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The Implications of International Research Collaboration for UK Universities

Research assessment, knowledge capacity and the knowledge economy

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The Implications of International Research Collaboration for UK Universities

Foreword from Universities UK

International collaboration is increasingly indispensable to excellent research. Working internationally enables individual academics to increase their impact and nations to pool talent and resources to address global challenges that no country can tackle alone.

Digital Science’s research report shows international research collaboration is also vital for individual institutions that aim to produce outstanding research, and that the increase in such collaboration has been very rapid indeed. The average UK university today is more international in its co-authorship than the most research intensive were ten years ago. By the same measure, many UK universities were already more international 20 years ago than the current average for the USA.

Because international collaboration increases citation performance, UK universities’ global reach is a source of strength and increases the quality and efficiency of the UK’s national research base. But in the context of the forthcoming referendum on the UK’s membership of the EU, it is worth noting one final point. The majority of our international collaborative partners in research are in other EU member states. Our collaborations with EU partners like Germany and France is growing faster than with other countries - showing how much we stand to lose if UK universities were to be cut off from EU programmes and influence.

Vivienne Stern
Director, UK Higher Education International Unit

Introduction

International collaboration has been an important priority for the national research strategies of all major research economies since the significant expansion of the ‘endless frontier’ of research after 1945 (Bush, 1945). Governments have encouraged research organisations, including universities and research laboratories, to increase their international engagement, with positive outcomes through institution-level agreements and shared research projects. Communications technology has enabled the leading edge to shift to an international network, creating what has previously been described as a Fourth Age of research (Adams, 2013).

At national level, an important motivation is cost-sharing. There are research facilities that no one nation can readily support: for example, particle physics and astronomy instruments. There are also cross-national risk and challenges addressed by international agreements like the International Geosphere-Biosphere Programme and agencies like the FAO and the World Bank. Research can also be a form of diplomacy, leading to alliances and memoranda between national academies. For universities, international links create esteem and demonstrate the wider engagement and status of an institution, helping to attract students and staff from an international catchment. At the level of individual researchers and research groups there has also been a significant growth of collaboration, much of which will have developed outside the frameworks of formal agreements. Research advances faster and further by combining your agenda with partners, but it is not cost-free since it involves not only tangible resources but time to discuss and agree shared priorities. Collaboration is therefore limited to the number of sustainable and rewarding links.
UK research collaboration

International research collaboration can be tracked via the numbers of publications that are co-authored between countries. This is readily done by examining address data for the authors of articles and reviews in journals indexed by Thomson Reuters Web of Science™. The index covers the most frequently cited part of the literature on a consistent global basis and, critically for this analysis, on a comparable basis from 1981 to the present.

Data show that total research output has more than doubled over 30 years for some established economies. In fact, since the mid-1990s, the domestic research output of the UK (47,500 papers per year), Germany (45,000) and France (30,000) has not grown by any significant measure while their international collaboration increased more than ten-fold. This means that growth in the national annual headline figures is dependent on international partnerships.

About 90% of UK output was domestic in 1981 whereas less than half is domestic recently (Figure 1). This means that almost all the growth in output of the last three decades has been produced by international partnerships. UK research groups and universities will have led many of these but some must have been led by overseas institutions.

For Western Europe, domestic share of output decreased from about five papers in every six (around 85% in 1981) to half of that (around 45% in 2011). The USA also saw a fall in domestic share of output but it started as less collaborative (only 6% of its papers in 1981 had a foreign co-author) and, although it is the most frequent partner for many other nations, it remains less internationally collaborative today. For the emerging economies, the domestic share of output in 1981 is similar to that of the established economies but remained high and is still exceeds two-thirds of output (Adams, 2013).

As the volume of international collaboration increased, these papers have increasingly enhanced the UK’s relative international performance in comparative citation analyses. The average citation impact of domestic papers has been only slightly better than world average, but that of internationally co-authored papers has been higher on average and that difference has increased (Figure 2).
The same pattern is seen in papers for the US (Adams, 2013), so every country appears to benefit in this way from the pool of publications that is shared.

Research collaboration with Europe

Growth in international research collaboration is almost certainly enhanced by the incentives provided by European Framework Programmes, which have significantly expanded UK research opportunities. Co-authors from EU countries have increased from 43% in 1981 to include more than 60% of the UK’s international co-authors after 2011 (Figure 3).

Although international collaboration has increased substantially, the UK’s research collaboration with Europe has increased at a faster rate than with other partners and now covers more than half of all collaborative papers. Most of these papers are bilateral collaborations.

Figure 2. Citation impact of UK articles and reviews indexed on Thomson Reuters Web of Science™ relative to world average. The citation impact is greater for papers with international co-authors than for papers that have only UK (domestic) authors and the disparity is increasing.

Figure 3. UK articles and reviews in journals indexed on Thomson Reuters Web of Science™. The left hand axis is annual output where (1) the continuous blue line refers to UK total (2) the red line refers to UK output with international co-authors of which (3) the pink line refers to UK co-authors in EU countries. The right hand axis refers to the percentage of UK output that has a EU co-author (dashed pink line).
The USA is usually the most frequent international partner for other countries, partly because its huge domestic research capacity creates so many opportunities. The USA has been and continues to be the UK’s most frequent partner country but its dominance has declined. Germany and France, in particular, became increasingly frequent partners after 1990 and this growth accelerated after 2000.

Growth with EU partners has been much faster than with other parts of the world. The UK’s total output actually dipped below the 2000 value until 2004 but collaboration with Germany increased by 35% during the same period and co-authored articles and reviews have risen more than three-fold from 3,370 in 2000 to over 10,000 in 2014 (Figure 4).

The USA has been a co-author on 124,950 UK papers out of a ten-year total of 878,006 articles and reviews between 2004-2013. It has been the most frequent collaborative research partner for the UK over the last decade but, as Figure 4 shows, the share of collaboration taken by Germany and France has risen at a faster rate than overall growth in research output. Most of these papers have been bilateral, so the growth is not driven by EU programmes requiring multiple partners.
The analysis of collaborative papers for the UK's most frequent partners shows that most collaboration is bilateral, with just one partner. Less than 1% of UK publications (7,009 articles and reviews) have co-authors from all three lead partners (Figure 5).

For UK collaboration with Germany and France, about 30% of these papers (18,736 of 63,276 and 15,028 of 46,667) also have a co-author from the USA. It is evident that these partnerships do intersect, as might be expected for leading research economies with a long history, but that they exhibit an even greater degree of complementarity. That complementarity also occurs within Europe, with just 13,567 papers – about 1.5% of the UK total - having UK, German and French co-authors.

**University research collaboration**

International collaboration is not evenly spread across the UK research base.

Some institutions are more collaborative - or are more attractive to partners - than others. Gazni and Thelwall (2015) have shown that the proportion of their research output that is collaborative among the top 100 universities in the CWTS world ranking (CWTS, 2015) has increased more than their links with the rest of the world. These elite universities also increasingly cite research within their own network.

The most internationally collaborative UK university in 1981 was the University of Cambridge. At that time, one in six of its papers had an overseas co-author when the UK average was one in ten. It has since increased its indexed research output almost five-fold and the share that is internationally collaborative has risen to 60% of its current output. The upward trajectory of both output and collaboration shows no sign of moderating.

Other universities were not as collaborative as Cambridge but the ‘golden triangle’ is generally more international than the UK average and Edinburgh is the most collaborative Scottish university. Of ten universities analysed in detail, collaboration has risen for all but has done so at slightly different rates. Exeter,
for example, has increased its profile from one of the less collaborative universities in 1981 to being ahead of the UK average in 2015. Geographically, the data suggest that acquiring a high level of international collaboration may be more challenging for institutions based in the north of England, and that post-1992 institutions are generally less collaborative (Figure 6).

Another way of looking at these data is to compare the degree of international collaboration with the citation impact of the institutions. This analysis is a very broad summation of the diverse performance of different departments and there are likely to be marked disciplinary differences in the opportunity to collaborate. It is evident from the national overview in Figure 2 that collaboration and average citation impact will be linked; the institutional analysis confirms this (Figure 7).

The data in Figure 7 are not current output but a recent period for which citation counts have accumulated more substantially (citation counts rise over time at a rate that is field-dependent). The UK average share of international co-authorship (around 50%: Figure 1) is much higher than the median university (43.2%) because universities with greater research output are relatively more collaborative. There is a strong association between each institution’s average citation impact (rebased for discipline and year of publication) and the percentage of its papers that have an international co-author. The median values partition the landscape into quadrants in Figure 7 and it is striking that those institutions with less than 43% international co-authors tend to have average citation impact at or below world average (the UK overall is well above world average). There are also some intriguing outliers.

![Figure 7](image-url)
Outcomes, impact and assessment

Internationally collaborative research publication has increased for the UK research base as a whole (Figure 1), in line with other research economies (Adams, 2013). The balance of partners is dynamic and collaboration has risen more steeply with the EU than with the rest of the world (Figures 3 and 4). The most research intensive universities are more collaborative than others but the trajectory of collaboration is progressively upwards for all universities (Figure 6). Less than half of the UK’s output is now purely domestic and the domestic share is much less for some leading universities.

Publications with international co-authorship are on average more highly-cited than UK domestic publications (Figure 2). This enhances other differences in research performance measured by citation analysis, with the consequence that there is a significant correlation between the average normalised impact of a university’s papers and the share that is internationally collaborative (Figure 7).

The broad pattern of collaborative publication, citation distribution and balance across institutions captures a Fourth Age of research enterprise where the leading edge of research and innovation is shared across countries (Adams, 2013). Several critical consequences emerge from this analysis: for institutions, for assessment, and for the knowledge economy.

Institutions in the Fourth Age of research

The most research-active universities are intensively engaged with partners in other countries (Figure 6) and the publications that emerge become the most highly cited part of the UK (and international) research base. This shifts the leading edge of research from a national base to an international network and the gap between that network and the domestic research base is growing (Figure 2).

By implication, universities that are not partnered with institutions in other countries are less closely engaged with that leading network. If they are not actively involved then they risk being left behind the advancing research front. Their reduced awareness impairs their ability to competitively acquire resources, and that will further compromise their research capacity.

To retain access to the network of knowledge and innovation and to remain competitive in accessing resources, it is essential that each university develops a strategy to expand its international engagement.

Assessment in the Fourth Age of research

If half of the UK’s output is shared with other leading research economies (Figure 1), and if that half is the part of research output that attracts most citations (Figure 2), then metrics comparing research performance with other nations are seriously compromised.

More than half the output used to profile the UK research base belongs, at least in part, to the countries with which the UK is compared. When we evaluate UK research publications, and particularly when we look at the most highly-cited research featured in UK government reports (BIS, 2013), then a large part of what we see is actually research produced by and in collaboration with the USA, Canada, European partners, Australia, China and others. Less than half the
volume, and much less than half the citations, are attributable exclusively to the UK research base.

Bibliometric comparison (the analysis of publications and citations) can no longer really claim to measure differences between countries because the most frequently cited research comes out of a shared pot of networked projects. Domestic citation rates are barely distinguishable from world average, so the exclusive national part is not what any country would choose to submit as evidence of global excellence.

What goes for countries also goes for universities (Figure 6), with the added complexity of collaboration with other universities within the domestic base. Less than one-third of Cambridge’s output of articles and reviews for 2011-2015 was authored solely by staff at that university. This means that most of its excellent publication profile, and more than two-thirds of the citation data that feeds into world university rankings, is shared with other institutions in the UK or abroad.

Universities like Cambridge are unquestionably producing much excellent research. The point is that neither Cambridge, nor Harvard nor Heidelberg, do this on their own and those who use assessment indicators (research ‘metrics’) are wrong if they suggest that a distinct attribute of a single institution is being captured. The more active, high profile and internationally engaged the institution, the wider of the mark will be a quantitative assessment.

The knowledge economy in the Fourth Age of research

A final point is that if key papers are shared then so is their intellectual content and so is any IP arising. Institutions may need to be wary about the agreements they sign over ownership and rights to exploitation of research outcomes. They may be in no position exclusively to capitalise on this.

For institutions and for countries, IP ownership and holding knowledge assets is a thing of the past. This is part of a shift to open research. From this point forwards the key will be how agile and competent you are to use assets that you cannot prevent others from accessing. The only organisations that can train people with this knowledge agility are universities and they do it best if they have a well-founded research environment in which researchers can be encouraged and given a high level of training (Dearing, 1997).
References


Dearing R. (1997). Higher Education in the Learning Society (the Dearing report). NCHE/97/850. HMSO, London. ISBN: 1 85838 254 8. London: Her Majesty's Stationery Office. See 11.2 (The main roles of research in Universities): to add to the sum of human knowledge and understanding; to inform and enhance teaching; to generate useful knowledge and inventions in support of wealth creation and an improved quality of life; and to create an environment in which researchers can be encouraged and given a high level of training.
