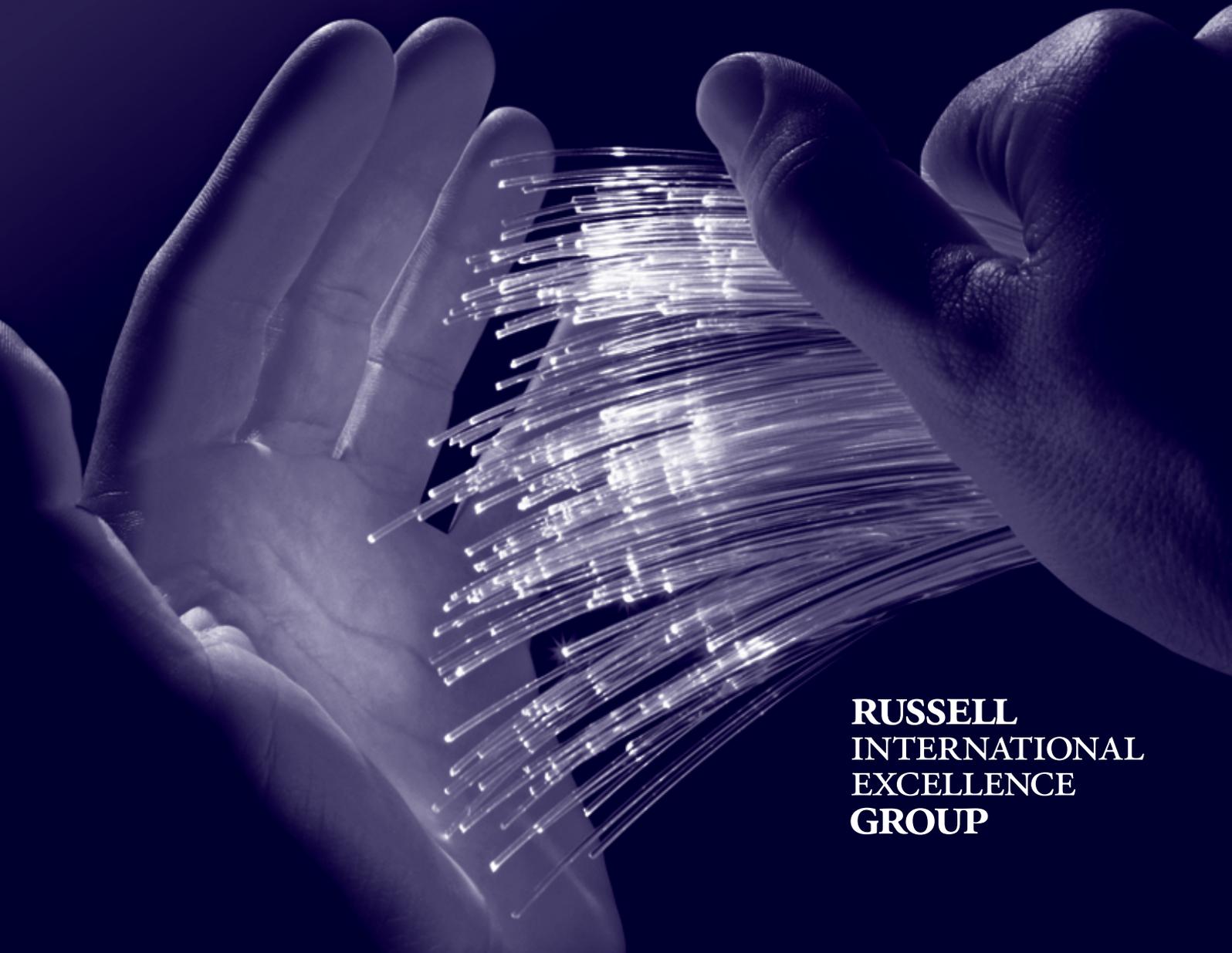


Jewels in the crown: The importance and characteristics of the UK's world-class universities

Russell Group Papers – Issue 4, 2012



**RUSSELL
INTERNATIONAL
EXCELLENCE
GROUP**

CONTENTS

Foreword	1
Executive summary	3
Section 1	7
The defining characteristics of world-class universities	
– Relative performance measures	8
– Specific critical success factors	8
– A high concentration of talent	9
– Sufficient resources to provide a state-of-the-art environment for research and learning	10
– Favourable and efficient governance	13
Section 2	16
The role of world-class universities in delivering benefits to society and to the economy	
– Generating impacts through a large volume of excellent research	18
– Solving global challenges through multidisciplinary research	18
– International leadership and global networks	19
– Formation of clusters of knowledge-intensive activity	22
– Attracting investment from business and international sources	25
– Exploiting the findings of research and technological breakthroughs	25
– Producing highly skilled graduate and postgraduates	28
– Universities are successful businesses in their own right	32
Section 3	33
International competitors recognise the importance of building world-class universities within a diverse higher education system	
– The benefits of a diverse higher education system	34
– The changing nature of the research endeavour	35
– International research collaboration	35
– Complexity of research issues	35
– The greater need for large-scale research infrastructure	36
– Implications for costs	36
– International experience and best practice	36
Section 4	41
Problems and policy solutions	
– Challenges facing the UK higher education system	42
– Policy solutions	43
Annex A	48
Glossary of terms	
References	49

Our international competitors are pumping billions of pounds into research and higher education and our leading universities are already under-resourced in comparison. If our world-class universities don't get the support they need, there is a real danger that overseas universities will not only equal us but will overtake us.

In the UK we have a very successful university sector which educates our young people to a high standard and brings great economic and cultural benefits. It is something of which we can all rightly be proud. All the different types of university in the UK have a hugely important role to play in promoting learning and expanding human understanding.

In the UK we are fortunate enough to have some of the world's very best universities. They are the jewels in our crown and compete in an international arena for the best students, staff and partners from the business world and the public sector. Many countries of a comparable size and world influence would dearly love to possess even a tiny handful of our leading universities.

Worryingly for us, right now many of them are doing everything they can to emulate what we already have. They are investing heavily in research and development and they are concentrating funding in a limited number of institutions to build the necessary critical mass to achieve real breakthroughs.

The amount of money they are spending is astounding. Of course America and China invest substantial sums in research and higher education. But other countries are also deliberately and consciously concentrating public funding in order to build up a small number of research-intensive universities. Already more than £1.2 billion has been invested in South Korea and there are plans to invest £2 billion in Germany. And we fear their approach will pay dividends. Our competitors increasingly recognise that they need a more diverse higher education system and that nations can't afford to fund all universities at the same level. But diversity is not only a necessity; it is a strength. We need a range of higher education institutions to suit the many and varied skills and needs of students.

This paper explores the critical success factors of leading universities, the benefits they bring and what they need to have the very best chance of competing on the global stage. These leading universities already raise their own funds but, alongside autonomy and freedom to operate, they also need the support of concentrated public funding if they are to continue to contribute.

It's vital that in straitened economic times, the UK Government does not make the grave mistake of making cuts to higher education and research funding or spreading limited funds too thinly.

UK Government policy has, to some extent, recognised the importance of investing in research, concentrating resources on excellence and allowing universities to raise more funds from private sources. But to compete globally our leading institutions must be able to secure sufficient funds. Only that way can they boost our economy and prosper in ways that will benefit everyone.

Professor Michael Arthur
Chair of the Russell Group

Dr Wendy Piatt
Director General and Chief Executive
of the Russell Group



ACKNOWLEDGEMENTS

The Director General of the Russell Group, **Dr Wendy Piatt** would like to thank the following Russell Group staff for their work on this report: **Julie Tam** and **Alex Thompson**.

The Russell Group would also like to thank:

Rodney Eastwood

Imperial College London

Michael Arthur

University of Leeds

David Eastwood

University of Birmingham

Michael Worton

UCL

Saul Tendler

University of Nottingham

Chris Thompson

Imperial College London

Graham Hutchings

Cardiff University

David Price

UCL

James McElnay

Queen's University Belfast

Steve Beaumont

University of Glasgow

Through their education, research and innovation the UK's leading research-intensive universities strive to contribute to society, and to change the world for the better.

- 1 Through their education, research and innovation the UK's leading research-intensive universities strive to contribute to society, and to change the world for the better. They are centres of opportunity and inspiration, where freedom of thought and expression are protected within an independent and autonomous organisation. They offer a unique environment in which intellectual inquiry and discovery can flourish and the boundaries of human knowledge and understanding are continuously extended. This has been their purpose for generations, and it remains so to this day.
- 2 The UK's world-class universities are therefore critical national assets providing intellectual leadership and delivering widespread benefits to individuals and society. They also provide the foundation for the nation's long-term economic growth and international competitiveness. In this country, our economic competitiveness is underpinned by a higher education system which is recognised internationally for the excellence of its research and educational provision. The UK's research performance, and attractiveness to overseas researchers, students, and inward investment, is in no small part due to it being home to a significant number of the world's leading universities. Higher education itself is also a very significant global business in its own right, worth billions to the economy.
- 3 This paper describes the key defining characteristics of world-class universities, and the critical success factors they demonstrate which in turn allow them to deliver key outputs crucial to economic growth and social improvement. It explores just how substantially a nation benefits from having world-class universities, both economically, and in other important respects. It examines the characteristics of a successful higher education system, where diversity is a key feature, and how world-class universities contribute to this diversity. Finally, the report briefly looks at the challenges facing the world-class universities in this country, and summarises some policy solutions which will ensure that the UK can continue to benefit from some of the best universities in the world.
- 4 **A world-class university can be characterised by the critical success factors it exhibits**, including:
 - a high concentration or critical mass of talent, both faculty and students
 - sufficient resources to provide an extensive, comprehensive learning environment and a rich environment for advanced research
 - favourable governance allowing and encouraging autonomy, strategic vision, innovation, efficient resource management and flexibility.
- 5 In world-class universities, a high concentration, or density, of talented individuals act across many academic disciplines, collaborate with other leading researchers domestically, and with leading counterparts around the world. We define critical mass as when a high concentration of talent exhibits this multidisciplinary scope, domestic and international reach. This definition of critical mass goes far beyond just looking at the size of a research group or unit, but encompasses dimensions of multidisciplinary and the ability to attract and work with the most talented researchers, both domestically and internationally. All three dimensions of international excellence, multidisciplinary capability and international collaboration must be fulfilled in order for a university to be considered to have institutional critical mass and to be considered world-class.
- 6 **World-class universities deliver outputs that are crucial to a nation's knowledge base and innovative capacity, creating the knowledge and scientific breakthroughs essential to innovation, underpinning long-term economic growth and social well-being.** In some cases, often when least expected, research within Russell Group institutions has led to truly world-changing discoveries, generating substantial revenues for the UK economy. A sample of such breakthroughs generated combined wealth of almost £2 billion.¹ At a time of weak economic growth, investing in world-class universities can help stimulate growth, and position the economy for a sustained recovery.

EXECUTIVE SUMMARY

- 7 World-class universities generate economic and social impacts through a large volume of excellent, leading **research**. The UK's world-class universities account for a significant proportion of the country's leading research due to their continuing ability to attract the world's top talent and their investment in cutting-edge, frontier research. They are capable of solving global challenges through promoting and facilitating multidisciplinary research. World-class universities are uniquely placed to tackle research challenges on a broad, multidisciplinary scale. The critical mass of talent and expertise within an institution means world-class universities are able to respond much more quickly to meet the challenging timescales needed by business and government. Such universities also provide international leadership and access the latest global breakthroughs in research. The UK's world-class universities attract top talent from across the globe and play a significant role in international collaborations. These collaborations rely on UK institutions having complementary standing to other leading research-intensive institutions in the world, and access to first-rate infrastructure.
- 8 To drive **knowledge exchange**, world-class universities are able to form high-tech innovation clusters of knowledge-intensive activity. Research and development (R&D) companies and venture backed companies tend to locate near the UK's top universities, and research-intensive universities are one of the main driving forces behind the development of high-tech clusters. Leading universities attract investment from business and international sources. The UK's world-class universities are highly successful in competitively winning funding from a wide range of sources, both domestically and internationally, due to the quality of their research and their international reach. They are committed to exploiting the findings of research and technological breakthroughs - the UK's leading research-intensive institutions have well-developed knowledge transfer operations, and their researchers are more likely to exploit the findings of their research and engage in commercialisation activities than researchers in other universities.
- 9 Through the high-quality, research-led education they offer, world-class universities produce highly skilled, employable graduates and postgraduates. The state-of-the-art learning environment provided at the UK's world-class universities produces graduates and postgraduates who are highly sought after by employers. Evidence shows that graduates at the UK's leading research-intensive institutions are amongst the most sought after in the world. Postgraduates, particularly research students tend to be concentrated in world-class research-intensive universities. Evidence also shows that the training of the next generation of researchers is best taken place in world-class universities. (See paragraphs 2.43-2.53 of the report).
- 10 **There are important benefits to students, employers and businesses arising from a diverse higher education system, within which world-class institutions are just one component.** Evidence suggests that world-class universities constitute an essential feature of a successful higher education system. They generate benefits, such as international reputation, from which other institutions in the same country can also benefit indirectly. But not all institutions within a system should attempt to be the same, or the system uniform. A diversity of higher education providers, with differentiated missions, gives students the opportunity to identify and pursue different types of higher education, skills training, and professional development at different stages of their careers. It also enables employers, collaborative partners, and potential investors to identify more readily the institutions which are most suited to their interests.
- 11 Not only is diversity beneficial, and a key feature of a successful higher education system, diversity is necessary, and the only financially viable way forward. The changing, and more demanding, nature of the research endeavour means it is not optimal for all institutions to aim to be research-intensive. Research challenges have become increasingly complex, with a rise in the need to collaborate internationally and across disciplines. Also, advances in technology have fuelled a need for better and more sophisticated equipment. These factors have increased the cost of research, so it is simply not feasible for all institutions to have a high degree of research intensity, without research funding being spread too thinly to have any real effect.
- 12 **Countries around the world are increasing their investments in higher education, and most are investing in a selective way and concentrating funding.** This is in recognition of the benefits of a diverse higher education system, and the dangers in spreading funding too thinly across too many institutions. For many governments, the priority is to make sure that their top universities can compete at the cutting edge of intellectual and scientific development.² Last year China committed £7.2 billion of its education budget towards achieving world-class status for just 100 of its more than 3,000 universities. By 2017, more than £2 billion will have been invested in Germany's Excellence Initiative, aiming to create 37 clusters of research excellence and nine excellent universities. Japan, South Korea, Taiwan, France and Canada are also investing selectively in leading institutions to attract academic talent, international students and research funding in order to boost their international competitiveness. Other countries seek to transform their higher education systems by creating new institutions capable of competing internationally at the very highest levels. Countries such as Malaysia, Vietnam, and Saudi Arabia are funding brand-new, well-equipped institutions. Section 3 of this report sets

out the extent and nature of these investments by other countries in developing world-class universities, and it is a sobering analysis.

- 13 Government policy in the UK has, to some extent, recognised the need to make the most efficient use of resources, and to concentrate funding further on centres with world-class capability and to go further in allowing universities to raise funds from external sources. But the UK higher education sector is significantly less diverse than in many competitor countries, notably the US. There are few structures within the UK system to promote diversity, or prevent institutional homogeneity.
- 14 Moreover, the UK higher education sector is experiencing a period of significant financial pressure. Evidence can be seen of severe and ongoing cost pressures across the teaching and research activities of the UK's world-class universities.³ The increased investment by international competitors, focused on enhancing world-class capability, presents a further major challenge. Even before any cuts in the Government's 2010 Spending Review were announced, the UK was in real danger of losing its international competitive edge, with the UK's very best universities finding it difficult to match the resources and incentives offered to leading researchers and postgraduates by universities in the US, and increasingly in the rest of Europe and Asia.
- 15 Income generated by the new fees regime introduced in 2012 will help to some extent, but it is important to recognise that there will be a funding shortfall before universities are able to access the new fee income, and for many high cost science subjects adequate government funding will remain essential. At the current time capital funding, particularly for research, is under great pressure, and this will really begin to bite in the next year or two. There are also challenges facing the funding of postgraduate provision which is so critical to world-class universities.
- 16 Not all the challenges facing universities are financial. As this report will demonstrate, world-class universities also require favourable governance, and autonomy from unnecessary government intervention. But there is a danger that government policies towards immigration, teaching quality assurance, fair access, transparency and freedom of information could create more unhelpful regulation at a time when they need to become more efficient and innovative in the face of growing international competition.
- 17 The Government needs to consider how best to make use of very limited funding in attempting to achieve the following:
 - reap the benefits from a diverse higher education system
 - maximise long-term economic growth, and ensure the UK maintains its international competitiveness
- address the increased cost pressures faced by the UK's world-class universities
- enable the UK's world-class universities to keep pace with international peers.
- 18 Policies towards university teaching, research and knowledge exchange should support and concentrate funding significantly on centres of international excellence and allow for greater diversity within the higher education sector. Regulation of universities should be proportionate, and should facilitate the freedom that world-class universities need to compete successfully internationally.
- 19 Supporting the nation's world-class universities and a diverse higher education system will help ensure the UK continues to enjoy the international recognition it rightly deserves for the quality of its educational provision and cutting-edge research. It is only by meeting a broad, diverse range of needs that the UK can hope to maintain its global competitiveness in the face of ever increasing competition. The UK must rise to this challenge, and not lose its hard-won comparative advantage.

The defining characteristics of world-class universities



SECTION 1 – THE DEFINING CHARACTERISTICS OF WORLD-CLASS UNIVERSITIES

- 1.1 This section sets out the defining features of a world-class university. The literature has approached defining a world-class university in a variety of ways:
 - relative performance against a set of measures (for example, ranking within league tables)
 - demonstration of specific critical success factors
 - delivery of a range of specific outputs and wider benefits.
- 1.2 These approaches are interlinked. For example, a world-class university may demonstrate critical success factors, which enable it to deliver a wide range of outputs and benefits. Section 1 of this report examines these three approaches in more detail.
- 1.3 Drawing on these approaches, **we define a world-class university as an institution that has a high concentration of excellence, talent and modern infrastructure, that is utilised with vision and creativity to deliver excellent learning and research in order to make a significant contribution to the world’s knowledge, health, wealth and well-being.**

Relative performance measures

- 1.4 The ability to compare different universities, within and across countries, is important to a wide range of stakeholders including students, business, policymakers and academics. However, for world-class universities success relates to the expansion of knowledge and the shaping of minds. These things are necessarily very difficult to quantify or measure, and therefore the performance and reputation of any world-class university cannot ultimately be judged numerically, or measured in simple terms.
- 1.5 Rankings within league tables are often used as a tool for making comparisons, and are produced by a range of different organisations, including the media and academic research organisations. International league tables include the Times Higher Education World University Rankings, Academic Ranking of World Universities (the Shanghai Index) and QS World University Rankings. These tables compare institutions based on a range of different factors and provide a snapshot of the comparative performance of universities, countries and regions. Overall, the UK tends to do well in these league tables. Ten Russell Group universities feature in the Times Higher Education’s top 100 world universities, 10 feature in the top 100 in the Academic Ranking of World Universities, and 18 in the QS World University Rankings.⁴
- 1.6 However, defining a world-class university simply by an institution’s performance in one or more league tables is misleading and inaccurate, for a number of reasons. In selecting a particular set of performance factors and

assigning weightings, league tables impose a specific definition of ‘quality’ on the institutions being ranked. However, as the Institute for Higher Education Policy⁵ highlights, there is no universal definition of ‘quality’, or a single correct way of measuring university performance. Many combinations of performance factors can be used. This has led to the proliferation of different league tables, and the widely varying results that are generated.

- 1.7 In addition, the data used to measure the different performance factors are, at best, only a proxy of performance. League tables are often constrained by the availability of comparable and verified data by which to measure performance. As the Higher Education Funding Council for England (HEFCE) has pointed out, this often means that league tables “count what can be measured rather than measure what counts”.⁶ The data that is available is often not comparable for institutions across different countries (due to differences in the structures of higher education), casting the overall comparison in some doubt. The quality assurance procedures for data also differ across countries, so there is an issue over whether all data is of the same standard in quality.
- 1.8 Given the subjective judgments on what constitutes quality in a university and the limitations of the data, interpreting headline rankings in league tables without taking into account additional information can be potentially misleading. Malcolm Grant, President of UCL, says rankings “do a disservice if they influence student choice, or come to be treated as a performance measure by the leaders of hugely diverse institutions”.⁷ International organisations which regularly publish cross-country comparisons have also questioned the value of league tables. The Organisation for Economic Cooperation and Development (OECD) has said “university league tables are fashionable, but should not be taken as accurate measures of the quality of education”.⁸

Specific critical success factors

- 1.9 An alternative approach to defining a world-class university is to examine the critical success factors which a world-class university demonstrates. A World Bank⁹ report suggests that there are three, inter-related critical success factors which distinguish a world-class university:
 - a **high concentration of talent**, both faculty and students
 - sufficient resources to provide an extensive, **comprehensive learning environment and a rich environment for advanced research**
 - **favourable governance** to encourage autonomy, strategic vision, innovation, efficient resource management and flexibility.

- 1.10 These critical success factors are examined in more detail below.

A high concentration of talent

- 1.11 The World Bank characterises a high concentration of talent as “the presence of a critical mass of top students and outstanding faculty. World-class universities are able to select the best students and attract the most qualified professors and researchers”.¹⁰ This section examines the definitions of concentration and critical mass, and evidence of their effects.
- 1.12 World-class universities attract large numbers of outstanding staff and students and sustain a high concentration, or density, of intellectually active and creative individuals. In world-class universities, this high density of talent acts across many academic disciplines, collaborates with other leading researchers domestically, and with leading counterparts around the world. We therefore define critical mass as when a high concentration of talent exhibits this multidisciplinary scope, domestic and international reach.
- 1.13 It is important to recognise that a world-class university has critical mass through its concentration of talent across all three aspects of international excellence, multidisciplinary capability and international collaboration. Some institutions may specialise in particular areas and be internationally renowned, but lack the coverage across disciplines. Similarly, some institutions may be broad based, but not have sufficient international reach to be world-class. Paragraphs 2.10-2.14 and 2.15-2.23 later in this report discuss the multidisciplinary and international reach aspects of critical mass in more detail.
- 1.14 These concepts of concentration of talent and critical mass go beyond the definitions that are often used in the literature which only looks at critical mass in relation to the size of a research unit. Our definition of world-class, set out in the previous paragraph, involves aspects of multidisciplinary and international reach, and goes far beyond just looking at the size of research group or unit, important though that is.
- 1.15 The literature which examines the relationship between research outputs and critical mass is somewhat mixed. Variations in methodology may contribute to these differing results:
- Critical mass can be defined in a variety of ways, with some reports using size of research group or unit, others using the size of an institution.
 - Different aspects of research outputs can be examined, including research quality, income, or the number of publications. Much of the literature relies on publication
- and citation data as a proxy for output and quality. While bibliometric data can be a useful indicator of performance, they are limited in scope, and cannot reflect an institution’s success in educating students or having real social and economic impacts.
- 1.16 Evidence shows support of a critical mass threshold at the research group or team level in some subject areas. This evidence appears to be strongest in those disciplines which are resource-intensive (for example, those which require physical infrastructure such as laboratory equipment), or where physical proximity of others in their field is more important.¹¹ Research findings which have looked at the size of research group or unit include:
- A study using research assessment exercises in the UK and France to look at the relationship between quality and number of researchers submitted, found evidence of maximum and minimum thresholds for group size in a range of subjects.¹²
 - A survey of six research-intensive universities (in the UK, Australia, Canada and the US) found that small academic departments are unsustainable as a primary organisational unit for research in a research-intensive university. While the lone scholar model remains viable in some disciplines, there is a strong case that researchers should be integrated within wider cluster subject-based groups.¹³
 - The Universities UK (UUK) 2003 report *Funding research diversity*¹⁴ found a statistically significant correlation between unit size and research performance measured by average citations per paper, research income per full time equivalent (FTE) staff, PhD awards per FTE staff, and publication output per FTE staff.
- 1.17 Some research has considered the size of a university rather than the size of a research unit. An analysis ranking European universities using bibliometric outputs shows¹⁵ that larger universities tend to publish more articles that are more highly cited – particularly in the sciences. HEFCE’s fundamental review of research policy¹⁶ and more recent work by UUK¹⁷ conclude that the selective funding of research based on excellence has driven up research performance, with more and better research being delivered. The greatest increase in performance and the most significant growth has been in larger universities with medical schools.

SECTION 1 – THE DEFINING CHARACTERISTICS OF WORLD-CLASS UNIVERSITIES

Sufficient resources to provide a state-of-the-art environment for research and learning

- 1.18 The World Bank report highlights that for a university to be world class, it requires sufficient resources to provide an extensive, comprehensive learning environment and a rich environment for advanced research. As well as the quality of the staff and students, it is the quality of the learning and research environments which also attracts the high concentration of talent by which a world-class university is characterised. This section examines some examples of investments and infrastructure in Russell Group universities which underpin state-of-the-art environments for research and learning.
- 1.19 The investment required to provide a globally competitive research and learning environment is substantial. As a consequence, many countries around the world are making selective investments in their world-class universities, in order to maintain and enhance their research and learning infrastructures. Germany, China, Japan, South Korea, France, Canada, and Denmark have all introduced initiatives. Paragraphs 3.18-3.23 later in this paper, provide additional details of these global initiatives.
- 1.20 High-quality teaching and learning environments are essential to help students from the UK and abroad get the most out of their university experience. As well as extensive access to library facilities, students expect access to lecture, laboratory and studio facilities and effective information and communications technology (ICT) support. Degrees in science, technology, engineering and maths (STEM) subjects, in particular, require access to first-class teaching laboratories and support from expert technical staff. With changes in technology, as the ways in which students learn changes, the associated facilities also need to change.
- 1.21 Leading universities regularly make significant investments to enhance the educational facilities for their students and are internationally recognised¹⁸ for providing high-quality learning environments. Russell Group universities are increasingly investing in high-quality spaces that foster new, more collaborative, student-led ways of learning. Some examples of the educational facilities available at Russell Group universities are given in case study 1.
- 1.22 To stay at the forefront of their field, researchers need access to cutting-edge facilities and equipment. While very large, specialist infrastructure such as synchrotrons, neutron sources and telescopes are operated primarily on an international or European basis, the majority of research undertaken in the UK relies upon access to small and medium-scale research infrastructure, much of which is located within leading research-intensive universities. The quality of this research infrastructure is an important determinant in the choices made by leading researchers to work in the UK.
- 1.23 R&D intensive businesses also place high importance on the ability to access state-of-the-art research equipment in deciding to undertake collaborative research with a university, use university facilities for contract research, or co-locate business operations. Much of the cutting-edge research infrastructure in leading UK universities is co-funded by government departments, charities, business and international partners. In making their investment decisions these organisations are looking to secure best value, access academic talent and ultimately generate excellent research. Some examples of research infrastructure at Russell Group universities are given in case study 2.

CASE STUDY 1

Examples of education facilities at Russell Group universities

World-class libraries:

– **The Bodleian Library (University of Oxford):**

The largest university library in the UK, the Bodleian Library holds over 11 million volumes and offers more access to online publications and databases than any other UK academic institution.

– **The British Library of Political and Economic Science (LSE):**

One of the largest libraries in the world devoted to the economic and social sciences, the collections offer unique primary source material of outstanding value for research into British political, economic and social history, social anthropology, and the history of philosophy.

– **John Rylands Library (University of Manchester):**

The library has more than four million printed books and manuscripts, over 41,000 electronic journals and 500,000 electronic books, as well as several hundred databases.

– **Cambridge University Library:** This major research library holds more than seven million volumes including the writings of Newton, Darwin, Walpole, Sassoon and Hawking.

Investments in state-of-the-art learning and teaching facilities:

– The **University of Bristol** hosts the **Applied and Integrated Medical Sciences Centre for Excellence in Teaching and Learning.**

This offers a clinical anatomy suite which provides facilities for teaching and surgical skills training for doctors and dentists, human patient simulators and virtual electron microscopes.

– The **University of Glasgow Wolfson Medical School** provides 24-hour study facilities for students, a ward and consulting rooms for practising clinical skills, and a heart simulator.

– The **University of Nottingham** is building a new £10 million engineering and sciences learning centre. This project will incorporate 12 seminar rooms (ranging from 10 to 160 person capacity), a computer room and a large atrium space to enable individual and small group discussions to take place.

CASE STUDY 2

Examples of research infrastructure at Russell Group universities

National research infrastructure at leading research-intensive universities:

- **The London Centre for Nanotechnology:** This is a joint centre between Imperial College London and UCL. The Centre hosts cutting-edge nanofabrication, design and modelling facilities which are shared between researchers at both universities and available for use by business. Research collaborations with business partners are helping to develop new drugs, photovoltaics for solar energy, and advances in computing.
- **The National Centre for III-V Technologies (University of Sheffield):** This EPSRC funded National Centre provides access to cutting-edge facilities for the production of semi-conductor materials and devices for use in research. The Centre also provides training and facilitates knowledge transfer activities. The facilities are used by 15 UK universities, as well as many business users. Research supported here has applications in the IT sector, mobile communications and high frequency radar.
- **National Oceanography Centre (University of Southampton):** As well as providing a national centre for coordinating UK oceanography research around the world, the NOC is home to the Royal Research Ship Fleet and an underwater systems laboratory for developing and evaluating marine technology. Academic and business users can access the technology and expertise available to undertake marine engineering research and work in support of the hydrocarbon industry.
- **HECToR – UK National Supercomputing Service (University of Edinburgh):** HECToR provides a world-class high performance computing (HPC) capacity for academic researchers, supports the development of new IT technology and helps industry and commerce to make effective use of HPC.
- **ScotChem:** This is a collaborative venture between Scottish universities for pooling research resources and enhancing collaboration in chemistry. Under the ScotChem umbrella, partnerships bring together the Universities of Glasgow and Strathclyde and the Universities of Edinburgh and St Andrews. Collectively ScotChem has an agreement which provides researchers with access to research infrastructure in partner universities on a common basis.

Government, charity and business investment in research infrastructure at leading research-intensive universities:

- **The Department of Health** in England invests in a large number of specialist research centres at or in partnership with, universities. These include:
 - Biomedical Research Units (BRUs), which undertake clinical research in priority areas of high disease burden and clinical need. In 2011, 20 new BRUs were announced, 16 of which feature Russell Group universities as academic partners.
 - Biomedical Research Centres (BRCs), which are designed to translate lab-based discoveries into new cutting edge treatments, technologies and other interventions in clinical settings. In 2011, 11 new BRCs were announced, 10 of which feature Russell Group universities as academic partners.
- **The Wellcome Trust** funds:
 - Clinical Research Facilities which undertake experimental medicine to speed up the translation of scientific advances into benefits for patients in key areas such as cancer and dementia (all 10 in the UK are at, or in partnership with, Russell Group universities).
 - University Centres of Excellence which have demonstrable, world-class research excellence in areas such as genetics and stem cell science (eight out of nine Centres are at Russell Group universities).
- **The Francis Crick Institute** is a consortium of six of the UK's most successful scientific and academic organisations: the Medical Research Council, Cancer Research UK, the Wellcome Trust, UCL, Imperial College London and King's College London. The organisations in the consortium will invest a total of around £650 million to establish the Institute and to ensure that it is resourced to make a major impact when it opens in 2015.
- **Arthritis Research UK** selected Cardiff University to become its UK Centre of excellence in biomechanics and bioengineering. Arthritis Research UK and Cardiff University are committing £10 million to apply cutting-edge expertise in engineering, bioscience, genetics and imaging to arthritis research in this new centre. The new centre involves close collaboration between biomedical scientists, engineers, orthopaedic surgeons, rheumatologists and physiotherapists to translate research to patient benefit in the clinic.

Favourable and efficient governance

- 1.24 The third critical success factor identified by the World Bank¹⁹ relates to a number of favourable governance features which distinguish a world-class university. They encompass the overall regulatory framework, a competitive environment, and the degree of academic and managerial autonomy. These key characteristics include:
- autonomy in recruitment, academic and financial affairs: which allows effective and efficient management of resources, flexibility to respond to the demands of changing markets, and freedom to recruit and attract top talent
 - a competitive environment: which incentivises researchers and institutions to achieve the best results, and institutions to admit the best students
 - leadership and strategic vision in the organisation
 - a culture of organisational learning and change.
- 1.25 International comparisons show that universities produce more outputs when they have the freedom to operate autonomously and face strong competition for people and funding.²⁰ The UK's leading research-intensive universities are highly productive due to their institutional autonomy, coupled with a research funding regime based on excellence that concentrates resources in the top performing institutions. Research shows that UK universities are amongst the most autonomous in Europe when judged against a range of factors, including the freedom to set budgets without government approval, and freedom in the recruitment and retention of academics and students.²¹ It is essential that government policies protect the autonomy of our leading universities, and that their capacity to compete with the best universities internationally is not put at risk by excessive regulation or bureaucracy.
- 1.26 An environment that allows an institution to recruit a high concentration of talent is particularly important for institutional autonomy. UK higher education institutions set their own individual admission requirements, across different degrees, courses and subjects. Russell Group universities are committed to attracting students with the most talent, potential and ability from all backgrounds, and each university has its own special entry routes for non-traditional students. Some examples are given in case study 3.
- 1.27 Russell Group universities are constantly looking for new ways to be as transparent and informative as possible in their search for the very best students. The Russell Group published *Informed Choices* in 2010, a guide to post-16 subject choices, to help teachers, parents and students understand more about the relationship between post-16 choices and university entry. A forthcoming Russell Group report will examine in more detail the importance of autonomy, including in relation to university entry.

CASE STUDY 3

Special entry routes for non-traditional students

– The **University of Leeds** provides preliminary years in four subject areas: medicine; physics; science, mathematics and engineering; and social sciences and law. The foundation years enable students without standard entry qualifications to progress to a wide range of degree courses such as medicine, science, mathematics, computing, engineering, healthcare, law, politics and social policy.

– The **University of Liverpool** runs various 1+3 and 2+2 foundation courses with local further education colleges as progression opportunities into university degrees. These include degree programmes in medicine and dentistry, science and engineering, computer science and information systems, earth sciences, geography, mathematics and physical sciences.

– The **University of Sheffield's** engineering and science foundation years are designed for those who have not studied the courses in school that would prepare them to move directly into the degree programme. The foundation years are aimed at students who, for whatever reason, need additional preparation or knowledge of additional science subjects before going on to an engineering or science degree.

– The foundation year at the **University of Southampton** is the first year of a four or five-year programme leading to a degree in acoustical engineering, biological sciences, chemistry, civil engineering and the environment, computer science, electronics, engineering, geophysics, physics and ship science disciplines. Successful completion of the year guarantees progression to degree programmes.



The role of world-class
universities in delivering
benefits to society and
to the economy



“Universities help companies innovate and the economy reaps the reward. [The] clustering effect, it works in our favour, in that great chase that is the global economy. Top talent likes to move to where other top talent is, so the more success you have, the more success you get. [Universities] are the key to Britain’s modern success in research and science.”

BBC AND THE OPEN UNIVERSITY, MADE IN BRITAIN, 2011

- 2.1 The contribution of universities in generating and disseminating new knowledge and ideas is an incredibly valuable public good, which should never be overlooked. It is important, especially in difficult economic times, to resist the tendency to view universities primarily as instruments to deliver short-term economic development or the skilled labour force of tomorrow. Their role is much more complex, and their contribution much broader than that. Nevertheless, it is indeed the case that very important economic and social benefits have been associated with world-class universities, and these should be acknowledged and fully appreciated.
- 2.2 As well as the critical success factors it demonstrates, a world-class university can be characterised by the specific outputs and benefits it generates.²² These benefits include contributions to the wider economy and society, and international competitiveness. A consensus exists in the economic literature that a nation’s knowledge base, innovative capacity, and economic growth and well-being are inextricably linked.²³ It has been estimated that UK universities make a significant contribution to national prosperity, a contribution estimated to be £31 billion to UK Gross Domestic Product (GDP) in 2007-08.²⁴ This is in no small part because the UK is home to a significant number of the world’s leading research-intensive universities. The former Director General of the CBI noted that:

“The UK is well placed to recover from the current global economic downturn because it enjoys strong comparative advantages. One is our university system, with far more world-class institutions than any country outside the US. Another is the strength of our science base”.²⁵

- 2.3 World-class universities are a crucial part of a nation’s knowledge base and innovative capacity, creating the knowledge and scientific breakthroughs essential to innovation, which underpin long-term economic growth and economic well-being. World-class universities make major contributions to society in the following areas:

Research

- generating economic and social impacts through a large volume of excellent, leading research
- tackling global challenges through promoting and facilitating multidisciplinary research
- providing international leadership, advising governments, business, media and accessing the latest breakthroughs in research.

Knowledge exchange

- forming high-tech innovation clusters of knowledge intensive activity
- attracting investment from business and international sources
- exploiting the findings of research and technological breakthroughs.

Learning and teaching

- producing highly skilled, employable graduates and postgraduates through the delivery of high-quality research-led teaching and supervision.

- 2.4 World-class universities have an enhanced ability to deliver these outputs over and above other institutions, due to their critical success factors discussed in the

SECTION 2 – THE ROLE OF WORLD-CLASS UNIVERSITIES IN DELIVERING BENEFITS TO SOCIETY AND TO THE ECONOMY

previous section, including a critical mass of talent, rich learning and research environments, and efficient governance. Section 2 examines in more detail how Russell Group universities utilise their critical mass of talent and infrastructure in the areas outlined above to the benefit of the UK.

Generating impacts through a large volume of excellent research

- 2.5 Over many years the UK has built up a powerful research base which few other countries can match. Numerous studies continue to show that the UK research base is both productive and excellent. For example the Royal Society's report *The Scientific Century* states that: "The UK produces more publications and citations per pound spent on research than any other G8 nation. With 1% of the world's population, the UK produces 6.4% of the world's publications, receives 11% of citations, and 14% of citations with the highest impact".²⁶
- 2.6 A significant proportion of this national research base is within the UK's university sector. The outcomes from the latest Research Assessment Exercise (RAE) show that over 60% of the UK's very best ('world leading') research took place in Russell Group universities. The UK's ability to attract global talent and provide excellent research facilities has contributed to the UK's success in winning Nobel prizes. Since 1900, academics working at 15 UK universities have won 61 Nobel prizes. Of these, 14 institutions are Russell Group institutions including in 2010:
- Professor Christopher Pissarides (London School of Economics) Nobel prize for economics for his work on the economics of unemployment
 - Professor Robert Edwards (University of Cambridge) Nobel prize for physiology or medicine for his work on human reproduction and IVF treatment
 - Professor Andre Geim and Professor Konstantin Novoselov (University of Manchester) Nobel prize for physics for their work on discovering graphene.
- 2.7 The ability to generate excellent research decade after decade reflects the continuing ability of the UK's world-class universities to attract academic talent, competitively win funding, and their freedom to deploy this funding to invest in high-risk frontier research. This is sustained by a strong commitment from the government to public investment in research and a tradition of collaboration with businesses, charities and international partners.
- 2.8 The publication *The economic impact of research conducted in Russell Group universities* focuses on the benefits of university research to new and existing businesses, and shows how research serves as a platform

for economic growth in the UK. The report describes almost 40 case studies highlighting successful research collaborations between Russell Group universities and a wide range of large and small companies. The case studies demonstrate how Russell Group research has:

- brought new knowledge and new perspectives to university-business partnerships, helping businesses to innovate
 - 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
 - shaped the development of new products and services within UK industry, and helped to improve businesses' strategy, management, and productivity.
- 2.9 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 the report generated combined wealth of almost £2 billion.²⁷

Solving global challenges through multidisciplinary research

- 2.10 Society needs the outputs of research to help identify solutions to complex global issues such as access to energy, environmental change, the ageing population and food security. However, solutions to complex problems such as these are well beyond the scope of any individual discipline. Increasingly governments and business are looking to invest in multidisciplinary research which brings together academics and end users from different disciplines and backgrounds. Such approaches can generate a greater understanding of complex problems, and help to find practical solutions drawing on contrasting approaches from different areas of expertise.
- 2.11 In the pharmaceutical industry, staying one step ahead of competitors is essential to profitable drug discovery. Businesses, such as GlaxoSmithKline (GSK), have discovered to improve their competitiveness, "it works to get the right cluster of talent together in one place." Andrew Witty, Chief Executive of GSK, has said:

"As science has evolved, it's becoming much more multidisciplinary and actually the discoveries all occur on the interface of disciplines. Quite often you will find an IT expert, or an informatics expert, or a molecular designer who uses computers sat next to someone who does everything in a test tube. The two together make things happen".²⁸

CASE STUDY 4

Examples of impact

– **Cardiff University: Using natural luminescence for medicine and diagnosis**

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.

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 \$7.2 million.

– **University of Birmingham: New materials for aeroengines allow more repairs, fewer replacements and greener flying**

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. The technology means that Rolls Royce no longer needs to replace the worn-out components with entirely new ones, saving it 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.

– **Newcastle University: A leader in developing new techniques and research in biopharmaceuticals**

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

Researchers at the centre 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.

SECTION 2 – THE ROLE OF WORLD-CLASS UNIVERSITIES IN DELIVERING BENEFITS TO SOCIETY AND TO THE ECONOMY

2.12 World-class universities are uniquely placed to tackle research challenges on this broader, more multidisciplinary scale. A larger, more diverse, group of researchers creates a vibrant intellectual environment which encourages and facilitates the development and exchange of new ideas, and ability to provide solutions.²⁹ One report describes the breadth of expertise and forward-looking nature of world-class universities as follows:

“World-class universities are institutions that are not dominated by, or focused on, only one field of knowledge...they are composed of a large community of scholars and students, who, in one form or another, are debating the great issues of today and tomorrow.” They are “engaged in not only debating the ethics and implications of their fields, but those of society at large.”³⁰

2.13 This critical mass of talent and expertise within an institution, and ability to pre-empt the issues of tomorrow, means world-class universities are able to respond much more quickly to meet the challenging timescales needed by business and government. A world-class university has the much needed flexibility to bring together resources rapidly, and to broker collaborations with external partners swiftly, to tackle large-scale, multidisciplinary research challenges.

2.14 The UK's leading research-intensive universities will continue to develop multidisciplinary research teams and shared research infrastructure, within and between institutions – for example pooling initiatives in Scotland and collaborations in England such as the Science City Research Alliance. Shared infrastructure is important because it enables research-intensive universities to maintain their competitiveness in the face of international competition and to respond rapidly to new research opportunities and priorities.

International leadership and global networks

2.15 As discussed in paragraphs 1.11-1.17, world-class universities attract a critical mass of top talent, which is both sourced from across the globe, and which also collaborates with leading counterparts located around the world. This section examines in more detail the ability of the UK's leading research-intensive universities to attract and collaborate with the world's top talent, and the importance of this to the delivery of benefits to the economy and wider society, and international competitiveness.

2.16 The market for higher education has become truly international, with academics and researchers having more choices than ever before about where to live and carry out their work. There are many reasons why academics and researchers choose one country,

institution or subject over another. However, a primary consideration is the quality and reputation of the destination department, or institution. Evidence from several Russell Group universities shows that the primary reason cited by overseas researchers for choosing to come to the UK is frequently the quality, relevance and reputation of the research group or department they are coming to join.

2.17 An analogous case applies to the world's most talented students – international students tend to travel to locations where they will receive the highest quality of education and greatest benefits. A survey of postgraduate research students studying in the UK conducted between 2005-2007 shows that the main factors influencing their decision to come to the UK were reputation of the department (31%), the nature of the course on offer (29%), and the reputation of the institution (26%).³¹ The quality of education received will depend on the quality of the destination department, and also on the quality of fellow peers. Evidence on peer effects in higher education³² shows that the quality of the education a student receives depends on the quality of his/her fellow students, as well as the quality of a university's resources (including faculty, facilities, and libraries).

2.18 Therefore, world-class universities, with their ability to deliver state-of-the-art research and learning environments, necessarily attract a significant proportion of the world's top talent. World-class universities such as Harvard, Yale, Princeton and Chicago all have a relatively high proportion of foreign-born staff. Over one third of staff at LSE and Imperial College London is of non-UK nationality. More generally 21% of academics and researchers at Russell Group universities are of non-UK nationality, compared to an average of 16% in all UK universities.³³

2.19 World-class universities not only attract top talent from across the globe, but are also involved in ongoing collaborations with talented researchers located around the world. Academics in the UK's world-class universities play a significant role leading and participating in international programmes, as well as participating in international reviews, councils and advisory bodies. The University of Cambridge, for example, has more than 2,400 international collaborations in 140 countries. Such collaborations may be informal such as sharing data or equipment (enabling access to the latest developments), or more formal collaborations such as joint research, visiting lecture or professorships, and student exchanges (which benefit undergraduates and postgraduates alike). These relationships are also often the catalyst for larger, more formal collaborations between institutions or groups of institutions around the world.

CASE STUDY 5

Examples of multidisciplinary research collaborations

- **The Science City Research Alliance (SCRA):** The Universities of Birmingham and Warwick have formed the SCRA partnership to develop internationally excellent research in the areas of advanced materials, energy, and translational medicine. These are areas where the universities have existing and complementary research strengths and there is potential for growth in the regional industrial base. For example, the Advanced Materials Centre is a new virtual, multidisciplinary centre based in both institutions. £25 million has been invested in new research equipment to help create the critical mass of infrastructure needed to enable the universities to compete effectively with other leading research groups in the UK and internationally and will also be available to other academic and business users.
- **The White Rose Consortium, Centre for Low Carbon Futures:** The consortium aims to facilitate collaboration between the Universities of Leeds, Sheffield and York, supporting teaching, research and innovation. The Centre for Low Carbon Futures is a multidisciplinary centre which brings together engineering, natural and social sciences expertise across the three universities and others in the region to undertake R&D to help businesses take advantage of low carbon technologies and investment opportunities.
- **UCL, Institute for Risk and Disaster Reduction:** The Institute brings together 70 academics from 12 departments to undertake teaching and multidisciplinary research on topics such as societal perception of risk, pandemics, extreme weather and disaster recovery.
- **University of Glasgow's Institute for Health and Wellbeing:** The Institute consolidates its academic research across public health, primary care, health economics, urban studies, crime and justice, disabilities, addictions, telehealth care and informatics to address the serious levels of health and societal deprivation prevalent in areas of the city and in other major post-industrial communities.

CASE STUDY 6

Examples of educational and research collaborations with leading universities overseas

- In 2009 **UCL** and Yale formed a major new alliance in global health including collaborations in education, research and clinical programmes. Collaborative research into the genes that cause congenital heart disease is being funded by a £2.8 million grant from the US National Institutes of Health.
- The Cambridge-MIT Institute (CMI) was established in 2000 between the **University of Cambridge** and MIT to explore how academics, industrialists and educators might work together to stimulate competitiveness, productivity and entrepreneurship. The partnership between Cambridge and MIT led to many enduring personal, professional and institutional links.
- **Imperial College London** has collaborated with Nanyang Technological University to create a new, third medical school within Singapore which provides an exciting prospect for innovation and collaboration that benefits both universities. The first students are to be admitted in 2013 and will graduate five years later, with a joint medical degree from both universities. Named after its generous benefactor who donated \$150 million, the Lee Kong Chian School of Medicine will pioneer innovative forms of medical education in Singapore, taking a science-based approach and adding modern methods such as e-learning. The donation was further augmented by a matching grant from the Singaporean government, some of which will be used to help poorer students.
- The **University of Liverpool** established a new international university in China in partnership with Xi'an Jiaotong University in 2006. The new university offers degrees accredited by the University of Liverpool as well as a range of research opportunities.

SECTION 2 – THE ROLE OF WORLD-CLASS UNIVERSITIES IN DELIVERING BENEFITS TO SOCIETY AND TO THE ECONOMY

2.20 International collaborations rely on partners having complementary standing and reliable access to funding and cutting-edge infrastructure. Therefore, the critical mass of top talent and infrastructure located in the UK's world-class universities enables academics and researchers to attract and develop relationships with their international peers. Researchers at the UK's leading universities are in demand as research partners, and are well integrated into international networks involving the world's top researchers, research groups and universities. Academics at the UK's world-class universities often lead, as well as participate, in pan-national research activities. In addition, top UK researchers are in demand as partners in university-business collaborations, enabling industry timely access to global developments in research and technology. Some examples of international collaborations that Russell Group universities are involved in are included in case study 6.

2.21 The ability of the UK's world-class universities to attract and collaborate with the world's top talent is crucial, as it allows access to the latest research breakthroughs across the world. The Minister of State for Universities and Science emphasised this point in his speech on science, innovation and the economy stating that it is "...necessary to conduct leading-edge research in order to understand, assimilate, and exploit the leading-edge research of others".³⁴ The Government's strategy for sustainable growth also emphasises the need for a world-class research base in the UK to provide the "absorptive capacity" through training highly-skilled graduates and postgraduates, which will be necessary if we are to access and utilise the vast majority of the world's new discoveries.³⁵

2.22 It is therefore essential that both researchers and businesses based in the UK are able to access overseas and global networks for the creation and dissemination of knowledge. The international mobility of researchers and students is also important in generating economic benefits, including³⁶:

- increased R&D, inward investment and economic activity due to the presence of highly-skilled researchers
- improved knowledge flows and collaboration with country of origin, including linkages with the private sector as well as universities
- increased enrolments in postgraduate programmes
- potential company and job creation by overseas researchers/entrepreneurs.

2.23 International collaborations also bring benefits, including enhanced knowledge production and greater research impact. A study looking specifically at the impact of foreign scientists and scholars working in Germany demonstrates the impact of ongoing relationships between domestic and foreign researchers and long-term international networks between different institutions.

Such relationships and networks enable the development of global centres of knowledge production, where additional knowledge is generated beyond which two countries could produce separately.³⁷ Moreover, international research collaboration delivers real benefits in terms of research impacts. Evidence suggests that UK researchers with long-term collaborators in the US, Germany and France produce papers with 50% higher impact (in terms of citations) than the UK research base average.³⁸ A higher citation rate is also evident with papers co-authored between UK and Chinese researchers.³⁹

Formation of clusters of knowledge-intensive activity

2.24 There has been a global shift to government policies focusing on the importance of knowledge, innovation and clusters in recent years. Many countries around the world have been seeking to strengthen or replicate the success factors that have encouraged the concentration of innovative firms associated with the new economy, as exemplified by Silicon Valley and Silicon Fen. Silicon Fen is characterised by 1,400 high-tech companies, employing over 14,000 people, and it has been noted that "it is an interesting feature that these more intellectual businesses like to be near each other, to be plugged in, they tend to cluster".⁴⁰

2.25 Although developments in ICT and social networking provide the new tools for dialogue and collaboration, physical proximity still matters. A paper by BIS⁴¹ defines 'agglomeration' as a "concentration of people and businesses within a geographical space" which can take the form of cities, city-regions, and clusters. Leading economists Nick Crafts and Tony Venables have similarly argued that the 'death of distance' in the new economy is premature, and that recognising the importance of agglomeration in economic development means that size and location will continue strongly to influence future relative income levels.⁴²

2.26 World-class universities have a dual role to play in building local economic mass to achieve the benefits of agglomeration. First, as an employer and provider of training, they make a major contribution to the local concentration of people. The literature estimates that a doubling of economic mass (including local people and businesses) can result in an increase in productivity of up to 20%. Benefits stem from the supply of labour on which firms are able to draw, easier access to inputs and suppliers, and the creation of knowledge spill-overs.

2.27 The high concentration of talent provided by top researchers and students generates benefits to the local area over and above contributions from other organisations. The critical mass of top talent located in world-class universities boosts the performance of local knowledge-intensive

businesses, and incentivises additional knowledge-intensive businesses to locate nearby. The benefit to businesses from co-location is higher productivity and profitability, with OECD research on clusters showing that businesses located in close proximity to research generators outperform their counterparts located in less rich environments.⁴³ The Vice-Chancellor of the University of Auckland has highlighted the importance of critical mass to industry as follows: “a critical mass of leading staff and outstanding students in a university, enabled by adequate investment and an international reputation for teaching and research, produces research outputs, an atmosphere of intellectual excitement, and productive relationships with industry that cannot be replicated elsewhere”.⁴⁴

- 2.28 The critical mass of talent and infrastructure within the UK’s world-class universities has enabled significant contributions to a number of clusters. The BBC and the Open University have noted that:

“Universities help companies innovate and the economy reaps the reward. [The] clustering effect, it works in our favour, in that great chase that is the global economy. Top talent likes to move to where other top talent is, so the more success you have, the more success you get. [Universities] are the key to Britain’s modern success in research and science”.⁴⁵

- 2.29 A well-established body of literature demonstrates that the quality of research generated by an organisation, and the associated quality of the researchers, is a dominant factor when businesses make their choices on collaboration and location. Findings from the literature include:
- R&D companies and venture-backed companies tend to locate near the UK’s top universities, and research-intensive universities are one of the main driving forces behind the development of high-tech clusters.⁴⁸
 - R&D facilities in pharmaceuticals tend to be co-located with the UK’s highly rated chemistry departments, with innovative businesses in the chemicals and vehicle sectors also having geographic proximity to related research flows from universities.⁴⁹
 - Companies co-located near to ‘top-tier’ universities choose to collaborate locally, while those located close to ‘lower-tier’ institutions show less propensity for local collaboration. This is particularly true for R&D intensive companies.⁵⁰
 - In the US, businesses are attracted to locating in areas where there is a high concentration of highly-cited researchers.⁵¹
 - A survey of 250 businesses in the US and Western Europe⁵² shows that the proximity of highly-qualified R&D personnel was the most important factor in decisions about where to locate company R&D facilities, and that

large research-intensive universities are among the most effective aggregators of highly qualified personnel.⁵³

- 2.30 Evidence directly drawn from businesses themselves has emphasised the importance of a critical mass of talent in their choice of collaboration partner. The Business Council for Britain states⁵⁴:

“To address the big industrial challenges, what is needed in academia is a critical mass of scientists, a multidisciplinary approach to problem solving and a reasonable degree of project management.”

- 2.31 Reports by the Council for Industry and Higher Education also emphasise the importance that business places on university partners having a critical mass of talent and expertise^{55, 56}:
- University partners are selected by business because “they have a critical mass of expertise and are likely to continue to do so because of their international pre-eminence, and the consequent expected longevity of the critical mass of relevant expertise”.
 - One business involved in a large-scale collaborative programme with universities tells how “the managing university partner was chosen through having a critical mass of expertise in [the area required] rather than an individual with specific expertise”.
 - “The structure of a professor and a few PhDs and post-docs may be adequate for some problem solving research, but may not be for certain types of fundamental research or for the development of strategic relationships [with business] that require critical mass and some assurance of continuity.”
- 2.32 World-class universities can also work with smaller or less research-intensive universities to enhance their critical mass, to combine collective expertise, and to enable smaller universities to tap into the knowledge of the larger university. Institutional-level collaboration can expand capability and capacity, bringing talented individuals and groups together to generate economic benefit and to meet the needs of businesses. It is also far more efficient and effective to build on existing capacity and critical mass, and to generate economies of scale. Examples where the UK’s world-class universities work in collaboration with others are given in case study 8.

CASE STUDY 8

Examples of inter-university collaborations in relation to technology transfer

- **University of Manchester:** The university has assisted other institutions in the evaluation and commercialisation of invention disclosures. One disclosure from Manchester Metropolitan University was invested in by the University of Manchester's seed funds, and now exists as a spin-off.
- **The White Rose Consortium:** As mentioned earlier in the report, the consortium aims to facilitate collaboration between the Universities of Leeds, Sheffield and York. The consortium includes joint seed-corn and proof of concept funds, as well as collaboration between professional knowledge transfer staff working with industry and other partners.

CASE STUDY 7

Examples of clusters of high-tech activity

- **Cambridge:** The centre of Europe's leading technology cluster which involves around 900 innovation based companies. Fifty one companies have spun-out directly from the University of Cambridge and a further 250 trace their origins to the university.⁴⁶ ARM Holdings is a multinational semi conductor and software company, and the market leader in the field of mobile phone chips. The BBC and the Open University have noted that "ARM's strength has been built around having a highly skilled and highly educated workforce. It is no coincidence that it is found in Cambridge".⁴⁷
- **Manchester:** The University of Manchester is at the core of a cluster of public bodies and over 90 science and technology businesses in the digital media, biotechnology and ICT sectors. This includes globally recognised companies such as Colgate-Palmolive as well as new companies and young entrepreneurs.
- **London:** The capital hosts a large cluster of high-tech companies, with particular strengths in the life sciences and financial services. Imperial College London and UCL have long and successful track records in creating some of the most successful spin-out companies in key new industries, with Imperial having equity holdings in 80 companies, and UCL in 45, across fields of science, engineering, medicine and business. The new Francis Crick Institute will be a major interdisciplinary medical research institute, operating as consortium of six of the capital's major scientific organisations, including UCL, Imperial and King's College. Also, London is a power-house for pioneering the rapid translation of biomedical research into clinical use, and is home to three of five UK Academic Health Services Centres (King's College London, Imperial College London and UCL).

Attracting investment from business and international sources

- 2.33 World-class universities are highly successful in competitively winning funding for research from a wide range of sources, including governments, charities and business, both domestically and internationally. Evidence shows there is a strong complementarity between private and public sources of funding, with increases in public funding leading to increased private funding.⁵⁷ More importantly this investment enables leading universities to offer better research infrastructure, educate more students, and undertake more cutting edge research than they would otherwise be able to. Much of this research, education and infrastructure is delivered in partnership with business and other universities, often as part of a long-term collaborative relationship.
- 2.34 The attractiveness of the UK research base to foreign investors is crucial in securing long-term economic recovery. In promoting the attractiveness of the UK as a location for international R&D, UK Trade and Investment (UKTI) states the success of the UK research base is largely because:
- companies can get “immediate access to leading research institutions”
 - leading research institutions provide “the means to tap into global networks on the back of their research excellence”.⁵⁸
- The attractiveness of the UK’s world-class universities to international investors is reflected in the examples of inward investment in case study 10.
- 2.35 Although leading research-intensive universities are successful in attracting and growing their investment from business, charities and international sources, this does not negate the need for sustained public investment in the UK research base. Evidence clearly shows that business investment in R&D in particular is correlated with public investment.⁵⁹ One study looking at the OECD found that a dollar increase in R&D performed by universities leads to additional industry R&D investment of about \$0.6 in the short-run and \$3.0 in the long-run.⁶⁰ Looking specifically at medical research, and within the UK context, a further study concluded that a £1 increase in government spending could lead to an increase in private research spending from the pharmaceutical industry of between £2.20 and £5.10.⁶¹ This demonstrates how business investment in R&D is dependent on public investment in university research.

Exploiting the findings of research and technological breakthroughs

- 2.36 World-class universities have strong track records in technology exploitation, and are highly effective in facilitating the exploitation of research for economic or social gain. Evidence suggests that this is in part due to the presence of a critical mass of expertise, infrastructure and resources, enabling larger, research-intensive universities to undertake more excellent research, educate more doctoral students, and also have more effective systems and support for knowledge transfer.⁶² Research-intensive universities have well-developed knowledge transfer operations, which may be in-house or delivered in partnership with commercial providers who help universities to commercialise their research.
- 2.37 A review of university intellectual property (IP) exploitation in the UK noted that the capacity and expertise within universities to identify and effectively exploit IP varies widely across UK universities.⁶³ Less research-intensive universities which do not generate sufficient IP tend to struggle to attract private venture capital investment. A report by the UK Innovation Research Centre shows that academics in Russell Group universities are more likely to exploit the findings of their research, and engage in commercialisation activities (taking out a patent, licensing research outputs or forming a spin-out company) than academics in other universities.⁶⁴
- 2.38 In 2010-11, 75% of higher education institutions who had over £5 million in contract research with commercial businesses were Russell Group universities. In the same year Russell Group universities accounted for 67% of the total income from contract research to UK universities, and 55% of the total income from collaborative research involving both public funding and funding from businesses to UK universities.⁶⁵
- 2.39 A key factor underpinning this strong performance is the dedicated technology transfer companies of some Russell Group institutions. These include Isis Innovations (Oxford), Alta Innovations Ltd (Birmingham), and Imperial Innovations Group plc. These companies invest in businesses based on IP from research undertaken in the university, and in some cases – for example Imperial Innovations – in other IP-rich companies with excellent commercial potential. Imperial Innovations is currently the biggest UK provider of early stage venture capital funding for research exploitation and has remained buoyant throughout the recession. It has recently announced £140 million in fundraising, which will enable it to accelerate the number and size of investments that can be made. As already noted in paragraphs 2.23-2.32, universities with strong knowledge transfer capabilities can extend assistance to smaller or less research-intensive universities to enable them to tap into the technology expertise or seed funding. For example, the University of Manchester has

CASE STUDY 9

Examples of business investment in research-intensive universities

– **UCL and Pfizer stem cell collaboration:** Pfizer is funding a programme of research that will accelerate the development of stem cell therapies, and will also provide regulatory and clinical management expertise to allow treatments to be tested in a clinical setting.

– **Rolls-Royce University Technology Centres:** Rolls-Royce has invested in long-term research centres to address the future technological needs of the company. University researchers work alongside the company's engineers and researchers to pursue cutting edge research. Fifteen of the 19 centres are at Russell Group universities including Bristol, Manchester and Nottingham.

– **The Global Medical Excellence Cluster (GMEC):** GMEC brings together the life sciences and medical research capabilities of University of Cambridge, Imperial College London, King's College London, Oxford University and UCL, together with GSK, GE Healthcare, Pfizer UK, The Maudsley Hospital and The Royal Marsden Hospital. The group aims to boost medical research, improve collaboration between academic, clinical and industrial partners and attract inward investment.

– **University of Newcastle Biopharmaceutical Bioprocessing Technology Centre:** The Centre will deliver research and doctoral training. The doctorate has been developed in response to industry demand and places students with industry partners for three and a half years following six months of training. This industry focus enables students to understand how industry thinks, and industrial timescales and challenges.

– **European Climate Change Mitigation and Adaptation Knowledge & Innovation Community:** Imperial College London is a founding partner of this €360 million initiative of leading European universities in Switzerland, Germany, the Netherlands and France, regional partners in Poland, Hungary, Germany, Italy, Spain and the UK, world-leading industrial partners such as Bayer, EDF, DSM and Vattenfall and cutting-edge small and medium size enterprises (SMEs). The community acts as a catalyst for innovation that will create a climate-resilient and low-carbon economy.

– **The Science City Research Alliance:** The Universities of Birmingham and Warwick have formed the SCRA partnership to develop internationally excellent research in areas where they have complementary research strengths. In the area of translational medicine, the universities are developing joint research programmes and establishing new clinical trials units and dedicated support for spin-out companies, as well as investing in new laboratories and equipment to facilitate translational research. This will create the necessary critical mass to enable the universities to compete internationally in translational medicine, whilst strengthening the regional business capability, creating new jobs and a pipeline for new technologies and therapeutics.

CASE STUDY 10

Examples of successful inward investment

- Microsoft established its European research centre at the University of Cambridge.
- Nokia has a long-term programme of nanotechnology research projects with the University of Cambridge and in human-computer interaction research with the University of Glasgow.
- The Bill and Melinda Gates Foundation has made major investments for research into HIV vaccine development at Imperial College London and at UCL.

CASE STUDY 11

Easy Access IP

Easy Access IP is a collaborative project initiated by the University of Glasgow, King's College London and the University of Bristol, but now also involving the University of Birmingham, University of Exeter, and several other universities around the world.

It aims to promote new ways of sharing IP and to encourage and implement new approaches which make it easier for universities and industry to work together.

The Easy Access portfolio contains IP that is difficult to commercialise through traditional ways. The universities choose to forgo an immediate, financial return in order to stimulate the development of the IP and promote new, long-term partnerships with industry.

Certain opportunities are chosen by each university to go into their Easy Access portfolio. These IP rights are licensed for free, using quick, simple agreements. This avoids lengthy, costly negotiations and gets IP rights into the hands of business rapidly, allowing the licensee to start work developing the opportunity.

SECTION 2 – THE ROLE OF WORLD-CLASS UNIVERSITIES IN DELIVERING BENEFITS TO SOCIETY AND TO THE ECONOMY

helped other institutions with the evaluation and commercialisation of their IP. Several Russell Group members (Glasgow, Kings, Southampton, Bristol, Leeds, Oxford) are partners with the IP Group, which funds early stage start-up companies commercialising University IP.

- 2.40 However, not all university intellectual property has immediate value that can be realised through licensing and spin-out company formation. In these cases, universities are increasingly pursuing alternative methods of working with businesses and the public sector to ensure that the economic benefits of research can be fully exploited by others.
- 2.41 World-class universities provide various kinds of incubation facilities for new companies, along with investment and knowledge transfer support. For example, the University of Warwick has a virtual tenancies programme which allows emerging companies to access the support and facilities at Warwick's science park without having to relocate physically. This encourages and stimulates knowledge-intensive activity in the local and regional economy. Alternatively, the universities of Nottingham, Glasgow and Newcastle have awarded local businesses thousands of pounds worth of 'innovation vouchers', enabling small companies to access research expertise through consultancy or collaborative projects.
- 2.42 The technology exploitation activities of Russell Group universities have resulted in direct commercial benefits to the companies involved. The publication *The economic impact of research conducted in Russell Group universities* describes almost 40 case studies of business and university collaboration and the resulting benefits. A selection of examples is given in case study 12.

Producing highly skilled graduates and postgraduates

- 2.43 More than ever, students are prepared to travel across the globe for the best educational experience, and the demand for an education at leading world-class universities far outstrips supply. The OECD estimates that since 2000, the number of students studying outside of their country of birth within the OECD has increased by 79%, and by 77% worldwide. The UK remains the second most popular destination in the world for international students, after the US.⁶⁶
- 2.44 The critical success factors demonstrated by world-class universities, namely a high concentration of talent (discussed in paragraphs 1.11-1.17) and a state-of-the-art learning environment (discussed in paragraphs 1.18-1.23) underpin the student experience provided by world-class universities. World-class universities are able to attract the world's top talent, and are highly selective in admitting their student intake. This results in a highly motivated student population, with home and international students alike benefiting from this peer group effect. Evidence suggests that the quality of an education a student receives crucially depends on the quality of his/her peer group and world-class academics at every level – including not only established professors but also the stars of tomorrow in the form of PhDs students, post-doctoral researchers, and young lecturers.⁶⁷ Attracting the world's top talent also helps to build a global environment within a university, bringing in new ideas and helping students build foundations for future international collaborations and opportunities.
- 2.45 As outlined in paragraphs 1.18-1.21, students studying at world-class universities benefit from first-rate academic infrastructure, including world-class libraries and learning facilities. These facilities contribute to a state-of-the-art learning environment for students. Some subjects (including medicine, dentistry and other STEM subjects) have a core need for cutting-edge equipment. Students at world-class universities benefit from the opportunity to take strategically important subjects which require advanced equipment and facilities, which are simply not available at all institutions due to their high cost.
- 2.46 A further dimension to the learning experience at world-class universities is that teaching is research-led, and enquiry based. Research-led learning aims to utilise cutting-edge research in the teaching experience, teaching skills and research methods to engage students in research and scholarship, and involve students in 'real' research projects and activities. Low student-staff ratios are integral to a high quality research-led education, and for some Russell Group universities maintaining low student-staff ratios has been a specific focus for investment of the additional income obtained through variable fees.⁶⁸ Russell Group universities are also placing increased emphasis on experiential learning, in recognition of the value of new technologies in changing traditional learning paradigms.
- 2.47 Some of the UK's world-class universities work with further education colleges and other universities to offer progression routes to enable existing students to transfer in to a research-led learning environment, if they have the ability and desire to do so. Examples of these opportunities are given in case study 13. This is in addition to a commitment to widening participation and support for a host of activities aimed at encouraging applications from non-traditional students (such as foundation courses with further education colleges).
- 2.48 The high concentration of talent and state-of-the-art learning environment at the UK's leading research-intensive universities contribute to high levels of student satisfaction. In 2011, 87% of students at Russell Group universities were satisfied with their course compared to 83% across the sector as a whole.⁶⁹ In addition, data

CASE STUDY 12

Examples of innovation

- **Avacta (Universities of Leeds and Glasgow):** Research led to the development of expertise in molecular detection technologies which has been commercialised through Avacta. This technology is now being used by pharmaceutical companies in drug development and has potential for use in homeland security applications. Floated on the Alternative Investment Market in 2006 the company is now valued at more than £23 million. It subsequently acquired a spin-out, ReactivLab, from the University of Glasgow.
- **Centre for Secure Information Technologies (CSIT) (Queen's University Belfast):** This is an innovation and knowledge centre which brings together research specialists to work on the development of secure solutions to a number of particularly modern problems, including the protection of mobile phone networks, guaranteeing privacy over unsecure networks for connected healthcare and the creation of secure 'corridors' for the seamless and rapid transit of people. With total funding in the region of £30 million over five years, CSIT will create the security infrastructure needed to safeguard the trustworthiness of information stored electronically, both at home and in the workplace.

CASE STUDY 13

Examples of transfer opportunities for able students

- **Newcastle University and the Open University:** Together the two universities have established an access route for science students. This enables those completing suitable university-level modules at the Open University to transfer to degree programmes at Newcastle University as an alternative to standard entry qualifications.
- **University of Leeds and the University of Bradford:** Able students who successfully complete a one-year clinical sciences course at the University of Bradford have the opportunity to progress to the University of Leeds medical school.

SECTION 2 – THE ROLE OF WORLD-CLASS UNIVERSITIES IN DELIVERING BENEFITS TO SOCIETY AND TO THE ECONOMY

from surveys of international undergraduate students demonstrate that the UK's leading research-intensive universities perform well against their international competitors on important aspects of the student experience such as good teaching, course content and expert lectures.⁷⁰ NUS research⁷¹ shows that students at Russell Group universities and also 1994 Group universities are significantly more likely to rate the quality of their teaching as good or excellent (93%) compared to the other university groups (86%). Students were also more likely to have been taught by professors.

- 2.49 The quality of the student experience at Russell Group universities leads to graduates going on to be amongst the most highly sought after by employers worldwide. Ten Russell Group universities are in the world's top 30 universities as ranked by an international survey of graduate recruiters.⁷² Key statistics on the employability of Russell Group graduates are given in case study 14. A substantial body of evidence shows that graduates from research-intensive universities secure a significant wage premium over peers graduating from other institutions and report a higher level of satisfaction with their careers.^{73, 74}
- 2.50 Postgraduates, and particularly those studying for research degrees, tend to be concentrated in world-class universities. Research-intensive universities have a key role in educating the next generation of researchers, scientists and engineers. In England, Russell Group universities account for around 56% of all doctorates awarded,⁷⁶ and 84% of PhD students successfully complete their doctoral studies compared to 73% in the rest of the HE sector.⁷⁷ The UK's leading research-intensive universities aim to develop PhD students who are capable of analysing problems in depth, working to exacting quality standards and have high-level specialist skills. Russell Group universities provide their doctoral students with transferrable skills as a core part of their degree programmes. This includes communications skills, leadership, management and team working, as well as an increasing focus on entrepreneurial skills, such as IP management, writing a business plan, raising finance, and marketing where this is appropriate to the degree programme and student aspirations. Evidence available from institutions and business suggests that this aspect of doctoral provision is highly valued by students and employers, and it is internationally recognised as a positive attribute of UK PhDs.
- 2.51 The effective education and training of highly skilled postgraduates is essential to academia, industry and commerce to help the UK sustain its international competitiveness. An established body of literature suggests that the training of the next generation of researchers should take place in the world's leading

research-intensive universities, where there is a critical mass of talent and infrastructure. Some of this research is summarised below:

- Research at the University of Warwick suggests that the quality of doctoral provision, and especially the opportunity to learn alongside leading academics, has a real and lasting effect on subsequent career paths of PhD students, and that “the most efficient way of training PhD students is to have large PhD programmes in a small number of very high quality universities”.⁷⁸
 - Research into UK skills needs has identified that “to support research and innovation countries need a sizeable but not vast number of top-class, superbly trained researchers and developers, not a very large number of imperfectly trained ones”.⁷⁹
 - Evidence shows that postgraduate education, especially doctoral programmes, is ideally undertaken in an environment where postgraduates are supervised by leading, active researchers in department with modern, well-equipped facilities, and a critical mass of other researchers and postgraduate students. Lord Rees, former President of the Royal Society, has stated on a number of occasions the need to ensure that the training of PhDs should only take place in departments or research groups where there is a strong research base in the appropriate discipline.
 - Funding policies of the Research Councils emphasise the importance of a well-funded environment in awarding doctoral funding, and other funding bodies such as the Wellcome Trust stress the importance of doctoral students being educated in “well-funded research environments where superior facilities, training opportunities and scientific mentoring would be available to them”.⁸⁰
 - Research looking at the future development of the European Higher Education Area has emphasised the need for excellent postgraduate training and to focus this on research-intensive universities,⁸¹ capable of attracting mobile international talent and providing the strongest learning environment.
- 2.52 Research has also explored the relationship between PhD completion, collaborative research income, publications, patents and income from the exploitation of IP.⁸² Findings show that institutions which successfully educate and award large numbers of doctoral degrees also generate a larger volume of research outputs, file more patents and secure more income from licensing their IP. This is likely to be because larger, research-intensive universities have the capacity to offer doctoral students comprehensive support and training, and to systematically identify and exploit their IP.



CASE STUDY 14

Employability of students attending Russell Group universities

In 2010-11 Russell Group universities accounted for around one fifth of all undergraduate students in the UK, producing around 30% of the UK's science and engineering graduates, and training nearly 80% of the nation's doctors and dentists. First destination data for Russell Group institutions show⁷⁵:

- 88% of first degree graduates are in employment or study six months after graduation (compared to 87% nationally)
- 94% of masters students are in employment or study six months after graduation
- 90% of doctoral students are in employment or study six months after graduation

SECTION 2 – THE ROLE OF WORLD-CLASS UNIVERSITIES IN DELIVERING BENEFITS TO SOCIETY AND TO THE ECONOMY

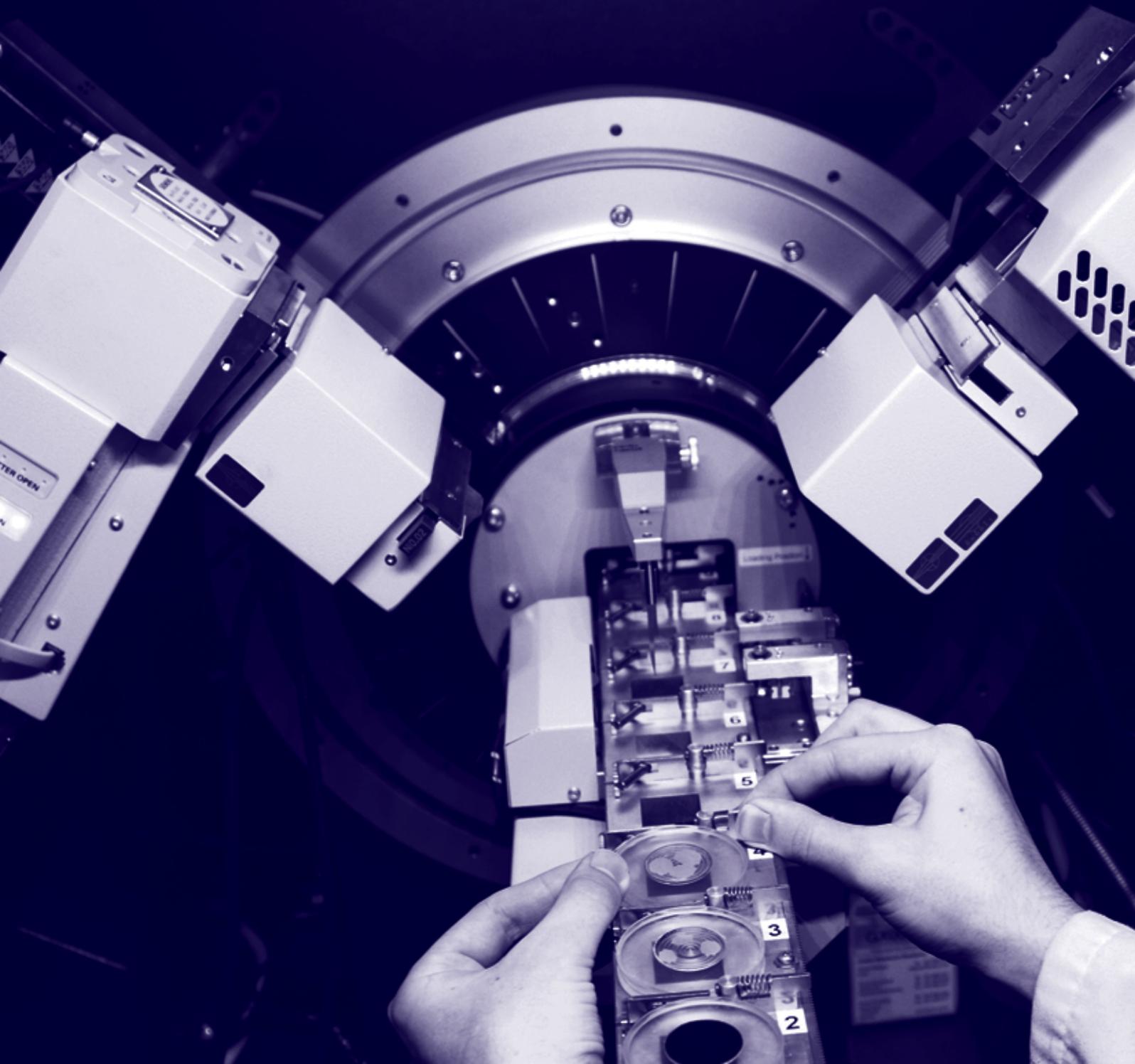
2.53 Many of the postgraduate students in the UK's leading universities are international students, or from other countries within the EU. Universities in this country face fierce competition for the best international postgraduates from other institutions around the world. These students bring huge benefits to our top universities, and it is crucial that our universities are well-placed to attract and compete for the best graduates wishing to pursue postgraduate study.

Universities are successful businesses in their own right

2.54 Finally, it should be noted that higher education is a thriving sector within the UK economy in its own right, generating employment and output, attracting export earnings and contributing to GDP. A key study has estimated that in 2007 UK universities generated over £59 billion in economic output and over 668,500 full time equivalent jobs, equivalent to 2.6% of all employment.⁸³ In overseas earnings alone, it is estimated that the HE sector generates over £8 billion per year.⁸⁴ This means that higher education is one of the nation's leading export industries.

2.55 World-class universities, with their large-scale research activity, and strong international reputations play a particularly key role in underpinning the economic success of the wider UK higher education sector.

International competitors recognise the importance of building world-class universities within a diverse higher education system



“To support research and innovation countries need a sizeable but not vast number of top-class, superbly trained researchers and developers, not a very large number of imperfectly trained ones.”

ALISON WOLF, DOES EDUCATION MATTER? 2002

3.1 Section 1 considered the defining characteristics of world-class universities and Section 2 their delivery of benefits to the economy, society and international competitiveness. This section examines how world-class universities constitute an essential feature of a successful higher education system, and the growing recognition internationally that policies must support the development and sustainability of a limited number of world-class universities, with a diverse higher education system.

3.2 The evidence suggests that:

- There are important benefits to students, employers and businesses arising from a diverse higher education system.
- The changing nature of the research endeavour means institutions face an increasingly specialised set of requirements in order to effectively carry out research, and it is not optimal for all institutions to meet these requirements.
- International experience and best practice shows countries around the world are choosing to focus on supporting a small number of leading universities.

The following sections examine these three areas of evidence in more detail.

The benefits of a diverse higher education system

3.3 The World Bank characterises high-performing higher education systems as those which are truly diverse, and says they should “encompass a wide range of institutional models – not only research universities but also polytechnics, liberal arts colleges, short-duration technical institutes, community colleges and open universities...that together produce the variety of skilled workers and employees sought by the labour market”.⁸⁵ A diversity of higher education providers, with differentiated missions, gives students the opportunity to identify and pursue different types of higher education, skills training and professional

development at different stages of their careers. It also enables employers, collaborative partners and potential investors to more readily identify the institutions which are most suited to their interests.

3.4 Different higher educational providers will differ in their emphasis on research, innovation, regional involvement, internationalisation and type of education. Students will also differ in their preferences and needs. For example some may prefer an institution well-linked internationally, others may prefer an institution with a greater regional focus. A range of providers, with differentiated missions, gives students greater choice, and more opportunities to identify and pursue different types of higher education.

3.5 Employers are similarly diverse in their needs, and different employers will require different types of skills from graduates. Some occupations require formal and rigorous training, for example in the medical professions or scientific fields, in which a research-led education is essential. Other occupations have a greater emphasis on skills acquired on-the-job, and do not require research-led training. Therefore students should have the choice to select the type of higher education institution which will provide the skills training that best matches the career path they aspire to. Professor Alison Richard, former Vice-Chancellor of the University of Cambridge, has noted that diversity amongst institutions is not an inherent form of unfairness, but a real strength for students, society and universities themselves. She notes that “in a homogenous world, the depressed average will be the norm and the UK economy and society will suffer as a result”.⁸⁶

3.6 Businesses also differ in their requirements from universities. Some businesses may be focused on developing regional collaborations with institutions in their area. Others will be focused on accessing the most cutting-edge research, wherever that research may be located. It is simply not possible or practicable for a single institution to meet the needs of all businesses – therefore a diversity of provider is needed. The Vice-Chancellor of the University of London

observed “the needs of the knowledge economy and the pressures of global competition cannot easily be met within the current ostensibly homogenous model of higher education and research”.⁸⁷

- 3.7 The UK’s world-class universities must compete with their peers across the world, and differentiate themselves from other UK universities sufficiently in order to attract business investment. Michael Walker, Group Research and Development Director at Vodafone, argues that too many universities in the UK claim to be research-led, and this is “very damaging for the UK’s reputation”.⁸⁸ He argues that this lack of differentiation may lead to overseas companies receiving an inaccurate depiction of the quality of research in the UK, and discourage inward investment. Professor David Eastwood, Vice-Chancellor of University of Birmingham has also emphasised the importance of differentiation:

“It is not about subordinating but about promoting individual identities in an increasingly competitive market place. Not all institutions can or will wish to do this, and international higher education, like national systems of higher education, will become increasingly characterized by mission differentiation. Wise institutions will choose which markets they can compete in, and will attend prudently to their comparative advantage. Others, especially the leading research universities, will and must think global, recruit globally, compete globally, but be recognizable and distinctive in that global environment”.⁸⁹

- 3.8 In the UK, our higher education system encompasses several hundred universities, higher education institutions and other higher education providers. The range of high-quality learning offered by universities and colleges gives potential students the opportunity to pursue different kinds of tertiary education, skills training, and professional development in a variety of settings. However, the UK higher education system is significantly less diverse than higher education systems in other countries, notably the US.

The changing nature of the research endeavour

- 3.9 As research continues to push towards new boundaries of knowledge and understanding, the very nature of the research endeavour has changed:
- With an increasingly open model of innovation and increased globalisation, it has become not only desirable, but essential, for researchers to collaborate internationally.
 - Research problems have grown in their level of complexity and scale, with global challenges such as energy, environmental change and the ageing population requiring ground-breaking and multidisciplinary solutions.

– Many disciplines have shifted from small-scale to ‘big-science’ activity, requiring investment in larger-scale infrastructure, and driving costs up.

- 3.10 These three factors mean that a nation’s ability to undertake cutting-edge research very much depends on the research base having the necessary international reach, scale and concentration of talent – characteristics exhibited by world-class universities. But it is not possible for all institutions to exhibit these characteristics, due to feasibility and cost constraints. These three factors and the implications for costs are explored in more detail below.

International research collaboration

- 3.11 International research collaboration is expanding rapidly, with estimates suggesting that cross-border scientific collaboration, as measured by co-authored publications, has more than doubled since 1990.⁹⁰ This can be attributed to a number of different factors, including the increasingly global nature of major research challenges such as climate change; the increased mobility of researchers with increased globalisation; the need for international collaborative research partnerships to fund the infrastructure needed for very expensive research; and the increasing evidence which suggests that research which involves international collaboration tends to have greater impact (as measured by citation data). It is now not merely enough to collaborate within national borders to remain internationally competitive. Paragraphs 2.15-2.23 described how the UK’s world-class universities are well placed to access the world’s leading research and have a high degree of collaboration with the world’s top talent. Therefore the UK must support its world-class universities in order to remain a partner of choice for international collaboration, and to maintain its excellent research base.

Complexity of research issues

- 3.12 Research issues have rapidly grown in their level of complexity. Challenges such as access to energy, environmental change, the ageing population and food security affect not just one or a group of countries, but are global in their scope. These challenges present the most significant challenge to research in the 21st century.
- 3.13 Solutions to these challenges cut across one or more disciplines, therefore it is important that relevant resources, expertise and infrastructure across disciplines are mobilised in the most efficient manner. Countries may respond through the pooling of expertise across institutions and across country borders. However, as discussed in paragraphs

SECTION 3 – INTERNATIONAL COMPETITORS RECOGNISE THE IMPORTANCE OF BUILDING WORLD-CLASS UNIVERSITIES WITHIN A DIVERSE HIGHER EDUCATION SYSTEM

2.10-2.14, collaboration or pooling is not a replacement for building critical mass within institutions. World-class universities can more efficiently meet the needs of businesses and governments as they have the flexibility to rapidly coordinate expertise within the university and centres of excellence to address new challenges as they arise, with highly skilled researchers, graduates and postgraduates forming teams as needed in the light of changing priorities.

- 3.14 Building critical mass within institutions is much more efficient than collaboration or pooling for several reasons. Collaborative relationships often require a period of time to develop and to generate successful results, with an initial period of high cost and low return. This timescale may not meet the needs of businesses and governments, who often need solutions in a very short-time scale (such as in the face of crises affecting public health, safety or national security). In these cases, resources and expertise needs to be mobilised and deployed more rapidly than collaborative relationships can deliver.

The greater need for large-scale research infrastructure

- 3.15 The changing nature of research in a number of disciplines is driving up cost pressures on research. While the cost of undertaking some research is coming down due to technological advances (e.g. cheaper DNA sequencing) in other areas technological developments are pushing the cost of some small and medium-scale equipment beyond the means of individual universities. In addition, the energy demands of undertaking research in many science subjects are escalating, as are the costs of employing the specialist technical staff needed to operate and maintain increasingly complex equipment.
- 3.16 In the life sciences, research has shifted away from traditional small-scale activity towards 'big-science' using national and international facilities such as synchrotron radiation sources, pushing up demand for large infrastructure and increasing costs. In other areas, such as climate change research and molecule/drug design, access is needed to high-performance computing to handle huge volumes of data and rapidly perform a vast number of calculations. Investments in infrastructure are expensive but necessary to keep the UK at the forefront of research in these economically important areas. As a result, research-intensive universities are looking to develop more research infrastructure which is shared within and between institutions. This will help to maintain a critical mass of cutting-edge infrastructure to enable UK researchers to continue to compete with the very best research groups around the world.

Implications for costs

- 3.17 The three sets of factors discussed in Section 3 show that it has become increasingly challenging to undertake research with global impact. It would not be possible, or practical, for all higher education institutions to attempt to rise to these challenges. Moreover, data from HEFCE's Transparent Approach to Costing (TRAC) shows that research is currently undertaken at an economic loss in UK universities. Given that research forms a disproportionate share of total activity in world-class universities, their research programmes could become unsustainable if adequate resources are not available. A more efficient solution is for institutions to focus on their area of comparative advantage – with the UK's research-intensive universities making the most of their strengths in research. This was recognised in Sir William Wakeham's review of financial sustainability and efficiency in full economic costing of research. His review said: "greater efficiency could be achieved by concentrating the funding of research into those institutions with a lower fractional deficit and thus a more effective research base".⁹¹

International experience and best practice

- 3.18 In order to reap the economic and social benefits of higher education, many countries around the world are pouring funds into their higher education systems to build human capital, stimulate socio-economic mobility and strengthen national economic competitiveness.⁹² Countries and regions are choosing to invest more in higher education and research but this increased investment is being made selectively. Policymakers are concluding that a single country cannot afford to support a higher education system in which all public universities are, or aim to be research-intensive, high-quality, world-class institutions. For example, research on building a stronger, more effective European Research Area emphasises the necessity of supporting a relatively small number of world-class institutions, stating that "there is no denying that the high peaks cannot make up a significant proportion of the whole... and Europe needs these peaks".⁹³ Similarly, a report by the Group of 8 in Australia states that "A model in which all universities aspire to be research-intensive is neither affordable nor desirable".⁹⁴
- 3.19 Consequently, international experience shows countries around the world are choosing to promote and support a diverse higher education system, with selective support for leading, research-intensive universities as part of a more diverse and differentiated higher education system. For many governments, the priority is to make sure that their top universities can compete at the cutting-edge of intellectual and scientific development.⁹⁵ China, Japan,

South Korea, Taiwan and Canada are investing selectively in leading institutions to attract academic talent, international students and research funding in order to boost their international competitiveness and ultimately reap the benefits from having world-class universities in their countries. Other countries seek to transform their higher education systems by creating new institutions capable of competing internationally at the very highest levels. Countries such as Malaysia, Vietnam, and Saudi Arabia are funding brand-new, well-equipped institutions.

- 3.20 In many countries the global financial crisis has not dampened investment in higher education but acted as a further stimulus. For example, France and Germany have decided to invest in higher education as a means to prompt a swift, but sustainable, recovery from recession, recognising that research underpins innovation and long-term economic growth. More detail is given in case study 15 on the selective and stimulus approaches to investments in R&D intensive countries.
- 3.21 The increased investment in higher education and research by the UK's competitors, both selective investments and investments to provide economic stimulus, means that the UK needs to address how it can maintain its international competitiveness. The UK already spends less on higher education than other developed nations (1.2% of GDP in 2008, less than the OECD average of 1.5% and down from 1.3% in 2007).¹⁰⁴ A recent report by U21 ranked the UK only 21st out of 48 countries, for the total resources invested in its higher education sector.¹⁰⁵ Businesses are looking to maximise the return on their investment by moving their operations and funding to take advantage of research capabilities and high-skilled workforces around the globe.¹⁰⁶ The UK must maintain the quality of its research base if it is to retain the country's attractiveness as a destination for researchers and students and its credibility as a partner for businesses and international collaborators.
- 3.22 OECD research concludes that it is crucially important that countries which are at the technological frontier, like the UK, sustain the performance of their world-class universities and maintain and improve the quality of research generated to underpin long-term economic growth.¹⁰⁷ There are already signs that the UK is falling behind, with the UK now in third place in the number of papers produced, with the US in first place and China moving into second place. Recent growth in the volume of papers published has been exceptional, with much of the growth focused outside the G8 nations, and the UK's share of world publications has fallen since 1999.¹⁰⁸

- 3.23 If the UK is to maintain its international position in higher education and research in the face of tougher, and fiercer, international competition, then there needs to be serious debate about how public funding is deployed, and private sector funding is incentivised, to achieve this. We address the implications for policy in the next section.

CASE STUDY 15

Countries making selective investments to grow or sustain world-class research-intensive universities

Germany

- Introduced the 'Excellence initiative' to increase international competitiveness.
- The funding for this was increased by 30% in 2009, totalling €2.7 billion until 2017, for 37 clusters of excellence to promote top-level research and nine selected universities.
- Economic stimulus package will provide about €17 billion for education and research institutions to carry out urgently required repairs to their estates.
- The Federal budget for education and research 2011 has increased by about €789 million - or more than 7.2% compared with 2010.

China

- Target: raise expenditure on R&D to 2.5% by 2020.
- Project 211 and Project 985 aim to enable selected universities to become world-class institutions. R&D activities are concentrated in a few large universities and focus on a few key disciplines in natural sciences and engineering.
- In 2005, R&D expenditure by the top 50 universities accounted for 66% of total R&D expenditure in natural sciences and engineering in the higher education.
- In 2011 China's government increased investment in education by 16% (to 296 billion Yuan or £29.9 billion), on top of a 9% increase the year before. This includes £7.2 billion (72 billion Yuan) targeted at making around 100 universities world leading. This is on top of an increase of 12.5% (to 194 billion Yuan, or £19.6 billion) in science and technology investment.

France

- Nicolas Sarkozy said: "The aim is quite simple: we want the best universities in the world."
- The higher education sector is centrepiece of stimulus plan, and will receive €11 billion, including the €7.7 billion "Excellence Initiative" (IDEX) to create 10 campuses that bring together leading institutions to compete with the best universities in the world.
- An additional €8 billion will be invested in research.
- France's Budget for 2012 was set to increase higher education funding by 2.5% (€373 million). In the same year universities will benefit from €167 million in additional investment as part of a €5 billion "operation campus" to invest in the top university campuses. The ministry states that "investment in higher education and research is the best answer to the crisis".

USA

- Under the Obama Presidency the US has substantially increased its investment in R&D to create the conditions for a rapid and sustainable economic recovery. Their rationale is that investing in R&D, the fundamental building blocks of productivity and long-term economic growth, ensures that once economic recovery begins, economic growth will be stronger and more sustainable.
- The President's proposal for the US budget for fiscal year 2013 increases discretionary spending on Education by 2.5%, or \$1.7 billion, above the 2012 enacted level, and the level of investment in non-defence R&D by 5% from the 2011 and 2012 levels, even as overall budgets decline. This "maintains the President's commitment to double funding for key basic research agencies", including \$7.4 billion for the National Science Foundation, an increase of \$340 million above the 2012 enacted level, and maintaining investment of \$30.7 billion in the National Institute for Health.
- The American Recovery and Reinvestment Act (ARRA), enacted in 2009, contained a fiscal stimulus package including \$21.5 billion for federal research and development. This included \$11.5 billion for basic research in fundamental science and engineering and \$1.5 billion to renovate university research facilities.⁹⁷ This funding will primarily be allocated by competitive peer review ensuring that it supports only excellent research. The focused increased resources for basic research and research infrastructure demonstrates a commitment to the long-term health of the US' research base.
- President Obama reaffirmed his commitment to invest in R&D as a means to generate economic growth in his 2012 State of the Union speech⁹⁸:

"Innovation also demands basic research. Today, the discoveries taking place in our federally-financed labs and universities could lead to new treatments that kill cancer cells but leave healthy ones untouched. New lightweight vests for cops and soldiers that can stop any bullet. Don't gut these investments in our budget. Don't let other countries win the race for the future. Support the same kind of research and innovation that led to the computer chip and the Internet; to new American jobs and new American industries."

Taiwan

- Significantly increased funding for its Academia Sinica institution – around 12% of the R&D budget in 2009 – in a concerted effort to foster a world-class research institution which can carry out leading research and attract the best staff and students from around the world.
- Taiwan's 'Promoting Academic Excellence & Developing World Class Research Centers' programme earmarked 500 million New Taiwan Dollar over five years from 2005 to focus on a small number of leading centres of excellence with critical mass to overcome the challenge that "an excessive number of universities and departments will dilute limited research resources and funding, making the goal of increasing international competitiveness harder to reach".¹⁰²

Denmark

- Restructured its public research base in 2006, merging the existing 25 universities and public research institutes into just eight universities and three research institutions.
- The new restructured system includes three large universities, created to rank amongst the largest in Europe in terms of resources, and aimed at retaining and attracting the most talented students and researchers. It is intended that two-thirds of Denmark's public research and university education will take place at these three new universities, and that the three universities will better reap professional synergies, utilise Denmark's research facilities, and achieve a larger share of EU research grants.

Sweden

- The 2008 Research and Innovation Bill provided the biggest increase in research funding in Swedish history, 15 billion Swedish Krona over four years.
- By the end of 2012 the increase is expected to be 20% compared with the 2008 level, bringing government investment in R&D well above the 1% of GDP target.
- The majority of the additional funding will go directly to universities through strategic investments and increased block grants which are further concentrated on the basis of research quality and volume.¹⁰³

Canada

- Leading Canadian universities are calling upon the Government to concentrate resources to more effectively support its highly performing universities.⁹⁹
- Economic Action Plan in response to the recession provides C\$2 billion government funding to expand and improve research and teaching infrastructure at Canada's post secondary education institutions.
- Budget 2011 announced continued increases in research grants and more funding to cover the indirect costs of university research and to support its commercialisation.
- \$159.1 million in September 2009 for 181 Canada Research Chairs in 45 Canadian universities, followed by a further £53.5 million over five years in Budget 2011. The programme is designed to attract the best talent from Canada and around the world, helping Canadian universities achieve international research excellence. In response to federal and provincial governments increasing funding to build a critical mass of expertise, Canada is now experiencing a brain gain, not brain drain, and a 'renaissance in research and higher education'.¹⁰⁰

South Korea

- The Brain 21 programme is aimed at developing world-class research universities.
- The second phase of Brain 21 commenced in 2006, investing 2.3 trillion won (£1.3 billion) to 2012. The project operates on principles of selection and concentration, with the ambition of achieving 10 globally competitive research universities.
- Hiring top talent from around the world is a key requirement for government financial support.

Japan

- Universities are being encouraged to take a more international stance. Under the 'Global 30' Project, 13 universities were selected in 2009 by the Government to play a major role in the internationalisation of higher education in Japan. These universities will play a core role in dramatically boosting the number of international students educated in Japan as well as Japanese students studying abroad.¹⁰¹

Problems and policy solutions



“The UK’s international reputation for world-class research encourages global businesses to want to work with UK academics, but as competitor countries are investing significantly in this area the UK must continue to invest to remain competitive.”

THE BUSINESS COUNCIL FOR BRITAIN, 2009

- 4.1 Section 3 showed how the evidence strongly suggests that world-class universities are an essential feature of a successful higher education system, but that not all institutions within a system should attempt to be the same, or the system uniform.
- 4.2 There are important benefits to students, employers and businesses arising from a diverse higher education system. The changing, and more demanding, nature of the research endeavour means it is not optimal for all institutions to be research-intensive. And international experience and best practice shows countries around the world are increasing their investments in higher education, but in a more selective way.
- 4.3 The increased cost pressures associated with the changing nature of research, and the increased investment by international competitors focused on enhancing world-class capability, present major challenges to the UK’s world-class universities. This section of the report suggests how Government policy might meet these challenges in the face of financial pressures in relation to the UK’s higher education system. It examines the nature of the financial pressures, and the potential consequences if policy does not respond sufficiently to the challenges.
- 4.4 The section concludes that at a time of fiscal austerity and significant challenge for the UK’s higher education sector, it makes sense for Government policy to continue to support the country’s university system. The Government needs to promote diversity, and the UK’s world-class universities, by significantly concentrating public funding to support leading universities. It must also ensure that these institutions are free from unnecessary regulation and bureaucracy and have sufficient autonomy to compete for talent, partners and resources with the best universities around the world. This will ensure that the whole of the UK’s diverse higher education system continues to enjoy the international recognition it rightly deserves, and the country’s economic competitiveness is

safeguarded. This has a number of implications for policy, which are briefly explored below.

Challenges facing the UK higher education system

- 4.5 The UK higher education sector is experiencing a period of significant financial pressure. Much of the additional income which universities have received from fees and public funding in recent years was needed to rectify severe underinvestment in higher education in the 1980s and 1990s. The publication *Staying on top: The challenge of sustaining world-class higher education in the UK* (2010) showed there is evidence of severe and ongoing cost pressures across the teaching and research activities of Russell Group institutions.¹⁰⁹ Some of the factors causing increased cost pressures on research were discussed in paragraphs 3.9-3.17. There are also cost pressures on teaching, particularly in relation to certain science subjects, and challenges posed by an increasingly digital world. Universities need additional investment if they are to keep pace with the way in which the world uses technology, and students’ expectations for new technologies.
- 4.6 The increased investment by international competitors, focused on enhancing world-class capability, presents a further major challenge to the UK’s world-class universities. The UK’s very best universities already find it difficult to match the resources and incentives offered to leading researchers and postgraduates by universities in the US, and increasingly in Europe and Asia. For example, four of the UK’s most talented scientists announced in 2010 that they were leaving the UK to take up new positions in Canada, taking advantage of the Canadian government’s investment in “excellence research Chairs”. Some of those leaving are taking their research teams with them.¹¹⁰
- 4.7 With increasing cost pressures and other countries investing billions of pounds in their leading universities, even before any cuts in the 2010 Spending Review were

announced, the UK was in real danger of losing its international competitive edge. When significant reductions to funding were announced in 2010, the importance of averting a potential crisis in UK higher education became even more urgent. Given these cuts, the Government's plans for introducing private contributions for teaching in England were the only viable way forward, so that the country's leading universities have a fighting chance of remaining world-class and able to compete with the world's best universities.

- 4.8 Income generated by the new fees regime introduced in 2012 will help the UK maintain a world-class student experience, by supporting the higher costs of excellent research-led teaching. The UK's leading universities need funding to innovate and set the pace of change in university teaching if they are to remain amongst the world's best. A system of graduate contributions should also facilitate a more diverse market in higher education, where differing models of teaching and learning can be efficiently supported. Graduate contributions provide more incentives for institutions to improve quality and responsiveness to students' needs, and encourage students to be more demanding of their universities. The retention of a cap on fees will, however, limit the extent of the diversity and dynamism generated by the new regime.
- 4.9 It is important to recognise that there will be a funding shortfall after the cuts really kick in and before universities are able to access any new fee income. The cuts have a number of implications for Russell Group universities, which are:
- actively pursuing innovative ways in which to deliver greater efficiency and higher levels of productivity
 - diversifying their sources of income and attracting investment through philanthropy and from the private sector
 - considering significant cost reductions which will involve reducing staff numbers.
- 4.10 Therefore, Russell Group universities have already been making concerted efforts to position themselves, to maintain and enhance their competitiveness both domestically and internationally. Paragraphs 2.33-2.35 showed how Russell Group universities are working to strengthen their abilities to attract investment from business and international sources. In addition, the Russell Group's publication *Staying on top: The challenge of sustaining world-class higher education in the UK* (2010) showed that Russell Group universities are successfully increasing their income from endowments and charitable income. However, additional income from private sources remains limited, and these sources alone will not be sufficient to meet the additional resources required by world-class universities now or in the future.
- 4.11 At the current time, capital funding, particularly for research, is under great pressure, and this will really begin to bite in 2012-13. World-class infrastructure, particularly buildings and equipment, is needed to facilitate the very best environment for research and teaching. Ongoing cuts are making it increasingly difficult for the UK's leading institutions to compete with better-resourced institutions internationally and risk creating real and long-term difficulties for universities and for the UK's international standing in higher education and research.
- 4.12 There are also challenges facing the postgraduate provision which is so critical to world-class universities, and to the future academic workforce. The new undergraduate fees regime could have a negative impact on the propensity of some UK and EU students to pursue postgraduate study if the student support system for postgraduates is not strengthened. Government funding to support universities' costs in providing postgraduate education and training looks increasingly vulnerable. At the same time, universities also face growing competition from universities in other countries who are increasing their investment in attracting the best postgraduate students. As demonstrated earlier in this report, attracting the best talent at postgraduate level is essential for universities to achieve and remain world-class.
- 4.13 Not all the challenges facing universities are financial. As discussed earlier in this report, to compete with the best universities in the world, they also need favourable and efficient governance, and autonomy from unnecessary government intervention and regulation. In the UK, there remain some aspects of government policy which currently generate disproportionate inefficiencies, burden and costs for our leading universities. Regulations concerning immigration, teaching quality assurance, fair access, transparency and freedom of information are examples of this.

Policy solutions

- 4.14 It is essential that future policy decisions in the UK ensure sufficient support for the nation's leading universities, and that they encourage greater diversity within the wider higher education sector. The following summarises our view on how public policy can achieve these goals. Details of these policy solutions are discussed more fully in separate Russell Group publications, which are referenced here.

A commitment to sustaining world-class universities

"It is essential that we recognise the vital role that universities play in our economy. In the global knowledge economy we can best secure our future by safeguarding the institutions that generate that knowledge. That feeds new technologies, new

SECTION 4 – PROBLEMS AND POLICY SOLUTIONS

products, new services and the breakthroughs that will ensure our competitive future.”

– Letter to *The Times*, 13 June 2010, signed by representatives from:

WPP Group, RBS Group, Centrica, PwC, KPMG LLP, British Fashion Council, University of Southampton, Standard Chartered Bank, EADS Innovation, i-graduate, NEPIC, CIHE, Chartered Management Institute, VT Group, and Wellstream International Ltd.

4.15 The significant reductions in funding for the higher education system, combined with increasing cost pressures and increased international investment, mean that the Government needs to consider how best to make use of very limited funding. The Government needs to achieve the following:

- continue to reap the benefits from a diverse higher education system (as discussed in paragraphs 3.3-3.8)
- maximise long-term economic growth, and ensure the UK maintains its international competitiveness (section 2 discussed how world-class universities contribute to this goal)
- address the increased cost pressures faced by the UK’s world-class universities (as discussed in paragraphs 3.9-3.17)
- enable the UK’s world-class universities to keep pace with international peers (as discussed in paragraphs 3.18-3.23).

4.16 These goals are not mutually exclusive, and could be achieved by targeting public funds, building on success, rather than trying to spread limited funds too thinly. Achieving this set of goals will require significant concentration of funding for research, knowledge transfer and capital on institutions with the necessary critical mass, quality of research and excellence in provision, and who are best placed to compete with the rest of the world.

4.17 If funding is not sufficiently concentrated to support world-class universities, the UK runs the risk of losing the benefits of a truly diverse, successful higher education system, with harmful effects for long-term economic growth. Research is undertaken at an economic loss in UK universities. Given that research forms a disproportionate share of total activity in world-class universities, then their research programmes would be unsustainable if adequate resources are not available.

4.18 Government policy in the UK has, to some extent, recognised the need to make the most efficient use of resources, and to concentrate funding further on centres with world-class capability. The Government has highlighted the importance of critical mass, in the

announcement of research budget allocations and annual grant letter to HEFCE. The Ministerial statement outlines the commitment:

“Funding bodies will concentrate on research centres of proven excellence, with the critical mass to address national challenges and compete internationally and the expertise to collaboration with business”.¹¹¹

4.19 The grant letter states that HEFCE should:

“continue to take forward funding both for research and for support for the next generation of researchers, by selectively funding on the basis of only internationally excellent research, and protecting funding leveraged from external sources such as the charitable and business sectors”.¹¹²

4.20 It is clear that institutions will need to take further action to continue to flourish in an economic climate which has seen significant cuts made to capital expenditure in the 2010 Spending Review. For leading research-intensive universities this will mean looking at how research and research infrastructure is structured, supported, and delivered to enable them to maintain sufficient critical mass to continue to compete with the very best in world. Professor David Eastwood, when Chief Executive of the HEFCE, highlighted the importance of concentration of funding in regard to infrastructure:

“research funding should be concentrated...because much – though not all – research demands scale and costly kit; and it should be concentrated because there are genuine affordability constraints”.¹¹³

4.21 Businesses share the view that funding should be prioritised to preserve the position of the UK’s world-class universities, if the UK is to continue to provide an excellent location for business R&D, and to continue to attract inward investment. Richard Lambert, former Director General of the CBI, has said that:

“The UK is blessed with a number of world-class universities – up there at the top of the global league tables when it comes to the quality of their research and teaching. Like football managers in the Premier League, they are competing for talent with the best in the world which is a very expensive exercise. If we want to stay in this division in what is becoming an increasingly competitive marketplace – which we surely should – then we are going to have to find ways of channelling more money in their direction”.¹¹⁴

4.22 In letters to *The Times*, Chief Executives and Chairs of businesses and employers called upon the Government to secure the UK’s economic future by “safeguarding the institutions that generate that knowledge”¹¹⁵ and senior executives from companies with major R&D investments

in the UK called for “a stable and positive policy environment which would give private R&D investors the confidence to undertake long-term projects here, helping to grow the UK’s economy into one that is truly modern and innovative”.¹¹⁶

- 4.23 The Business Council for Britain has emphasised the importance of world-class universities and sustained investment, saying that:

“The UK’s international reputation for world-class research encourages global businesses to want to work with UK academics, but as competitor countries are investing significantly in this area the UK must continue to invest to remain competitive”.¹¹⁷

- 4.24 Great strengths of the UK’s higher education system include its world-class universities, and, to some extent, its diversity, providing the flexibility to meet the needs of a broad range of students, employers and business. However, the UK higher education system does not present many barriers to homogeneity, and does not encourage diversity, with underlying funding models driving a degree of uniformity in the system.¹¹⁸ For example, all universities are permitted to bid for research funding, be it through quality related streams or research council grants, and most institutions are allowed to award PhDs. It is important that public policy decisions (such as those on the allocation of funding) encourage more diversification within the higher education sector.
- 4.25 A clear policy commitment to sustaining world-class universities in the UK should be accompanied by corresponding shifts in policy towards the funding of university teaching, research and capital, and government regulation of institutions. These are discussed in more detail below.

Teaching

- 4.26 The Government should ensure that universities are able to access sufficient funding to maintain excellence in teaching, and a world-class student experience. Universities also need sufficient funding to innovate and set the pace of change in university teaching if they are to retain their edge internationally. Teaching funding should include investment from both public and private sources, including graduate contributions. Such a funding mix reflects both the considerable benefits of graduates to our economy and society, and the private benefits that individual graduates gain from their degrees.
- 4.27 It is essential that sufficient investment is available to support the higher costs of excellent research-led teaching especially in laboratory-based subjects such as physics, chemistry and engineering. These subjects are strategically important to the UK, but teaching costs in these subjects are considerably higher than in most

other subjects, and they cannot be sustained through tuition fee income alone.

- 4.28 UK universities need sufficient investment to continue to provide the high quality teaching which has made their degrees so highly respected internationally, and the world-class teaching experience which attracts the most talented international students to this country. More details of the Russell Group’s views are in *Staying on top: The challenge of sustaining world-class higher education in the UK* (2010).¹¹⁹

Research

- 4.29 It is essential that research funding is further concentrated to support world-class universities. Research is undertaken at an economic loss in UK universities. Research forms a disproportionate share of total activity in world-class universities, and their research programmes would be unsustainable if adequate resources were not available. Therefore funding council quality-related funding (QR) and Research Council funding needs to be focused on rewarding truly world-class excellence on a grand scale and in high volumes, on supporting a multidisciplinary approach to research and on enabling the critical mass of expertise across disciplines to be efficiently mobilised.
- 4.30 Funding should ensure that the next generation of researchers receive world-class training and support. Resources for postgraduate provision should be directed towards those institutions most capable of delivering excellent provision, to maximise the UK’s competitiveness in the global market. This view was shared by the 2010 review of postgraduate education, where Professor Adrian Smith recommended that to get the best value from public investment in postgraduate research degrees, funding should “be targeted in areas of excellence”. More details of the Russell Group’s views are in our position paper *Concentration of research funding* (2010).¹²⁰
- 4.31 Consideration should also be given to the UK’s competitive position in attracting the most talented postgraduate students. There is fierce global competition for the best internationally mobile research students, but the UK’s leading universities often struggle to match the funding packages offered at institutions in other countries, particularly the US. There is also a real gap in support for home and EU postgraduates, for whom very little financial assistance is currently available from either public or private sources. This should be rectified through the introduction of additional financial support for home and EU postgraduates, possibly through improved access to bank lending, or a limited extension of government-backed loans. This would help ensure that financial considerations are not a barrier to the most talented graduates wishing to enter postgraduate programmes. Further information is

SECTION 4 – PROBLEMS AND POLICY SOLUTIONS

available in the Russell Group's submission to Adrian Smith's review of postgraduate education.

Knowledge exchange

4.32 It is far more efficient and effective to build the capacity of existing major centres of both research and knowledge transfer rather than to create multiple small centres of activity with few economies of scale. Funding for knowledge transfer and exchange should be concentrated on world-class centres of innovation and centres of excellence in university-business collaboration. Other institutions can be encouraged to draw on the technical expertise in technology transfer and other innovation-related activities already available within world-class universities. There are already collaborative models in existence where multiple universities work together to generate economic benefit, and successfully meet the needs of businesses. Further details of the Russell Group's views are in the Russell Group's response to Professor Tim Wilson's Review of business-university collaboration.¹²¹

Capital

4.33 It is crucial to maintain the UK's higher education and research infrastructure, as this underpins the teaching, research and knowledge exchange endeavours undertaken by the country's world-class universities. Funding for capital needs to be focused on institutions with sufficient critical mass to compete globally.

4.34 Recognition of critical mass is particularly important in making capital investments given the changing nature of the research endeavour (with increased costs) and the larger scale of investment (see paragraphs 3.9-3.17 for further details). Additional Russell Group comments on the changing nature of the research endeavour and rising costs are in *Staying on top*.

4.35 The Budget 2012 announcement of £100 million for capital co-investment in university research facilities is a step in the right direction, especially following recent cuts to capital spending. We welcome the ambition to increase private sector funding – but this must be in addition to Government funding and not a replacement for it.

Regulation

4.36 World-class universities have a high degree of academic and managerial autonomy, and it is this characteristic which allows them the flexibility to respond to the changing needs of business and the economy. Given the pressures on funding and recent changes in the Government's higher education policy, we consider that it is appropriate to step back and consider whether the overall regulatory environment best supports the autonomy of institutions. As our leading universities face growing competition from universities around the world, it's essential that their

competitive position is not undermined by the burden of unnecessary regulation and excessive costs of legal compliance across multiple government policy areas. Particular issues that warrant further investigation include:

- The Government's policies on access. These risk focusing too much on regulation rather than resolving the real problems which are underachievement at school and poor advice on the best choices of A-level subjects and university degree course.
- Whether the overall approach of QAA's institutional review is still appropriate. It is necessary to examine ways in which the administrative burden of the review process can be reduced. The review process should incorporate a risk-based approach, varying the level of attention based on the risk of poor provision. It should also be considered whether a 'one size fits all' approach to teaching quality adequately supports diversity within the higher education sector, or whether greater self-regulation of quality would be appropriate, for example in the case of world-class universities.
- The immigration system needs to recognise that higher education is one of our most successful export industries. It is vital that the UK continues to attract the very best students from around the world, particularly at postgraduate level, and the immigration system needs to allow universities to continue to sponsor the best-qualified international students and for graduates to have some opportunity to work in the UK at the end of their course.
- The Government's policies on transparency and Freedom of Information (FOI) need to allow for the particular challenges associated with opening up access to research publications and research data. Leading universities are absolutely committed to openness and transparency, but the full implications of new policies need to be properly understood, and must not put at risk the excellence of the UK's university research. FOI legislation should explicitly exempt research which has not yet been published, in order to reduce risks associated with releasing complex scientific results too early and out of context. The costs of recently announced policies to open up access to research publications are as yet unknown, and risk falling disproportionately on leading universities or putting further pressure on already shrinking research funds. Greater consideration should be given to the possibilities of a 'green' model of open access, at least during a period of transition towards full 'gold' open access.

4.37 The higher education system must take stock and respond to the needs of students, employers and businesses for greater diversity and to preserve the position of the UK's world-class universities. These policy implications will help ensure that support for the UK's world-class universities is sustained, and that the UK's higher education system continues to enjoy the international recognition it rightly

deserves for the quality of its educational provision and cutting-edge research. They will also help to support a more diverse higher education system, which the UK needs now, and in the future, to compete effectively in a global economy. It is only by meeting a broad, diverse range of needs that the UK can hope to maintain its global competitiveness in the face of ever increasing competition. At a time of weak economic growth, investing in world-class universities can also help stimulate growth, and position the economy for a sustained recovery. The UK must rise to the challenge of increased competition, and not lose its hard-won comparative advantage.

Glossary of terms

BIS Department for Innovation, Business and Skills

CBI Confederation of British Industry

EPSRC Engineering & Physical Sciences Research Council

FTE Full time equivalent

G8 Group of 8 nations (Canada, France, Germany, Italy, Japan, Russia, UK & USA)

GDP Gross domestic product

GSK GlaxoSmithKline

HEFCE Higher Education Funding Council for England

HEI Higher education institution

HPC High performance computing

IP Intellectual property

IPR Intellectual property rights

KTP Knowledge Transfer Partnership

LSE London School of Economics & Political Science

MIT Massachusetts Institute of Technology

MRC Medical Research Council

OECD Organisation for Economic Cooperation and Development

QAA Quality Assurance Agency for Higher Education

QR Quality-related funding

R&D Research & Development

RAE Research Assessment Exercise

SME Small and medium enterprises

SPRU Science Policy Research Unit (University of Sussex)

STEM Science, Technology, Engineering & Mathematics

TSB Technology Strategy Board

TRAC Transparent Approach to Costing

UCL University College London

- 1 Russell Group, *The economic impact of research conducted in Russell Group Universities* (2010)
- 2 World Bank, *Constructing knowledge societies* (2002)
- 3 Russell Group, *Staying on top: The challenge of sustaining world-class higher education in the UK* (2010)
- 4 Based on 2011 rankings
- 5 Institute for Higher Education Policy, *College and university ranking systems: global perspectives and American challenges*. (2007)
- 6 HEFCE, *Counting what is measured or measuring what counts?* Report to HEFCE by the Centre for Higher Education Research and Information, Open University, and Hobsons Research (2008)
- 7 Guardian, *University world rankings are pointless, UCL president says*. (21 September 2010)
- 8 OECD, *Breaking ranks* OECD Observer No 269 (October 2008)
- 9 Salmi, J. *The challenge of establishing world-class universities* World Bank (2009)
- 10 Salmi, J. *The challenge of establishing world-class universities* World Bank (2009), pp5
- 11 Tunzelmann, N., Ranga, M., Martin, B., and Guena, A. *The effects of size on research performance* (2003)
- 12 Kenna, R. and Berche, B. *The extensive nature of group quality* (2010)
- 13 Taylor, J. *Managing the unmanageable*. HE Management and Policy Vol.18, No.2 (2006)
- 14 Universities UK *Funding research diversity: the impact of further concentration on university research and regional research capacity* (2003)
- 15 Moed, H. *Bibliometric rankings of world universities*. Centre for Science and Technology Studies, Leiden University (2006)
- 16 Higher Education Policy Unit, *The role of selectivity and the characteristics of excellence* (2000)
- 17 Universities UK, *Monitoring research concentration and diversity* (2009)
- 18 Data from IGRAD highlights the importance of learning facilities are to international students. Good internet access was rated consistently as being of the highest priority, along with high quality library facilities, sports facilities and good accommodation. In all of these areas, international students at Russell Group universities report a level of satisfaction equal to, or greater than, those at leading international competitors.
- 19 Salmi, J. *The challenge of establishing world-class universities*. World Bank (2009)
- 20 Aghion, P., Dewatripont, M., Hoxby, C., Mas-Colell, A., and Sapir, A. *Higher aspirations: an agenda for reforming European universities*. Bruegel Blueprint Series, Volume V (2008)
- 21 European University Association *University Autonomy in Europe II, The Scorecard* (2011)
- 22 For example, the Australian Group of 8 Universities suggests that world-class universities can be distinguished by their activities and outputs, including: underpinning basic research; leadership in the development of disciplinary knowledge; contribution to educational innovation; public policy inputs; analysis and critical commentary; and conduit for international scholarly debate.
- 23 Department for Innovation, Universities and Skills, *Economic impacts of investment in research and innovation* (2008)
- 24 Universities UK, *The impact of universities on the UK economy* (2009)
- 25 Lambert, R. *Reasons to be cheerful?* in Business Voice, (December/January 2008)
- 26 Royal Society, *The scientific century* (2010) and Department for Business, Innovation and Skills, *International comparative performance of the UK research base* (2011)
- 27 Russell Group, *The economic impact of research conducted in Russell Group Universities* (2010)
- 28 BBC and Open University, *Made in Britain* (2011)
- 29 Higher Education Policy Unit, *The role of selectivity and the characteristics of excellence* (2000)
- 30 Douglass, J. *Higher education's new global order* Centre for Studies in Higher Education (2009)
- 31 UK Higher Education International Unit, *The UK's competitive advantage: the market for international students* (2008)
- 32 Winston, G. and Zimmerman, D. *Peer effects in higher education*, *College choices: the economics of where to go, when to go, and how to pay for it* (2004)
- 33 2010/11 HESA data
- 34 Minister of State for Universities and Science, *Science, Innovation and the economy*. Royal Institution (2010)
- 35 Department for Business, Innovation and Skills, *A strategy for sustainable growth* (2010)
- 36 OECD *The global competition for talent: mobility of the highly skilled* (2008)
- 37 Jons, H. *Brain circulation and transnational knowledge networks* (2009)
- 38 Department for Business, Innovation and Skills, *International comparative performance of the UK research base* (2009)

REFERENCES

- 39 RCUK China Office figures (2010)
- 40 BBC and Open University, *Made in Britain*(2011)
- 41 Department for Business, Innovation and Skills, *Understanding local growth* Economics Paper No. 7 (2010)
- 42 Crafts, N. and Venables, T. *Globalization in history: a geographical perspective chapter in: Globalization in historical perspective*, National Bureau of Economic Research (2003)
- 43 OECD, *Competitive regional clusters: national policy approaches* (2007)
- 44 Office of the Vice-Chancellor, *Commentary on issues of higher education and research* (August 2007)
- 45 BBC and Open University, *Made in Britain* (2011)
- 46 Library House, *The Impact of the University of Cambridge on the UK economy and society* (2006)
- 47 BBC and Open University, *Made in Britain* (2011)
- 48 Library House, *An analysis of UK university technology and knowledge transfer activities* (2007)
- 49 Abramovsky, L. and Simpson, H. *Geographical proximity and firm-university innovation linkages*, Institute for Fiscal Studies working papers W09/03 (2009)
- 50 Laursen, K., Reichstein, T., and Salter, A. *Exploring the effect of geographical proximity and university quality on university-industry collaboration in the UK*, Regional Studies (2010)
- 51 Zucker, L., and Darby, M. *Movement of star scientists and engineers and high-tech firm entry* NBER (2006)
- 52 Thursby, J. and Thursby, M. *Here or there? A survey of factors in multinational R&D location*, National Academies (2006)
- 53 Usher, A. *Ten years back and ten years forward: developments and trends in higher education in the Europe region*, European Centre for Higher Education (2009)
- 54 Business Council for Britain, *Overcoming barriers to collaboration to enable richer university-industry links* Research Base Funders Forum (2009)
- 55 CIHE *Universities, business and knowledge exchange* (2008)
- 56 CIHE *International competitiveness: businesses working with UK universities* (2006)
- 57 See for example, Haskel and Wallis (2010) and Office of Health Economics and Alzheimer's Research Trust (2009)
- 58 UKTI *UK inward investment 2007-08* (2008)
- 59 Falk, M. *What drives business R&D intensity across the OECD? Applied Economics*, 38 (2006)
- 60 Falk, M. *What drives business R&D intensity across the OECD? Applied Economics*, 38 (2006)
- 61 Alzheimer's Research Trust, *Forward Together: Complementarity of public and charitable research with respect to private research spending*, (2009)
- 62 Wellings, P. *Intellectual Property and research benefits* (2008)
- 63 Ibid.
- 64 UK Innovation Research Centre, *Knowledge exchange between academics and the business, public and third sectors* (2009)
- 65 HESA, HE Business and Community Interaction Survey, 2010-11. Based on 20 Russell Group member institutions as of 01 July 2012.
- 66 OECD, *Education at a glance* (2011) p. 319 and p. 321
- 67 Winston, G. And Zimmerman, D. *Peer effects in higher education*, College choices: the economics of where to go, when to go, and how to pay for it (2004)
- 68 Evidence of this is outlined in Russell Group *Staying on top: The challenge of sustaining world-class higher education in the UK* (2010)
- 69 National Student Survey (2011). Based on 20 Russell Group members as of 01 July 2012
- 70 GRAD International Student Barometer Survey, (2009)
- 71 NUS/HSBC student experience survey (2009)
- 72 QS *World university rankings* (2011)
- 73 Chevalier, A. and Conlon, G. *Does it pay to go to a prestigious university?* Centre for Economics of Education (2003)
- 74 1994 Group, *Graduate employment and earnings: are universities meeting student expectations?*(2008)
- 75 HESA, Destinations of Leavers from Higher Education (DLHE) data, 2010/11. Based 24 Russell Group members as of 01 Aug 2012.
- 76 HESA 2010/11
- 77 HESA 2008/09, based upon the cohort of English PhD students commencing their studies in 2002-03, and 20 RG members as of 01 July 2012.
- 78 Waldinger, F. *The importance of university quality for PhD student outcomes: new insights from the expulsion of professors in Nazi Germany* (2010)
- 79 Wolf, A. *Does education matter?*(2002)
- 80 The Wellcome Trust *Review of Wellcome Trust PhD training* (2000)
- 81 Aghion, P., Dewatripont, M., Hoxby, C., Mas-Colell, A., and Sapir, A. *Higher aspirations: an agenda for reforming European universities* Bruegel Blueprint Series, Volume V (2008)
- 82 Wellings, P. *Intellectual property and research benefits* (2008)

- 83 UUK, *The impact of universities on the UK economy*, 2009
- 84 BIS, *Estimating the Value to the UK of Education Exports*, research paper 46, (June 2011)
- 85 World Bank, *Constructing knowledge societies* (2002) & Salmi, J. *The challenge of establishing world-class universities* World Bank (2009)
- 86 Richard, A. *Deliberate Diversity: Cambridge and the UK Higher Education System*, annual address (2009), available at: www.admin.cam.ac.uk/offices/v-c/role/speeches/
- 87 Crossick, G. *The future is more than just tomorrow*, UUK Recession to Recovery series (2010)
- 88 Times Higher Education, *UK higher education's research claims are 'ridiculous,' says Vodafone director*, (4 March 2009)
- 89 Eastwood, D. *Speech at annual Dearing conference* (2011)
- 90 Wildavsky, B. *The new global university marketplace*, Wall Street Journal (2010)
- 91 RCUK and UUK, *Financial Sustainability and Efficiency in Full Economic Costing of Research in UK Higher Education Institutions* (2010)
- 92 Douglass, J. *Higher education's new global order* Centre for Studies in Higher Education (2009)
- 93 Aghion, P., Dewatripont, M., Hoxby, C., Mas-Colell, A., and Sapir, A. *Higher aspirations: an agenda for reforming European universities*, Bruegel Blueprint Series, Volume V (2008)
- 94 Gallagher, M. *The role of elite universities in national higher education systems* (2009)
- 95 World Bank *Constructing knowledge societies* (2002)
- 96 General sources for this section include ERA-Watch country profiles and Universities UK *The global picture* (2010)
- 97 UKTI *Information on the American recovery and reinvestment Act* (2009)
- 98 Obama, B. *State of the Union address* (2012)
- 99 *Chronicle of higher education* (September 4, 2009)
- 100 *Chronicle of higher education* (February 20, 2011)
- 101 Ministry of Education, Culture, Sports, Science and Technology Japan
- 102 Development Plan for World Class Universities and Research Centers of Excellence
- 103 Research and Innovation Bill 2008, and confirmed in the 2009 budget.
- 104 OECD *Education at a glance* (2011)
- 105 U21 Ranking of National Higher Education Systems, University of Melbourne, (2012)
- 106 NSF *Globalization of science and engineering research* (2010)
- 107 Vandenbussche, J., Aghion, P., and Meghir, C., *Growth, distance to frontier and composition of human capital* Journal of Economic Growth (2006)
- 108 Department for Business, Innovation and Skills, *International comparative performance of the UK research base* (2009)
- 109 Russell Group *Staying on top: the challenge of sustaining world-class higher education in the UK* (2010)
- 110 The Guardian *Fears of brain drain as renowned British scientists move to Canada* (17 May 2010)
- 111 Department for Business, Innovation and Skills *Written Ministerial Statement on the allocation of science and research funding 2011/12 to 2014/15* (December 2010)
- 112 Department for Business, Innovation and Skills *Annual grant letter to HEFCE* (January 2012)
- 113 Professor David Eastwood, *Quietly flows the Don? Higher Education, turbulence, and timeless verities*, AUA Annual Guest Lecture, (24 October 2007)
- 114 Lambert, R. *Reasons to be cheerful?* in Business Voice, (January 2008)
- 115 *The Times*, (June 13 2010)
- 116 *The Times*, (June 13 2010)
- 117 Business Council for Britain, paper to the Research Base Funders Forum (2009)
- 118 Crossick, G. *The future is more than just tomorrow*. UUK Recession to Recovery series (2010)
- 119 Russell Group, *Staying on top: the challenge of sustaining world-class higher education in the UK* (2010)
- 120 Russell Group, *The concentration of research funding in the UK: driving excellence and competing globally* (2010) Available at: www.russellgroup.ac.uk/Policies-research/
- 121 Russell Group, *Response to Professor Sir Tim Wilson's Review of Business-University Collaboration* (2011), available at: www.russellgroup.ac.uk/Policies-research/

REFERENCES

Images

Front cover: Courtesy of Getty images © Getty images

P16: Courtesy of University of Edinburgh © University of Edinburgh

P11, p24: Courtesy of University of Manchester © University of Manchester

P12, p14: Courtesy of University of Sheffield © University of Sheffield

P7, p19: Courtesy of Newcastle University © Newcastle University

P21: Courtesy of University of Warwick © University of Warwick

P26, p27: Courtesy of University of Glasgow © University of Glasgow

P29: Courtesy of University of Leeds © University of Leeds

P31, p38, p39: Courtesy of Shutterstock © Shutterstock

P33: Courtesy of Durham University © Durham University

P41: Courtesy of University of Nottingham © University of Nottingham/ Lisa Gilligan-Lee

The Russell Group

www.russellgroup.ac.uk
enquiries@russellgroup.ac.uk
020 7969 5288

A company limited by guarantee,
registered in England and Wales
under company number 06086902

RUSSELL

University of Birmingham

University of Bristol

University of Cambridge

Cardiff University

Durham University

University of Edinburgh

University of Exeter

University of Glasgow

Imperial College London

King's College London

University of Leeds

University of Liverpool

London School of Economics
and Political Science

University of Manchester

Newcastle University

University of Nottingham

University of Oxford

Queen Mary, University of London

Queen's University Belfast

University of Sheffield

University of Southampton

University College London

University of Warwick

University of York

GROUP