

Map of scientific collaborations from 2005 to 2009  
Computed by Olivier H. Beauchesne @ Science-Metrix, Inc.  
Data from Scopus, using books, trade journals and peer-reviewed journals

## **‘The Fourth Age of Research’: implications and actions for global universities**

Professor Sir Steve Smith and Dr Jonathan Adams, British Council in Tokyo, 9 December 2014



# Summary of session

This session will cover:

1. **What is the 'Fourth Age of Research'?**
2. **International research collaboration – the latest evidence**
3. **Global success – how university leaders should respond**
4. **Questions and discussion**



# International Research Collaboration

- ‘*The Fourth Age of Research*’ (Jonathan Adams, *Nature* (May 2013))
- Most highly cited work is international (50% increase with papers with authors in more than one country)
- In 2012: 48% of UK papers had no overseas author (down from 85% in the 1980s)
- US: 67% of research is still domestic (1981: 94%)
- Japan and China: 75% of research is produced in-country



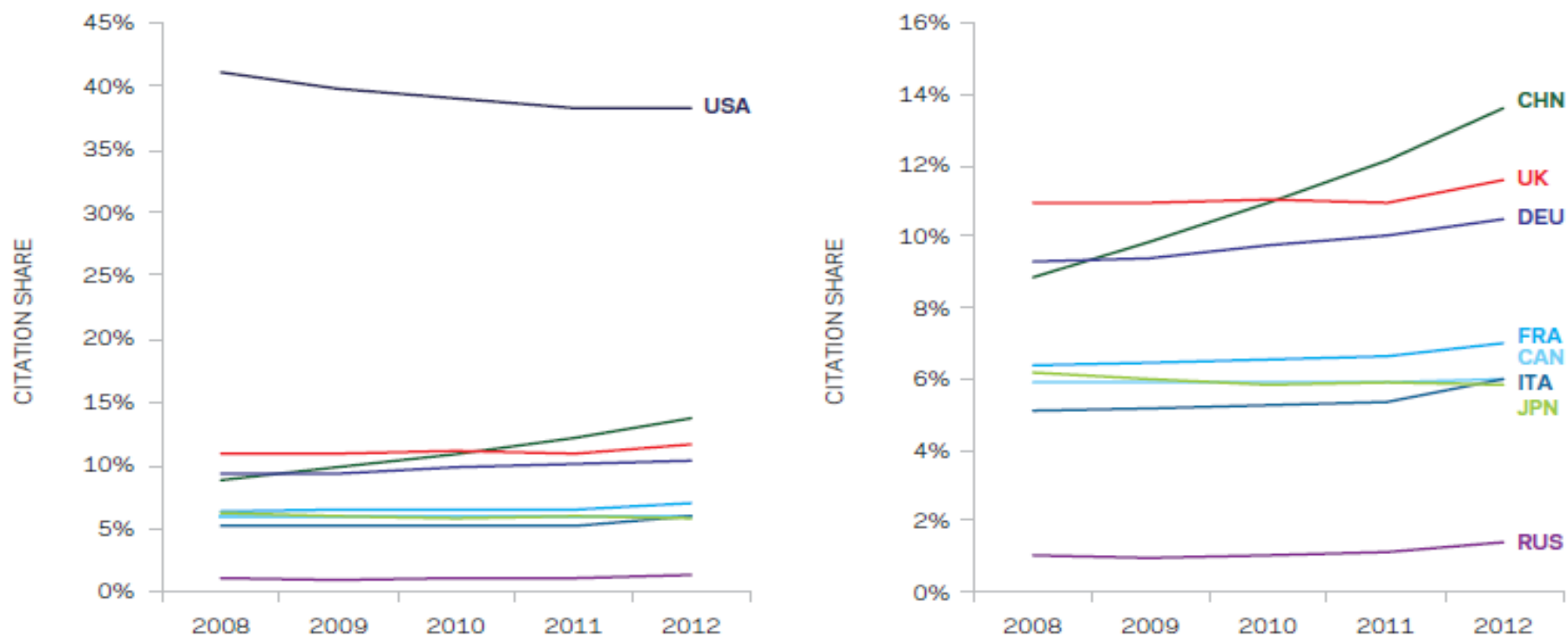
# International Research Collaboration

- UK & US: international collaboration = adds 20% to average citations
- UK: 2001 publications: 1.21 world average levels of citation
- 2011 publications: 1.47 world average levels of citation
- Papers with at least one international co-author: rose from 1.48 to 1.72 world average citations (2001-2011)
- Growing divide between international- and domestic research-focussed institutions. 65 UK HEIs with <40% international co-authored papers: 1.1 world average citations; 10% of research funding; 5% research grants; 1% of research council studentships



# Share of world citations...

**Figure 4.4** — Share of world citations for the UK and comparators, 2008-2012 with right-hand panel excluding the US for clarity. The share for '2008' is comprised of citations in the period 2008-12 to articles published in 2008, while for '2012' it is comprised of citations in the period 2012 to articles published in 2012. Source: Scopus.

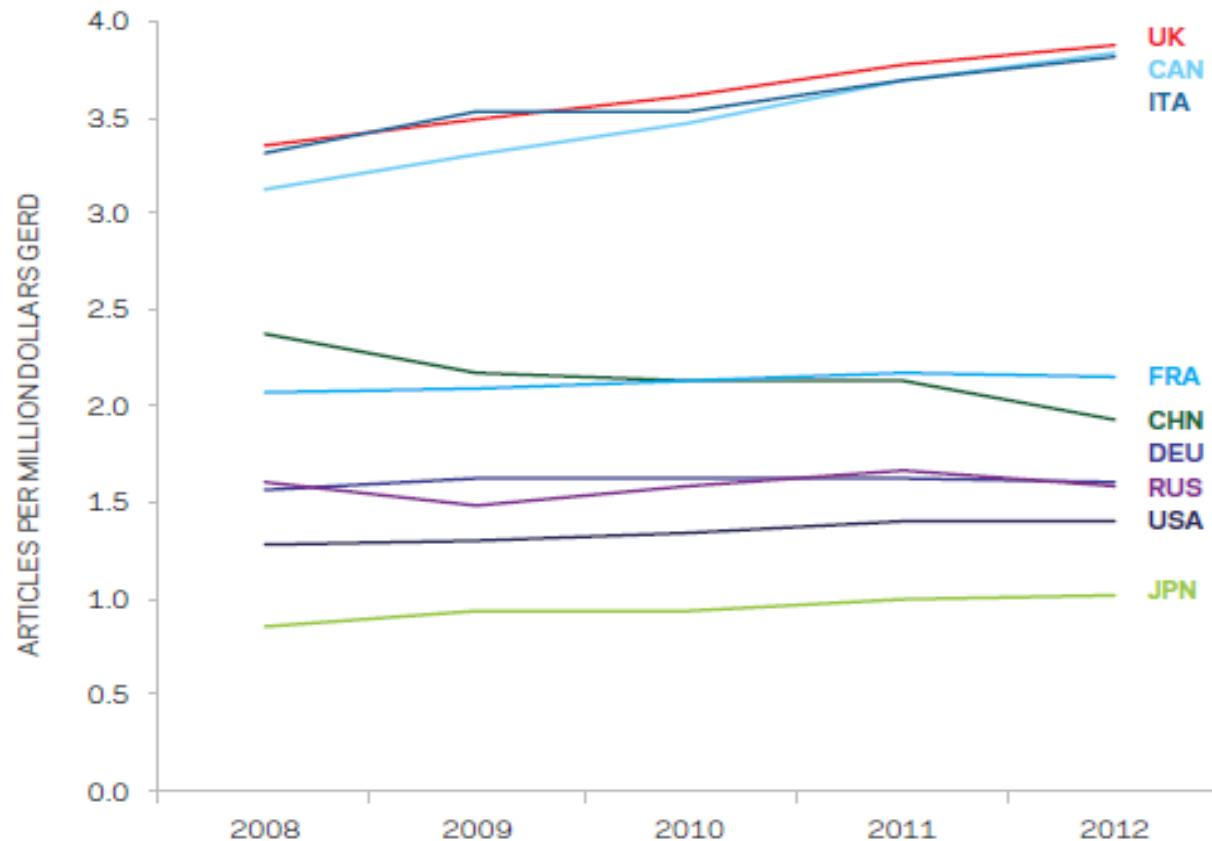


# Correlation: International co-authorship share and field-weighted citation

**Figure 5.2** — Correlation between international co-authorship share and field-weighted citation impact of internationally co-authored articles, 2008. The square of the correlation coefficient ( $R^2$ ) of the linear regression is 0.4577, meaning that the regression explains 45.77% of the variance, suggesting a relationship between them. Source: Scopus.



# Articles per unit spend on GERD

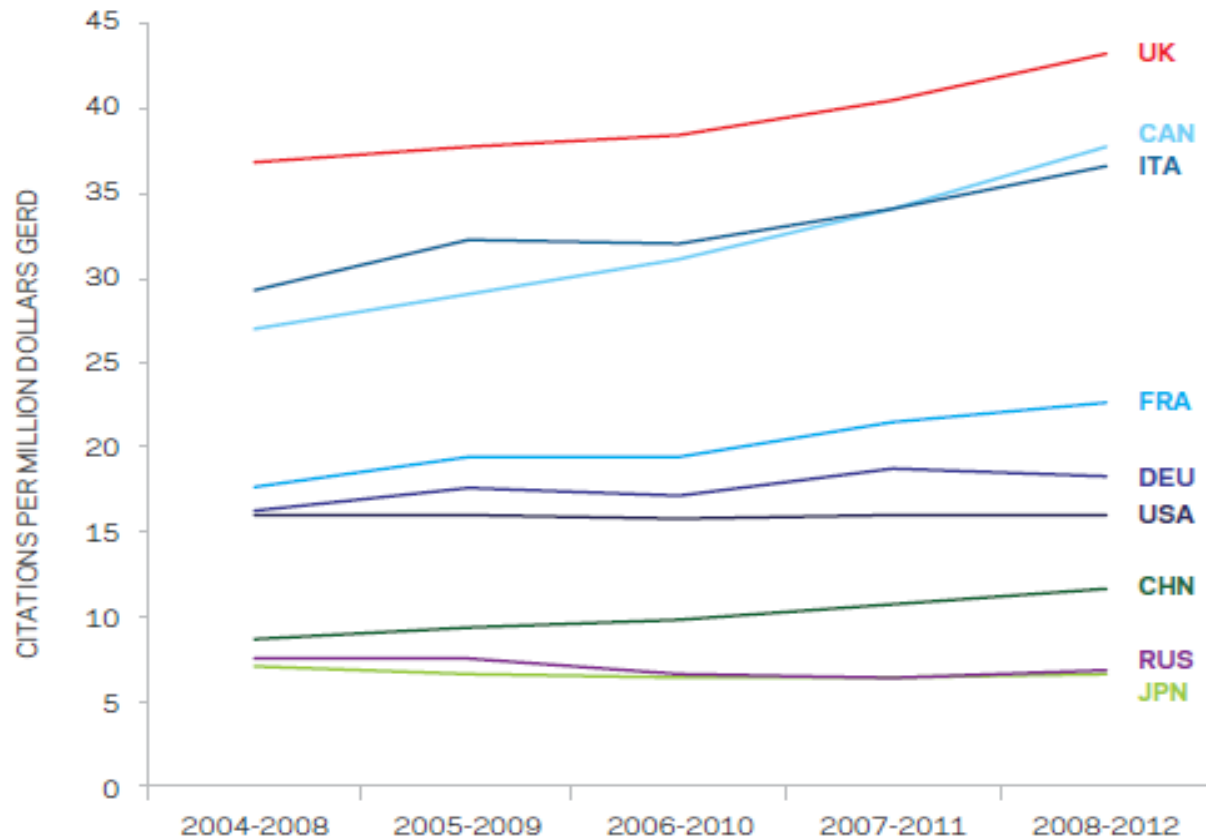


**Figure 6.1** — Articles per unit GERD for UK and comparators, 2008-2012. UK ranking in EU27 is amongst 22 (of 27) countries with available data. Source: Scopus and OECD MSTI 2013/1.





# Citations per unit spend on GERD



**Figure 6.2** — Citations per unit GERD for UK and comparators, 2008-2012. Each data point corresponds to articles published in the first year shown and citations to these articles over the subsequent 5 years, and GERD for the first year shown; i.e. the data point for 2008-2012 corresponds to 2008 articles and citations to these in the period 2008-2012, divided by 2008 GERD. Note that, owing to refinement of the methodology used to calculate citation indicators, these shares differ slightly from those presented in the previous report in this series. UK ranking in EU27 is amongst 22 (of 27) countries with available data. Source: Scopus and OECD MSTI 2013/1.





# International research collaboration: the Fourth Age of Research

**Jonathan Adams**

**See also: Nature, 497, 557-560 (30 May 2013)**

# Research in the longue durée

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The impact of research led to changes in the economy and society and then in research itself

## The age of the individual

- Newton, Leibniz, Banks, Owen, Darwin

## The age of the institution

- The Humboldtian model of the research university (1810)
- The Royal Institution (adopts research in 1862)
- The Victoria University in northern England (1880s)

## The age of national research enterprise

- Foundation of mission-led Research Councils (UK)
- Science – the endless frontier (USA)

## The age of international research networks

- 1984 – European Framework Program (now starting 8<sup>th</sup>)
- 1987 – Human Frontiers Science Program led by Japan
- The researcher as an individual remains, but the structure of success has evolved
- Engagement with research users has – perhaps – gone back to its roots

# Typologies of change in knowledge production

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Commentators take multiple perspectives on the evolution of research

Research producers create knowledge which is transferred and used  
Mode 1 to Mode 2 (knowledge production – Gibbons, Nowotny, Scott, Trow)

- Mode 1 – research, publish, read, use
- Mode 2 – engage, develop, share

Science 1.0 to Science 2.0 (many, various)

- Science 1.0 - research leaders seek grants, run teams, publish
- Science 2.0 – put ideas on the web, share development, users participate, pool resources, modify continuously, eventually publish

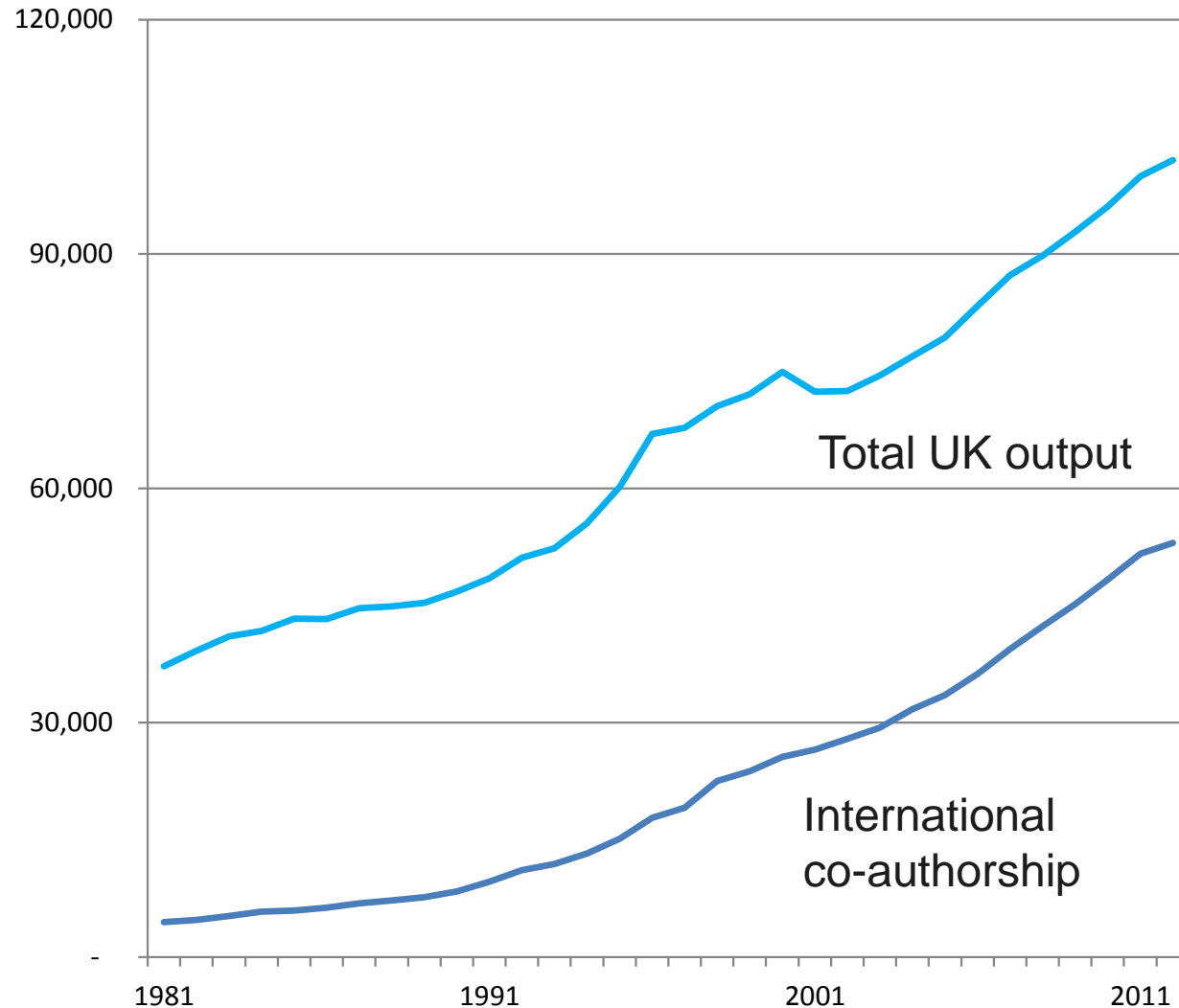
Four ages mirror these changes

- Collaboration is critical for both producer and user
- Research and transfer accelerate

# Rising levels of international collaboration are welcomed – but not always understood

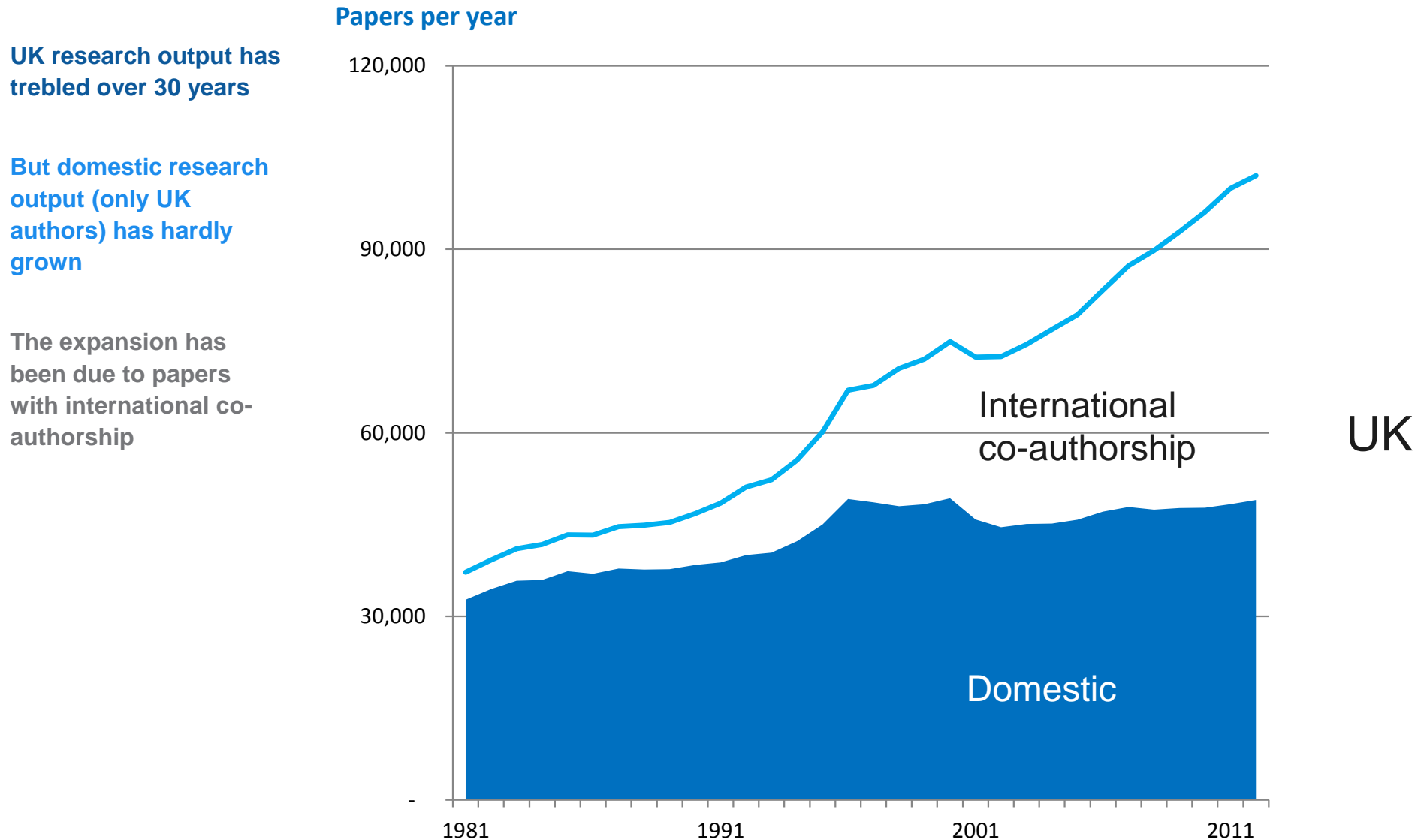
UK research output has trebled over 30 years

Papers per year



UK

# Rising levels of international collaboration are welcomed – but not always understood



# Rising levels of international collaboration are welcomed – but not always understood

UK research output has trebled over 30 years

But domestic research output (only UK authors) has hardly grown

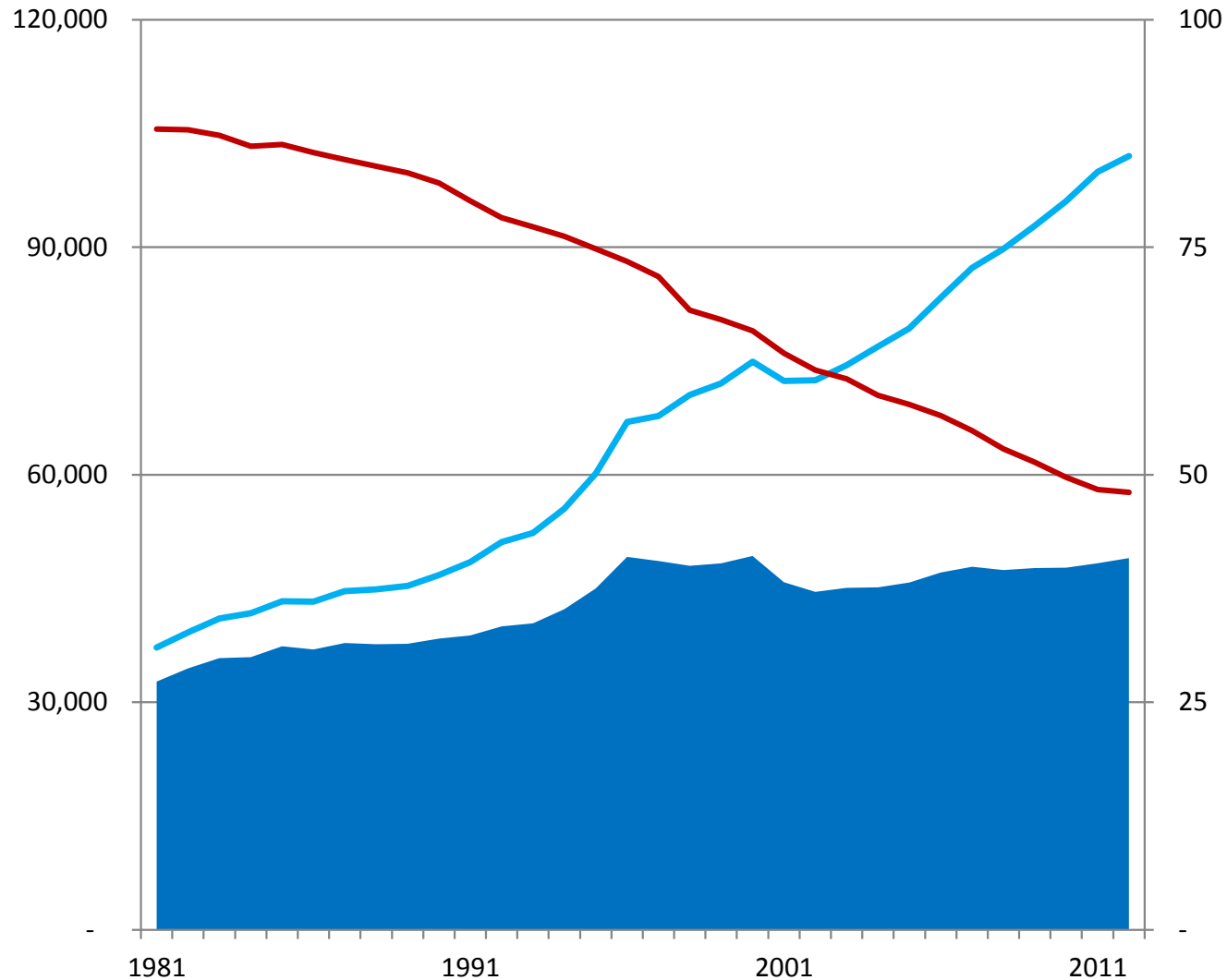
The expansion has been due to papers with international co-authorship

Less and less of what UK researchers and universities publish is 'home grown'

In fact, domestic research is less than half national output

Papers per year

% domestic





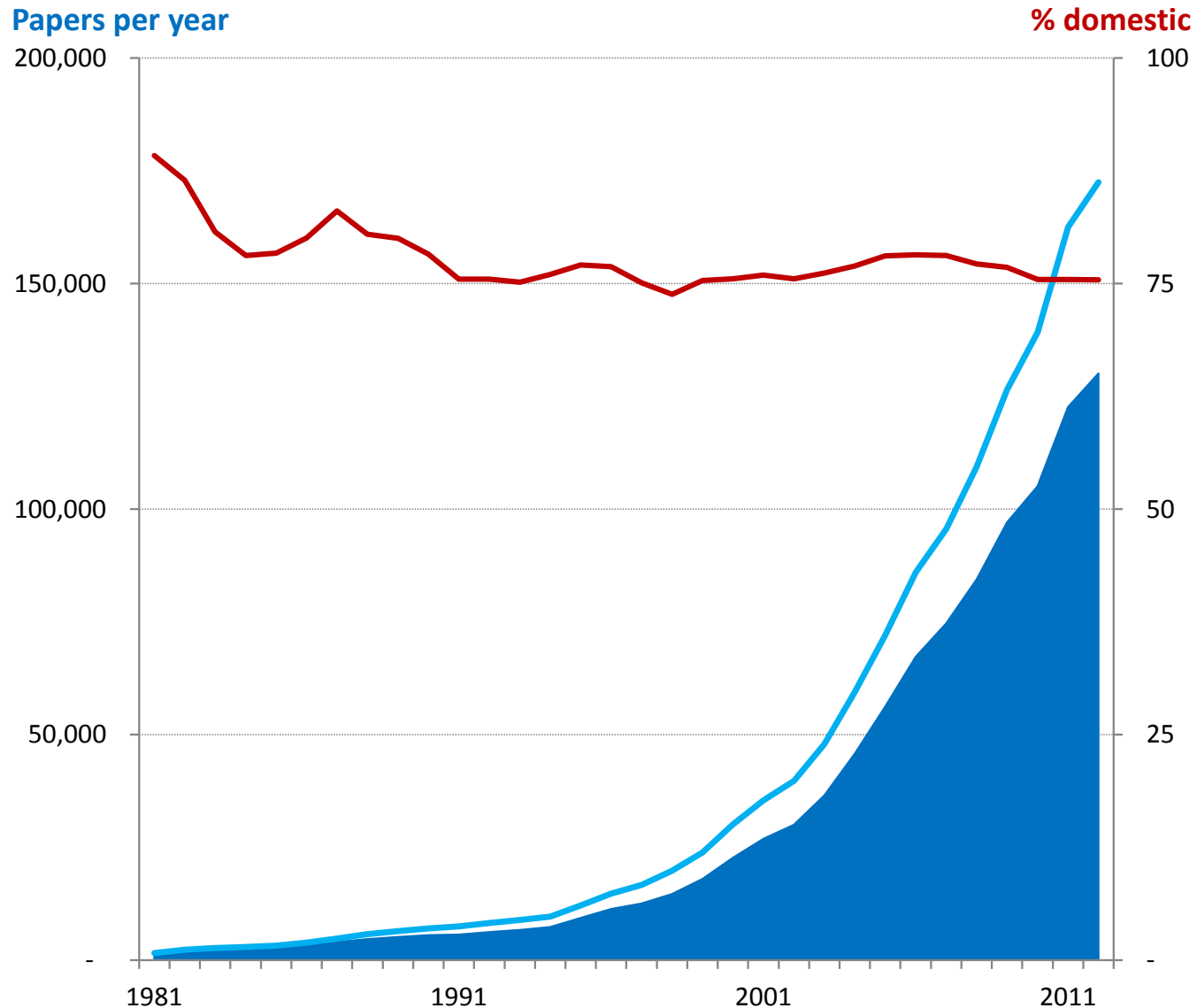
# Meanwhile, BRIC economies have a rather different profile

China's research output has grown 100-fold over 30 years

Most of that growth has been domestic research output

There has been expansion in the international sector

China is growing too fast for older economies to be able to engage at the same pace; domestic research remains the larger part of national output



China

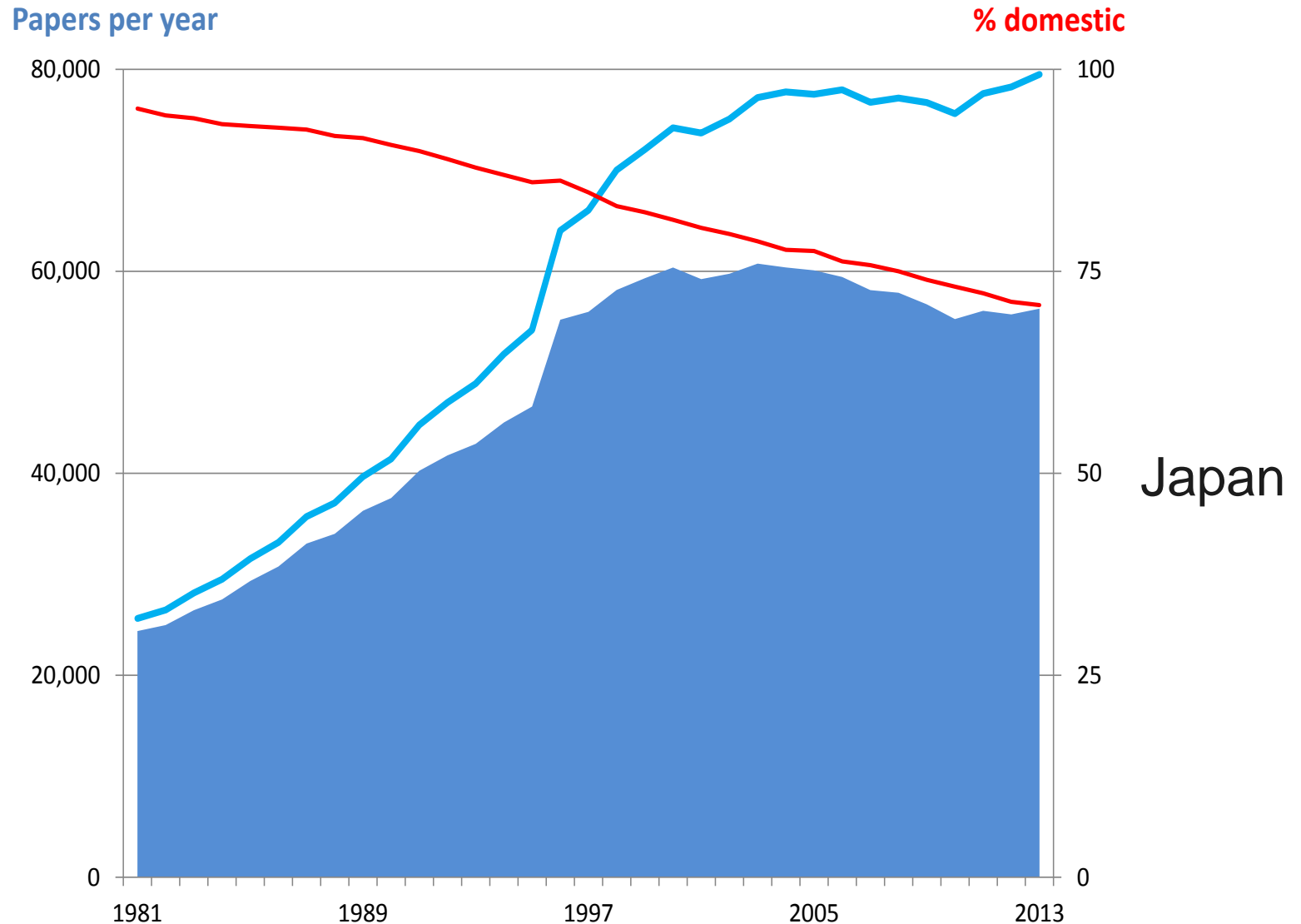
# Japan has increased collaboration more slowly which may have limited growth

Japan's research output grew rapidly in the 1990s but then stopped

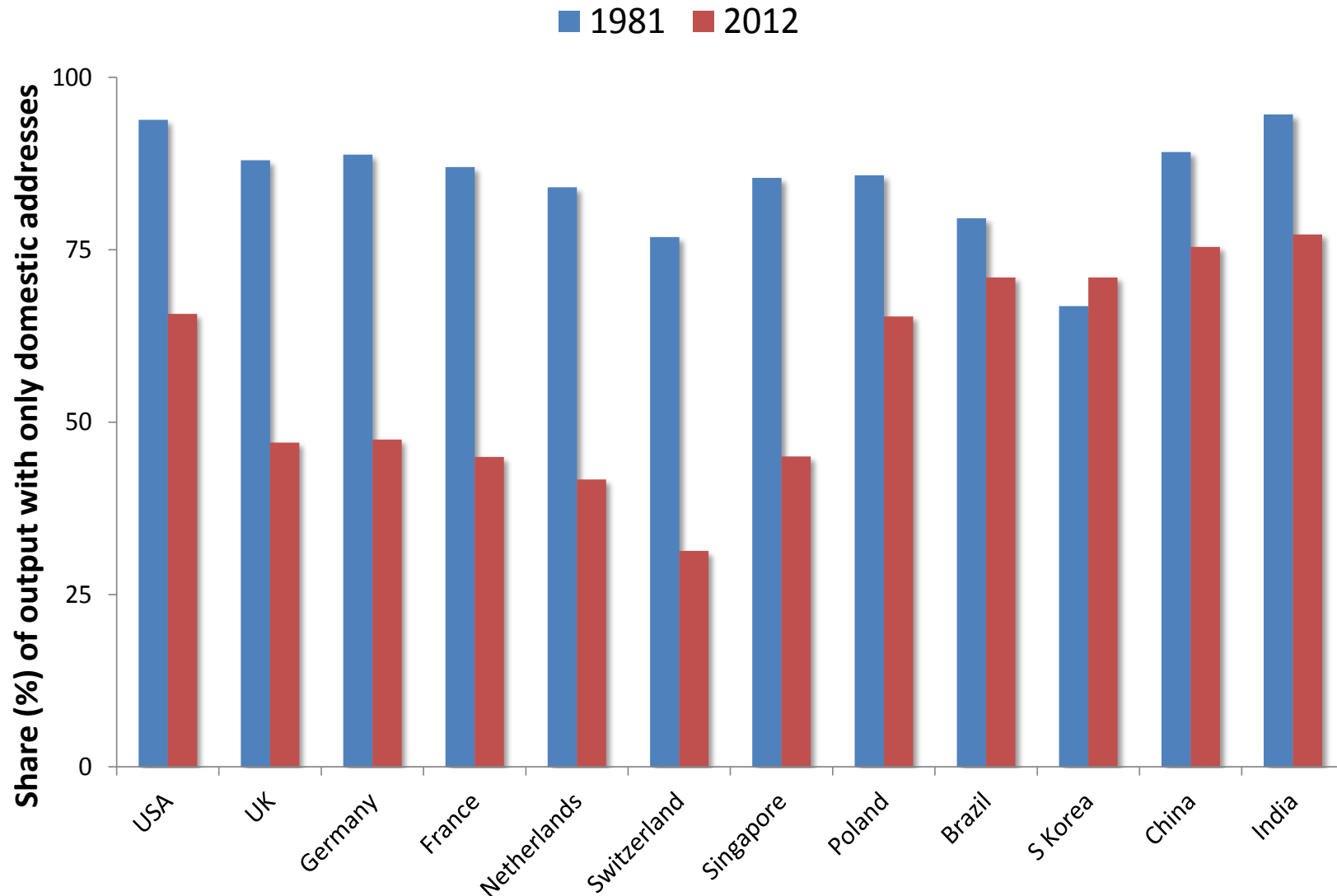
Domestic research output remains high but is not expanding

International collaboration has increased steadily but more slowly than Europe, USA

Japan's domestic output is not the problem but its relatively low level of collaboration may be a limiting factor for international performance



# Established economies grew by collaborating while emergent economies just grew



UK – less than 50% of research output is purely domestic

Switzerland – domestic capacity boosted by international facilities

China, India and Brazil – growing so fast that collaboration cannot keep up

Poland and Singapore – economies that bridge regional cultures?

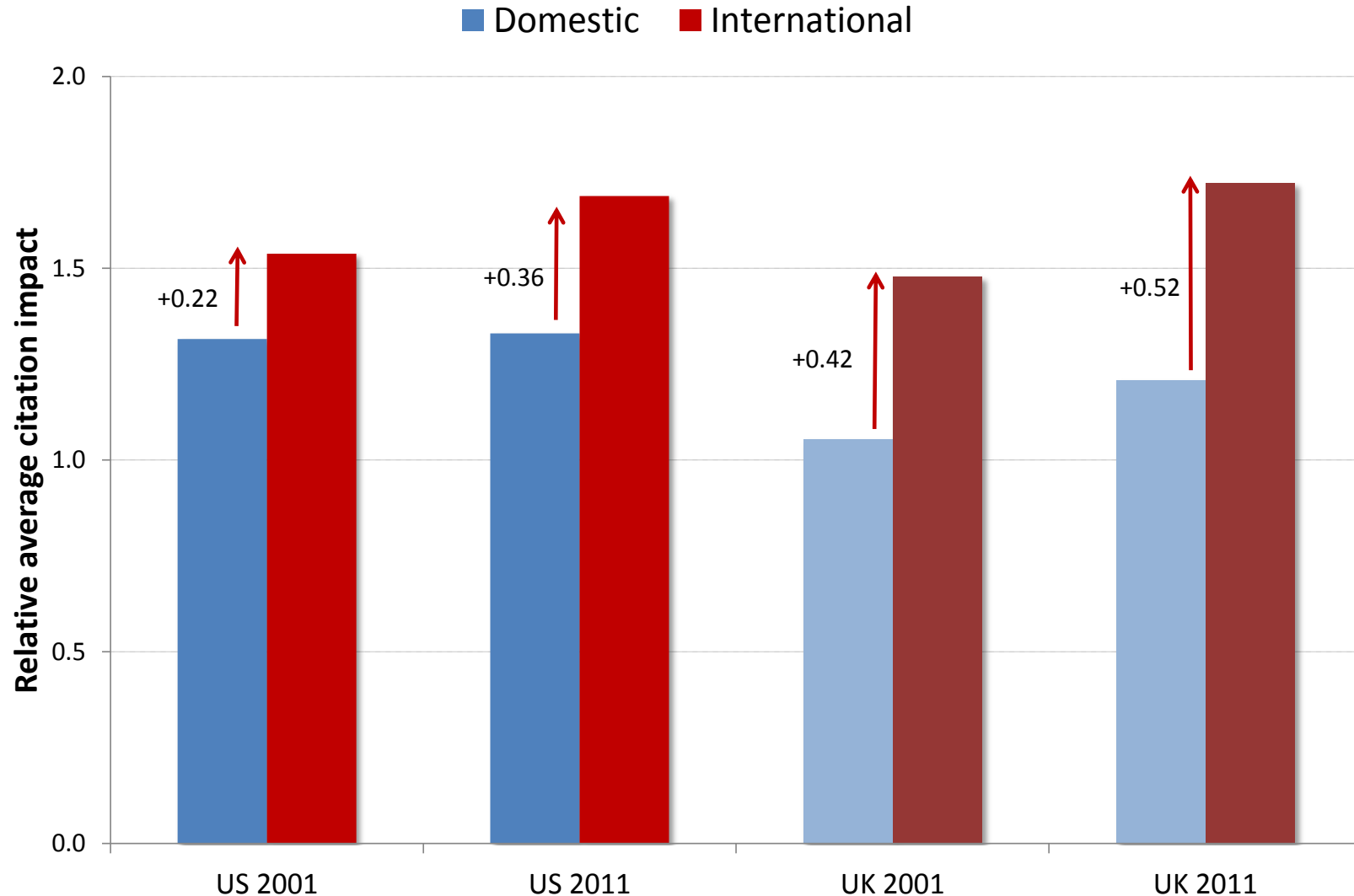
# Quantity is nothing without quality – and quality is increasingly linked to collaboration

Even leading researchers gain in average citation impact with international co-authors

That gain is increasing with time

[Rising impact gain] + [Falling domestic volume] = the leading edge of research is the collaborative network

What are the national and institutional implications?



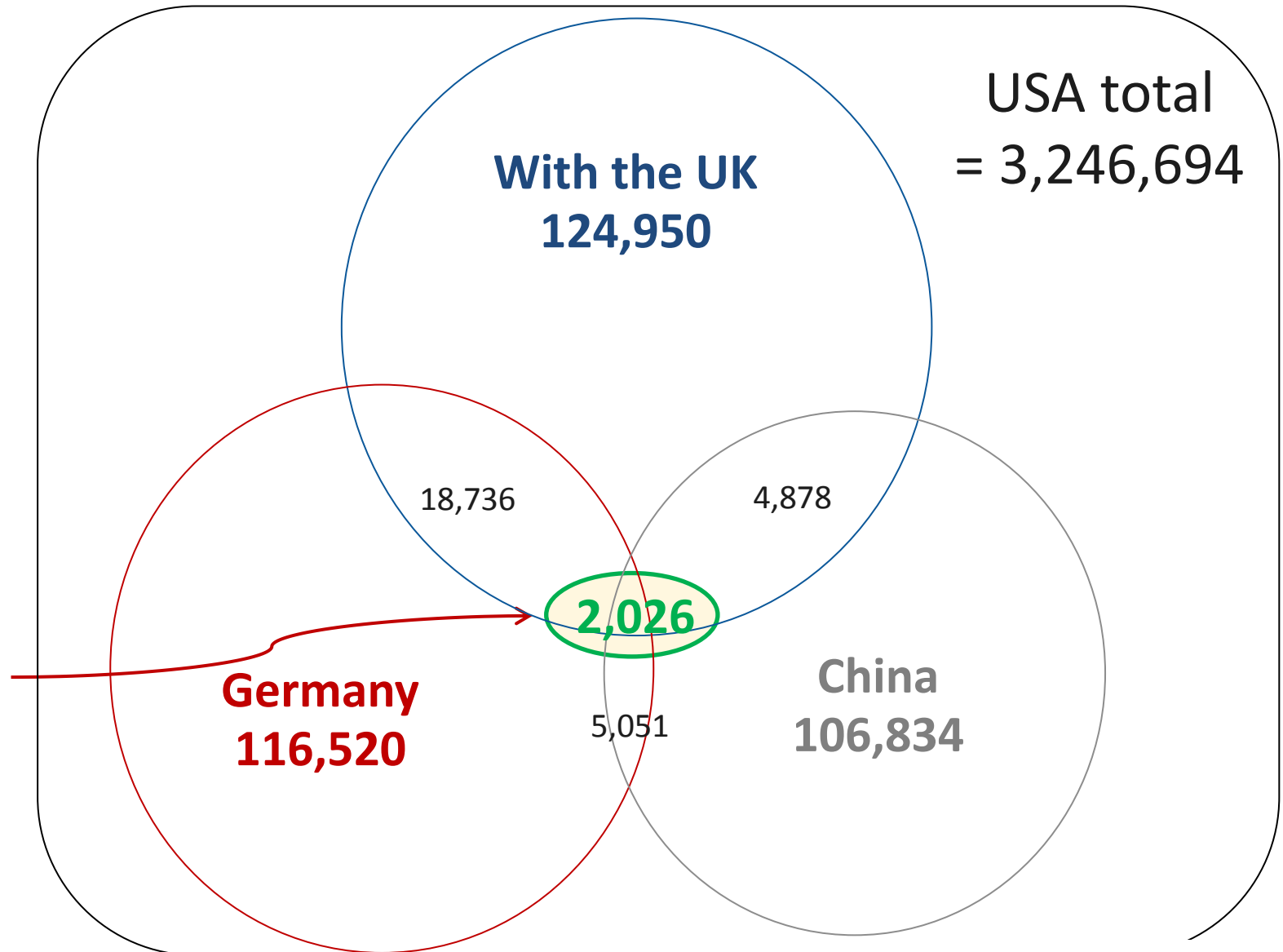
# Most collaborative research is bilateral; multi-national programmes are a small part of total activity

USA published over 3 million papers on Thomson Reuters *Web of Science* in 2002-2011

30% of US output is now internationally co-authored

Most US papers co-authored with researchers from leading partners are bilateral

Tri-lateral and highly multilateral papers make up less than 0.1% of total output



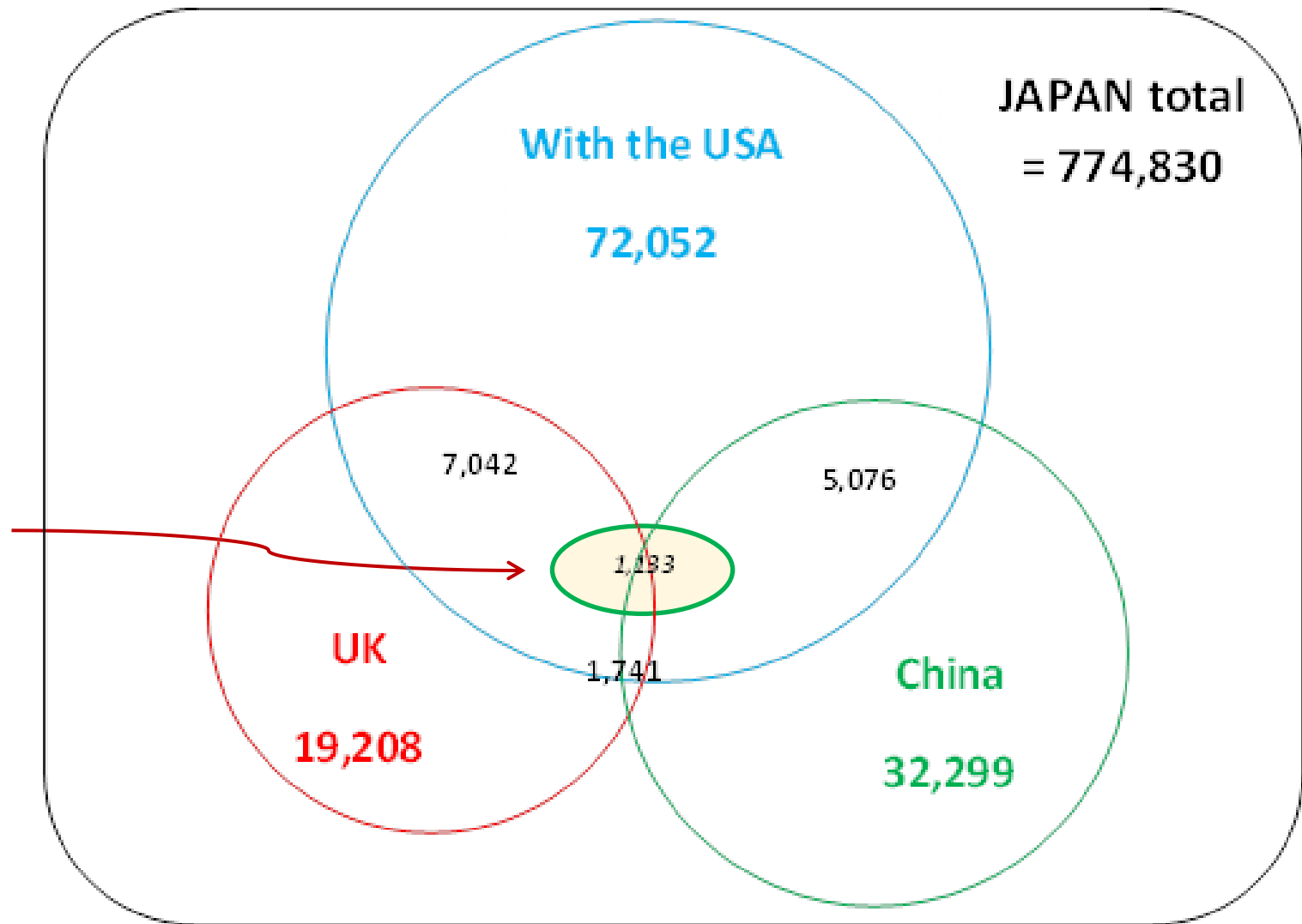
# Bilateral activity also predominates for Japan; multi-national papers are a very small part of total activity

Japan published  
774,830 papers on  
Thomson Reuters  
*Web of Science* in  
2004-2013

25% of Japan's  
output is  
internationally co-  
authored, mostly  
bilaterally

Highly multilateral  
papers make up less  
than 0.25% of total  
output

2/3 of these papers  
have more than 15  
national addresses





# Japan's collaborative publication network is becoming more regional, less global

| 1991-2000   |         | 2001-2010 |             | Growth |
|-------------|---------|-----------|-------------|--------|
| JAPAN       | 593,019 | 765,430   | JAPAN       | 1.29   |
| USA         | 39,837  | 67,542    | USA         | 1.70   |
| Germany     | 8,542   | 24,505    | China →     | 4.33   |
| UK          | 7,841   | 17,391    | Germany     | 2.04   |
| China       | 5,660   | 16,104    | UK          | 2.05   |
| Canada      | 5,083   | 13,196    | South Korea | 3.72   |
| France      | 5,033   | 11,893    | France      | 2.36   |
| South Korea | 3,543   | 9,362     | Canada      | 1.84   |
| Russia      | 3,121   | 7,234     | Australia   |        |
| Italy       | 3,083   | 7,168     | Russia      | 2.30   |

# Strategic and management implications

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**Governments pay for research, universities host it, but individuals decide where the best opportunities appear**

**A fourth age of  
research  
organisation**

## Strategic national implications

- ♦ Research has shifted from the individual through institutional and national organisation to a fourth age of international co-authorship.
- ♦ The highest quality research is in the international network, not the home base.
- ♦ Most collaboration is bilateral. Multinational enterprise is important but it is not the driver for the individual.
- ♦ It will be difficult for nations to 'capture' the intellectual benefit.

**The very best  
research has  
escaped  
institutional and  
national boundaries**

## Institutional management implications

- ♦ Research progresses faster through collaboration.
- ♦ Connect to international research networks or risk being marginalised intellectually.
- ♦ Institutional alliances sound good but the right partnership for your biologists may not be the right partnership for your sociologists.
- ♦ You have limited capacity for partnerships. Be careful what you choose. Collaborate through your strengths. Know your own numbers and be able to assess others.

**Those not in the  
network will be left  
behind**

**Assess and choose  
partners with care**

# International research collaboration: the Fourth Age of Research

**Jonathan Adams**

**See also: Nature, 497, 557-560 (30 May 2013)**

# Implications of the Fourth Age for Higher Education Institutions

An **evidence-based International Strategy**, owned by managers, faculty, administration and students, including:

1. Creating **deep and sustainable international partnerships** with like-minded institutions (research, education and staff/student exchange)
2. Investing long-term and concentrating resource in **a small number of strategic global partnerships**
3. Creation of **significant and diverse international campuses**; highly international university communities of the best staff and students, irrespective of nationality



# Implications of the Fourth Age for Higher Education Institutions

4. Effective administration to **remove bureaucratic barriers** – both institutionally and governmentally
5. To **lobby for support with your local community** to ensure shared global aspirations for the locality
6. To **invest in world-class research and teaching facilities** in order to attract the best global talent and remain globally competitive



# Driving global *research* collaboration

- Modern academic dilemmas are complex, interconnected; intractable?
  - *How do we predict the effects of climate change?*
  - *How do we deal with food security in an urbanising world?*
- Research in the first three ages has led to incomplete answers to the grand challenges of the modern world.
- The fourth age approach to global problems can harness global expertise, across disciplines.
- So only by taking an global transdisciplinary approach can highly complex research questions be addressed.





# Driving global *research* collaboration

- So the Fourth Age of Research will be driven by international collaborations between elite research groups. To recap:
  1. Universities must encourage, facilitate and engender a culture of international research collaboration and break down internal barriers
  2. Universities should seek to cement 4th Age interactions with key strategic research partnerships built around common research areas
  3. Universities should form large interdisciplinary groups within and between universities as a pre-requisite to success
  4. Universities should establish a culture of internationalisation



# What is the University of Exeter doing?

- Over 400 live international partnerships covering a wide range of activities but concentrating resource into around 12 key strategic partnerships with like-minded institutions.
- Over 5,300 students from over 140 different countries (28% of population).
- Income from international fees over the last 5 years totalled £237 million. During the preceding five years it was £67m.
- Investing £680m in teaching and research facilities between 2009-2016.
- 200% increase in the number of students participating in outbound Study Abroad 2008-2014 (to 769 in 13/14).
- 216 Outward Mobility Academic Fellowships awarded in last 5 years (worth £636,000). 66 Visiting International Academic Fellowships (VIAFs) awarded in last five years (worth £154,000)
- Our international students contribute £88m a year to the Exeter economy, or 2.8% of GDP, supporting 2,900 jobs.



# Global trends

- **Research concentration:**
  - **Japan:** 'Super Global Universities' initiative
  - **China:** £7.2bn for achieving world-class status for 100 of its 3000 universities
  - **Germany:** £3.9bn to create 37 clusters of research excellence and 11 world-class universities by 2017
- **Expenditure on tertiary education as a percentage of GDP (2011)**
  - UK 1.2% (0.9% public; 0.3% private)
  - Japan 1.5% (0.5% public; 1.0% private)
  - OECD average 1.6% (1.1% public; 0.5% private)



# What can national governments do?

1. Public investment in higher education and R&D.
2. Concentration of research funding?
3. Promote international collaboration and internationalisation and create the right conditions for universities to truly internationalise.

*“Universities that do not engage in international collaborations risk disenfranchisement and countries that do not nurture research talent will lose out entirely”*

- Jonathan Adams, *Nature* (May 2013)



# Thank you for listening

## Questions and Answers

**Contact us:**

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