Global science: Is it a tool of national contestation, neo-colonial hegemony writ large, the hope of the world, or all of the above?

University of Bath ICHEM conference 19-20 June:

*The future of higher education: Competition, collaboration and the global good*

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**[TITLE SLIDE: Global science: tool of national contestation etc]**

Thank you [ ] Greetings, it’s good to be with you! This morning I want to talk about *global science*. In the first instance ‘global science’ means knowledge in the two main bibliometric collections, Web of Science and Scopus. But as I will discuss it does not stop there. Note that here ‘science’ includes part of the social sciences and some humanities. Why talk about research and science at a conference on higher education? Science and higher education are closely joined. Not all higher education institutions are research universities, but universities are important players in science. More than four fifths of published science papers have at least one university author.

I’ll start with the global science system, and the relation between on one hand global science, and on the other hand national government and national science. Then I will move to who are dominant in global science, who are excluded, and how relations of power in science are changing.

[**1. Growth of global science]**

First, the growth of global science. This is an outcome of the spread of Internet-mediated communications after 1989. The global science system became patterned by the expansionary dynamics of an open network. Because US universities led the early growth of the Internet, also became shaped by American faculty norms, including free collegial interaction independent of government. And the Anglophone sense of superiority!

**[The global science system]**

Since 1996 papers in the global literature have grown by 5 per cent per year, doubling every 12 years or so. There has also been rapid growth in papers with authors from more than one country. Partly through this, active science has spread to many more countries. Most of the important new work in STEM starts in the global literature, not single nation literatures.

**[Dynamics of open networks]**

There’s a lot to be said for open networks. Knowledge, messages and information travel with lightning speed without regard for national borders. Innovations diffuse very rapidly, and networks become cheaper per connection as they expand. By joining the pre-existing network, new researchers and new national science systems gain access to immense resources. Established institutions and large countries cannot gatekeep. New researchers can form ties with anyone else in the network. The fastest growth is in relations between researchers in different emerging science countries.

**[Growth of science papers in Scopus by country]**

The graph on the left shows indicates rapid growth since 1996 in science papers in China, India and the rest of the world. Established science systems in US, UK, Germany and Japan expanded more slowly. Three decades ago the Anglophone countries, Western Europe, Russia and Japan dominated science. This is no longer the case. The number of countries generating 90 per cent of world science rose from 20 in 1987 to 32 in 2017. Over 60 countries now have viable science systems, with their own PhDs in at least some disciplines. All these national systems connect to the common global system.

**[Number of science papers in Scopus, by type of collaboration, world]**

The number and proportion of papers co-authored in more than one institution in the same country has risen sharply. Papers co-authored in more than one country have risen faster. Internationally co-authored papers jumped from less than 2 per cent of all papers in 1970 to 23 per cent in 2020.

**[Internationally mobile/ foreign[\*] doctoral students as % of all doctoral students]**

Mobile doctoral students played a great part in the globalisation of science, though the international proportion varies by country. It’s 41per cent of all research students in UK, much higher than the OECD average.

**[Why researchers collaborate]**

Why do researchers collaborate across borders? There are several explanations in the research literature and the real world. Funding and programmes can incentivise cooperation, as in Europe, but the inner drives of researchers are probably the most important factor. First epistemic – knowledge-related – motivations. The drive to discover, to create new work. Respect for other scientists good at what they do and a willingness to trust them. Shared problems, interests and curiosity. Second, common values. Friendship. Third, individual self-interest: there may be career gains in going global. Partnerships between established researchers in the global North and emerging researchers in the global South are common, but can also be exploitative.

**[The science network is not a level playing field]**

The global science system is shaped to some degree by agreements between governments, and between universities, but primarily shaped from bottom up. Bottom up, but not egalitarian. Resources, capacity and influence in science are not equivalent and still less equal across the world. Not a level playing field.

[**2. National and global science]**

The bottom-up faculty to faculty dynamic is more potent in shaping *global* science than are national governments. Let’s look more closely at the relations between global science and national science.

**[“Sciences develop internationally, but funding is mainly national”]**

National governments and research agencies are materially essential to science. They underpin the institutions in which basic science is housed. They should provide a stable policy, legal and regulatory framework. Many in government see the global science system as simply an outgrowth of national science, interlocking with other national science. But this misses the fact of global networking, collaboration and creativity. Global knowledge and its organisation is grounded not in universities or in countries but in disciplinary groups, in freely connecting research networks. The global science system is much more than the sum of the different national parts.

**[Science is *multi-scalar*: Global science and national science constitute distinct and overlapping systems]**

In geographical terms, science is multi-scalar. It operates at different levels – iindividual, locally collaborative, national, often regional, and global, all at the same time. These scales of science differ in fundamental ways. National science is centred by the nation-state, by governments. Global science has no normative centre. It is bottom-up. It is regulated not by rules and funding allocations but voluntary cooperation, shared understanding, and scientific protocols. It is influenced by national governments but largely outside any one nation. Of course there is a large area where national and global science overlap. Scientists who lead global disciplines often also lead at institutional and national level. Globally sourced knowledge enters into national agendas.

**[Methodological nationalism blocks a clear view of science]**

However, methodological nationalism, the belief that only the national scale matters and has consequences for us, can stop us clearly seeing global science. Global science, and nationally controlled science, are different. If nations treated science as a common human endeavour, focused on shared global problems such as climate change or epidemic diseases, the relationship is more seamless. But if nations treat science as a tool of ‘technological nationalism’, hoping to mobilise science to pursue competitive nation-bound agendas, global s and national science can find themselves pulling different ways.

**[Global science is science driven – national research funding does not necessarily link to national innovation]**

Methodological nationalism leads to confusion about the relation between science and the national economy. Governments hope that by investing in science in universities and other agencies, they foster economic innovation. But the so-called ‘national knowledge economy’ is a myth. On the balance of probability, national science that enters the global pool is much more likely to be used by foreign capital, not local capital. Innovations by national industry are mostly sourced in foreign science. Further, the majority of research is ‘altruistic’, not focused on economic development or national security at all.

**[3. Hegemony and exclusion]**

Nations have resource power and legal power. The global system has knowledge power. They often work together, but are sometimes pulling apart. Now let’s unpack that earlier statement: ‘science is not a level playing field’. Science is a beautiful thing, but not *everyone’s* beautiful thing. There are walls around it. Let’s look at ‘hegemony’ as Gramsci called it, dominance via consent, and also at which knowledge, and which agents, are included. And excluded.

**[Leading research universities in global science]**

This table lists the world’s 16 leading research universities in production of highly cited science papers. Citations measure recognition, not quality, but an order based on recognition does show us where science power is concentrated. This list favours large institutions with big groups of productive scientists. It includes 8 universities from US, 3 from UK, 1 from Canada, and 4 from China. China is rising. Four years earlier there were 12 from the US and none from China. In a few years Tsinghua will be second. But Harvard, with twice as much high citation science as Stanford, remains dominant. This is primarily because of the research output of the Harvard medical school.

**[Global science is real *but* its boundary is constructed]**

That list told us a lot about global science. It is led from familiar universities that concentrate resources and talents. So, you might think, they house the main work with scientific merit. Scientific merit is dominated by English speaking universities. Rising stars in China excel by being good at Western science. So the West is the best and the rest nowhere? It’s not that simple. The universities that dominate the comparison house the leading scientists who shape the basis of comparison. They determine what is legitimate as global science, interacting with the publishing companies that circulate global science, in journals edited by these same leading scientists. They also determine what is included in Scopus and Web of Science. Through these processes, knowledge is rank ordered in terms of value and prestige. Not that some knowledge is selected as legitimate and other knowledge is excluded. There is also a hierarchy within the selected global knowledge, based on journal ranking and citation impact. Global science is real but also shaped by social relations.

**[‘Global science’ is knowledge published by five firms, legitimated and value-ordered by bibliometrics]**

Let’s look more closely at how global science is defined, circulated and valued. Global science publishing is largely monopolised by five huge companies. Like science they operate freely across national borders. Science is a public good but by publishing it, these companies gain ownership and monetarise it. Open access publishing has become another way of monetarising science, via author processing charges. The networked scientific world is a goldmine to publishers. They actively encourage the publish or perish growth of science, regardless of content or originality, because this expands their market share and profitability. They use faculty as peer reviewers and editors on a non commercial basis. Is science subsumed into capitalist production? Are scientists reduced to wage labour for publishers? Largely, no. Publishers do not create knowledge. They are parasitic on knowledge. But they affect the rhythms of its production and its use as a tool of institutional, national, economic and cultural power.

As noted, journal output is fed into the two bibliometric collections. Books play only a minor role here, as peer reviewed journals are more amenable to rank ordering based on journal selectivity and citation impact. Bibliometrics underpin a quasi-economy of science in which all outputs are ranked, regulating the value of individuals, academic units, institutions, countries.

**[Bibliometrics in global rankings stratify worldwide higher education]**

This machinery now has great momentum. Yet it rests on decisions about inclusion and legitimacy made by leading faculty in the disciplines. A crucial part of the machinery is global university rankings. Research metrics directly determine most of the Shanghai and Times Higher ranking, and the prestige effects of research metrics indirectly determine the surveys used by Times Higher and QS. Rankings translate bibliometric performance into the recognised hierarchy of universities, in which the Anglophone universities are dominant, and privileged social groups reproduce their place in the world. Here we have moved a long way from the shared joys of grass-roots scientific collaboration. The collegial decisions of peer reviewers are not only monetarised by publishers, they are used to fix university hierarchies.

**[Global science as hegemonic social practice]**

This is the ambiguity of global science. On one hand it is open collaborative knowledge creation. On the other hand it is annexed to institutional and geo-political power, and reproduced in circular fashion by a combination of national science infrastructures, leading universities, leading scientists, publishing companies, bibliometric companies, and university rankings. It is also neo-imperial. It reproduces a global cultural hierarchy, inherited from the colonial era, which at bottom believes that some cultures, some languages, countries, people, are more highly valued, more creative and scientific, more objective, than others. There is universal science. The rest is just local, or so the bibliometrics say. What falls outside the charmed circle? Everything else.

**[What is *excluded* from global science?]**

Which knowledge is not included in global science? (I am not talking here about fake news, or propaganda, I mean what truth-oriented material?). First, research-based ‘grey literature’ in government and commerce. Second, research for local or national use, including most social sciences and humanities. Third, nearly all knowledge in languages other than English, including all indigenous knowledge. English is the world’s third largest first language after Chinese and Spanish, and the first or second language of less than a fifth of all people, but 95 per cent of Scopus papers are in English.

**[The ‘abyss’ between the dominant culture and the excluded others]**

The divide between knowledge that is inside global science, and outside global science, is the old colonial divide between the dominant powers and the rest. The languages of the colonised are all excluded. Why? The Anglophone countries and the Western countries do not monopolise all wisdom. Quite the contrary. Monocultural Western capitalist economies are destroying the earth.

[**4. Signs of change]**

Fortunately, everything is always changing. No system of power is fixed in stone. It is possible to have a more inclusive and diverse science conversation. Though it is also possible that things could get worse - science could become more closely annexed to national interests, fracturing the global system and the hope of building a more inclusive system on a worldwide basis.

**[Pushback in Latin America]**

The paradox of global science is this. Open networking is fostering all round capacity development, but global hegemony has imposed hierarchy and closure on the network. This has not stopped scientific development but it has imposed closure based on a single system of value. New science players must conform to the content requirements of the leading players, reproducing their dominance. Latin American scholars point out that when science is defined as work in English, Latin American science seems impoverished. But that is totally incorrect. When work in Spanish and Portuguese is included the picture is different. There is pushback against the Anglophone control of science also in Latin America and Africa, and in China’s emphasis on higher education and research with ‘Chinese characteristics’.

**[In the last two decades science capacity has developed rapidly in middle income and some lower income countries]**

In the long run the spread of science must foster a more inclusive and diverse world of knowledge. Let’s look closer at all-round capacity development. Science output in China now exceeds the US. India has passed Germany, UK and Japan to become third largest producer. Brazil, Iran, Turkey, South Korea, all outside the West, have large-scale science infrastructure and output.

**[Established and slow growing science systems in the period 2000-2020]**

The next two charts make the point. They show two contrasting groups of national science systems. The charts indicate national output (the size of the ball), the rate of annual growth in papers between 2000 and 2020, the vertical axis, and national income per head, the horizontal axis. The dotted line is world average income per head. The first chart shows science systems that after 2000 grew *more slowly* than the world average rate of 5.15 per cent per annum. These are mainly established science systems in Western countries with incomes well above the world average.

**[Emerging and fast growing Science systems in the period 2000-2020]**

The second chart is a different story. The systems where science output is increasing *faster* than the word average rate. Mostly new science powers. Some show spectacular growth – almost 20 per cent per year in Iran, almost 25 per cent in Indonesia. And look at the diversification in terms of economic indicators. Half of these countries have incomes per head below the world average. Like mass higher education, global science has spread to many middle income countries and some low income countries as well.

**[Top universities in STEM research, Leiden ranking]**

There is also pluralisation at the top levels of science. Let’s look at the universities leading high citation research – top 5 per cent papers – in STEM. Physical sciences and engineering on the left, mathematics and computing on the right. These tables are absolutely dominated by China. The two Singapore universities also figure. Five years ago, 11 of the top universities in physical sciences and engineering were from the US and one from China. Now ten are from China and two from the US. It is not that American science has declined, it is just that Chinese science, fed by state investment, has developed very quickly and moved past the US. China is even more dominant in maths.

These numbers greatly worry some in the US. The US has now moved to decouple US/China research collaboration. China’s rise in science partly rested on collaboration with US research but I don’t think weakening US-China ties will ‘contain’ the rise of China. China’s science capacity is now well established.

**[Top universities in other science fields]**

It is a different story in other science fields. In biomedicine and health Anglophone universities are still dominant. The highest Chinese university Shanghai Jiao Tong at 66. Earth and life sciences are more geographically plural.

**[Growing impact of geo-politics]**

In the last five years governments have become more nation-bound and competitive about science. Some collaborative projects are being discouraged, reducing university autonomy and academic freedom. Geo-politics are cutting into the global system. The US China Initiative is associated with racial profiling of Chinese heritage American citizens, investigations shading into persecutions, discouragement of joint appointments and projects, visa blockages affecting Chinese students. A large minority of American scientists are now reluctant to work with Chinese scientists. Sino-American tensions have spilled over into securitisation of research policy in UK, Australia and Western Europe. Meanwhile Brexit has taken the UK out of the EU and the UK is yet to negotiate re-entry to the Horizon research programme. The war in Ukraine is undermines research capacity in Ukraine and global cooperation in Russia. These geo-political developments are a threat to the open global science system.

[**5. Finally – is global science ..?]**

So to the conclusion. What is the answer to the question posed at the start of this paper? Is global science

[**A tool of national contestation?]**

A tool of national contestation?

**[A neo-colonial monster?]**

A neo-colonial monster?

[**The hope of the world?**]

The hope of the world?

**[All of the above?]**

All of the above?

You know the answer. It is all of the above.

**[Global science: upsides and downsides]**

Global science has great potential and both upsides and downsides. Scientific knowledge is collective, collaborative and accumulative. It is a common good that transcends the separated self-interests of individuals, institutions, companies and nations. At best it looks beyond a nation-bound perspective and thinks as the world as a whole. It has been open and has facilitated diverse national nodes and scientific voices. It can talk truth to power. It undermines populism, social media rants and fake news. The reflexivity of science, its mode of judgement, is the test of truth. This is tremendously valuable to us.

But global science is almost exclusively Western, neo-colonial and in the its assumptions and relations and worldviews. The global system is steeply hierarchical inside and it excludes the vast majority of human knowledge, including almost all knowledge in languages other than English. Extraordinary. All indigenous knowledge. Think of the indigenous knowledge of land, nature and ecology. We lose so much by excluding this diversity.

**[Independent global science, yes. But hegemonic and exclusive – now geo-politics threatens to lock it into national silos. Science should be autonomous. But also open, not closed]**

Autonomous global science has evolved in a hegemonic and exclusive form. Autonomous scientists have been the excluders. Though they have been aided and abetted by publishing and bibliometrics. Now geo-politics threatens to overbear the autonomy of science, lock it into national silos, weaken or fragment the global system. So where do we go from here? I believe we should defend the autonomy of global science from technological nationalism and from commercial publishers, but also push for the fuller opening of science. We should maintain open cooperation between scientists across the world. We should strongly oppose any manifestations of a cold war in science.

**[Yes, “listen to the science” But which science? Time will tell!]**

‘Listen to the science, yes’. But which science? In face of global problems, global knowledge and cooperation are all we have. Science is crucial. That makes it all the more important to bring all the voices, all the different ways of seeing, all insights, all ideas, into the common conversation. The ways forward to more democratic relations of power are genuine open access publishing, and global science based on multiple languages. Using software to translate knowledge in languages other than English into English, and knowledge in English into other languages. That would immediately change things.

Thank you very kindly for listening. I look forward to questions.