell Group universities have a strong track record of working in partnerships with businesses on research which would generally be regarded as fundamental in nature, and where the business partner can recognise long-term potential to address its own needs. Case studies 1 and 2 provide good examples, looking at GlaxoSmithKline's investment in a Clinical Imaging Centre at Imperial College and a partnership between the University of Bristol and Airbus UK conducting fundamental research into the properties of aerospace materials.

A number of major companies have co-located their research laboratories or research staff alongside leading university departments to ensure that their researchers are able to work closely with academics pursuing more fundamental research goals. Access to state of the art research equipment and facilities is also another motivating factor. This is exemplified by Toshiba and Microsoft, both of whom have invested in major research laboratories within departments of University of Cambridge.[12] According to the CIHE, a primary motivation for Toshiba embedding research facilities within University of Cambridge was to afford its researchers access to the university's sophisticated equipment to explore the fundamental properties of materials.[13]

The UK derives significant economic benefit from this co-location of leading industries alongside centres of research excellence. It is a model which has been adopted not only by manufacturing companies in the science and technology fields, but also by innovative companies in the service sector (See case study 3), and research has highlighted its importance in generating clusters of innovation worldwide.[14] The EU has also sought to stimulate similar centres of research and innovation through its investment in knowledge innovation clusters (KICs).

Case study 5
Centre for Materials Discovery
University of Liverpool

Key funding source: NWDA, ERDF, Industry, university own funds (including HEIF)

The Centre for Materials Discovery (CMD), based at the University of Liverpool, provides a research centre and a research and knowledge transfer service to academia and industry in the area of high throughput materials discovery.

Building on the strong base of academic expertise within Liverpool, and working closely with other universities in the North-West, the centre aims to support businesses by providing access to leading research, training for industry personnel, and world-class facilities such as robotics and advanced ICT.

The Centre is explicitly targeted at the use of research excellence to support business endeavour, particularly businesses based within the Northwest. Figures provided by the university indicate that, after three years, the centre has had a major impact within the Merseyside region, including:

– 245 Merseyside net jobs created
– 65 NW businesses received advice
– 27 Merseyside SMEs receiving assistance
– more than 70 individuals trained in "High Throughput" techniques
– £5.85m Net Value Added to the Merseyside region.

2.2 Research to address more specific and near-market business problems

A considerable proportion of university-business research collaboration is concerned with helping companies to find new ways of addressing challenges which are nearer to market . The AIM / EPSRC study emphasises that access to the problem-solving capability of expert academic researchers is a key priority for many companies both large and small.

Case studies 4 and 5 provide good examples of this kind of activity at Russell Group universities. They also demonstrate how universities have been successful in collaborating with one another, in order to meet the needs of businesses.

2.3 Research for improved business processes and efficiency

As well as technological solutions, businesses also look to leading universities for new research and thinking on leadership, management and organisational development. Research in business management, finance and related subjects can help to improve business models and contribute to the development of more efficient business management (eg more effective marketing strategies).

Case study 6 highlights the work of the University of Liverpool in bringing its management and marketing expertise to local businesses in particular, through its Agility Centre. Later, we will consider an example of how university-business collaboration on research has provided consultancy and skills developments which helped to improve sales and customer services (case study 15).

Case study 6
Agile Marketing
The University of Liverpool

The Agility Centre at the University of Liverpool has been established to help local businesses, particularly SMEs, develop flexible marketing and strategic approaches to a changing business environment.

Building on research expertise developed initially within the Department of Engineering at the University, the centre is able to offer a range of assistance to companies in the region; from consultancy with its expert business analysts, to arranging work placements with graduates and final year undergraduates.

One local SME which has benefited from the research expertise at the centre is Newton Instruments, a manufacturer of instrumentation and measurement equipment for major multinational companies such as UniLever.

Newton turned to the Agility Centre for assistance in developing its marketing strategy and updating its website. The expertise at the centre helped Newton develop a more focussed marketing strategy and to develop its website as a front-line marketing tool. According to Newton's Chief Executive:

"… the Agility Centre has been a tremendous help. It was like having my own marketing mentor."

2.4 Research collaboration with SMEs

The AIM/EPSRC survey found that "access to state of the art thinking" is the most important factor overall in driving research collaboration amongst SMEs as well as larger businesses.

Whilst Russell Group universities collaborate with most of the world's leading multinational companies and leading British industry, they also have a strong record of engagement with SMEs. The 2009 HEBCI survey showed that:[15]

– 19 out of 20 Russell Group institutions have established a dedicated unit or enquiry point for SMEs

– 18 of 20 have the capacity to assist SMEs in specifying their needs

– Russell Group universities secured £15m in research contracts from SMEs (41.1% by value of the sector total).

Case study 7 describes a typical example of university-SME research collaboration, facilitated via a Knowledge Transfer Partnership (KTP).

3.0 Human capital

Russell Group universities make a major contribution to the UK economy through the training and development of graduates and researchers with the skills that businesses need to succeed. This includes those who will go on to be managers and business leaders, as well as researchers, engineers, technical and other specialists.

The knowledge that graduates and postgraduates bring to the workplace is recognised to be one of the most important pathways through which research exerts influence and impacts upon the economy.[16] The training of skilled graduates is one of the principal benefits of research – facilitating transfer not only of a knowledge base informed by the latest scientific developments, but also a familiarity with the most up-to-date scientific techniques, a capacity for creative thinking and ability to solve complex problems.[17]

Russell Group universities are committed to equipping their students with the personal and professional skills that employers are looking for in an increasingly knowledge-based economy. This is fostered through distinctive research-led teaching which encourages a culture of enquiry-based, independent learning in a world-class environment. Research-led learning actively engages students in their learning experience, encouraging them to pursue new knowledge and to develop independence of thought, critical thinking, entrepreneurial skills and the ability to handle a wide range of challenges.

Case study 7
Improving management within a local SME
University of Warwick

The skills and expertise developed by one student at the University of Warwick business school have helped to rejuvenate the management techniques and company culture within a local manufacturing SME.

Strip Tinning Ltd (STL) is a Birmingham-based SME which manufactures components for the automotive, communication and construction industries. It turned to the research expertise within the University of Warwick business school in order to review and re-develop its strategic management processes and help change company culture.

Through a knowledge transfer partnership, STL were able to gain direct benefit from the research-informed skills of Susanne Tanner, who was carrying out an MSc at the Business School. Working closely with Dr Charles Tennant, the lead academic from the University, Susanne was able to employ research techniques developed within the business school to identify an appropriate management process for the company. She recommended the a Western adaptation of a Japanese management technique, "Hoshin Kanri" would help meet the company's goals.

The partnership helped introduce improved management techniques, more effective reviewing and assessment of progress, and an improved company culture which has made a real impact on performance.

Case study 8
Improving the market position of a manufacturing company
Queen's University Belfast

A project undertaken by a KTP associate from Queen's University provided a manufacturing company with a major competitive advantage and improvements to customer satisfaction and confidence.

Macrete Ireland Ltd is an independent precast concrete manufacturer based in Co Antrim with over 30 years' experience in the design and manufacture of a wide range of concrete products and systems.

Steel reinforcement in concrete bridges tends to corrode with time undermining the structural integrity and recent changes in European legislation have necessitated the replacement of relatively modern bridges to meet new load-carrying criteria.

Macrete recognised the market potential in developing a new unreinforced bridge arch utilising a non-corrodible polymer. However, it also recognised the complexity of this task. Successful product development demanded cost analysis, advanced material development, numerical analysis and field testing alongside resource and staff management.

Macrete entered into a KTP in collaboration with the School of Planning, Architecture and Civil Engineering at Queen's University Belfast. The KTP Associate, engineer Abhey Gupta, worked with Macrete to successfully develop a unique, cost-effective, highly durable and aesthetic concrete block arch system.

The project provided Macrete with a major advantage in the bridge market.

Case study 9
A statistical methodology for asset surveys
Newcastle University

Newcastle University's Industrial Statistics Research Unit (ISRU) has been delivering consulting, learning programmes, coaching, and research services since 1984 and has worked extensively with the National Grid.

One project was to determine sample size and sample selection methodology for a major survey of National Grid's assets. After reviewing data availability, the work involved sample size calculations and advising on methodology for selecting a random, representative sample which would give precise estimates efficiently. A well-constructed questionnaire and measurement protocol were developed and thorough follow up ensured a very high response rate. After assuring the quality of the data, estimates of asset properties were obtained. In addition, extensive statistical analysis was carried out to look for relationships between different aspects of the data.

The statistical analysis helped National Grid to improve its understanding of the performance of its assets.

There is clear evidence that employers value this kind of research-led education:

– a study of graduates from 'research-intensive' universities, including universities from the Russell Group, indicated a wage premium over other graduates. Almost half of all graduates from research-intensive institutions were found to be earning £25,000 or more 3½ years after graduation, compared with just 29% of graduates from 'other HEIs'[18]

– six months after graduation, Russell Group graduates can expect an average salary premium of more than £3,500 over graduates from the rest of the sector[19]

– Russell Group graduates are rated amongst the best in the world by employers. Five of them featured in the top ten institutions in the world in a major survey of graduate recruiters, and a total of 13 of them featured in the top 50.[20]

A substantial proportion of undergraduate programmes at Russell Group universities already offer students internships with leading companies and other employers in the UK and overseas, and many also provide opportunities for participation in real life projects and problem solving particularly during the final year of study.

Russell Group universities host more than half of the UK's PhD students. They host 60% of students supported by CASE studentships. This is where the student is co-funded by a business, government or charitable partner, and spends a proportion of their time working on a project within the workplace.[21] Russell Group universities also aim to provide all PhD students with training in transferrable skills as a core part of their doctoral degree.

Run by the Technology Strategy Board, Knowledge Transfer Partnerships (KTPs) co-fund graduates and postgraduate to work on solving technical or business problems within a company or public sector organisation. The aim of the initiative is to help businesses and organisations access skills and expertise from within the university sector to help improve their productivity and performance. Russell Group universities are the academic partners on 215 current awards (almost 25% of the total), supervising students and researchers working in a huge range of organisations from big pharmaceutical and aerospace companies, to construction, engineering, IT, telecoms, utility, and healthcare companies of all sizes as well as local authorities and the NHS.

Case study 8 from Queen's University Belfast is one example of how KTP projects can enable businesses to benefit from the high-level skills of university associates, and gain access to knowledge and facilities of university research departments.

Case study 10

Increasing commercial understanding of intellectual property rights regimes
London School of Economics & Political Science

A world-leading pharmaceutical company approached LSE to commission research and consultancy into developing a better understanding of the international intellectual property rights regime, and to conduct a comparative study of two specific countries.

LSE Consulting put together an expert team of academics and coordinated both the knowledge-creation and knowledge-dissemination stages of the project. Two groups of experts conducted field research, interviews and data collection in the two countries assigned. The findings were analysed and compiled into a comprehensive report for the client. The dissemination stage of the project culminated in a workshop held at the LSE, which was attended by the client, specialist academic consultants and distinguished academic experts, and public sector officials working in the field.

LSE's expert team delivered much more than just a research and consultancy project. The team achieved for the client their objective of raising overall awareness of international intellectual property rights. Their analysis of the application of specific laws in selected countries directly informed discussions regarding the ways in which these might influence the ongoing and future operations of the client.

4.0 Consultancy

Consultancy is a very important way in which universities work with business to realise practical benefits from research, and to enhance business performance. A recent survey found that 40% of academics at Russell Group institutions had engaged in consultancy services with external organisations in the last three years.[22] Moreover consultancy is not limited to academics in the engineering and physical sciences, but is also frequently carried out by researchers in the social sciences and the arts and humanities.

19 out of 20 Russell Group institutions use a commercialisation company or have a department within their institution to manage consultancies and commercial interactions. The influence of such support mechanisms is considerable in enabling the research expertise of our institutions to be communicated to a wider business audience. For example, Oxford University Consulting has a dedicated staff of seven. Its UK and international client base includes Astra Zeneca, Microsoft, the National Audit Office and the UN Development Programme. Many Russell Group academics have formed their own consultancy companies to externalise their research. A survey of over 8,000 Russell Group academics found that 13.1% had formed or run a consultancy company based on their research.[23]

Case studies 9, 10 and 11 demonstrate how businesses have worked with universities to meet business challenges and gain practical benefits from research expertise through consultancy services.

Case study 11
Advice on flow splitters for the oil industry
University of Nottingham

Professor Azzopardi from University of Nottingham's School of Chemical and Environmental Engineering provided consultancy services to Statoil, a Norwegian oil and gas company which ranks as one of the world's largest oil traders.

Statoil needed advice on a planned project to divide oil and gas mixtures gathered from North Sea wells to two separate destinations. Professor Azzopardi is one of the few experts in the world dealing with flow splitters in the oil industry. As the flow splitter is designed to be placed right at the bottom of the seabed, it is vital to get it right first time, because replacing it is a very difficult task. He used his experience to analyse the plans for the flow splitter Statoil was hoping to implement, carrying out calculations to support his assessment, based on the results of his own experiments and the published engineering literature.

On the basis of Prof Azzopardi's advice Statoil installed its new splitter into the North Seas in the summer of 2007.

Case study 12
The Climate Leadership programme
University of Cambridge

Key funding source: Industry-funded fees

Established with the input of former US Vice-President Al Gore, the Climate Leadership programme at the University of Cambridge aims to educate business leaders about climate change, and the risks and opportunities associated with mitigating its effects through their business practices. The programme draws on the research and expertise of senior University of Cambridge academics, as well as a number of external contributors. 75 delegates from businesses based within 17 different countries have so far attended the course, with the potential for significant benefits through the implementation of climate change mitigation strategies across UK and international businesses.

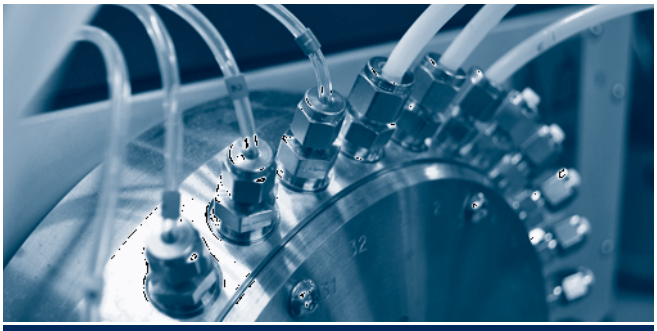
5.0 Continuing professional development

Universities have an important role to play in helping adults re-train or improve their skills to enable career progression or a change in career. Whilst this report does not attempt to address this skills agenda per se, it is worth exploring how research can inform continuing professional development (CPD) activities.

Engaging with universities, via collaborative projects, consultancy or other means enables company employees to work alongside researchers learning the latest skills and techniques which can improve their company's own research activities. In turn this can also help a business to develop its "absorptive capacity" to enable it to take advantage of new products or processes developed in the future.

In addition, Russell Group universities offer CPD as part of their portfolio of consultancy services. For example, professional development training offered by the Climate Leadership Programme at Cambridge, is a core means by which the expertise of this leading environmental research hub is disseminated to a wider audience (case study 12).

Case studies 12–15 from the universities of Cambridge, Newcastle, Leeds and Southampton all illustrate a number of different ways in which research informs CPD.



Case study 13
Biopharmaceutical processing
Newcastle University

Key funding source: EPSRC; pharmaceutical industry funders

The Newcastle University Research Centre in Biopharmaceutical Processing is a UK leader in developing techniques for drug development and production processes. The centre facilitates interdisciplinary research collaborations between biological, physical and engineering scientists; developing research expertise which is relevant to the problems and needs of industry.

The work of the research centre in collaboration with industry spans a broad range of knowledge transfer activities. Experts at the centre offer consultancy services and continuing professional development (CPD) courses to the pharmaceutical and biotech industries, such as the application of Process Analytical Technologies (PAT) for the pharmaceutical sector. Researchers at the centre also have long-term research partnerships with industry: Professor Gary Montague, Director of the centre, works closely with some of the UK's leading pharmaceutical companies through a consortium called Britest. Britest has been established as a forum for supporting strategic research collaborations between industry and academia, aimed at developing innovative approaches to drug processing and manufacturing.

Thus the centre exploits a range of knowledge transfer mechanisms both to underpin its research programme, and to achieve economic impact from that research by offering a competitive edge to its industry partners.

Case study 14
Community policing in the US
University of Leeds

The research expertise of a University of Leeds academic has helped to advise and inform new approaches to community policing within the second largest city in the US.

Lieutenant Mark Stainbrock, a veteran from the Los Angeles Police Department, came to West Yorkshire on a six-month Fulbright Police Research Fellowship in 2007 to study British community policing and to benefit from the expertise of University of Leeds academics.

The research of Lieutenant Stainbrook, who has received over 50 commendations, was overseen by theology and religious studies lecturer Dr Alistair McFadyen of the University of Leeds, who also serves as a special constable for West Yorkshire Police. His research saw Stainbrook going on patrol with officers from Stainbeck Police Station, meeting with leaders of the Central Jamia Mosque and holding workshops.

Through his research, Stainbrook returned to the States with a toolkit of practical ideas for police officers, most of whom, according to Stainbrook, had a limited understanding of Islam or the "big picture issues".

Case study 15
From research to skills in marine engineering
University of Southampton

The Institute of Sound and Vibration Research (ISVR) at the University of Southampton, has developed a productive strategic partnership with Halyard – a manufacturer of marine exhaust systems – which spans research, consultancy and skills development.

Halyard specialises in noise reduction systems for boats and yachts. In 2003, responding to new EU regulations limiting the permissible noise generation on leisure craft, the company initiated a research project to investigate the key elements of noise generation on boats. The project was co-funded by the EU, and led to a fruitful research collaboration with the ISVR at Southampton.

The research identified marine exhaust systems as being the key problem and led to the development of a novel noise measurement device, which allowed Halyard to gain an advantage over its industry rivals.

Halyard approached the ISVR about developing a bespoke course for staff on noise and vibration awareness for its sales and development staff which has been hugely beneficial for Halyard: staff are able to apply technical expertise to an early stage in the design process, and customer satisfaction has improved, with clients evidently impressed by the technical knowledge of Halyard staff. The company was recently rated 9.3 out of 10 for customer satisfaction in this area.

Case study 16
Wyeth Early Clinical Development Centre
King's College London

The world-leading quality of biomedical research at King's and its NHS partner Guy's and St Thomas' hospital has been recognised through the award of Biomedical Research Centre status by the National Institute of Health Research (NIHR). The Wyeth Early Clinical Development Centre at King's was established in April 2007. The Centre, established in collaboration with King's partner NHS trusts, aims to accelerate the progress of clinical trials and facilitate the establishment phase. It is based within the NIHR Biomedical Research Centre (BRC) and employs monitoring staff at the Joint Clinical Trials Office (JCTO), which is operated between the College and the hospital.

The Early Clinical Development Centre at King's is the only such centre in Western Europe.

The Centre is expected to leverage significant research investment from Wyeth over the next few years, and will be a fulcrum for new clinical studies, many of which will be first-into-man trials of new compounds.

As well as this substantial investment from Wyeth, King's College's world-class reputation for biomedical research, cemented by the award of Biomedical Research Centre, has also led to significant research investment by other major pharmaceutical companies such as GSK and Pfizer.

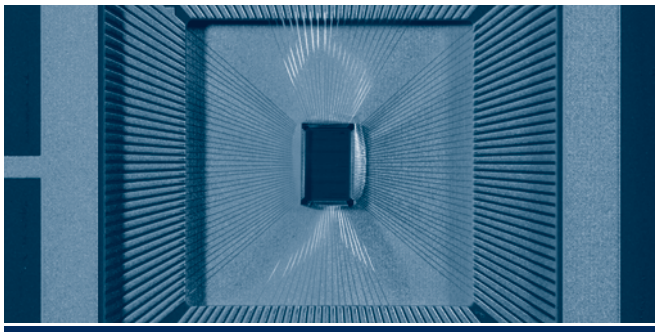
6.0 Attracting inward investment

The concentration of highly skilled and talented researchers in Russell Group universities, coupled with cutting-edge facilities and resources, plays a significant role in attracting international R&D investment to the UK, particularly from research-intensive businesses. Inward flows of investment are important in stimulating further innovation, as globally competitive firms and universities tend to be better able to access the global knowledge stock and the latest technological advances occurring worldwide. Abramovsky *et al* (2006)[24] found that there was a strong correlation between the presence of world-class academic research groups and location of commercial R&D investment; a correlation that was particularly notable for the pharmaceutical industry, and for foreign-owned businesses.

The UK has been highly successful in attracting commercial investment in R&D from overseas. According to a 2005 UN Conference on Trade and Development (UNCTAD) report, 45% of the UK's commercial R&D spending derived from affiliates of overseas-based companies – proportionately more than the US, Japan and the majority of European countries. The UK was found to be the second most popular destination for international outsourcing of commercial R&D after the US.[25]

Russell Group universities have more than doubled the research investment they receive from overseas sources since 2001[26] £75m (40%) of this investment derives from commercial sources. Case studies 16 to 19 highlight the success of Russell Group universities in attracting inward R&D investment.

A strong reputation for research is also a major factor in attracting the large numbers of international students who study at British universities, bringing important investment to the UK through the fees they pay and their living expenditure.[27] A recent UNESCO research paper found that the perceived academic excellence of host institutions was a key determinant of cross border student flow, and that "one can find a positive association between the global ranking of universities and the preferred destinations of students".[28] Some international students choose to stay and work in the UK after their studies, and therefore continue to contribute to the economy. The growing international population with experience of study in the UK provides a valuable asset to the UK in terms of international trade and investment. For example, Tesco has said that its operations in Asia have frequently benefited from the goodwill towards the UK amongst Asians who have graduated from UK universities.[29]

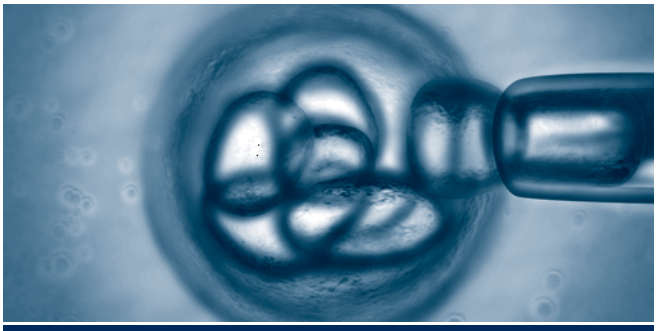


Case study 17
Ultrafast Systems
University of Glasgow

Key funding source: US semiconductor research corporation; EPSRC, SFC, EU Commission

The Ultrafast Systems Group at Glasgow University is one of the world leaders in compound semiconductor transistor technology. The group's internationally-renowned expertise has seen it secure research funding from a variety of sources, both domestic and international, including government departments, research councils and business.

In 2007 the group entered into a £1.2m partnership with the US Semiconductor Research Corporation (SRC), a consortium of multinational electronics companies including IBM, Hewlett-Packard and Intel. Building on research funded by the EPSRC, the Scottish Funding Council and the European Commission, the three year project seeks to replace existing silicon chips. By increasing the speed of processing, the new chips will speed up computers, enhance the battery life of mobile phones and digital cameras and improve the graphics in computer games. These advances could be available to manufacturers by 2010 and in large-scale production by 2016.



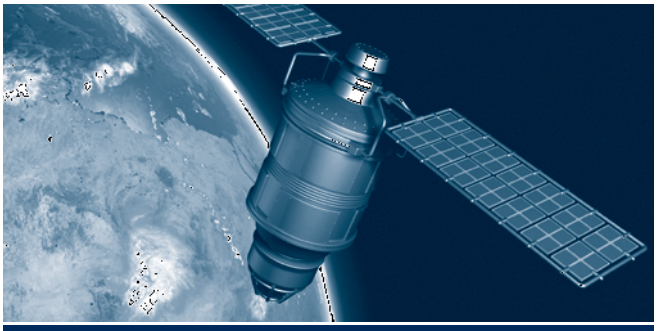
Case study 18
UK-Pfizer stem cell collaboration
University College London

The UK's global leadership in stem cell research is a factor not only of cutting-edge biomedical research within Russell Group institutions, but also of their pre-eminence in social sciences, ethics and philosophy research, which has helped to contribute to the permissive legislative environment surrounding stem cell research which exists in the UK.

The UK was the first country in the world to introduce permissive legislation for stem cell research, and Russell Group universities were quick to capitalise, allowing them to make a series of breakthroughs.

The UK's leading position is a key factor in attracting investment from multinational corporations interested in the treatment potential which stem cell research offers.

Professor Pete Coffey and his team at University College London are pioneering a technique which uses stem cells to treat age-related macular degeneration – a principal cause of blindness. The team's expertise has attracted major investment from the world's largest pharmaceutical company, Pfizer, who will sponsor a programme of research within the university which will accelerate the process of investigating stem-cell based therapies. In addition to funding, Pfizer's involvement will provide the regulatory and clinical management expertise to allow treatments to be tested in a clinical setting.



Case study 19
Leica Geosystems
The University of Nottingham

The University of Nottingham has acknowledged international expertise in the field of global navigation research, including its Institute for Engineering Survey and Space Geodesy research and the Centre for Geospatial Science. The university and the East Midlands Development Agency built on this expertise with a £9m project to establish a new state-of-the-art Global Navigation Satellite Systems research facility on the University of Nottingham Innovation Park.

The project achieved early success when Leica Geosystems, a leading international company with sites in the US, Canada, Europe and Asia, decided to invest in a new research facility in close proximity to the university.

Mark Concannon, president of Leica Geosystems Machine control division, commented "Our long association with the University of Nottingham, along with the ability to carry out GNSS testing on construction machines in a controlled environment, made the decision to locate in the East Midlands both logical and appealing".

After an initial investment which led to ten new jobs in the region, Leica are now working closely with the university on developing systems which will enable dynamic positioning of machines and equipment within agriculture, mining and construction. The new systems will help improve efficiency by improving work flow between different market segments.

Part 2
Achieving economic impact through the commercial exploitation of research

"It is not about the promise of future revenues that might be generated from this activity... Of course, revenue generation serves as an incentive. But first and foremost, technology transfer must serve our core mission: sharing ideas and innovations in the service of society's well-being."

Dr Mary Sue Coleman, President, University of Michigan

1.0 Introduction

In this section of the report we demonstrate the diversity and breadth of impacts from the commercial exploitation of excellent research undertaken in Russell Group universities.

We first present an overview of the track record of Russell Group universities in the commercial exploitation of research, as demonstrated by the 2009 Higher Education Business and Community Interaction Survey (HEBCI) and our own survey of Russell Group institutions. We explain how universities work with business and industry, and utilise knowledge transfer professionals to facilitate and support the commercial exploitation of IP.

The case studies used throughout this section of the report are from a new survey of Russell Group universities undertaken in 2008 to identify successful examples of the commercial exploitation of research through IP licensing, patents, spins-outs, and co-production of research with potential users. This exercise collected 125 case studies, which have been analysed as far as practicable to explore the nature of the underpinning research, the influence of university knowledge transfer professionals and funding on successful commercialisation, the timescales involved in commercialisation, and the revenue generated. The methodology used is set out in Annex A.

The case studies illustrate:

– the economic impact from basic research

– the need for sustained long-term investment in research and development to realise commercial potential

– the wider benefits and impacts arising from commercialisation.

2.0 Overview of the commercial exploitation of research from Russell Group universities

2.1 Some key statistics

Russell Group universities are effective and successful in the commercial exploitation of their research. A sample of ten Russell Group universities showed that all but one had higher overall venturing efficiency than two major research-led US institutions chosen by the study.[30] Moreover, a recent survey of academics confirmed that academics within Russell Group institutions are more likely to have taken out a patent, licensed their research to a company or formed a spin-out than academics at other UK institutions.[31]

This performance is backed up by information from the 2009 HEBCI survey (for 2007–08) which shows that:

– whilst the 20 Russell Group universities comprise 12.5% of the UK's HEIs, they recorded 64% of the total HE sector income from IP in 2007–08

– the total estimated annual turnover from companies spun out from Russell Group was £724m, 70% of the total for the whole of the HE sector

– active spin-outs from Russell Group universities accounted for 58% of those which had survived for three years.

Of the 125 case studies the Russell Group collected separately from its member institutions, 66 included information about the financial outcomes of research exploitation in the form of income generated from licencing or spin-out companies established within the last ten years. An analysis of these 66 case studies shows that:

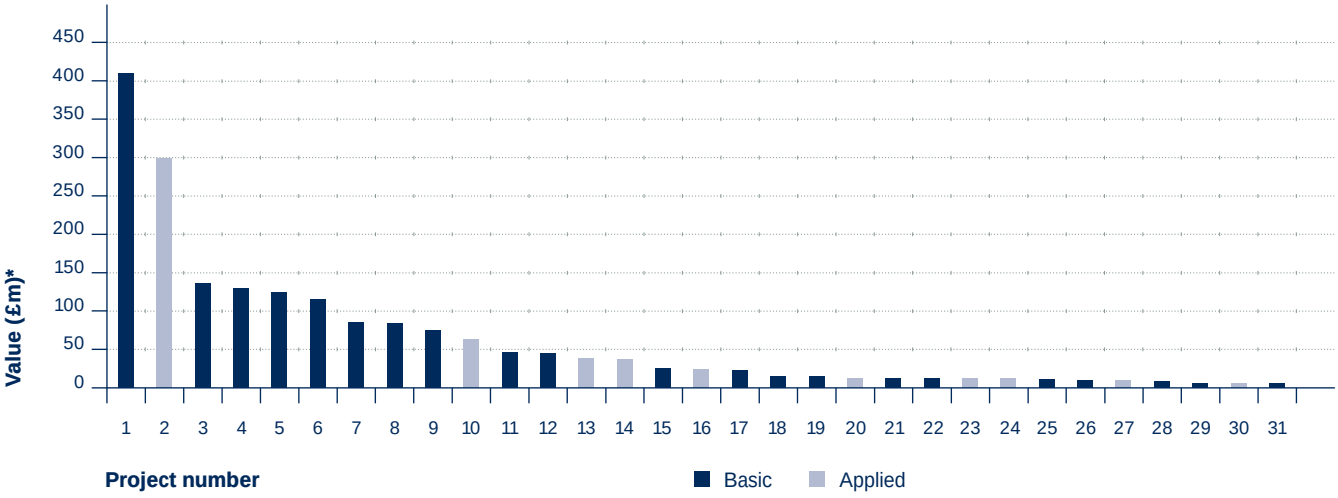
– £1,090m was accrued in sales or licensing revenue

– 24 spin-out companies had achieved a combined market value of £498m[32] (where estimates of market value were available)

Figure 3: Distribution of financial returns from commercialised research at Russell Group universities

RG case studies - skewed distribution of outcomes

*"value" is intended as an indication of value added, drawn from a combination of sales and licensing revenue, market valuation and investments made



– a further 24 new spin out companies had secured commercial investment with a combined total of £330m.

Together these examples represented a combined "value-added" to the economy of almost £2bn, a significant financial return on investment.

An analysis of the distribution of financial returns from the licensing and spin-out case studies from Russell Group universities shows a typical pattern: the majority of the income generated comes from a very small number of licences or spin-outs. Figure 3 above shows that just over 20% of the case studies accounted for over 80% of the financial returns calculated. It also shows that the vast majority of the value returned over time originated from more fundamental, basic research.

Although it may take many years to see direct commercial returns from research, benefits can arise during the development process. One of the clearest examples of this is the new job creation associated with university spin-out companies. The spin-out companies identified in our case study data each generated on average 40 additional, highly-skilled jobs.

This analysis provides only a limited snapshot of direct economic impacts. All of the case studies featured will have significant economic and other impacts which extend beyond the information a university will typically capture. For example, whilst the Edinburgh spin-out company MTEM (case study 20) generated $275m of direct revenue from its successful sale in 2007, the economic returns of the underpinning research extend far beyond this. As noted by Leon Walker, MTEM CEO:

"The economic impact of this technology has the potential to extend far beyond simply the value of the oil produced. By identifying new pockets of oil and gas, MTEM could extend the life of many oilfields, increasing recovery rates also from the known reservoirs."

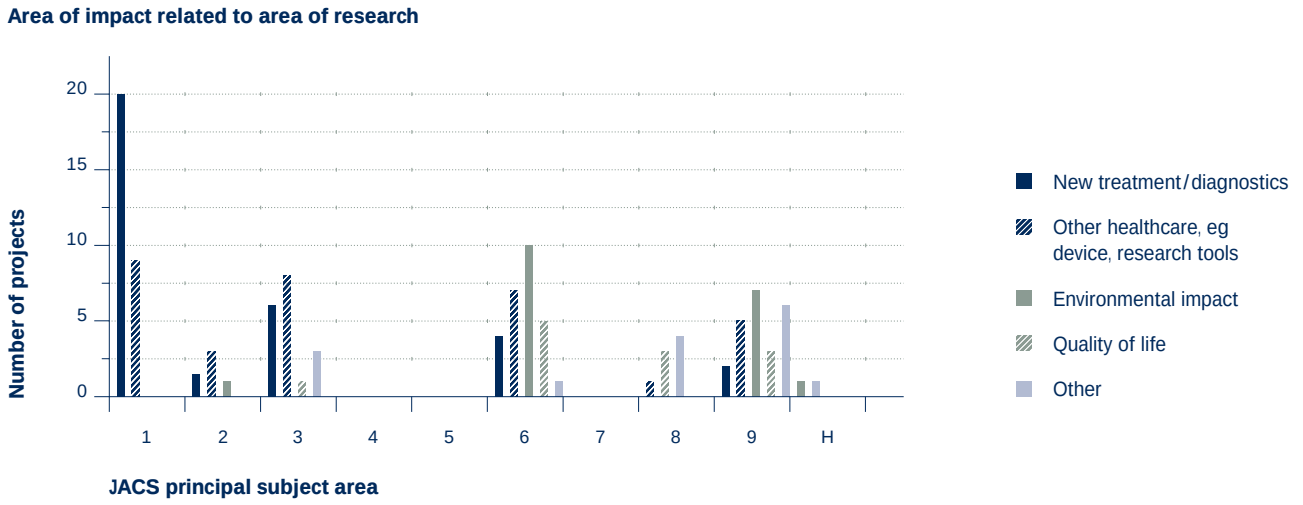
2.2 The impact of different subjects and multidisciplinary research

An analysis of the IP licences and spin-out companies identified from the Russell Group case studies by subject area (Figure 4) gives an indication of the areas of research from which the majority of this IP has sprung. Given that some disciplines lend themselves more than others to the generation of IP with commercial potential, it is not surprising that the majority of licences and spin-outs have been derived from medical research, the biological sciences, physical sciences, computer sciences, and engineering and technology.

The number of licences and spin-outs which have originated within clinical and medical disciplines is noteworthy. The existence of a medical school with strong links to local hospitals and patient communities has previously been highlighted as an important determinant of successful university innovation.[33] Approximately 80% of medical research in the higher education sector is within Russell Group institutions,[34] and medical schools make a major contribution to achieving impact from research.

Figure 4 also explores the range of different kinds of impact resulting from IP licensing and spin-out formation. This demonstrates a much broader spread of impacts than might be anticipated.

Figure 4: Licences/spin-outs related to subject area



JACS principal subject areas
1 Medicine & Dentistry; 2 Subjects allied to medicine; 3 Biological Sciences; 4 Veterinary Sciences; 5 Agriculture & related subjects; 6 Physical Sciences; 7 Mathematical Sciences; 8 Computer Sciences; 9 Engineering and Technology; H Creative Arts and Design

A key feature of Russell Group universities is concentration of excellence. They have a large and high quality research staff, a critical mass of expertise and facilities and in most institutions a very wide range of academic disciplines. This strength and breadth enables Russell Group universities to support cutting-edge interdisciplinary research within and between institutions in the UK and internationally. It also provides a strong attractant for industrial partners and other users.

Russell Group universities are home to many of the UK's major interdisciplinary research centres such as the Warwick Innovative Manufacturing Research Centre, the Manchester Interdisciplinary Biocentre, and Institute of Biomedical Engineering at Imperial College.

The ability to support and facilitate cutting-edge research across a broad range of disciplines generates an exchange of ideas and techniques which is a fertile source of innovation and advancement. It offers an opportunity to apply new perspectives to research challenges, propagating new lines of thought and investigation. Businesses are increasingly looking for interdisciplinary and multidisciplinary research as the source for future innovation[35] and it is well recognised that multidisciplinary approaches are required to address major societal challenges such as sustainable energy generation and climate change.

Case studies 20 and 21 provide good examples of the value of interdisciplinary research in underpinning the design of new products and techniques.

Case study 20
MTEM
University of Edinburgh

A new technology to support deep-sea oil exploration

Key funding source: NERC/EU THERMIE

MTEM (Multi-transient Electromagnetic Technology), a spin-out company from the University of Edinburgh, developed a technology which allows the detection of hydrocarbons in deep underground reservoirs. Oil companies can use the technology to detect the presence of oil before drilling; potentially saving huge costs: it is estimated that more than a billion barrels of oil could be found using the technology.

MTEM stems from basic research conducted by Professor Anton Ziolkowski, in 1992, to test the fundamental principles behind the technique. After more than 11 years of further development, the company was founded in 2004.

MTEM's technology has the potential to generate enormous economic returns, addressing an oil exploration market with an estimated value of around £500m.

In 2007, MTEM was sold to a Norwegian oil firm for $275m.

Case study 21
HeliSwirl
Imperial College London

Improving the efficiency of oil, gas and other fluid transport

Key Funding Source (development): the Carbon Trust, Imperial Innovations, business angels

HeliSwirl provides a powerful example of the impact which can be achieved when multidisciplinary research creates new ideas, and applies them within new and unexpected fields.

The technology underpinning HeliSwirl was first developed within Imperial College's department of Bioengineering: a department which describes itself as "inherently cross disciplinary" and where research "involves diverse academic disciplines such as physiology and medicine as well as mathematics, physics, chemistry and the different areas of engineering."

Over 40 years of research exploring the connection between arterial disease and blood-flow eventually led to a novel technology to improve the efficiency with which fluid flowed through pipes and other vessels. A patent was initially registered for a medical application. However, the management of HeliSwirl recognised that the new technology, called Small Amplitude Helical Technology (SMAHT) had the potential for much wider commercial application.

HeliSwirl's primary focus is now directed towards engineering applications in the petrochemical, oil and gas industries, creating the potential for major reductions in energy use and greenhouse emissions associated with fluid transport. Thus far, the company has secured £1.4m in external investment.

Case study 22
Critical Pharmaceuticals Ltd
University of Nottingham

A new technology to help drug delivery in vulnerable patients

Key funding source: various industry collaborations; EPSRC Adventure Fund

In 1999, Professor Steve Howdle, a researcher in the University of Nottingham's Department of Chemistry, was conducting basic research into the properties of "supercritical" fluids; these are gases which, at a defined temperature, take on unique physical properties.

When he noticed that supercritical carbon dioxide (scC02) was able to penetrate certain polymers, he realised that it could be used to mix sensitive substances into the polymers.

Founded in 2002, Critical Pharmaceutical Ltd is a pioneering company which uses scC02 to mix drugs and other bioactive compounds with medically approved polymers, to allow controlled drug release in patients. This means, for example, that young patients with growth hormone deficiency can be saved the inconvenience of daily injections, or that doctors can better ensure that schizophrenia patients comply with their prescribed treatment. After more than five years of additional research, CPL realised its first commercial licence in 2004.

Thus, research into fundamental physical chemistry has created the potential for major impacts in healthcare. Although still in its early stages, the company has to date attracted inward investment in excess of £1.7m.

3.0 Enabling successful commercial exploitation of research

Achieving significant impacts from the commercial exploitation of research often involves long-term, strategic partnerships and collaborations with business and industry. As described in the first part of this report, this could include the co-design, funding and production of basic or more applied research, joint sponsorship and training of doctoral students, networking activities with supply chain partners, consultancy, or continuing professional development, as well as licensing and patenting and the formation of spin-out companies.

In Russell Group institutions these activities are supported by teams of knowledge transfer professionals who work alongside academics to support and enable the commercial exploitation of their IP. This work is underpinned by institutional strategies, funding and processes aimed at enhancing effective knowledge transfer.

All Russell Group institutions have dedicated technology transfer offices (TTOs) or teams in order to commercialise new technology and ideas arising from their research. The Higher Education Innovation Fund (HEIF) in England (and the preceding funding streams HEROBC and University Challenge) and similar knowledge transfer funding streams in Scotland, Wales and Northern Ireland, have been crucial in supporting these developments.

"We simply wouldn't have been able to do it without (University of Manchester Technology Transfer Company) UMIP... setting up a company is a complicated process, and UMIP took care of it all"

Dr Mary McGee, CEO, Assessment 21 Ltd

The organisational structures and experience residing within university TTOs are essential to the institution's overall success in realising returns on research and in disseminating its benefits to the wider economy:

– the capacity of a TTO and its relationship to the parent university can significantly impact on both its overall success rate in commercialising technology and on the preferred strategies by which technology is licensed to industry[36, 37, 38]

– policies on licensing revenue are strongly correlated to disclosure rates and licensing success[39]

– expenditure on IP protection and the business development capacity of a TTO is significantly and positively correlated with spin-out formation[40]

– TTO size and the level of expertise it is able to draw on can be an important determinant of its success.[41]

Case study 23
Intense
University of Glasgow

Laser technology for telecommunications, medicine and defence

Key funding source: EPSRC

"Intense" is a spin-out company formed in 1999 to commercialise high-power laser technology developed in the Department of Electronic and Electrical Engineering at the University of Glasgow.

The commercial technology was developed from underpinning basic research over a period of more than ten years. Intense manufactures state-of-the art laser diodes which it markets to the defence, telecommunications, medical and computing industries. The company now employs over 130 people in Scotland and in the US, and has so far attracted over £48m in additional investment.

The expertise and long-term support provided by Glasgow's Technology Transfer office was crucial to the success of Intense. TTO staff initially provided support in securing patent protection for the new technology. Their expertise subsequently enabled a market evaluation, and business support officers identified a product opportunity. In the subsequent development of the company, the TTO continued to provide essential underpinning support in business planning and securing external investment.

The effectiveness of the TTO's in Russell Group institutions is evident from the case studies. The vast majority of the licences granted and spin-outs established benefited from input from the institution's in-house technology transfer capacity, which provided non-financial input in the form of business development, marketing or IP protection. Case study 23 describes the formation of Intense, a spin-out company from the University of Glasgow and provides a typical example of the role of a TTO in achieving impact from research.

Many of the case study examples also benefited from additional investment provided through Russell Group university Proof of Concept funding. Proof of Concept funding is an essential stage in the development of many emergent technologies from initial prototype to the stage where they are able to attract investment from venture capital firms or other commercial interest. The majority of innovations developed from Russell Group universities result from early stage, curiosity-driven research, and are at an embryonic stage of development at the time of disclosure to the TTO. Proof of Concept funding can therefore play an important role in bridging the gap between the initial research findings and demonstrating potential commercial viability. This funding typically supports additional research and development or market research. The sums involved are often small (£10,000–£30,000 would be typical), but there is generally thought to be a shortfall of funding available to universities for Proof of Concept support, which can be essential in helping to overcome the initial barriers to commercialisation and economic impact.

The case studies collected from Russell Group institutions showed that:

– 57% of projects had received Proof of Concept or seed funding during their early development

– of these, 62% were supported through by university funding (including institutional University Challenge funding)

– 17% were supported by regional funds, of which half were funds provided by RDAs, and half were provided through the Scottish Enterprise Fund.

Information about the use of Proof of Concept funding at the University of Sheffield is highlighted in case study 24.

Case study 24
Proof of Concept funding
The University of Sheffield

The University of Sheffield first established a Proof of Concept scheme in 2004, under the auspices of HEIF 2 funding. Its success was such that the scheme was extended under HEIF 3 and will again be continued under HEIF 4.

The scheme awards funding up to a maximum of £10,000, to help innovative concepts developed by university staff with marketing, design, or further research. Thus far, a total of £603,000 has been awarded to 64 separate projects, resulting in five new spin-out companies, three new licence deals worth nearly £100,000, and over £9m in additional research grants, including contract research with industry.

The scheme has been a huge success with academics:

"The 'Proof of Concept' fund was an absolute godsend! It is a vitally important means of encouraging, promoting and creating IP and commercially orientated research. The scheme is extremely well administered by the University of Sheffield… The 'Proof of Concept' funding was absolutely essential in developing our IP portfolio and forming a company."

Dr Jamal Nasir, Academic, University of Sheffield

"I wish to emphasise that, in my view, Proof of Concept funds are an essential resource for faculty to fully develop and secure their IP"

Professor Steven Armes, Academic, University of Sheffield

As well as employing knowledge transfer professionals, many research-intensive universities have established their own technology transfer companies to accelerate the exploitation of IP with commercial potential. 14 Russell Group universities have established such companies, and eight institutions have formed relationships with IP commercialisation companies to help exploit their IP.

Nonetheless, relative to the size of their research output, there is room to develop significant further capacity to support technology transfer and knowledge transfer.

4.0 Economic impact case studies from Russell Group universities

This final section of the report showcases further examples of successful commercial exploitation from research undertaken at Russell Group universities.

4.1 Economic impact from basic research

Whilst the differentiation between basic and more applied research is becoming increasingly less relevant, we have undertaken an analysis of the 125 case studies collected from Russell Group universities using the standard Frascati definitions[42] of research. This shows that basic,[43] curiosity-driven research has led to some of the most significant returns to the UK economy and society arising from our case studies. Of the case studies submitted:

– 57% were the result of basic research

– we were able to estimate financial returns for 66 case studies. 74% of the total financial return calculated was associated with commercial projects derived from basic research

– commercialisation of basic research generated average returns of £36m; more than twice the average return from applied research case studies

– the median financial return from commercialisation of basic research was £8.7m – almost three times the median return from applied research case studies

– of the top ten projects, measured by financial returns, eight were the product of basic research. (See figure 5)

Figure 6 shows the relative proportion of licences and spin outs arising from our case studies which were based on basic and applied research respectively. It also shows the percentage of the financial returns calculated which can be attributed to basic or applied research.

The case studies below (25-32) all demonstrate the commercial potential released from basic research.

Figure 5: Top ten case studies by research type

Distribution of 'basic' vs 'applied' research for the Top Ten Commercialisation case studies

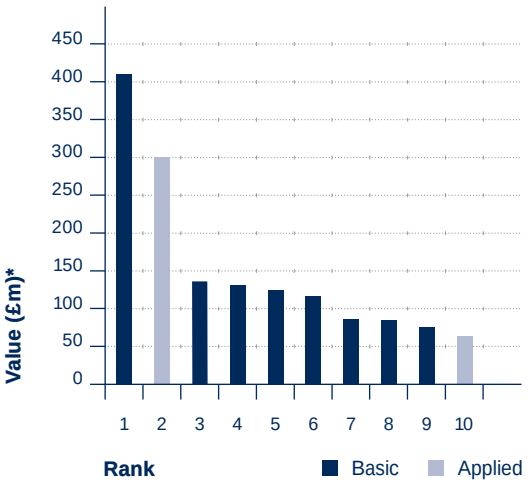
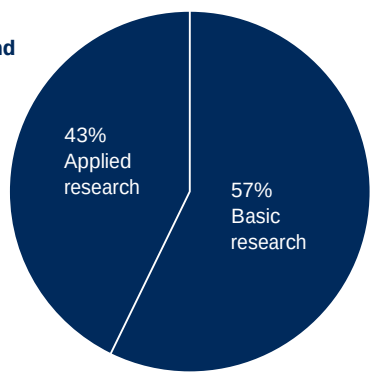
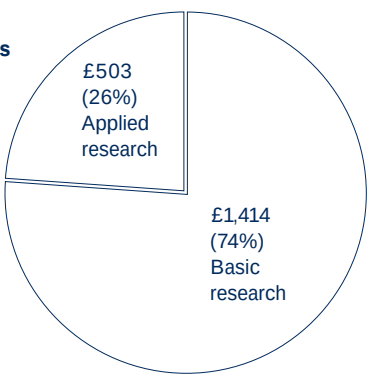


Figure 6: Relative proportions of case studies and of financial returns based on basic and applied research

Spin outs and licences resulting from basic and applied research



Financial returns associated with projects involving basic and applied research



Case study 25
Renovo
University of Manchester

How alligator embryos advanced thinking on scar healing and wound reduction

Key funding source: research programme funded by a variety of sources, including MRC, BBSRC and EPSRC

Renovo, a University of Manchester spin-out company established to commercialise novel treatments for wound healing and scar reductions, is one of the largest university spin-out companies in the UK. Listed on the London Stock Exchange in April 2006, the company was valued at £348m in 2007.

Research at Renovo has been directed at addressing the unmet medical need for pharmaceutical products to effectively aid wound healing and scar reduction. However, the basic science underpinning this research was discovered unexpectedly, by its co-founder, Mark Ferguson.

During the late 1980s, as a professor at Manchester, Mark conducted studies on alligators as part of his research into ways to correct cleft palates. He made the accidental discovery that, when working on alligator embryos, the incisions which he made healed without scarring. Over the course of 15 years, Mark and Renovo co-founder Sharon O'Kane worked on developing a synthetic formulation to mimic these healing properties.

Renovo now employs 180 staff, and its lead product, Juvista, was recently licensed to SHIRE plc in a licensing deal worth up to $825m.

Case study 26
Avacta
University of Leeds

Advanced technology to support drug development and health screening

Key funding source: BBSRC/EPSRC

Avacta's technology developed out of basic biotechnology research. Beginning in 1998, research by Professor Alastair Smith, Simon Webster and Kurt Baldwin at the University of Leeds led to the development of expertise in molecular detection technologies, which is now commercialised through Avacta.

The company was founded in 2004, after 6 years of underpinning research. Avacta's molecular detection technologies are now at the forefront of drug invention; they are used by pharmaceutical companies, amongst others, in developing promising new therapies. The company's expertise is also deployed to detect pathogens, such as dangerous viruses. This innovative detection technology has huge potential to be used in homeland security, as well as in screening for the protection of human health.

As well as important healthcare benefits, the company has achieved considerable commercial success. It was listed on the Alternative Investment Market (AIM) branch of the London Stock Exchange in 2006, and expanded rapidly. It is currently valued at more than £23m.

Case study 27
Transitive Corporation
University of Manchester

Transitive Corporation was founded in 2000, to commercialise the outputs of basic computer science research at the University of Manchester.

The research underpinning Transitive resulted from problems encountered by an unrelated computer design project in 1992. Professor Alasdair Rawsthorne, the company founder, says that the research was begun in 1995 "purely for academic and personal reasons… Around two years into the research, I began to realise how important the technology could be."

The technology which had been developed allowed for software applications to be easily translated across different computing systems: this allows software to be run on any computer platform without requiring changes to the software.

The technology has huge commercial potential. Transitive has already developed relationships with Apple and IBM, and have over 15m customers worldwide. The company has secured external investment to the value of US $30m.

Case study 28
Cambridge Display Technologies and Plastic Logic
University of Cambridge

Building on fundamental physics research to develop a new generation of digital display technologies

Key funding source: EPSRC

In the early 1980s fundamental research by Professor Sir Richard Friend and Professor Andrew Holmes led to the unexpected discovery of organic electroluminescence from polymers, and the subsequent realisation that Light Emitting Diodes (LEDs) could be made from conjugated polymers.

Founded in 1992 on the basis of this discovery, Cambridge Display Technology is now the leading global manufacturer of technologies based on Polymer Light Emitting Diodes (PLEDs). Very efficient, and able to form ultra-thin lighting displays which operate at very low voltages, PLEDs are set to underpin the next generation of lighting displays and to replace liquid crystal displays (LCDs) and cathode ray tubes (CRTs) in many existing technologies, as well as opening up exciting possibilities for new product forms such as flexible or even wearable displays. CDT Ltd has so far raised over $170m through investments and sale of stock.

The research also led to another spin-out, Plastic Logic Ltd, whose revolutionary process for printing electronic circuits on flexible plastic substrates enables the manufacturing of light, flexible and robust electronic displays for electronic reading devices. The company currently employs a staff of 90, and has so far raised over $200m from venture capital funding in Europe, Asia and the US.

Case study 29
Bioluminescence
Cardiff University

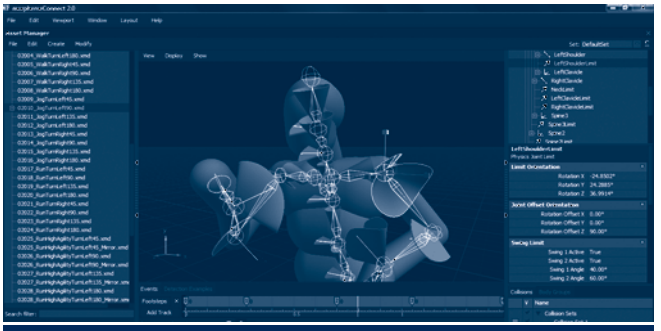
Harnessing natural luminescence for medicine and diagnosis

Key Funding Source: MRC, EPSRC

Over 20 years of research into the way in which living creatures can generate their own natural lights or “bio-luminescence” enabled Professor Anthony Campbell and his colleagues at the University of Wales School of Medicine (now part of Cardiff University) to develop an important new tool for medical and health research.

Professor Campbell’s research throughout the 1970s and 1980s led him to the discovery that living creatures could produce light using special proteins called luciferases. He then realised that by combining these special proteins with other molecules, he could use the emission of light to measure important biological processes. The tools discovered by Professor Campbell are now used routinely in science and medicine, and have helped scientists to explore biology and disease – from the process of blood-clotting, to exploring how cells communicate with each other, to screening for potential new drugs.

In 1988, Molecular Light Technology Ltd was formed by Professor Campbell’s co-inventors, and in 2003, the company was acquired by Gen Probe Inc for $7.2m. As he points out: “It all started by me being curious about how animals that make their own light can produce a rainbow”.



Case study 30
NaturalMotion Ltd
University of Oxford

Developing ground-breaking software for the gaming industry

NaturalMotion Ltd, a spin-out company from the University of Oxford, was formed in order to commercialise research conducted by Torsten Reil and Colm Massey at the Department of Zoology.

The original research was targeted towards achieving a better understanding of the neural basis of animal and human motion. However, in designing new computer-based technology to gain further insight into this problem, the researchers created a novel IT application with enormous commercial potential.

NaturalMotion's technology, Dynamic Motion Synthesis (DMS) uses artificial intelligence to simulate the human nervous system. Its euphoria product synthesises 3D character animation in real-time on the Playstation 3, Xbox 360 and PC: it has already been incorporated in blockbuster video games such as Grand Theft Auto IV, and Star Wars: the Force Unleashed. Another product, endorphin, is also widely used in the film and game industry.

Case study 31
Ceres Power
Imperial College London

Generating electricity efficiently within homes and offices

Key funding source: EPSRC

Ceres Power, a spin-out company from Imperial College London, is pioneering the field of efficient, low carbon power generation.

Building on over ten years of research at the university's Department of Materials, Ceres Power is developing world leading fuel cell systems able to generate energy quietly and efficiently within office buildings and homes. Because this method is more efficient, and because the heat produced by electricity generation is also used to heat the building, fuel cells produce far fewer emissions than traditional forms of power generation.

Ceres Power builds on a portfolio of IP developed by a group of materials experts including Professor Brian Steele; Professor Nigel Brandon; Professor John Kilner; Professor Alan Atkinson and Bob Rudkin. Basic research into novel materials and catalysts underpinned a research programme that later demonstrated significant commercial potential.

Ceres Power is listed on the London Stock Exchange, and is currently valued at £73m (as at 12 January 2009). The company employs 70 people, and in January 2008, Centrica (owner of British Gas) subscribed for 9.999% of the issued share capital of Ceres Power at 300p per share – equivalent to a cash investment of about £20m.

Case study 32
Sucralose
King's College London

Developing a zero-calorie sweetener

Key funding source: research collaboration with Tate & Lyle

The discovery of Sucralose has been described as perhaps being one of the strangest "accidental" research discoveries of all time. In 1978, researchers at King's College London were investigating ways of using a chlorinated form of sucrose as a chemical intermediate. A graduate student was apparently asked to "test" the new compound, which he mistook for "taste". On tasting it, he found that it was incredibly sweet.

Sucralose, a sucrose derivative many times sweeter than ordinary sugar, is now marketed by Tate & Lyle as Splenda: a zero calorie artificial sweetener. Splenda has generated enormous financial returns for Tate & Lyle, and unquestionably delivered wider benefits to the UK economy: last year, sales of Splenda were £148m. In addition, the product has improved the quality of many people's lives, becoming an important ingredient in desserts and other sweet foods for diabetics, and in diet products.

Finally, an extended collaboration between Tate & Lyle and King's College London has established the Tate & Lyle health research centre, which conducts research into gastrointestinal health, carbohydrate metabolism and related health implications such as obesity, diabetes and cardiovascular disorders.

4.2 Why sustained long-term investment is necessary to realise commercial potential

"The Internet? We're not interested in it."
Bill Gates 1993

Many of the case studies showcased in this report highlight the long-term timescales and non-linear processes involved in the journey from research to commercial exploitation. For example, it took 12 years for the research begun by Professors Friend and Holmes to result in the formation of Cambridge Display Technologies (case study 28) and 20 years for the formation of Plastic Logic. It was even longer before these companies were able to attract significant commercial investment.

Across all of the case studies collected:

– the average timescale for a technology to progress from initial discovery to a first licence was nine years

– the average commercialisation timescale for the top ten commercial successes (where financial data was available) was more than ten years.

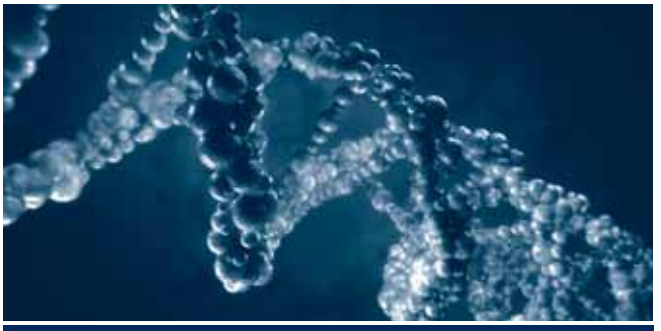
Similar trends have been identified in published literature on technology transfer.[44]

There are two key factors which contribute to the development timescale of research impacts. The first relates to the research itself, and the time-delays from its inception to the development of a commercially relevant idea. The second factor is the time-delay associated with bringing a commercially relevant idea to the market.

It can take years to develop research to the point of commercial potential

In many of the examples looked at in this document, the problems which the research set out to tackle were not ones with immediate commercial relevance, and it was only after years of underpinning research that commercial potential was revealed.

Even where research sets out to explore an idea with obvious commercial potential, it may take many years of further investigation to develop the idea to the point where commercialisation is possible. For example, Solexa, one of the most successful companies spun-out from the University of Cambridge, was founded after researchers sought to develop a novel solution to DNA sequencing. The technology on which the company was eventually founded was directly related to the researchers' initial goals, but it still took 11 years of research before their work was developed to the point that Solexa was formed (see case study 33). Through focused interactions with industry, universities can in some cases deliver important technological solutions rapidly and efficiently. Yet their ability to do this invariably rests on the expertise developed through much longer-term, often fundamental, research (see case study 34).



Case study 33
Solexa
University of Cambridge

Spearheading DNA sequencing technology

Key funding source: BBSRC, Wellcome Trust, Abingworth LLP

Inspired by breakthrough "molecule watching" technology first described in 1994, Professor Shankar Balasubramanian and Professor David Klenerman decided to develop a joint research effort focused on DNA sequencing. They realised that, by combining their expertise in nucleic acids (the "building blocks" of DNA) and in molecular imaging, the potential was there to revolutionise DNA sequencing technology.

Early stage funding was secured from the BBSRC and the Wellcome Trust, and Proof-of-Concept funding from Abingworth (a life-sciences venture capital firm) followed. A patent was filed in 1998, but it took seven years of additional research before Solexa was eventually founded, in 2005.

In 2007, 13 years after the research began, Solexa was sold to bioscience company Illumina for $600m. The technology has been used to sequence an entire human genome in just weeks. Understanding the human genome will be a vital tool in learning about how differences in people's DNA can cause disease: as well as generating significant revenue for the University of Cambridge, the technology developed by Professors Balasubramanian and Klenerman could help scientists to understand and eventually to treat a huge number of illnesses.

Case study 34
A new technique for repairing aero engines
University of Birmingham

Developing novel repair mechanisms to avoid costly component replacements

Key funding source: EPSRC/ERDF/Rolls Royce plc

A research collaboration between Rolls Royce plc and researchers at the University of Birmingham's School of Metallurgy and Metals has resulted in a breakthrough new technology which is saving the company millions of pounds every year.

Researchers, led by Professor Xianhua Wu, were able to apply their dual expertise in metallurgy and new laser technology to develop a new means of repairing wear and tear in vital aero engine components by using lasers to apply a thin layer of the required metal alloys.

The technology means that Rolls Royce no longer need to replace the worn out components with entirely new ones, saving them millions of pounds. It has also had significant environmental benefits through reducing the company's use of raw materials and the need for an energy-hungry manufacturing process.

The university's researchers were well placed to deliver a rapid and efficient solution to the technological challenge which Rolls Royce presented, developing a major new technology within just three years. Yet the expertise which underpinned this work drew on over 20 years of fundamental metallurgical science and advanced manufacturing research.

Time delays in bringing technologies to market

Commercial licensing of a research idea can be a complex process, involving many steps, all of which can cause delay. A UK patent application, for example, takes an average of 18 months to process, and international patent applications can add a further 18 months, resulting in a possible three year delay simply to protect a new technology. The process of negotiating a technology licence can also be complex and involve long delays; often, further investigations must be carried out in order to demonstrate market potential or estimate the value of a new product. Similarly, the formation of a spin-out company to commercialise research is not achieved overnight; it requires market research and valuation, and early stage investment must be identified and secured. The legal processes associated with company formation can in themselves be complex: the CEO of University of Manchester spin-out firm Myconostica Ltd estimated that it took a total of seven months to agree terms for the new company with the university and with investors.

Finally, developing a licensed technology to the point where it begins to generate commercial returns can often involve many years of additional work. In some cases, particularly where a new technology addresses challenges within an existing market, universities can successfully license their technology to a commercial partner. Since these technologies tend to be "near market" the commercial partner is more likely to be able to develop a marketable product within a short timescale, generating revenues for the university and returns to the economy. In cases where a spin-out company is formed to develop the new technology, however, the commercial opportunity tends to be much further from the market, and there may follow many further years of research and development to reach the stage where a marketable new technology is created, and returns on investment can be realised.

Analysis of the Russell Group case studies showed that it took on average a further 8.5 years after a licence was granted for revenue generation or in the case of spin-out companies a buy-out or exit. For these case studies, the timescale from research to first realising a commercial return averaged over 17 years.

In its Annual Review 2008, Cambridge Enterprises outlines the timeline of development for Plastic Logic, a breakthrough spin-out company with the potential to revolutionise the world of plastic electronics (see case study 28). The formation of Plastic Logic built on 15 years of fundamental physics research beginning in the 1980s. But as the timeline below shows, it took many years of further development and investment before the company's products could be brought to the cusp of making a major commercial impact.[45]

Figure 7: Timeline for the commercial development of 'Plastic Logic'[46]

1986–00
Fundamental Engineering & Physical Sciences Research Council funded research on the physics of semiconducting polymers for transistor applications in the laboratories of Professors Richard Friend and Henning Sirringhaus, Cavendish Laboratory, Department of Physics.

1998
Demonstration of organic transistor with performance comparable to that of thin film silicon.

2000
Demonstration of fully printed organic transistors.

2000
January
Company formed and first licence transferred from University to the company. The University Venture Fund invested in Cambridge Research and Innovation Limited (CRIL) which in turn provided seed funding for Plastic Logic.

2002
April
$18m funding round.

2005
November
$25m funding round.

2006
December
$115m funding round.

2007
May
Building begins on factory located in Dresden, Germany.

2008
August
Headquarters moved to Mountain View, California; R&D in Cambridge, UK.

2008
September
Product demonstrated at DEMOfall 08 in the United States and awarded the DEMOgod People's Choice. Official opening of the Plastic Logic factory in Dresden.

2010
Launch of the QUE proReader at the International Consumer Electronics Show.

Long development timescales are particularly associated with new medical interventions, which can have profound effects on societies' health and wellbeing, as well as generating more direct economic returns. A recent paper found that the median time-lag from discovery to demonstration of clinical efficacy was 24 years.[47]

There is clear evidence of this from within the Russell Group. For example, research conducted at Cardiff University in the 1980s led to a patented chemical process that was licensed to GE Healthcare (then Amersham) five years later, but it wasn't for another six years that GE Healthcare's new diagnostic product, Myoview, was first introduced to the US market. In another example, research conducted at Cambridge during the 1970s led to the development of a breakthrough technology in therapeutic monoclonal antibodies for leukaemia. Licensed as Campath in 1985, it wasn't until 2007 that development by a series of pharmaceutical companies led to US Food and Drug Administration approval for Campath as a first-line treatment for a type of chronic leukaemia. These examples illustrate how even once the commercial potential of research has been identified through the licensing process, many years of development work are involved before a final product or technology reaches the market and begins to deliver economic impact.

4.3 Wider benefits and impact arising from commercialisation

All of the case studies collected from Russell Group universities have demonstrated the potential of their underpinning research to benefit society through endowing businesses with competitive advantage, bringing new consumer products to market, and often creating numerous job opportunities.

However, we estimate that over 90% of the case studies also have the potential for delivering societal benefits as well, via better health care, cleaner and more efficient energy sources or 'quality of life' benefits such as new entertainment, improved communication devices or other services.

An analysis of the major areas where the research might be of benefit to society is shown in figure 8.

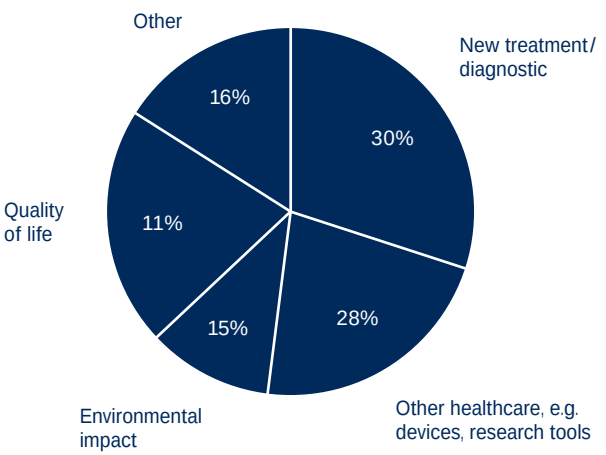
– 34% of the case studies have resulted or may result in a new treatment or diagnostic tool

– 32% have resulted or may result in other healthcare impacts, such as new medical devices or research tools

– 17% have the potential to generate significant environmental benefits (for example through energy saving devices or reducing pollution)

– 13% are associated with technologies which could improve people's quality of life (through recreational or cultural activities, or added convenience to everyday life).

Figure 8: Achieving benefits for society



The following case studies illustrate very clearly how the commercial exploitation of research can lead to societal benefits and improvements in quality of life, as well as economic benefits. A further way in which research can have a significant impact on society is through its influence on government and policy development. This is an area we intend to explore more fully in a subsequent report looking at the impact of Russell Group research on policy.

Case study 35
Oxford Catalysts Group plc
University of Oxford

Novel technologies to develop clean fuel and low-carbon energy

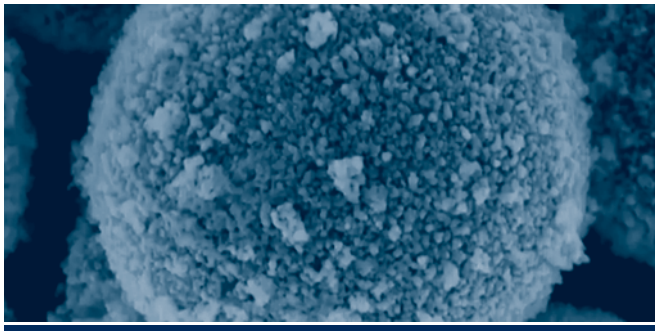
Key funding source: various multinational oil, gas and energy companies

Oxford Catalysts Group is a University of Oxford spin-out company, formed to commercialise research originating in the Department of Chemistry. Based on over 18 years of research by Professor Malcolm Green and his more recent partnership with Dr Tiancun Xiao, the company markets technology based on a number of novel catalysts for generating clean fuels.

The company recently floated on the Alternative Investment Market (AIM) branch of the London Stock Exchange, with an initial market valuation of $50m.

In addition to its significant financial return, however, the company has the potential to create real environmental benefits in the area of energy and fuel production. The catalysts which it markets have broad ranging application, including removal of sulphur from crude oil fractions, generating virtually sulphur free liquid fuel from natural gas, coal or biomass, and converting biogas into syngas in order to generate liquid fuel.

Another innovative application of the technology is the generation of instant steam, at temperatures ranging from 100–600 degrees centigrade, which has the potential to serve as a source of green energy in the form of motive power or electricity.



Case study 36
Arrow Therapeutics Ltd
University College London

Improving our understanding of viruses to help develop new medicines

Based on research at University College London, Arrow therapeutics has developed an array of potential candidates for novel anti-viral drugs. Basic research by Professor Ian Charles into molecular pathogenicity led to the creation of a novel technology termed Transposon-mediated Differential Hybridisation (TMDH), which allows researchers to analyse the genes of a target organism.

Arrow therapeutics was purchased by Astra Zeneca in 2007 for around $150m in cash, generating large financial returns for the researchers and the university. The products being developed by the company work to combat important pathogens such as Hepatitis C and Respiratory Syncytial Virus (RSV): they could therefore have enormous impacts on healthcare, and potentially save many lives.

Methodology used in collecting and analysing Russell Group case studies of commercialisation

Approach

In 2008 representatives from Russell Group institutions were asked to submit case studies where significant impacts had been achieved as a result of the commercial exploitation of their research and IP. Institutions were encouraged to include examples which had both financial and non-financial significance and impact.

Each institution was invited to submit up to ten case studies taken from the last decade (1998 to 2008), although encouragement was given to focus on more recent examples which have utilised the expansion of university technology transfer capacity, largely funded through HEIF. However, as one of the aims of the exercise was to identify interesting and informative case studies, we accepted some case studies which pre-dated the ten year period originally specified.

Institutions were given a template for use as a guide when submitting case studies. For each case study, they were asked to provide:

– a description of the new knowledge, technology or innovation

– information about the research which had led to it

– information about timescales from research commencing to a licence being granted and/or spin out company formed, and where relevant to commercial application

– a description of the impact including a "value" estimate based on financial outcomes where financial data was available.

Response

A total of 125 case studies were collected from 17 institutions.

36 case studies related to commercial licences.

78 case studies related to spin-out companies.

The largest number of case studies received from a single institution was 13, and the smallest 3. The date of licence or spin-out formation ranged from 1978-2007.

Analysis

Whilst the data provided in the case studies do not lend themselves to statistical analysis, it possible to undertake some broad analysis and categorisation of the information provided. Each case study was appraised to identify:

– the nature of the research which underpinned it (basic/strategic basic/applied)

– the major source(s) of funding for the research and, where possible, development activities

– the support provided by the university Technology Transfer Office (TTO), including Proof of Concept funding

– the number of years to progress from research inception to licence or spin-out formation

– the "value" generated by the project, where this could be readily quantified in terms of direct financial returns

– "societal" impact: where the project clearly had potential to impact on healthcare, the environment, quality of life or other clear benefits to society

– research area (by JACS principal subject area).

Where information about financial returns was available this was aggregated to provide an indicative figure of "value-added", recognising that the estimated value of the financial returns depended largely on how far the work had progressed. For some case studies institutions were able to provide a figure for overall revenues generated – from licensing revenue or sale of equity – while others provided a figure for spin-out company valuation or external investment accrued.

Where possible, the information used was total sales/licensing income, rather than income accruing to the university, in order to provide a clearer estimation of "value-added" to the UK economy. In all cases efforts have been made to avoid double counting of returns and over-weighting those cases for which more detailed information is available.

The market valuation of spin-out companies is subject to fluctuation, and this is likely to have been particularly marked during the recent economic downturn. We have used – both in the case studies and the overall statistics – the most up to date information that was available, but this may differ significantly from present day values for some companies.

Key results

56% of cases in this data set were classed as resulting from basic research, while 43% were classed as resulting from applied research.[48]

An estimate of financial value generated was ascertained for 66 case studies.

Of these 66, the total financial returns generated were estimated at £1.99bn.

Of the 66 case studies, 38 were classed as resulting from basic research, representing a total financial value of £1.5bn; 28 were classed as resulting from applied research, representing a total financial value of £0.5bn.

Contributors

The 125 commercialisation case studies were submitted by the following institutions:

University of Birmingham

Cardiff University

University of Cambridge

University of Edinburgh

University of Glasgow

Imperial College London

King's College London

University of Leeds

University of Liverpool

London School of Economics & Political Science

University of Manchester

Newcastle University

University of Nottingham

University of Oxford

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Acronyms

ACARE Advisory Council For Aeronautics Research In Europe

AIM Advanced Institute of Manufacturing

BBSRC Biotechnology and Biological Sciences Research Council

BRC Biomedical Research Centre

CASE Campaign for Science and Engineering

CDT Cambridge Display Technologies

CIHE Council for Industry and Higher Education

CMD Centre for Materials Discovery

CPD Continuing Professional Development

CRT Cathode Ray Tube

DIUS Department of Innovation, University and Skills

EFE (project) Environmentally Friendly Engine project

EPSRC Engineering and Physical Sciences Research Council

ERDF European Regional Development Fund

EU European Union

GNSS Global Navigation Satellite Systems

GSK GlaxoSmithKline

GWR Great Western Research

HE Higher Education

HEBCI (survey) Higher Education Business and Community Interaction (survey)

HEIF Higher Education Innovation Fund

HEROBC Higher Education Reach Out to Business and Community

HESA Higher Education Statistics Agency

ICT Information and Communication Technologies

IP Intellectual Property

ISRU (Newcastle University) Industrial Statistics Research Unit

ISVR Institute for Sound and Vibration Research.

JACS Joint Academic Coding System

JCTO (King's College London) Joint Clinical Trials Office

KCL King's College London

KTP Knowledge Transfer Partnership

LCD Liquid Crystal Display

LED Light Emitting Diodes

LSE London School of Economics and Political Science

MRC Medical Research Council

MTEM Multi-transient Electromagnetic Technology

NIHR National Institute of Health Research

NWDA Northwest Regional Development Agency

OECD Organisation for Economic Co-operation and Development

PAT Process Analytical Technologies

PLED Polymer Light Emitting Diode

R&D Research and Development

RSV Respiratory Syncytial Virus

SFC Scottish Funding Council

SME Small or Medium-sized Enterprise

SPRU Science and Technology Policy Research Unit (University of Sussex)

STL Strip Tinning Ltd

THE-QS Times Higher Education-Quacquarelli Symonds

TMDH Transposon-Mediated Differential Hybridisation

TTO Technology Transfer Office

UCL University College London

UMIP University of Manchester Technology Transfer Company

UNCTAD United Nations Conference on Trade and Development

UNESCO United Nations Educational, Scientific and Cultural Organisation

1 DIUS, *Science and Innovation Investment Framework 2004–2014: Economic impacts of investment in research and innovation*; December 2008.

2 These statistics draw on the Universities UK report *The impact of universities on the UK economy*, Universities UK, November 2009. The report calculated the Gross sectoral output of HEIs as being equivalent to 2.38x the Sectoral Gross Output (Total Turnover), and the total number of jobs created as being equal to 2.03x the number employed directly for the sector (figures for total sector income – turnover – and total number employed are taken from HESA stats for 2007–08). Total export earnings is calculated based on total university revenue from international sources plus the estimated expenditure and secondary economic activity generated by international students. Again, multipliers are taken from the UUK report. Since an international breakdown was not available for most areas of HESA-reported income, figures are based on the ratio of international: UK income reported for the whole sector in the UUK report, the exceptions being research grant income and overseas tuition fees and contracts, for which the RG figure for non-EU students has been used).

3 HESA Finance returns 2007–08.

4 HESA 2007–08.

5 The Government's productivity agenda recognises that "science and innovation" is one of the five key drivers in increasing the productivity component of economic growth.

6 *Science and Innovation Investment Framework* 2004–14; July 2004.

7 Guellec D, and van Pottelsberghe de la Potterie B, OECD *Economic Studies No. 29, 1997/II.*

8 The AIM/EPSRC research shows that 'Access to R&D facilities' was the third most important motivating factor for businesses engaging with university research.

9 Abramovsky L, Harrison R, Simpson H. *University research and the location of business R&D*. Economic Journal, 2007;117(519):114–41.

10 Mansfield E, *Academic Research and Industrial Innovation*, Research Policy 20; 1991, 1–12; and *Academic Research and Industrial Innovation: An update of empirical findings*, Research Policy 26, 1998, 773–776.

11 Advanced Institute of Manufacturing, *The search for talent and technology: examining the attitudes of EPSRC industrial collaborators towards universities*, January 2009.

12 Richard Brown and Phillip Ternouth, *International Competitiveness: businesses working with UK universities*, The Council for Industry and Higher Education (CIHE), May 2006.

13 Richard Brown and Phillip Ternouth (Ibid).

14 André Andonian, Christoph Loos, and Luiz Pires, *Building an innovation nation*; McKinsey and Company, 4 March 2009.

15 HEFCE Higher education-business and community interaction survey 2007–08 (2009).

16 See, for example: Salter, A J and Martin, B R, *The Economic Impacts of Basic Research: a critical review*, Research Policy 30 2001. 509–532 and references within; Martin P R and Tang P, *The Benefits from Publicly Funded Research*, SPRU paper no. 161, June 2007; Pavitt, K (1991) *What makes basic research economically useful?* Research Policy, 20, pages 109–119.

17 Salter, A J and Martin, B R (Ibid).

18 1994 Group (2008) *Graduate Employment and Earnings: are universities meeting student expectations?* London: 1994 Group.

19 HESA Destinations of Leavers Survey 2007–08.

20 THE -QS World University Rankings 2008.

21 Based on grants awarded for 2008 obtained from individual research council websites.

22 UK Innovation Research Centre, *Knowledge exchange between academics and the business, public and third sectors*, 2009.

23 UK Innovation Research Centre, ibid.

24 Abramovsky L, Harrison R, Simpson H. University research and the location of business R&D. Economic Journal 2007;117(519):114–41.

25 UNCTAD World Investment Report (2005).

26 HESA finance returns: 2001–02 to 2007–08

27 See, for example: Phil Vickers and Bahram Bekhradnia, *The Economic Costs and Benefits of International Students*; HEPI, July 2007 and UUK, *The Impact of Universities on the UK Economy, fourth report*, November 2009 . Both reports demonstrate the significant contribution which international students make to the UK economy.

28 NW Varghese *Globalization of Higher Education and Cross-Border Student Mobility*; UNESCO research paper, 2008.

29 Comment made by Sir Terence Leahy, at a meeting with the Russell Group 2008.

30 *Spinning out quality: University spin-out companies in the UK*. A briefing by Library House to accompany the event "Meet the Spin-Outs" 8 March 2007.

31 UK Innovation Research Centre, *Knowledge exchange between academics and the business, public and third sectors*, 2009.

32 We are aware that there is likely to be significant fluctuation in market valuations. The figures we have used are based either on estimates of market value provided by our universities or, in the case of publicly limited corporations, the market capitalisation value as of 29 September 2009.

33 See, for example: Thursby, J, Jensen, R and Thursby, M *Objectives, Characteristics and Outcomes of University Licensing: A Survey of Major US universities*; Journal of Technology Transfer, 26, 59–72, 2001.

34 Based on proportion of research grants and contracts awarded. (source: HESA).

35 CIHE, *International Competitiveness, Businesses working with UK universities*, 2006.

36 G. Markman *et al* demonstrate that the organisational structure of a university TTO can have a significant impact on its commercialisation success, and on the preferred mechanisms by which technology is commercialised. (Gideon D Markman *et al: Entrepreneurship and university-based technology transfer*. Journal of Business Venturing 20 (2005) 241–263).

37 Bercovitz *et al* show that organisational differences in University TTOs including information processing capacity, coordination capacity and incentive alignment resulted in differences in technology transfer activity (Bercovitz, J, M Feldman, I, Feller, and R. Burton, 2001, *Organizational Structure as Determinants of Academic Patent and Licensing Behavior: An Exploratory Study of Duk e, John Hopkins, and Penn State Universities,* The Journal of Technology Transfer, 26, 21–35).

38 A 2007 report by Library House again highlighted the importance of TTO structure to the overall efficiency of technology transfer. It showed that the efficiency of technology transfer could be greatly improved by measures such as creating a subsidiary company to manage the technology transfer process, or by working with commercial technology transfer enterprises. (*Spinning out quality: University spin-out companies in the UK*. A briefing by Library House to accompany the event 'Meet the Spin-Outs' 8 March 2007).

39 Lach, S., and Schankerman, M. (2004), *Royalty Sharing and Technology Licensing in Universities*. Journal of the European Economic Association, 2 (2–3), 252–64.

40 Andy Lockett and Mike Wright: *Resources, capabilities, risk capital and the creation of university spin-out companies*. Volume 34, Issue 7, September 2005, Pages 1043–1057.

41 InÉs Macho-Stadler, David Pérez-Castrillo, Reinhilde Veugelers (2008) Designing Contracts for University Spin-offs Journal of Economics & Management Strategy 17 (1), 185–218.

42 The Frascati manual sets out standard practice for surveys on R&D across OECD member countries; it defines basic research as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view" (http://europa.eu.int/estatref/info/sdds/en/rd/rd_frascati_manual_2002.pdf). However, many definitions and uses of the term are current among policy makers and scientists: in part, this may stem from a blurring of the distinction between 'basic' and 'applied' research as basic research outcomes are often translated into unexpected but direct commercial applications (Jane Calvert and Ben R. Martin: *Changing Conceptions of Basic Research?* SPRU, September 2001).

43 Throughout this document, we define 'basic' research as that which is curiosity-driven; directed towards problems which are academic in nature, and which do not address any *specific* end goal, wider application or commercial need (this can therefore include strategic basic research, such as basic aetiological study). 'Applied' research refers to that which has set out to solve a particular problem which is predicted to have commercial or wider application.

44 Sherwin and Isenson (Chalmers W. Sherwin and Raymond S. Isenson, *Project Hindsight; Science 23 June 1967: Vol. 156. no. 3782, pp. 1571–1577*) reported on weapons system improvement by the US Department of Defense and National Science Foundation: they found that many new systems could be traced to basic academic research carried out 10-20 years prior to the innovation. Maxwell (E Maxwell, Academic Research and Industrial Innovation, Research Policy 20; 1991, 1–12; and *Academic Research and Industrial Innovation: An update of empirical findings*, Research Policy 26, 1998, 773-776), through interviews with major R&D intensive companies, found that a significant number of industrial innovations relied significantly on recent (within the last 15 years) academic research. The average time-lag between a new innovation and the academic research which informed it was 6–7 years.

45 Cambridge Enterprise Ltd, *Annual Review: 1st August 2007 – 31st July 2008.*

46 Figure extracted from Cambridge Enterprise Annual Review, 2007–08.

47 Countopoulos-Ioannidis D G, Alexiou G A, Gouvias T C and Ioannidis P A: *Life Cycle of Translational Research for Medical Interventions*: Science, 321 5 September 2008, p.1298–1299.

48 Eight case studies could not be classified as resulting from either basic or applied research. This was in some cases due to insufficient data, while in others the nature of the research described did not lend itself to classification in this manner. Two studies were classed as "strategic basic" research. The percentages for "basic" and "applied" research relate only to the 104 case studies which were categorised.

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