Higher Education Policy Institute (HEPI), Thursday December 2, 2010: 'Research Excellence: competition or collaboration in today's globalised Higher Education sector'

NF speech (20 minutes): Perspectives on UK's Research Strengths

Script

0. Good morning. I'm delighted to have the opportunity to discuss the UK's Research Strengths from the perspective of a science publisher. Elsevier is one of two thousand science publishers and is part of Reed Elsevier that is headquartered just a few hundred metres from here.

   I will first say a few things about our industry and our role before going on to offer perspectives on the UK's research strengths from the vantage point that we have. I will end with suggestions of areas for further collaboration with the UK Higher Education sector to address specific challenges and opportunities that we see.

1. Every year the Science, Technical and Medical information industry publishes over 25,000 journals, 100,000 new book titles, and several hundred databases and analytical tools. These are used by researchers and practitioners in universities, government, funding bodies, corporations and hospitals to help advance science and improve healthcare outcomes.

   I will speak today about science journals and even though we are a global industry I will give mostly UK examples today. That said, in many respects the science journals industry is a UK success story: it employs over 10,000 people in the UK and generates over £800 million of annual export revenue for the UK. With over 70% of turnover coming from electronically delivered content we are at the forefront of Digital Britain. But more importantly the industry supports the global success story that is UK science that I will describe today.

2. We are very fortunate as science journal publishers to have a unique vantage point on the world of scientific and medical research.

   Each year our industry receives three million article submissions globally, each one seeking to advance science in its sub-field. We co-ordinate their peer review via relationships with 300,000 expert reviewers. We accept, edit, produce, disseminate and preserve around 1.5 million articles via electronic and print journals to a worldwide audience of 30 million researchers and practitioners. They download over 2 billion articles a year: around 75,000 will be downloaded during this twenty minute speech alone. We then record the citations that are made to those articles at the rate of 80,000 per day, or 30 million per year.

   Science journals also create the norms and rules that determine the ethics and integrity of science in society, and as such are crucial in building public trust in science. Without journals, there would be a cacophony of claims and voices with no means of judging quality or authenticity. Journals shape an ethics of knowledge, which is critical to the effective use of that knowledge in public affairs.

   In summary, the science journal publishing system is the global forum in which scientists report, debate and advance research. By managing its inputs, interactions and outputs, we are get to see much of what is going on in that forum.

3. While we are fortunate to have a unique vantage point, it has limitations. Our view is weighted towards basic rather than applied research, and to academic rather than commercial outputs such as patents, licenses and spin-offs. While publications and citations are widely recognised measures of output and impact, they are proxy not absolute indicators.

   For example, consider Robert Edwards who won this year's Nobel prize for Medicine. He published a seminal paper about In Vitro Fertilization (IVF) in *The Lancet* in 1978 that was cited 44 times more frequently than all the other highly cited papers in *The Lancet* that year. Does that mean his paper was 44 times better? Of course not.

   Compare that to Andrew Geim and Konstantin Novoslev who won this year's Nobel Prize for Physics. They published a seminal paper in *Nature* in 2005 about Graphene, the thinnest and strongest material known to us. It was cited 23 times more frequently than all the other highly cited papers in *Nature* that year. Does that mean that their paper was 23 times better? Of course not.

And was the IVF paper twice as good as the Graphene paper because it was cited almost twice as much relative to others in the same journal that year? Or is IVF which has resulted in about four million human births more than twice as important to society as Graphene which enables faster computers and lighter aeroplanes? Who are we to say?

Publication impact is certainly not the same as societal impact even though the two are often associated. These case studies also illustrate the great care that needs to be taken if qualitative and quantitative approaches are to be combined meaningfully as measures of "Impact" for national assessment purposes.

So with these caveats, let me make some observations about what we see of the UK's Research strengths.

4. UK researchers published over 114,000 articles in 2009, giving them a 6% share of articles published globally. The number of articles authored by UK researchers grew between 3 and 4% per year from 2003-2009, slightly below the global average of 4%.

5. The volume of the UK's published research outputs reflects the amount that it spends on R&D. As you can see here, this is the case for most countries: there is a very strong correlation between research inputs (i.e. annual spending on R&D) and research outputs (i.e. published articles). The US spends the most and publishes the most. As a result, changes in R&D inputs by country are driving profound shifts in the share of R&D outputs.

6. For example, in 2006 China's share of global R&D spending was 4%. However, because it continues to increase its R&D spending by over 20% every year compared to single digit growth in the UK, US and Europe, it is projected to account for 13% of global R&D spending by 2015.

7. As a result, China's article output is exploding: it has already overtaken the UK as the world's second largest producer of research publications and it is poised to equal the US in this decade, possibly even as early as 2013 as this extrapolation shows.

8. While the UK may have lost share slightly in terms of volume, in terms of publication impact it is a major player: UK articles are cited on average 5.8 times, higher than the global average of 4.6. As the Royal Society has noted, UK Research 'punches well above its weight'. The UK accounts for just 1% of the world population and 4% of R&D spending, yet it has a 6% share of articles published and accounts for 14% of the world's most highly cited articles. The UK's publication impact is continuing to increase, and this is associated with a steady increase in its collaboration rate.

9. This dynamic is part of a global trend in which science is becoming more collaborative. For example, the percent of articles that were co-authored by researchers residing in separate countries increased from 26% in 2003 to 33% in 2008. The UK's rate of international collaboration, however, is significantly higher: 41% of articles were co-authored with non-UK researchers in 2008.

10. This chart shows that this trend of international collaboration is good news because international collaboration is associated with higher publication impact. In both 2000 and in 2008, articles that have four co-authors residing in separate countries are cited around three times more than articles with no international co-authors.

11. So who are UK researchers collaborating with? This diagram gives the answer. The nodes show countries whose researchers co-author at least 1,000 articles with UK researchers. The closer the nodes are together, the higher the volume of co-authored articles. Not surprisingly, the US accounts for the largest number of co-authored articles reflecting the size of its research base and the strength of geopolitical ties. Other collaborating partners reflect geographic as well as geopolitical proximity, such as France and Ireland. However, relative to their research strength, ties with China, Japan, India and Brazil are comparatively weak.

12. As science is becoming more collaborative, scientists are becoming more mobile. They move from nation to nation to develop their careers, expand their networks, pursue funding opportunities and to work with the best faculty and facilities. The same is true for the UK, which is important because the UK makes significant investments to attract and develop research talent, so it is now more likely that it will not directly earn a return on its investments. For example, this map shows that of over 250,000 authors once affiliated with UK institutions, almost half are now working outside the UK, most commonly in the US, Germany, and France. But of course, migration works in both directions. So as researchers become more mobile it is also

theoretically more possible for the UK to capitalise on others' investments. For example, we analyzed the publications of over 100 of today's UK university vice chancellors and found that 88% were previously affiliated with non-UK institutions.

13. So if UK researchers are increasing their impact through collaboration and mobility, where are UK researchers strong? This map helps answer that question. It show's the UK's distinctive research strengths and is based on articles published in 18,000 journals globally, not just those published by Elsevier. It shows that there are about 400 areas of research in which the UK is distinctively strong by international standards. Each bubble represents an area of research in which UK researchers are especially prolific or highly cited. The larger the bubble, the more articles there are in that area of research. Bubbles on the edge of the circle fit neatly into traditional subject classifications such as Maths, Physics, Chemistry, Biology and Engineering. However, bubbles close to the centre are more inter-disciplinary in nature.

    The map shows that the UK's strengths span a broad range of disciplines, from specializations in Social Sciences such as public policy and education, in Health Sciences such as mental health care and treatment of schizophrenia to asthma control, in Earth Sciences such as climate change research, and in Physical Sciences such as cutting-edge areas of theoretical physics like quantum dots. It is impossible to do justice to all the UK's research strengths here, so I will pick just three examples to discuss.

14. This first example shows an area of research that pertains to the application of Magnetic Resonance Imaging (MRI) technologies in clinical neurophysiology, in particular to problems of vision and memory cognition. It is a large fast growing area of research comprising over 20,000 articles in 2009 in which the UK has an impressive 24% share, closely behind the most prolific and most cited country in the field, the US. So the UK's share in this field is four times higher than the UK average. But also this State of the Art indicator here shows that the UK is also citing far more recent work than the US, an indicator that its researchers are truly cutting edge.

    UK institutions leading this field include some of its most research-intensive institutions such as UCL, Oxford and Cambridge. The field's most prolific author is from the University of Birmingham, and from the point of view of publication impact UCL is the leading institution in the world in this field, publishing almost twice as many articles and being cited more than twice as much as Harvard University which is number two in the field.

15. A second distinctive UK research strength shows a smaller field of research, also in health sciences, that pertains to Acute Psychiatric Nursing. It is interesting because it is the area of research in which the UK leads by the greatest margin in terms of articles and citations: the UK publishes roughly three times as many articles and has almost twice as many citations as the US, its closest follower. Unlike the former MRI example, here universities with quite different profiles are collectively driving this leadership, notably King's College London, City University London, the University of Central Manchester and the University of Nottingham.

16. My final example of a distinctive UK research strength is one of the UK's many interdisciplinary strengths. It pertains to sea levels and climate change. It is a distinctive strength for the UK because while UK scientists publish slightly less overall than their US counterparts in this sub-field, they are being cited more frequently than researchers from any other nation. The top institutions in the field globally in terms of publication impact include the British Antarctic Survey, Oxford, Reading, Bristol and Durham.

    To illustrate its inter-disciplinarity, one of the sub-field's most highly cited articles was co-authored by fifteen researchers in six UK institutions. These included physicists and computer scientists from Oxford, climate modellers from the Met office and the Rutherford Appleton Laboratory, a times series analyst from LSE, an earth scientist from the Open University, and a meteorologist from the University of Reading. The example also shows how effective collaboration across multiple UK institutions of quite different profiles can collectively create a national strength.

17. While I have picked just three examples of UK research strengths from around 400 that I could have chosen from, what is striking is the breadth of institutions that contribute to these competencies. So while the UK has many well-known research intensive universities, not one of them appears in more than 160 (i.e. 40%) of the UK's 400 areas of research strength. It is the combination and collaboration of many UK research institutions that is driving the UK's collective strengths.

    To illustrate this point, this chart shows the number of articles vs. the number of citations for all UK universities. Each data point represents a UK university. As we would expect, the research intensive Russell

Group publish more and are cited far more than the world average. However, while non-Russell group members generally publish less, they are also being cited more highly than the world average.

Combined with our knowledge of the wide distribution of universities accounting for the UK's research strengths, this analysis implies that the UK punches above its weight on a global scale because at the level of highly specific subfields, individual researchers across all types of institutions are contributing, often via direct collaboration with each other, to the UK's strengths, whether they are in large or small, research-intensive or research-selective universities.

18. My final observation is to point out a certain paradox: while the UK collaborates with other countries, it is also simultaneously competing with them in a process that some we might call 'Collabetition.' This page compares the UK's strengths in 2009 to the three other most prolific countries in the world. As we have seen, two of these – the US and Germany – are among the UK's strongest collaboration partners. The fourth – China – is not yet a close collaborator for the UK. While most areas of strength differ, they are all increasingly inter-disciplinary as indicated by all the bubbles in the centre of the maps. Nowhere is this more apparent than in most of all in the world's most prolific nation, the US.

19. Stepping back from these analyses, there are four key trends underway in science globally that create challenges implications for those who set policy and who fund research, whether in the UK or elsewhere.

    First, the relationship between R&D spending inputs and outputs means that nations and institutions will have to increase their relative investments to hold let alone advance their global position given the scale of spending by countries such as China and India.

    Second, as science becomes more collaborative, it will become increasingly important to find and build strong links in chosen focus research areas with the right research partners across traditional departmental, institutional and national boundaries.

    Third, because science is global it will be increasingly important to remain competitive to attract the best faculty and researchers.

    And fourth, the increasingly interdisciplinary nature of science means funding research projects across disciplinary boundaries, while at the same time ensuring that there isn't duplication of effort across complex webs of research.

    Science information companies stand ready to collaborate with UK researchers, UK universities, UK funding bodies, and UK government to help address these difficult challenges. I will close by briefly suggesting four ways in which we might do so.

20. First, through our core publishing activities we will continue to register, filter, disseminate and preserve the ever-growing outputs of research to maximise the impact of UK research. The efficient circulation of quality information helps drive the efficiency of research, as this study from the Research Information Network shows.

    While science journals account for less than half a percent of universities' expenditures they help drive the efficiency of the other 99% of spending: across universities, as the number of article downloads doubles, the number of papers authored more than doubles, the number of PhDs awarded triples, and the number of grants won quadruples.

    In turn, efficient research institutions drive quality of life and societal benefits, as the examples of like IVF and Graphene illustrate, and as a wealth of economic development literature shows.

21. Second, publishers can help provide access to research datasets. 93% of researchers globally say they are satisfied with access to journals, which they rank as their most important form of information to access. Yet only 38% are satisfied with access to experimental datasets which are also important for them. Through collaborations with key players such as the Wellcome Trust and the Cambridge Crystallographic Data Centre we are stepping up efforts to address this next big challenge in science information.

22. Third, we can help amplify the outputs of objective scientific research to inform government policy through collaborations such as we have with the Royal Society on the forthcoming global science report and with the League of European Research Universities on its position papers.

Individual journals can also work with scientists to inform international initiatives. For example, the UCL/*Lancet* commission brought together 29 researchers across 13 UCL departments including epidemiology, medicine, law, development planning, engineering and political science to examine the Health Effects of Climate Change. Since being published, its report was the most requested in Scopus of over 7,500 UCL-authored articles and was in the top 1% of most downloaded articles from ScienceDirect. Its findings were discussed at a meeting of commonwealth health ministers and were mentioned at the World Health Assembly.

The Lancet has extended this model, publishing a joint commission on the future of health and development with the London School of Hygiene and Tropical Medicine to coincide with the UN Summit held in New York. It is developing a second commission with UCL on Healthy Cities, and it will soon launch a commission with Harvard University on the future of health professional education.

23. Finally, through projects such as our collaboration with Imperial College London, and our joint follow up with Imperial, UCL, Oxford, Cambridge, Bristol, Queen's University Belfast and Leeds, we can develop metrics and tools to help institutions maximise the impact of their research investments. We can also provide data and analysis of collaboration networks, research strengths, and emerging hot spots of research to inform institutional and national decision-making.

24. In summary, quality information helps increase the impact of scientific research which in turn drives the impact of science on society.

    We are already working with scientists and policy-makers to protect and strengthen science in society, and we want to collaborate further with UK researchers, universities, and government to help you maximise your returns on research investments.

    There is much that we are doing, but there is much more that we can do.

    Through closer collaboration we aim to help you sustain and advance the UK's remarkably strong position. Moreover, we aim to help the UK address the complex, global and interdisciplinary challenges of our time to advance science and improve health for the betterment of society.

    Thank you.