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Fuelling prosperity

Research and innovation as drivers of UK growth and competitiveness

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Joint statement
From the Academy of Medical Sciences, the British Academy, the Royal Academy of Engineering and the Royal Society.

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Research and innovation as drivers of UK growth and competitiveness

Groundbreaking advances in research are harnessed to transform society, revitalise the economy and improve our health and wellbeing. They also enable us to tackle major national and international challenges such as food security and building a green economy. The UK is a world leader in research, with expertise across the spectrum of intellectual endeavour so is well placed to exploit the fruits of knowledge and creativity.

But our research strength must not be taken for granted. Our international competitors also recognise the opportunities presented by research and innovation, and are increasing their investment. In response to the Chancellor's promise to do more to back great science in the UK, the Presidents of the four UK National Academies call on Government to enhance its support for research and innovation with a long-term vision for the UK's knowledge economy. We recommend that Government:

Builds a stable ten year investment framework for research, innovation and skills. This should sit at the heart of its emerging industrial strategy and plans for growth.

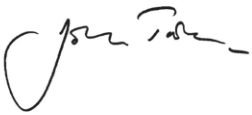
Commits to increased investment in research and innovation to keep pace with other leading scientific nations.

Secures the ringfencing of the science budget and continues to increase investment in research capital.

Ensures that research continues to be at the heart of evidence based policy making across Whitehall.

Creates a world class research and innovation environment that is attractive to talent, collaboration and investment from industry and from overseas.

The Academy of Medical Sciences, the British Academy, the Royal Academy of Engineering and the Royal Society are working together to highlight the value of research and innovation to the UK, and to support researchers, industry and policymakers to make the UK the location of choice for world class research, development and innovation. We are working with our research communities to maximise the value of research funding and to support the translation of knowledge into benefits for individuals and society at large. We look forward to working with policymakers, industry and broader society to create the conditions that will secure the UK as the best place in the world to explore, discover and innovate.



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THE VALUE OF RESEARCH

Discovery and creativity are the foundation of the modern world. Our everyday lives are filled with their achievements. Smartphones keep us connected to friends and family, work and the wider world. Agricultural advances help ensure we are fed. Antibiotics and vaccines save lives. Transport systems enable us to travel locally and internationally. And books, the arts and the media expand our horizons and understanding.

Research and innovation are essential fuels for our economy. Between 2000 and 2008 innovation was responsible for nearly two thirds of the UK's economic growth, and investment in research has been demonstrated to have long-term economic and social benefits.[1,2] In the years to come research and innovation will play an even more central role in our knowledge-driven economy.

Of course research offers benefits far beyond increasing wealth. Scientists develop new and reliable tools to provide sound knowledge that allows us to navigate and shape our world. Engineers apply their knowledge and experience to improve the human condition while creating value and wealth. The humanities and social sciences can help us better understand our lives, the world we live in and the choices we make. Medical science will enhance the length and quality of our lives. Drawing together expertise across disciplines allows us to tackle global issues more effectively than we would be able to otherwise. Challenges from water scarcity to terrorism, from population change to the effects of new technology on our everyday lives, will require solutions which will be identified across the frontiers of research.

A GLOBAL SCIENTIFIC SUPERPOWER

The UK has a proud track record of research excellence. We are responsible for 14% of the top 100 medicines in use today (second only to the USA) and have developed technology found in 95% of the world's mobile phones.[3,4] Thanks to previous sustained investment we have the most productive research base of the world's leading economies and our researchers have claimed over 90 Nobel Prizes.[5] Our top universities are ranked second only to the best in the USA; they attract students from around the world across the full range of subjects, and develop sustainable, knowledge-driven spin-out companies.[6,7,8] We are home to some of the world's most innovative large and small companies, including leading names such as Rolls-Royce and GSK, and a wealth of small and medium enterprises. Our largest public service, the NHS, offers unique potential for innovation and our long

history of openness, entrepreneurship and freedom encourages innovative thinking. Research is a jewel in the UK's crown; it offers us a genuine competitive advantage which should be nurtured and developed.

Public investment is crucial in leveraging private and charitable funding from home and abroad. For example, every £1 increase in public funding for medical research stimulates up to £5 of investment into research by the pharmaceutical industry and there is a strong correlation between overall levels of investment in university and business R&D.[9,10] The strength of our research base means that the UK is the second largest recipient of funding from the European Union's flagship research programme, and has the highest percentage of funding from overseas sources for R&D in the G8.[11,12]

WATCHING OUT FOR THE COMPETITION

The UK is not alone in pursuing research excellence and prosperity through investment in knowledge. The Chancellor, George Osborne, has committed to "do more" to support UK science, but our international competitors also increasingly recognise the transformative potential of research and innovation and are growing their investment.[13] In January 2013, President Obama made this very point in his State of the Union Address: "Now is the time to reach a level of research and development not seen since the height of the Space Race" while Indian Prime Minister, Manmohan Singh, has called for his country to "endeavour to harness the tools of science to cater to the needs of the underprivileged and to bridge the gap between the haves and the have-nots."[14,15]

Political vision is being matched by investment. In the US, 2.8% of GDP is spent on R&D.[16] Science spending in China rose at a rate of 19% per year in the first decade of the new millennium, growing from less than 1% of GDP to 1.7%.[17] Brazil nearly tripled R&D spending between 2000 and 2008, and Singapore is set to do the same between 2010 and 2015.[18] In Europe, Finland is investing heavily in research, with spending on R&D now not far short of 4% of GDP, and last year Germany committed an extra €12bn to education and research.[19,20] Meanwhile, UK funding lags behind in comparison at 1.79% of GDP.[21] We are not matching our global neighbours' and competitors' investment or their ambition.

Public funding for R&D in the UK falls below that provided by our global partners (only 0.57% of GDP in the UK in 2011, in comparison to 0.85% in Germany, or 0.92% in the USA).[22] And companies in the UK do not

invest as heavily as firms do in other countries, investing significantly less than, for example, the 60% of US R&D funding which comes from industry, or the 72% of South Korean expenditure originating from the same sector.[23] If the UK economy is to be sustainable and competitive, there needs to be a broader recognition by business leaders of the importance of research in generating long-term growth and profits. Governments can play an active role in encouraging business investment in research; this is something that the UK Government has recently scaled up by increasing the Small Business Research Initiative, enhancing R&D tax credits, and with public funding in the UK Research Partnership Investment Fund starting to leverage substantial private investment.[24]

THE UK'S EMERGING INDUSTRIAL STRATEGY

The Government's industrial strategy concentrates on particular sectors where the UK has or can obtain a world-leading position. Research and innovation must lie at the heart of this plan. The Academies welcome the Government's acceptance of Lord Heseltine's recommendation that it should continue to commit to long-term stable funding of science and research, at a level which keeps pace with our international competitors.[25] Concerted action is now needed to support this commitment. The Life Sciences and Aerospace Strategies have been good first steps and we look forward to similar initiatives in other fields.[26,27]

DEVELOPING SKILLS

The supply of highly skilled people trained in research is vital both to UK research and to a wide variety of other vibrant and important sectors, such as financial services or information technology, driving innovation and growth and helping to address major business and economic challenges.[28] To generate such high quality human capital we need to foster world class research and researchers from whom others can learn. Global competition for excellence makes it essential that the UK remains an attractive place for the most talented individuals and teams to work, whether they are from home or from elsewhere in the world.

Excellent people will in turn attract commercial investment.[29] With over one million new science, engineering and technology professionals and technicians required by 2020, the supply of high quality STEM skills in the UK will be even more important than it is today.[30] The UK's ability to nurture domestic talent and attract the best international researchers will be an important component of the response to this shortfall. Ambitious and imaginative schemes, such as the

£1 million Queen Elizabeth Prize for Engineering, are crucial for inspiring young people to pursue STEM careers and signalling to international partners the UK's commitment to research and innovation.

The strength of the research base across the range of subjects in UK universities goes hand in hand with world class teaching and development, which is attractive to overseas students and staff. The UK higher education sector is a major source of earnings in its own right: worth almost £60bn in jobs, exports, innovation and added value.[31] Investment in knowledge and skills is directly contributing to UK growth and competitiveness, and has the scope to deliver more.

MAXIMISING THE VALUE OF RESEARCH INVESTMENT

The research community is working hard to improve the efficiency of publicly funded research and to evaluate its impact.[32] For example, in the Midlands the M5 universities group has established a register of equipment that can be shared between its members and the new Francis Crick Institute in London has been specially designed to encourage novel collaborations between researchers from different groups and disciplines.[33] Universities are working more closely with industry through initiatives such as the High Value Manufacturing Catapult that brings together academic centres and manufacturing companies to support the commercialisation of research and help UK manufacturing businesses become more competitive on a world stage.[34] Successful approaches from one field are being applied elsewhere: randomised controlled trials that are used widely in medicine are now being applied to evaluate public policies, such as the impact of text messaging on the payment of fines that led to the average value of payments increasing by over 30%.[35]

Funders are developing innovative collaborations such as that between the National Institute for Health Research, AstraZeneca and National Cancer Research Network offering academic investigators an opportunity to research promising molecules that fall outside industry's core programme.[36] And research councils have introduced new methods of evaluating their grants involving companies such as Researchfish.[37] In a challenging economic climate, researchers and their institutions are finding innovative ways to push the boundaries of knowledge efficiently and effectively.

MAINTAINING A DIVERSE RESEARCH BASE

Many of the 21st century's critical challenges such as food security, climate change, energy security and the impacts of ageing require expertise and collaboration across the full range of humanities, social, engineering, physical, medical, chemical, biological and mathematical sciences.

Responding to climate change, for example, requires an understanding of the scientific evidence, as well as the socio-economic effects and their interaction – environmental sustainability cannot be achieved without addressing deep-rooted socio-economic patterns. Synthetic biology brings together the biological and physical sciences and engineering to develop new fuels, food and medicines.

The value of research lies not only in strengthening our competitiveness but also in contributing in numerous ways to addressing the major challenges facing us today, which all have a global dimension. International collaboration is crucial and the UK contributes in numerous ways to international stability and understanding. Over one third of all academic papers are now written by multinational teams of authors, and the leading business investors in R&D are global firms with offices around the world.[38] Research is an ever-expanding exercise in an increasingly interconnected world with new emerging scientific powers such as China, India and Brazil.[39] The UK needs expertise in a wide range of disciplines to realise the opportunities created by these changes.

Research is often described as 'basic' or 'applied'. Such distinctions should not be over-emphasised. What can be called applied research can lead to fundamental discoveries (such as the identification of the bacterium Helicobacter pylori as the cause of most stomach ulcers), while research labelled as 'basic' can create unforeseen opportunities, (as with the development of the World Wide Web by Sir Tim Berners-Lee while he was working at CERN). To reap the full rewards of research an iterative cycle of ideas is needed between the people involved in these different approaches. Supporting a diverse range of 'basic' science, often through response mode funding, is crucial to the success of more strategic 'applied' research and vice versa.

CREATING A LONG-TERM VISION FOR RESEARCH

Public investment in individual research projects can produce exciting results that are rapidly implemented. In 2011, only a year after research demonstrated that its use reduced deaths from traumatic bleeding by a sixth, tranexamic acid was listed as an essential medicine by the WHO and its use shown to be highly cost effective.[40,41,42] A 2010 study has stimulated huge interest in a novel approach to housing for the hard to reach homeless that has led to a pilot scheme in Glasgow and considerable high level debate among policymakers.[43]

Although such fast impacts can occur, much research has longer horizons. The laser, which is now used in areas as diverse as eye surgery and DVD players, was invented in 1960 through the application of basic ideas Einstein had developed 40 years earlier.[44] The Nobel Prize winning technique of Magnetic Resonance Imaging (MRI) was preceded by a series of important contributions from mathematicians, physicists, and chemists dating back to the 19th century and subsequently followed by rapid developments in clinical MRI.[45]

As we reap the benefits of yesterday's investments in knowledge and ideas, we need to continue to fund research to drive future prosperity. Turning the tap off and then on again disrupts discovery and innovation, hampers the long term approaches needed to deal with challenges such as nuclear power and energy and climate change, and makes it difficult to capitalise on past investments. Unpredictability in funding also risks internationally mobile researchers, companies and capital switching country or sector. In contrast, stable long-term funding is essential for investment and exploitation by industry as has been demonstrated by the sustained approach of the Fraunhofer Institutes in Germany. **We advise the Government to develop a stable ten year investment framework for research, innovation and skills in consultation with the research communities in academia, industry and charities. This framework should sit at the heart of its emerging industrial strategy and plans for growth.**

As research becomes an ever more global enterprise, the UK cannot afford to be complacent about its reputation as world leader in research and innovation. Our R&D intensity (the proportion of GDP spent on R&D) falls behind the average of our partners in the EU and the OECD, and we are only ahead of Canada, Russia and Italy within the G8. The UK has a rich heritage of scientific excellence which is the envy of many around the world; this is a legacy on which we should capitalise. **We call on the Government to commit to increased investment in research and development to keep pace with other leading scientific nations.**

In 2010 the 'science budget' was ringfenced at £4.6bn per annum, providing stability and protecting against short term cuts that would threaten future rewards. This flat cash settlement spared UK research from deep reductions in funding, though in real terms this has amounted to a cut of around 10%. Capital investment was not protected, and decreased significantly. However, since 2010, the Chancellor has found another £1.5bn to invest in facilities and emerging technologies, which has redressed some of this decline. This additional investment is welcome, but will not, without increased future commitment, allow the growth in research required to harness forthcoming opportunities.

Science funding in the Department for Business, Innovation and Skills is only one element of Government support for research and innovation. The Department of Health, through the National Institute of Health Research, the Ministry of Defence, the Department for International Development, the Department of the Environment, Food and Rural Affairs and other public bodies also invest heavily in research. The whole spectrum of support provided for R&D, within BIS and across other Departments and agencies, is vital to ensuring the strength of the UK's research capacity, performance and impact. **We strongly support the ringfencing of the science budget, and urge the Government to continue to increase investment in research capital in future funding decisions.**

Robust scientific advice is recognised as being at the core of good policy making, and we are pleased to see Chief Scientific Advisers in each of the Departments of State. This formal advice is complemented by specific research taking place in different fields. Research in behavioural economics and psychology, for example, has shown how subtle changes to the framing of choices can have a disproportionate impact on how people respond.[46] These results can be applied to such varied areas as

crime, energy use and public health, and not surprisingly therefore have been widely discussed by central and local government. The UK's world class research and development should be reflected in world-class policy making. **We advise the Government to ensure that research continues to be at the heart of evidence based policy making across Whitehall.**

Ambitious and imaginative schemes are needed to ensure the supply of people with world class skills. We have to welcome talented researchers to our shores, and invite the world to work with us in developing the new ideas that will drive future innovation. The Government must signal loudly and clearly that the UK is open for business and is a smart place for industry to invest. **We encourage the Government to build on its commitment to date to create a world class research and innovation environment that is attractive to the brightest talent, collaboration and investment from industry and from overseas.**

Discovery and innovation helped to make the UK an economic powerhouse during the enlightenment and industrial revolution. To escape our present economic troubles, and become a true knowledge economy with a broader base, we need an innovation revolution, a new Enlightenment for the 21st century, with UK research front and centre. Bold leadership and decisive action is required now to make the UK the best place in which to conduct world class research and innovation.

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The Academy of Medical Sciences

The Academy of Medical Sciences is the independent body in the UK representing the diversity of medical science. Our mission is to promote medical science and its translation into benefits for society. The Academy's elected Fellows are the United Kingdom's leading medical scientists from hospitals, academia, industry and the public service.

For more information, please visit **acmedsci.ac.uk**

The British Academy

The British Academy for the humanities and social sciences. Established by Royal Charter in 1902. Its purpose is to inspire, recognise and support excellence and high achievement in the humanities and social sciences, throughout the UK and internationally, and to champion their role and value.

For more information, please visit **britac.ac.uk**

The Royal Academy of Engineering

As the UK's national academy for engineering, we bring together the most successful and talented engineers from across the engineering sectors for a shared purpose: to advance and promote excellence in engineering.

The Academy's activities are driven by four strategic challenges:

- Drive faster and more balanced economic growth
- Foster better education and skills
- Lead the profession
- Promote engineering at the heart of society

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The Royal Society

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, reflected in its founding Charters of the 1660s, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities are:

- Promoting science and its benefits
- Recognising excellence in science
- Supporting outstanding science
- Providing scientific advice for policy
- Fostering international and global cooperation
- Education and public engagement

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