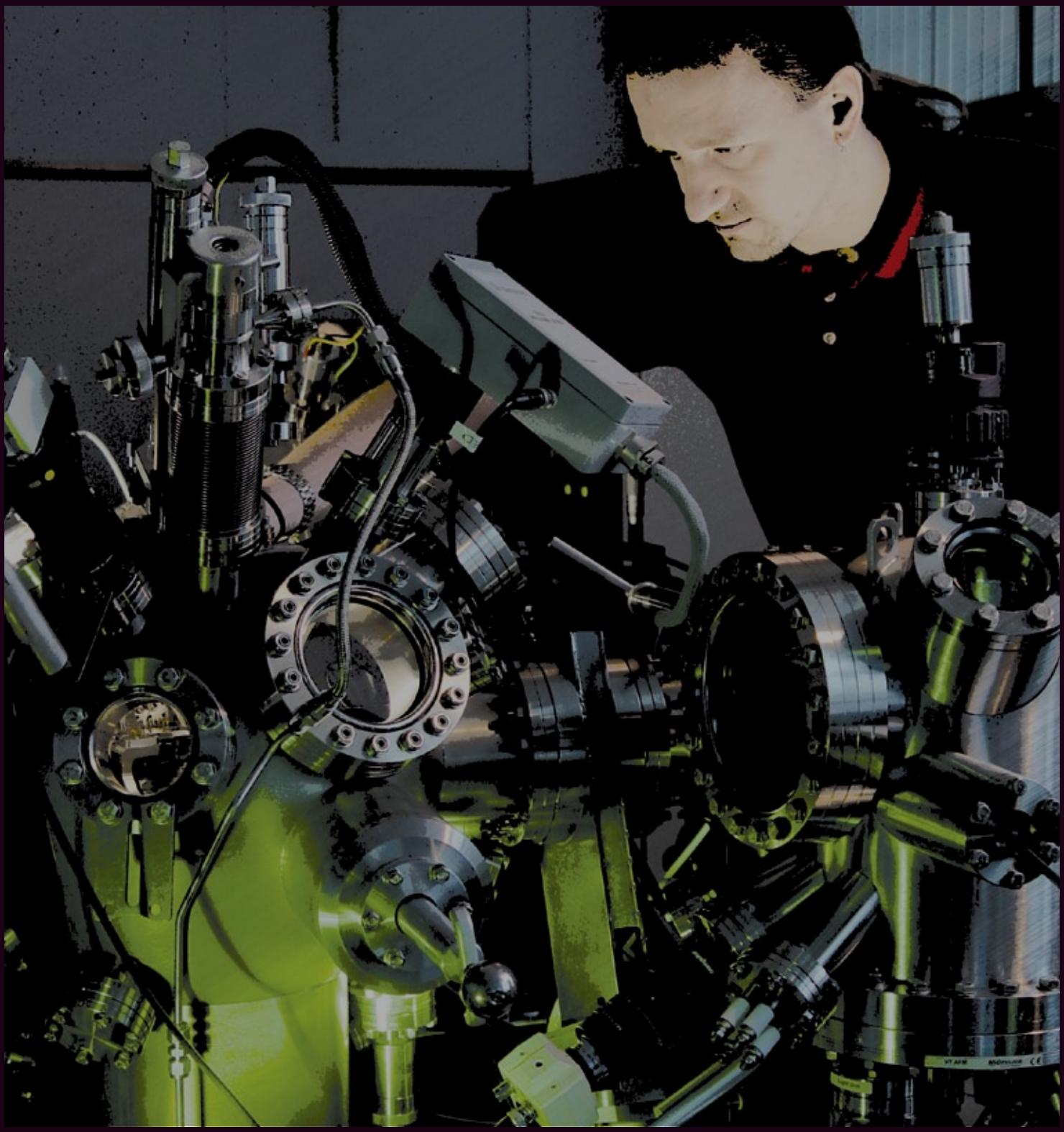
The future of research

Universities UK



Contents

This series of Research reports published by Universities UK (UUK) will present the results of research we have commissioned or undertaken in support of our policy development function. The series aims to disseminate project results in an accessible form and there will normally be a discussion of policy options arising from the work.

Foreword

The timing of this report is critical. The UK's coalition government is facing the toughest spending decisions in recent history and the 10 year science and innovation investment framework is approaching its final stages. As the new Minister for Universities and Science has rightly acknowledged, the success of the UK's science and research base is absolutely critical to ensuring the UK's future economic growth and prosperity. As such, continued political commitment and investment – even in times of relative austerity – is vital.

This report considers how the UK's research community – the funders, enablers and supporters of research – can work together to build on, maintain and enhance the world-leading science and research in our universities. We hope that this report will help inform the government's spending and policy decisions which will impact significantly on the ability of the UK's universities to deliver the world-leading research which supports and drives the UK economy.

The strength of the UK university research base is well documented and widely accepted. The UK continues to punch well above its weight and our research remains the most productive and efficient of all the G8 countries. The UK has 14.4 per cent of the most highly cited one per cent of papers (which places us second to the US overall, but ahead in clinical sciences, health sciences, biological sciences and environmental sciences). And crucially during the current economic climate, the UK offers the best value for money. We now rank first among the G8 nations on the number of citations in relation to public spend on R&D. The most recent Research Assessment Exercise (RAE) also demonstrated that we continue to produce many university departments of international and world leading status.

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1. Researcher from the University of Swansea's internationally recognised multidisciplinary team within the school of engineering (shown here and front cover).

However, we cannot take our position for granted. The world is changing rapidly and the environment within which university research now operates is very different from the system that has produced these very striking achievements. This report, prepared for Universities UK, by *Evidence*, a Thomson Reuters business, suggests that a degree of re-balancing and re-focusing – rather than a cataclysmic change – is required in order for the UK to maintain its world leading position in science and research. Equally, we need to build on the mechanisms which currently work well and have played a key role in driving our success, such as the dual support system and the flexibility of the quality related (QR) block grant, distributed by the UK funding bodies, which must be retained. This dual approach must inform a strategic approach to policy and investment in science and research over the next 10 years.

The report makes a number of recommendations and we hope that its key findings will be of interest to policy makers across the UK as well as to the university sector and the wider research community. We look forward to working with government, the higher education funding councils and the research councils on the development of a clear and coherent strategy to take forward some of the issues and challenges presented in the report.

We are grateful to the authors for analysing the issues so clearly. We would also like to thank Universities UK's Advisory Group, chaired by Professor Eric Thomas, Vice-Chancellor, University of Bristol, for their very valuable input throughout this process. Finally, we would like to thank the many organisations and individuals who attended a round table event on 27 April 2010 to discuss the key emerging issues, the dialogue from which has helped to inform the report's final conclusions and recommendations.

Professor Steve Smith
President, Universities UK

The future of research

This report looks at the future opportunities and challenges facing the UK university research base and makes recommendations as to how the system can respond to these. It comes at a time when the UK has elected its first coalition government for 70 years and is facing unprecedented economic challenges. The report is aimed at policy makers within the UK (including both government and funding bodies) and more widely at the university sector and the research community. The report and its recommendations relate to the UK as a whole, including the devolved national assemblies and governments. A small number of key themes have emerged.

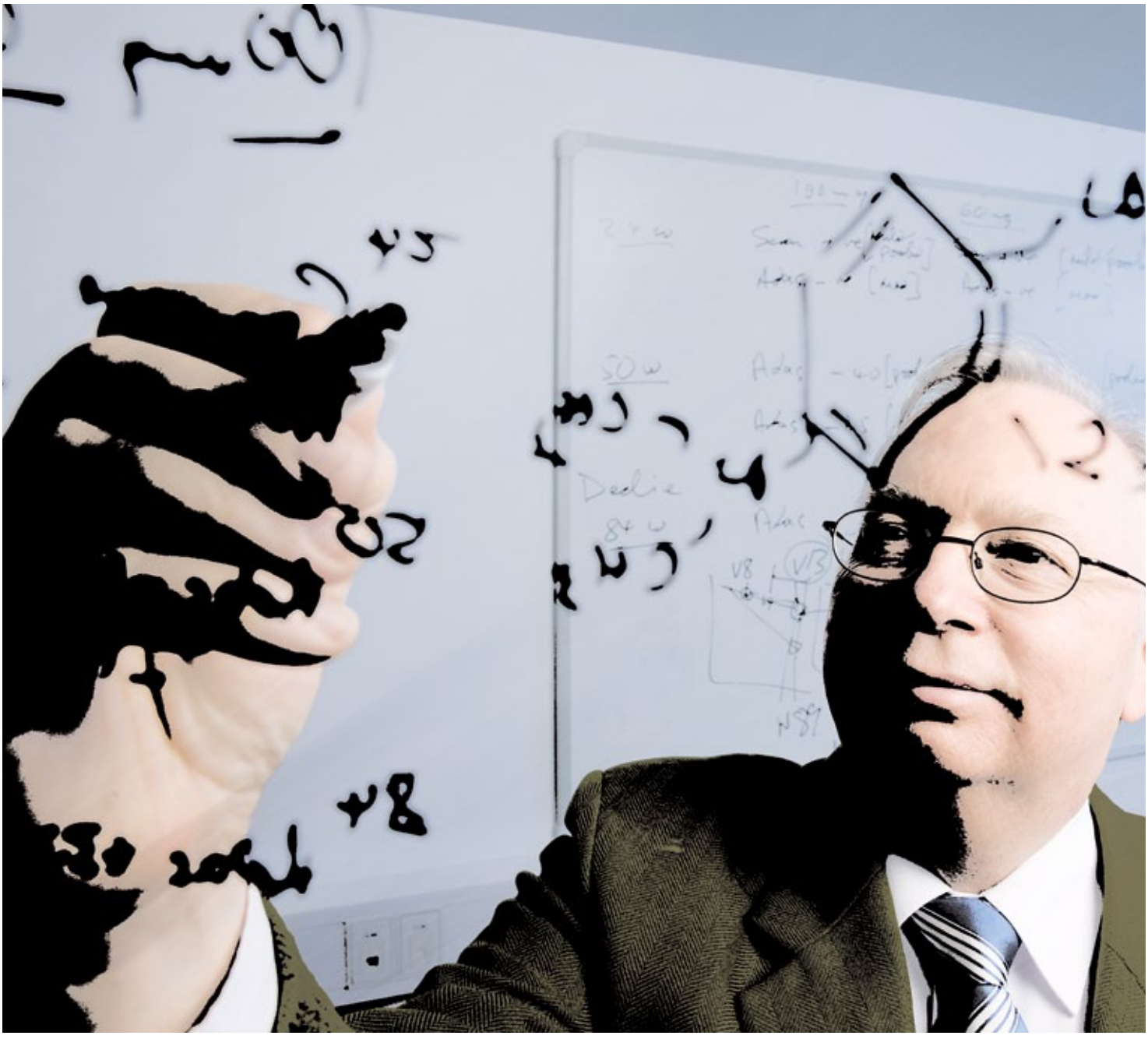
First, the greatest contribution that the higher education research base makes in the short to medium term is through skilled, competent and able people, who train and mature in an atmosphere of research excellence. Our knowledge-based economy cannot recover and grow without a steady renewal of our stock of skills and such people are likely to be more valuable if the research to which they are exposed is at an international standard. The rapid feedback process on the supply of skilled people, needs wider internal recognition and acknowledgement. The outcomes of research itself are complex, indirect, long-term and uncertain. Government should not expect, and the system should not promise, that universities will deliver specific research outcomes of direct and immediate benefit to specific economic sectors, but universities should recognise and support impact wherever it occurs. Research investment creates intellectual capital of wide and flexible application to problems not yet defined. While that is happening, people acquire experience in knowledge handling and problem solving that enables them to move quickly and with great benefit into many parts of the economy.

Second, UK higher education research works well when it works with partners. Those partners are found in other universities, other parts of the economy and other countries. Such partners will be essential if the research base is to continue to tackle major challenges, make sure that its activity is cutting-edge and relevant and keep a full appreciation of research innovation world-wide. It will be necessary for those partnerships to be more active than in the past, with clearer strategic investment, engagement and feedback. The UK will need to embrace a wider cultural and linguistic response and UK researchers must become more mobile between sectors and between countries. At the same time, government must look to stimulate more effective engagement from industry than is current. Commercial research investment has not grown at the rate that might reasonably be expected, given the quality and opportunities the UK research base provides.

Third, the track record of international research excellence that is associated with the UK's higher education research base has been supported in part by elements which may have less influence in the future. Other characteristics, such as the dual support system, are deeply embedded and central to sustained performance. As the 10 year science and innovation framework enters its final stages, it is desirable that a government strategy should emerge which addresses the timely rebalancing of some central priorities and structures, but which does so while avoiding undue changes which might undermine achievement. The minimum viable size of internationally competitive research units and the role of collaborative networks to link dispersed research capacity, must be given due consideration.

Finally, the higher education research base must and will commit to addressing the necessary changes that will enable these improvements in people and partner development. Some significant changes to the distribution and structure of research funding may be required at this time. The relationship between research capacity and research resources must be addressed and the sector must be prepared to accept significant change. The efficiency gains that this will deliver will be its contribution to justifying the sustained level of investment in the sector that the UK government will need to make in order to generate the people and knowledge resources that ensure that the wider economy can move confidently into recovery.

This document draws on a substantive data and literature review prepared for Universities UK by *Evidence*, a Thomson Reuters business, and on a Universities UK round table discussion event held in April 2010 at the Royal Academy of Engineering, attended by vice-chancellors and other senior representatives from the university sector, business representatives and key funders and supporters of UK university research. It is not a summary of that review and it ranges broadly across the main topics around which the review focussed. All of the statements in this document do relate however, to evidence contained within the review, which is available online alongside this report.



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2. Professor Claude Wishik's research team at the University of Aberdeen are working with a spin-out company from the university to develop a treatment for Alzheimer's Disease.

Facing up to the future

The environment within which higher education (HE) research now operates is different from that in which the UK system evolved and is set to change considerably more over the coming decade. Universities respond to these changes: many in the UK and elsewhere have already demonstrated an inventiveness and competitiveness which emphasises both the capabilities of the sector and the global nature of contemporary events.

The UK HE research base approaches these challenges from a position of considerable strength, but its historical competence must not become a trap. It has been excellent in its activity, usually second to the USA in measures such as output volume and citation impact. Moreover, it has been efficient in achieving this with a higher output per researcher and per unit investment than other leading research nations. In international comparisons published by the UK Department for Business, Innovation & Skills (BIS), the UK invests about four per cent of Organisation for Economic Co-operation and Development (OECD) Gross Expenditure on R&D (GERD). With this it produces about eight per cent of world PhDs and of papers on Thomson Reuters 'Web of Science'® and is first in the G8 on publication productivity. From this it generates 12 per cent of world citations and 14.4 per cent of the world's most highly-cited papers.

14.4%

The UK invests four per cent of OECD gross expenditure in R&D and produces 14.4 per cent of the world's most highly cited papers.

The university sector has contributed substantively to the goals set out in the UK Science and Innovation Investment Framework 2004–14[1]. For example:

- The target of remaining second to the USA on share of world citations was met.
- The UK remained the leading OECD country on citations per Gross Domestic Product (GDP) and per researcher.
- Research contract income to HE from business more than doubled between 2001–2006.
- PhD awards per million population are increasing in the UK and are now second only to Germany.

However, in related sectors elsewhere in the UK, it is notable that progress has not been made, for example against the government's key objective to increase Business Expenditure on R&D (BERD) from 1.25 per cent to 1.7 per cent of GDP by 2014. In fact this value had fallen to 1.15 per cent in 2007 on OECD data.

The world has changed since the system that produced the university sector's recent achievements was created:

- Investment in universities generally and their research in particular, has grown on the back of expectations about the transforming power of higher education, the mobility of people and the contribution of research-driven innovation to the economy.
- Universities have grown enormously in number and size in recent years. Expansion has arguably placed the system, at least in part, in the role of a service provider and has an impact on the distribution of resources, activity and outcomes.

- Whilst universities remain autonomous institutions, increased public investment both through grants and fees income, has made them more visible and more accountable. They must now strive harder to retain the respect once naturally granted.
- With the growth of the information society, universities are no longer the primary sources of information for many people, so they must work to assert their role as arbiters of knowledge. The creation of accessible repositories is a signal of their potential contribution.
- Many research fields have grown, diversified and matured to an enormous extent. Many play an important role in public policy. Contemporary challenges cross disciplines and methodologies. Quality research demands huge resources, the allocation and use of which becomes a complex national and international challenge.
- Public expectations of research outcomes have changed from discovery to utility, reflected particularly in the overt objectives of policy instruments.
- Universities have become global brands, partly because of internet technologies, and compete for prestige, staff and students in an environment beyond national boundaries.
- The UK no longer sits at a unique hub between a global network in the Commonwealth, a link to European partners and a particular friend of the USA. The countries which will dominate the future global research base have altered the regional balance. Understanding their research culture and using their research language has a new priority.

Despite the scale of these challenges, there can be no consideration of retreat. The UK must continue to participate in discovery if it is to understand and use the balance of knowledge produced by the rest of the world. The many aspects of university research that remain effective and fit for purpose must be retained while the system thinks through required change. The core values of universities protect a culture which distinguishes them from other research environments: an innate dynamic responsiveness and a fundamental role in training people to develop, to analyse and to explore new ideas. This is vital not only to the research base itself, but in training those who then go on to develop their careers elsewhere in the economy.

At the same time, university research will more transparently demonstrate its increasing connection with utility, and the way in which economic and social impact derive naturally from mission-led research in all disciplines. There is no stark choice between either academic/discovery research or economic/development research, but a conceptual adjustment is needed to promote the balance and feedback between them.

Partnerships will change. Changing knowledge balances and growing financial accountability will cause the higher education research base to reconfigure its external relationships, with stakeholders inside the UK and with international partners in Europe and elsewhere. Resource distribution may also need to change. But the most important focus will be around people, what people gain in competence and potential while in the research base and the overarching significance of people as a driver in the economy. This is higher education's unique contribution, without which economic revitalisation is unachievable.

Do we need universities to undertake research?

University systems are self-managing, flexible and self-renewing. They determine their own priorities, tuned against the direction of public funds, and thereby escape the limitations of policy-set missions. They continually reorientate their goals as discoveries overtake objectives. The constant turnover of research students and staff creates vigour and continuous reanalysis. Because they also compete through diverse and overlapping missions, institutions maintain a constant vigilance that would make external management an irrelevance. Their sustained innovation makes a compelling argument for their primacy as a venue for research, which is strengthened by their people-development role. Given these characteristics, central oversight of universities has been appropriately light in the UK while outcomes have become increasingly excellent.

But universities are not the only place where the public sector could buy research. Some national research systems are more dependent than the UK on institutes with stated missions, usually focussed on specific areas of economic or social impact. When such impact becomes a policy priority, these become an attractive tool in the public sector armoury. Consequently, an academic emphasis on discovery and curiosity-driven research looks vulnerable if funding and public expectations are more about beneficial impacts for the wider economy and society.

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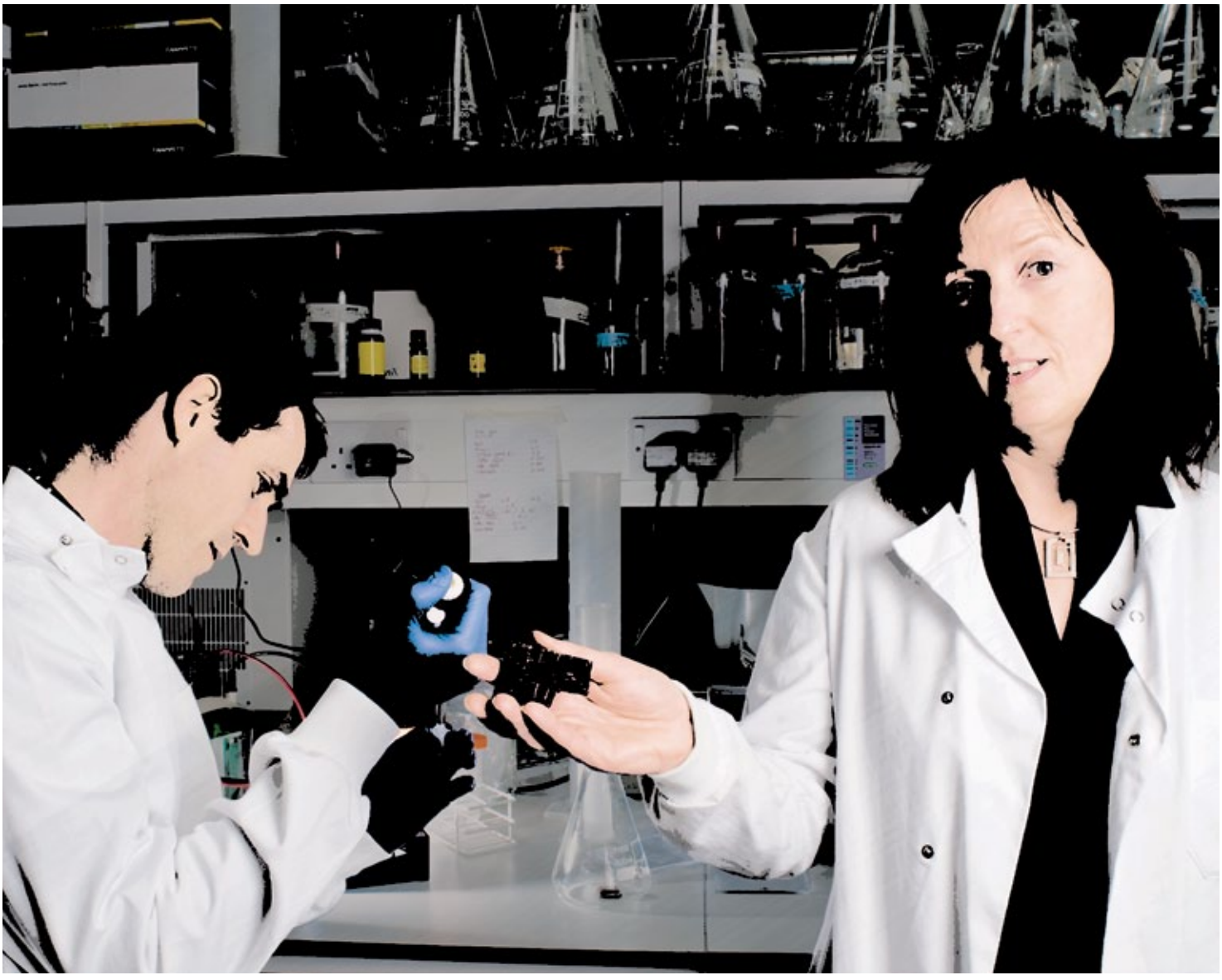
3. Professor Aedin Cassidy from the University of East Anglia's Diet and Health Group is working with Diabetes UK to investigate if compounds found in cocoa can improve the level of defence against heart disease over and above the protection provided by conventional drugs.



It has been argued, however, that there are more systematic and pervasive gains from university-based research systems. For example, they support a multidisciplinary diversity absent from any research institute and those nations that have traditionally concentrated their research in universities, have generally produced a more competitive international performance. *Evidence*'s comparative study showed that HE-based UK, Australia and Canada achieved higher impact for their share of world publications across a diversity of research fields than did institute-based France, Germany and Japan.[2]

The Max Planck organisation (Germany) and the Centre National de la Recherche Scientifique (France) have long records of significant contributions to international research. However, both countries are changing the structure of their research bases and drawing such units alongside universities, so they are evidently no panacea. The UK has also created and closed networks of institutes in the past. In the 1990s, the former Agricultural and Food Research Council found that research laboratories focussed on agricultural production were no longer serving an effective purpose. The network of industrial research and training organisations (the Association of Independent Research and Technology Organisations) has also changed to fit a new role, still in training and development, but away from traditional economic sectors.

There are arguments for intermediate institutes, not carrying a full research mission, but set to effect the translation of research outcomes into applications and thus to support new products and processes. The Fraunhofer network (Germany) has recently been cited in the Hauser report[3] as a model for 'Clerk Maxwell' institutions in the UK (as they were for 'Faraday' institutions by the Advisory Board for the Research Councils in 1992). The challenges for intermediate institutes are four-fold: as an island, they may be a haven for collaboration but require bridges to both universities and industry; they do not perform cutting-edge research; they are not a source of highly-trained people; and they lack the self-renewal of an institution that also teaches. They would require significant investment to have the capacity for significant outcome and this would in itself take time to build and emerge. While they can provide no rapid solution to current economic challenges, their investment would starve other targets of scarce resources.

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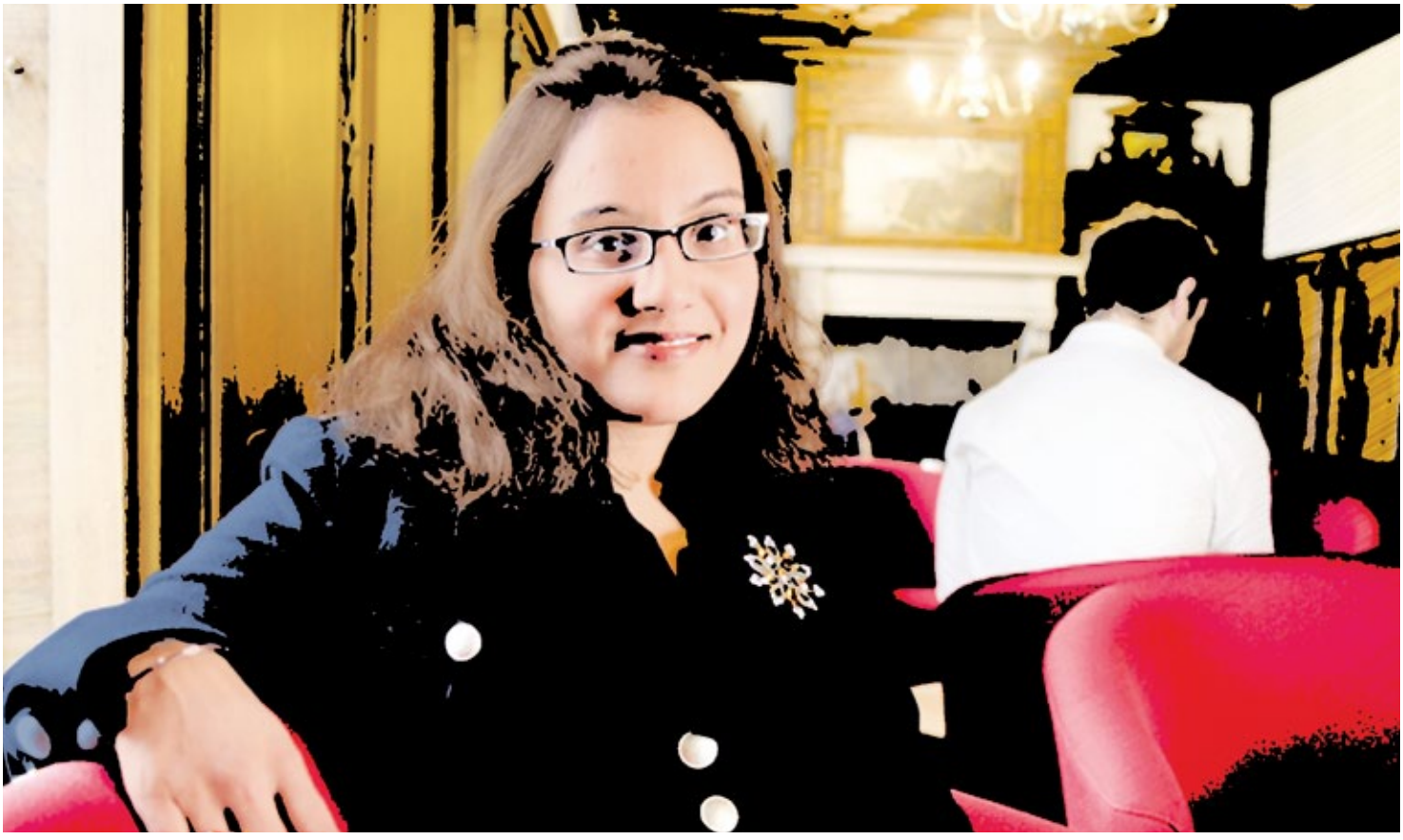
4. At Roehampton University Dr Aisha Gill's widely recognised work on social justice has informed policy making on issues of gender-based violence and human rights.



Stakeholders within the UK

An important element in the political agenda which has developed over the last quarter-century is the expectation of 'impact' for university research. The progressive shift in focus to the economic and social impact of research is seen, for example, in the Research Councils' grant application process, which requires applicants to consider potential impacts. This agenda may vary in emphasis, but it will not disappear. Universities should take ownership and interpret the way in which it can be met. It will need to be internalised as a part of the sector's pact to meet sustained investment with a flexible and adaptive response. It must be adapted to all disciplinary cultures. It must not be forced on a reluctant sector in a haphazard and maladapted way.

Universities face a complex task in balancing potentially competing external expectations, even demands. The 'stakeholders' are the interest groups who stand to benefit or suffer from a more or less effective performance by the universities. Since taxes pay for universities, public interests are usually represented by government. But government also seeks to represent industry which benefits competitively from trained people as well as innovations and thereby boosts the economy.

Government has not always expressed its expectations well but universities could be accused of being complicit by failing to deconstruct and reinterpret those expectations in more coherent and constructive forms. In the translation of discovery into innovation, UK policy culture has presumed that a deficit exists and that the fault lies with the producer. But even the deficit is open to question. The UK has a strong biomedical research base where it has a world lead in output quality and where the pharmaceutical sector invests heavily in R&D and has excellent links with universities. Other leading companies, such as Rolls Royce, stand out for similarly good links with excellent research. The generic record for business is dismal, however, for while the UK's comparative research quality has improved so the level of BERD as a share of GDP has fallen.

Cycles of government innovation policy have focussed on universities as the sector most readily levered, but have not analysed the coherence of expectation. University research cannot respond in a short cycle, nor does it focus on existing need so much as future opportunity, nor can it force its output on industries which lack the capacity to use the knowledge.

Why are the expectations unrealistic? Those in industry, in the NHS, and in other public sector agencies, have only infrequently been able to articulate, perhaps even to conceive, what they really need from university research. More people are needed among both research producers and users who can engage in an appropriate dialogue. We argue, and develop this argument further in the context of workforce competency, that the capacity to articulate possibilities, needs and responses across this boundary could be a firmer and more achievable policy goal ahead of unquantified expectations. A two-way movement of researchers – able to translate research opportunity into social, economic and technological sectors – and of industrialists, able to explore development opportunities and mentor budding research talent in wider development pathways, could entrain the transfer of useful knowledge far more effectively than initiatives focussed on knowledge transfer alone.

£300m

Between 1995–07, private contract income to higher education rose from £170 million to £300 million though fell as a share of total grant and contract income from 11 per cent to eight per cent.

A new contract is therefore required between universities and society, not least in response to the need for university research to make a clearer impact on real world economic, social and environmental problems. Many civic universities had strong industrial links in the past, forged through a theme of relevance and their origins in the local economy. Inevitably, these particular links have weakened over the last thirty years or so, although wider networks have diversified. Between 1995–07, private research contract income to higher education rose from £170 million to around £300 million. But, at the same time, it fell as a share of total grant and contract income from about 11 per cent to about eight per cent. This also fell as a share of BERD, which was itself shrinking as a share of GDP. This was not a new phenomenon but the extension of a trend well marked in the previous decade. Other links between universities and business have developed in various forms, however, and Higher Education Funding Council for England (HEFCE)'s 2010 Higher Education-Business Community Interaction survey showed that UK universities received £2.96 billion from business (and community interaction) in 2008.

In the 1990s universities responded to pressure through the creation of more spin-off companies. These have had an impact, but universities' capacity to become 'fledgling economic powerhouses' may be optimistic, given the resources required to translate a start-up into a major, independent employer. To meet the legitimate expectations of wider society, the university will need (to an extent) to compromise its preferred agenda and critically review its underlying culture and prejudices. Public and private sector partners need a larger stake in a relationship of 'mutual confidence' – both sides need to respect what the other knows and wants. The challenge for all involved is to identify innovative ways in which the wider academic, commercial and social communities can combine together to deliver useful outcomes.

Recommendations

Rec 1 Universities should set out more clearly what they can do in relation to innovation in industry and they should assert the need to work with, not for, willing and contributing industrial partners. Collectively, through Universities UK, they should examine and deconstruct investment agendas and reinterpret to government what is realistic and achievable, and then ensure that the objectives are collectively met through the collaborative development of stronger local and regional forums with committed business partners.

Rec 2 Universities should take ownership of the 'impact' agenda and provide a more effective and useful interpretation of its meaning instead of leaving this to policy makers outside the research base. In particular, they should adapt and translate the impact agenda in relation to different disciplines which address diverse economic and social objectives.

Rec 3 Universities and industry should collaborate in owning any intermediate 'knowledge transfer' institutions established by government and should do so as partners in regional consortia. This would provide the new institutions with direct access to partner organisations and their knowledge and facilities. Mutual ownership would reduce threats and distance and joint management would foster collaboration, strategy and exchange.

Rec 4 BIS should enhance schemes to enable researchers and industrialists to exchange places for three or six-month periods, which means engaging with motivation. This will increase dialogue, enable researchers to acquire understanding of industrial problems, and enable industrialists to mentor young researchers in new perceptions of problem identification. (See also Rec 15).

Global partnerships

Universities are global brands and need to consider their profile and status. The UK is no longer an exceptional pinnacle of excellence to which others are attracted, but part of a more complex system in which competitiveness will be continuously challenged. Emergent research economies (particularly, but not only, China, India and Brazil), together with new global models of research and education, could present UK universities with a tremendous opportunity.

The impact of much research from the emerging research economies is often low at present, but the volume of research is increasing rapidly and there is no doubt that – as a result of increasing levels of investment – growing research quality will become pervasive. China and India will diversify and consolidate; south-east Asian 'tiger' economies are already maturing; new networks in Asia are strengthening. Current UK research collaboration with institutions in these countries often results in net benefit to them but, when the balance alters, the UK will benefit from a significant and supportive collaborative track record.

x4

China has increased its research output four-fold over 10 years, overtaking all but the USA. India and Brazil have both doubled their output.

China has increased its output four-fold over 10 years, overtaking all but the USA. The quality of this output has yet to match G7 levels but is constantly improving. India has doubled its output since 2000. Brazil has more than doubled its output. All have steep trajectories, as do Argentina, Iran, Korea and Mexico. Much of the growth has been in physical sciences and engineering, but it would be a mistake to interpret this as a key area for competition. Those economies once invested primarily in areas suited to industry, but are now turning to information and communications technologies (ICT), health and biotechnology and will challenge the UK's lead in these more innovative sciences. Areas such as environment, health and social care, and business and economic studies present further opportunity.

Understanding what the new economies are doing will not come from reading publications. The UK needs to be sitting at the laboratory bench to understand choices, decisions and priorities and to be able to absorb different cultural approaches that may produce distinctive outcomes. Unfortunately the historical relationship has been one where researchers from these countries have come to learn in the UK, which they will less often need to do in the future, while UK researchers have been less driven to travel, usually because the needs and benefits were that much less.

Beyond the movement of individual researchers there is the nature of institutional relationships. The UK has tended to focus on driving research excellence, but a growing economy may want something simpler and more tangible, since excellence remains aspirational. Feedback suggests that German universities have been preferred partners because they provided access to technology as much as science, offering advanced equipment against firm partnership commitments. The possibility that the Max Planck network may link into South Korean institutes reinforces this.

UK universities have many international links, some of long standing. Relationships with Europe are pervasive and often strong, but elsewhere they are often surprisingly thin. For example, the UK university collaborating most frequently with India in engineering produces an average of just five co-authored papers per year. UK universities will want to examine how they can commit to a wider range of partnerships with practical foundations, including collaborations that open opportunities to access transnational-funding for projects that are too large for one country to pursue.

Closer to home, if the UK is to meet the ERA target of 20 per cent of EU doctoral candidates working outside their home country, then further cultural change is required. The UK lags well behind most other European countries. While a rising 2.6 per cent of EU27 students spent at least part of their studies in another EU member state in 2006, the UK has a lower 0.7 per cent of students studying abroad.

2.6%

While a rising 2.6 per cent of EU27 students spend at least part of their studies in another EU member state in 2006, the UK has a lower 0.7 per cent of students studying abroad.

Interaction within Europe will not just be about greater researcher mobility. Grand challenge programmes, such as climate change and the needs to pool resources to meet the demands of internationally competitive research, will mean that collaboration becomes an increasingly frequent part of normal business. The concept that individual EU countries might split the agenda seems absurd, but the idea that there should be some specialist hosting of shared, major facilities is a realistic extension of established institutions such as the European Organization for Nuclear Research (CERN), the European Molecular Biology Laboratory and the Institut Laue-Langevin. The European Commission's research budget is expected to increase after 2013 and, particularly in light of the current funding climate at home, UK universities will need to continue to work strategically and collaboratively with universities in other EU member states in order to maximise their funding opportunities.

Language training is a strategically important but vulnerable area for researchers. As a deficit, it contributes to the general reluctance of UK students and researchers to travel. The Higher Education Funding Council for England's Strategically Important and Vulnerable Subjects (SIVS) programme shows that language departments in universities are not always as strong as may be desirable – and what is desirable may be a conversational rather than academic approach. There is good evidence, however, that overcoming the challenge is beneficial. There is a marked tendency for the UK's most highly-cited researchers to have had one or more periods of their early research career overseas (although usually to the USA or other Anglophone country). Furthermore, countries with exceptionally high levels of international mobility turn this into high levels of international collaboration. Both Switzerland and the Netherlands are notable in this regard, and both also have an exceptionally competitive research base for their size.

Recommendations

Rec 5 Universities should look at strategic partnerships in terms of tangible, long-term commitments, rather than only academic exchange and short-term student recruitment. At the moment, the UK is in a position to strike a good bargain because it has much to offer. But the balance will change and when strategic partnerships become a necessity, it may find a scarcer availability of good partners.

Rec 6 Research Councils, other funding bodies and Higher Education Institutions (HEIs) should consider enabling a much larger proportion of academic staff they support, to gain overseas experience, with funded sabbaticals in other research economies.

Rec 7 Universities should work with schools to assert the need for competence in a foreign language as a prerequisite for a research career in any field. They should work with the Funding Councils to strengthen appropriate provision in modern languages for their own research staff.

Rec 8 Research Councils and BIS should expand current investment in international mobility when financial flexibility once again allows. One way might be for BIS, through the Research Councils, to offer an enhanced salary plus a completion bonus on a research studentship when at least 12 months have been spent studying in an overseas university (but at only marginal cost to the Research Council, which would otherwise see this as a constraint on numbers of studentships). An even larger premium could be offered to those who choose to work in one of the emerging research economies. The net gain to the UK in terms of collaborative links, knowledge of overseas activity and net expertise, would be very large. The cultural shift could be even more significant.

Research quantity and quality

Excellent research is expensive, but poor research is worthless. There are concerns that the UK system tries to do too much research, that the dispersion of resources across institutions is unbalanced, and that new arrangements are needed to support costly national and international facilities. A national reflection is required about the use of research resources.

UK university research is characterised by a highly self-motivated culture, without which quality and effectiveness could not arise. In the absence of alternative objectives formalised by management, a common tendency in the research enterprise has been to prioritise growth. More activity – postgraduates, contracts and publications – has been valued ahead of more support for the best activity.

Between 2000–07, researcher numbers in the higher education research base increased by approximately 85 per cent. The volume of UK publications increased by approximately 50 per cent over the same period and UK research impact also improved – but only marginally against world average. Average world impact also increased, but it is nonetheless disappointing that such an increase in research capacity did not improve the UK's position. Research resources rose but so also did unit costs. Recent Transparent Approach to Costing (TRAC) data shows that despite the introduction of full economic costing (fEC) there remains a £2 billion deficit for research. Some of this may be down to problems with TRAC, and fEC is still 'work in progress', but the residual deficit is cause for concern. It is therefore a question as to what benefit accrues from a plethora of badly-funded researchers?

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5. The UK's only dedicated soil science department at the University of Reading aims to develop an understanding of soil within the earth's systems using field research, laboratory experiments and modelling techniques.

Scarcer resources inevitably mean increased competition for funds. Should it also mean an increase in selectivity? It is increasingly expensive to compete at international level. The cost of raising very good research to excellence is high. It is easier, but pointless, to raise modest research to national competence because this will not maintain the UK's world-leading position.

There is no argument for concentration on scale alone (critical mass in some concepts). While larger units (more Full Time Equivalents) generally have high average impact and high relative income, there are also smaller units that perform equally well. Correlations emerge because it is very rare for a large unit to survive with poor research performance. At unit level, research groups of around eight people are frequently associated with relatively good performance, while smaller teams tend to be under-resourced and large teams tend to split. Large departments are made up of groups of smaller teams and colocation may be synergistic. Thus, some scale benefit driven by diversity, not size, may emerge but such diversity remains unevaluated.

The spread of excellent, good and weak units is uneven at all levels. RAE2008 revealed small pockets of excellence in departments, sometimes in institutions, where most research was more modestly graded. Other data show that in most subject areas there are a few units with outstanding average performance, units which spread across the middle-ground of UK performance and are often above world average, and units which perform less well. This pattern is then replicated at institutional level, where five HEIs stand out ahead of the rest, while the middle ground is contested by a diversity of institutions from different interest groups.

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6. Professor John MacIntyre, Pro Vice-Chancellor and Dean of the faculty of applied science at the Sir David Goldman Informatics Centre at Sunderland University.

Not all research is of high quality but trawling money risks a deleterious effect on morale with little benefit. A shift of significant resources from the centre would be deleterious because it would undermine research that is well above world average without producing an equivalent top-end gain. However, for the research system as a whole, the objective in times of scarcity must be to sustain the contribution at the highest level and avoid irreparable damage to the national profile.

How can this be achieved? One option is to invest substantial resources in collaborative programmes which concentrate resources in a smaller number of leading departments by engaging and entraining joint ventures with other departments. This would need to be organised on a regional basis to avoid the deterrent of distance. The Great Western Research project involves research teams in 13 HEIs across South West England. Research pooling arrangements in Scotland, supported by the Scottish Funding Council, span a range of disciplines and enable the sharing of facilities and equipment, as well as joint doctoral training programmes. These are examples of structured and managed collaboration as a route to maintaining networks of research competence.

Another – or potentially parallel – option is to consider whether policies that have overtly differential effects and benefits, generally avoided in a unitary system, may have a role. For example, it may be desirable to introduce capacity thresholds, such as a minimum of eight active researchers in a unit or some minimum of excellence – although the optimum size may vary between subjects. About 2,400 units across universities and subjects were submitted to RAE2008. Fewer than ten of these units had as much as 10 per cent of activity rated at the high-end 4* and yet also had 75 per cent or more rated at the low-end of 2* or below. In other words, islands of excellence are rarely associated with pools of mediocrity. However, there were 350 units that had just five per cent at 4* and 25 per cent or more above 2*. Some 500 units had both five per cent or less at 4* and less than 25 per cent above 2*. In other words, if we applied a performance threshold that required a minimum of 10 per cent at 4* and 25 per cent at 3* or above, below which core QR funding would not be triggered, then this would remove one-fifth of all units from the research pot.

Recommendations

Rec 9 The system needs to be stringent in building on TRAC to achieve sustainability. Universities should exercise greater oversight to ensure that investigators avoid taking on contracts that are not properly resourced. Investigators need to accept that they are project managers and must work to scope and cost projects more fully and then to work within resources. This echoes the 2010 report of the Research Councils UK (RCUK)/Universities UK task group chaired by Sir William Wakeham[4] on financial sustainability and efficiency, which states that 'it is not clear that institutions are actually using the metrics [provided by TRAC] as effectively as they might' and concludes 'that the use of metrics to analyse trends, can and should be improved.'

Rec 10 Research Councils should consider resource 'packets' across the system, in a constructive way that reduces the lower value margin while enhancing the rest. For example, there could be fewer but better funded studentships to encourage high-quality candidates. Numbers of grant awards could be reduced, while research contracts must be properly costed and then fully funded. The HE research base can offer this as support of quality over quantity.

Rec 11 Funding Councils should reflect on the options for a 'minimum level of capacity' in research activity. This is not about the relationship between scale and outcome but about true 'critical mass'. However, balancing arrangements must be put in place to sustain the pervasive network of research activity that enables the UK to be both competitive and flexible in responding to challenges.

The competency of the workforce

The primary output from universities is a supply of talented and trained individuals. People who have undertaken advanced research training in universities spread throughout the economy, with huge potential to add value to employers. These individuals are also able to articulate real world problems back to former university colleagues. Nonetheless, university culture has arguably downplayed its role in training people for the wider world, perhaps because it seems to diminish individual research achievement and progress.

One ambition of the Science & Innovation Investment Framework 2004–14, supported by the Concordat to Support the Career Development of Researchers (Research Concordat)[5], is a 'strong supply of scientists, engineers and technologists' and we are currently at a point in the economic cycle when commentators – including the OECD – agree that nations should be investing in research training. A prime determinant of the way in which countries emerge from financial crisis will be their stock of human capital and their consequent ability to restructure in response to new conditions.

The number of contract research staff has doubled since 2000 having increased more than 10-fold over three decades. Cycle after cycle has seen demands for expansion of opportunity: more research students, more posts for PhD graduates, longer research careers. The effects of growth on this scale have not been fully described or evaluated, so it is unclear whether such capacity is in practice either desirable or of long-term benefit for the system or, more pertinently, the individual.

As well as being the most important output of university research, competent and motivated people are the most critical input: an institution can maintain its competitiveness by recruiting and retaining the best people. Research assessment has driven better management of the entire research process within universities. In the global war for talent, improved development and mentoring to enable people to realise their potential will be increasingly important. Measures to address the need to develop researchers include the Research Concordat as a statement of the expectations and responsibilities of researchers, their managers, employers and funders. While some who train to PhD level stay in academic research careers, most go on to work outside universities in environments that do not overtly require research. The dominant academic culture does not consistently recognise or support this; rather, the assumption remains that 'the best' expect to stay in academia. For example the Royal Society's '*Scientific Century*'[6] reports that 'only a tiny proportion of PhD students can expect to end up as university professors', while the Council for Science and Technology (CST)[7] suggests that, after a Masters degree, the 'best and most committed' people proceed to a doctorate.

Too often leaving university with an Master of Research (MRes) is portrayed as a sign of failure, as in the CST Report's 'exit points at masters level for those who will not make the very top'. For many people, however, an MRes followed by two years in a non-university environment may be a more useful career track. The environment in which young researchers make these career decisions needs to be one that is responsible and balanced but studies suggest that the university privileges its own priorities.

It is not an original suggestion that the boundary between academic research and wider knowledge development in the public and private sectors, could usefully be made more permeable. As noted earlier in this document, it would be extremely valuable if more people in knowledge-based careers could spend some time back in a university as part of their career development, so as to help build understanding, mentor developing researchers and reduce the cultural barriers. An ambition of the Science & Innovation Investment Framework is for the UK to achieve 'increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent'. People who come from, or move between, universities and other parts of the economy, can have a role in developing this productive relationship between research users and universities.

Too often university research has been conjured by policy-makers as producing answers to the 'wrong' questions, while research-users have been unable to state clearly what they need from research. Articulating the problem is as difficult as finding answers: another reason to encourage the 'best and most committed' to move, and to move in both directions. An example which tests this analysis is medicine. Health professionals expend considerable resource on interpreting medical research so that it can be used across the health community. The 'mobile people' analysis holds good here, as clinician-researchers straddle the research/user boundary.

It is challenging for those moving between ladders to progress up them. Mobility between sectors and countries must nonetheless be encouraged. Early career stage researchers move between HEIs, and frequently to a non-university research environment. Universities should seek new ways to remain engaged with these bright people as their careers develop, through research collaborations outside the sector and by bringing people back, for example as mentors for the next generation of researchers. Universities also need a research workforce with an international perspective, as we noted above. This mobile, flexible workforce will come at a cost, but that may be the most important and beneficial part of what universities can offer to the economy if investment can be sustained.

Recommendations

Rec 12 Universities should continue the development of talent with which they have engaged much more effectively in recent years and promote a strong mentoring culture.

Rec 13 Universities should provide more effective and balanced careers advice to all those involved in research. They should ensure that all individuals, of whatever talent, recognise the diversity of relevant career opportunities, the possibility of having impact in a knowledge-based career in the economy and society, and the mutual benefit then of remaining engaged with academia throughout that career.

Rec 14 Universities should seek to make use of their relationships with alumni to acquire better links with organisations and companies that use research. This will not only help to build research capacity in those organisations but also build knowledge of the research users needs within the research base. Alumni relationships could provide additional mentoring links for researchers.

Rec 15 Universities should enhance their knowledge capital by promoting mobility and circulation, nationally and internationally, as a key part of career development for their best people. (See also Rec 4).

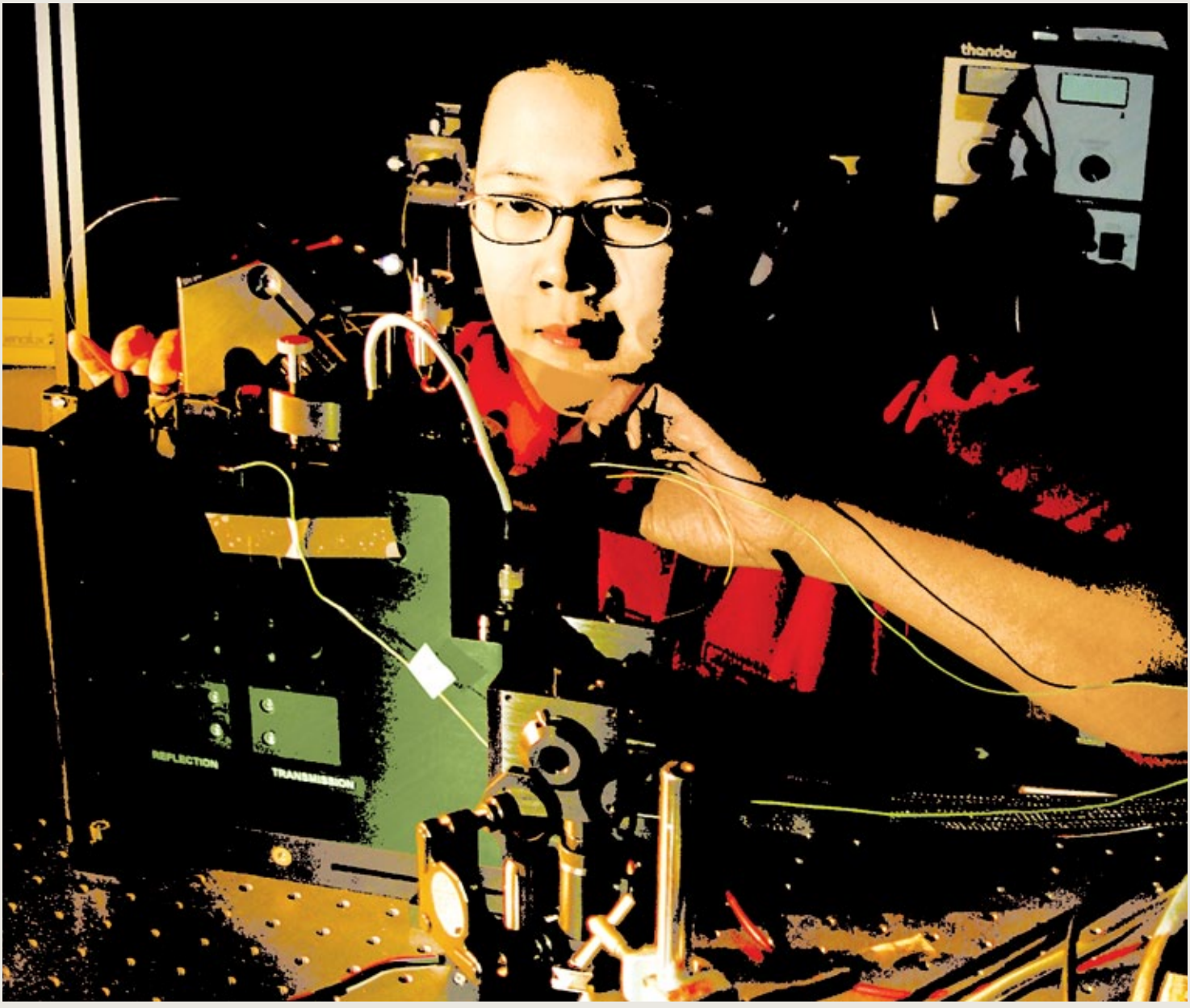
Summary of recommendations

Rec 1 Universities should set out more clearly what they can do in relation to innovation in industry and they should assert the need to work with, not for, willing and contributing industrial partners. Collectively, through Universities UK, they should examine and deconstruct investment agendas and reinterpret to government what is realistic and achievable, and then ensure that the objectives are collectively met through the collaborative development of stronger local and regional forums with committed business partners.

Rec 2 Universities should take ownership of the 'impact' agenda and provide a more effective and useful interpretation of its meaning instead of leaving this to policy makers outside the research base. In particular, they should adapt and translate the impact agenda in relation to different disciplines which address diverse economic and social objectives.

Rec 3 Universities and industry should collaborate in owning any intermediate 'knowledge transfer' institutions established by government and should do so as partners in regional consortia. This would provide the new institutions with direct access to partner organisations and their knowledge and facilities. Mutual ownership would reduce threats and distance and joint management would foster collaboration, strategy and exchange.

▼
7. Researcher from the University of Swansea's internationally recognised multidisciplinary team within the School of Engineering.



Rec 4 BIS should enhance schemes to enable researchers and industrialists to exchange places for three or six-month periods, which means engaging with motivation. This will increase dialogue, enable researchers to acquire understanding of industrial problems, and enable industrialists to mentor young researchers in new perceptions of problem identification. (See also Rec 15).

Rec 5 Universities should look at strategic partnerships in terms of tangible, long-term commitments, rather than only academic exchange and short-term student recruitment. At the moment, the UK is in a position to strike a good bargain because it has much to offer. But the balance will change and when strategic partnerships become a necessity, it may find a scarcer availability of good partners.

Rec 6 Research Councils, other funding bodies and HEIs should consider enabling a much larger proportion of academic staff they support, to gain overseas experience, with funded sabbaticals in other research economies.

Rec 7 Universities should work with schools to assert the need for competence in a foreign language as a prerequisite for a research career in any field. They should work with the Funding Councils to strengthen appropriate provision in modern languages for their own research staff.

Rec 8 Research Councils and BIS should expand current investment in international mobility when financial flexibility once again allows. One way might be for BIS, through the Research Councils, to offer an enhanced salary plus a completion bonus on a research studentship when at least 12 months have been spent studying in an overseas university (but at only marginal cost to the Research Council, which would otherwise see this as a constraint on numbers of studentships). An even larger premium could be offered to those who choose to work in one of the emerging research economies. The net gain to the UK in terms of collaborative links, knowledge of overseas activity and net expertise, would be very large. The cultural shift could be even more significant.

Rec 9 The system needs to be stringent in building on TRAC to achieve sustainability. Universities should exercise greater oversight to ensure that investigators avoid taking on contracts that are not properly resourced. Investigators need to accept that they are project managers and must work to scope and cost projects more fully and then to work within resources. This echoes the 2010 report of the RCUK/UUK task group chaired by Sir William Wakeham[8] on financial sustainability and efficiency, which states that 'it is not clear that institutions are actually using the metrics [provided by TRAC] as effectively as they might' and concludes 'that the use of metrics to analyse trends, can and should be improved.'

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